



AWS ParallelCluster User Guide (v3)

# AWS ParallelCluster



# **AWS ParallelCluster: AWS ParallelCluster User Guide (v3)**

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# What is AWS ParallelCluster

AWS ParallelCluster is an AWS supported open source cluster management tool that helps you to deploy and manage high performance computing (HPC) clusters in the AWS Cloud. It automatically sets up the required compute resources, scheduler, and shared filesystem. You can use AWS ParallelCluster with AWS Batch and Slurm schedulers.

With AWS ParallelCluster, you can quickly build and deploy proof of concept and production HPC compute environments. You can also build and deploy a high level workflow on top of AWS ParallelCluster, such as a genomics portal that automates an entire DNA sequencing workflow.

You can access AWS ParallelCluster by using the following methods:

- [AWS ParallelCluster command line interface \(CLI\)](#)
- [AWS ParallelCluster API](#)
- [AWS ParallelCluster UI](#) (added with release 3.5.0)
- [AWS ParallelCluster Python library API](#) (added with release 3.5.0)
- As an [AWS CloudFormation custom resource](#) (added with release 3.6.0)

## Pricing

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

# Setting up AWS ParallelCluster

## Topics

- [Setting up an AWS account](#)
- [Create a key pair](#)
- [Installing the AWS ParallelCluster command line interface \(CLI\)](#)
- [Steps to take after installation](#)
- [Installing the AWS ParallelCluster UI](#)
- [Getting started with AWS ParallelCluster](#)
- [Multiple user access to clusters](#)
- [Best practices](#)
- [Moving from AWS ParallelCluster 2.x to 3.x](#)
- [Supported Regions for AWS ParallelCluster](#)

## Setting up an AWS account

Set up an AWS account to use AWS ParallelCluster.

### Sign up for an AWS account

If you do not have an AWS account, complete the following steps to create one.

#### To sign up for an AWS account

1. Open <https://portal.aws.amazon.com/billing/signup>.
2. Follow the online instructions.

Part of the sign-up procedure involves receiving a phone call and entering a verification code on the phone keypad.

When you sign up for an AWS account, an *AWS account root user* is created. The root user has access to all AWS services and resources in the account. As a security best practice, assign administrative access to a user, and use only the root user to perform [tasks that require root user access](#).

AWS sends you a confirmation email after the sign-up process is complete. At any time, you can view your current account activity and manage your account by going to <https://aws.amazon.com/> and choosing **My Account**.

## Create a user with administrative access

After you sign up for an AWS account, secure your AWS account root user, enable AWS IAM Identity Center, and create an administrative user so that you don't use the root user for everyday tasks.

### Secure your AWS account root user

1. Sign in to the [AWS Management Console](#) as the account owner by choosing **Root user** and entering your AWS account email address. On the next page, enter your password.

For help signing in by using root user, see [Signing in as the root user](#) in the *AWS Sign-In User Guide*.

2. Turn on multi-factor authentication (MFA) for your root user.

For instructions, see [Enable a virtual MFA device for your AWS account root user \(console\)](#) in the *IAM User Guide*.

### Create a user with administrative access

1. Enable IAM Identity Center.

For instructions, see [Enabling AWS IAM Identity Center](#) in the *AWS IAM Identity Center User Guide*.

2. In IAM Identity Center, grant administrative access to a user.

For a tutorial about using the IAM Identity Center directory as your identity source, see [Configure user access with the default IAM Identity Center directory](#) in the *AWS IAM Identity Center User Guide*.

### Sign in as the user with administrative access

- To sign in with your IAM Identity Center user, use the sign-in URL that was sent to your email address when you created the IAM Identity Center user.

For help signing in using an IAM Identity Center user, see [Signing in to the AWS access portal](#) in the *AWS Sign-In User Guide*.

## Assign access to additional users

1. In IAM Identity Center, create a permission set that follows the best practice of applying least-privilege permissions.

For instructions, see [Create a permission set](#) in the *AWS IAM Identity Center User Guide*.

2. Assign users to a group, and then assign single sign-on access to the group.

For instructions, see [Add groups](#) in the *AWS IAM Identity Center User Guide*.

## Create a key pair

To deploy clusters, AWS ParallelCluster launches Amazon EC2 instances to create the cluster head node and compute nodes. To perform cluster tasks, such as running and monitoring jobs, or managing users, you must be able to access the cluster head node. To verify you can access the head node instance using SSH, you must use an Amazon EC2 key pair. To learn how to create a key pair, see [Create a key pair](#) in the *Amazon Elastic Compute Cloud User Guide* for Linux Instances.

## Installing the AWS ParallelCluster command line interface (CLI)

AWS ParallelCluster is distributed as a Python package and is installed using the Python pip package manager. For instructions on how to install Python packages, see [Installing packages](#) in the *Python Packaging User Guide*.

### Ways to install AWS ParallelCluster:

- [Install AWS ParallelCluster in a virtual environment \(recommended\)](#)
- [Installing AWS ParallelCluster in a non-virtual environment using pip](#)
- [Install AWS ParallelCluster as a standalone application](#)

You can find the version number of the most recent CLI on the [releases page on GitHub](#). In this guide, the command examples assume that you have installed a version of Python that is later than version 3.6. The pip command examples use the pip3 version.

## Manage both AWS ParallelCluster 2 and AWS ParallelCluster 3

For customers who use both AWS ParallelCluster 2 and AWS ParallelCluster 3 and want to manage the CLIs for both packages, we recommend that you install AWS ParallelCluster 2 and AWS ParallelCluster 3 in different [virtual environments](#). This ensures that you can continue using each version of AWS ParallelCluster and any associated cluster resources.

## Install AWS ParallelCluster in a virtual environment (recommended)

We recommend that you install AWS ParallelCluster in a virtual environment to avoid requirement version conflicts with other pip packages.

### Prerequisites

- AWS ParallelCluster requires Python 3.7 or later. If you don't already have it installed, [download a compatible version](#) for your platform at [python.org](#).

### To install AWS ParallelCluster in a virtual environment

1. If `virtualenv` isn't installed, install `virtualenv` using `pip3`. If `python3 -m virtualenv help` displays help information, go to step 2.

```
$ python3 -m pip install --upgrade pip
$ python3 -m pip install --user --upgrade virtualenv
```

Run `exit` to leave the current terminal window and open a new terminal window to pick up changes to the environment.

2. Create a virtual environment and name it.

```
$ python3 -m virtualenv ~/apc-ve
```

Alternatively, you can use the `-p` option to specify a specific version of Python.

```
$ python3 -m virtualenv -p $(which python3) ~/apc-ve
```

3. Activate your new virtual environment.

```
$ source ~/apc-ve/bin/activate
```

#### 4. Install AWS ParallelCluster into your virtual environment.

```
(apc-ve)~$ python3 -m pip install --upgrade "aws-parallelcluster"
```

#### 5. Install Node Version Manager and the latest Long-Term Support (LTS) Node.js version. AWS Cloud Development Kit (AWS CDK) (AWS CDK) requires Node.js for CloudFormation for template generation.

##### Note

If your Node.js installation isn't working on your platform, you can install an LTS version prior to the latest LTS version. For more information, see the [Node.js release schedule](#) and the [AWS CDK prerequisites](#).

Example Node.js installation command:

```
$ nvm install --lts=Hydrogen
```

```
$ curl -o- https://raw.githubusercontent.com/nvm-sh/nvm/v0.38.0/install.sh | bash
$ chmod ug+x ~/.nvm/nvm.sh
$ source ~/.nvm/nvm.sh
$ nvm install --lts
$ node --version
```

#### 6. Verify that AWS ParallelCluster is installed correctly.

```
$ pcluster version
{
  "version": "3.7.0"
}
```

You can use the `deactivate` command to exit the virtual environment. Each time you start a session, you must [reactivate the environment](#).

To upgrade to the latest version of AWS ParallelCluster, run the installation command again.

```
(apc-ve)~$ python3 -m pip install --upgrade "aws-parallelcluster"
```

# Installing AWS ParallelCluster in a non-virtual environment using pip

## Prerequisites

- AWS ParallelCluster requires Python 3.7 or later. If you don't already have it installed, [download a compatible version](#) for your platform at [python.org](#).

## Install AWS ParallelCluster

1. Use pip to install AWS ParallelCluster.

```
$ python3 -m pip install "aws-parallelcluster" --upgrade --user
```

When you use the `--user` switch, pip installs AWS ParallelCluster to `~/.local/bin`.

2. Install Node Version Manager and the latest Long-Term Support (LTS) Node.js version. AWS Cloud Development Kit (AWS CDK) (AWS CDK) requires Node.js for CloudFormation for template generation.

### Note

If your Node.js installation isn't working on your platform, you can install an LTS version prior to the latest LTS version. For more information, see the [Node.js release schedule](#) and the [AWS CDK prerequisites](#).

```
$ nvm install --lts=Gallium
```

```
$ curl -o- https://raw.githubusercontent.com/nvm-sh/nvm/v0.38.0/install.sh | bash
$ chmod ug+x ~/.nvm/nvm.sh
$ source ~/.nvm/nvm.sh
$ nvm install --lts
$ node --version
```

3. Verify that AWS ParallelCluster installed correctly.

```
$ pcluster version
{
  "version": "3.7.0"
```



```
}
```

4. To upgrade to the latest version, run the installation command again.

```
$ python3 -m pip install "aws-parallelcluster" --upgrade --user
```

## Install AWS ParallelCluster as a standalone application

Install AWS ParallelCluster as a standalone application on your environment. Follow the instructions for installing AWS ParallelCluster on an available OS in the following section.

### Prerequisites

- An environment with an operating system compatible with an available version of the installer.

#### Note

AWS ParallelCluster requires NodeJS. AWS ParallelCluster Installer includes a bundled version of NodeJS (v18), which is installed if it does not already exist. If your system is not compatible with NodeJS v18, you should install NodeJS before installing AWS ParallelCluster.

### Linux

Linux x86 (64-bit)

#### Install AWS ParallelCluster on your environment.

1. Download the latest [pcluster installer](#).
2. Unzip the installer bundle and install AWS ParallelCluster by using the following commands:

```
$ unzip pcluster-installer-bundle-3.10.0.701-node-v18.20.3-Linux_x86_64-signed.zip  
-d pcluster-installer-bundle  
$ cd pcluster-installer-bundle  
$ chmod +x install_pcluster.sh
```

3. Run the following install script.

```
$ bash install_pcluster.sh
```

4. Verify that AWS ParallelCluster is installed correctly.

```
$ pcluster version
{
  "version": "3.10.0"
}
```

### Troubleshooting pcluster installation errors

- If the AWS ParallelCluster version isn't returned in step 4, restart the terminal or source the `bash_profile` to update the `PATH` variable to include the new binary directory as shown in the following example:

```
$ source ~/.bash_profile
```

- If you use your `pcluster` installation to create clusters with `CustomActions` specified as `HTTPS` resources, rather than `S3 URIs`, you might see a `WARNING` message indicating that these resources might not be verified (`[SSL: CERTIFICATE_VERIFY_FAILED]`). This is caused by a known issue and you can ignore this warning if you trust the authenticity of the specified resources.

### Previous installer bundle versions

- None

## Steps to take after installation

You can verify that AWS ParallelCluster installed correctly by running [pcluster version](#).

```
$ pcluster version
{
  "version": "3.7.0"
}
```

AWS ParallelCluster is updated regularly. To update to the latest version of AWS ParallelCluster, run the installation command again. For more information about the latest version of AWS ParallelCluster, see the [AWS ParallelCluster release notes](#).

```
$ pip3 install aws-parallelcluster --upgrade --user
```

To uninstall AWS ParallelCluster, use `pip3 uninstall`.

```
$ pip3 uninstall aws-parallelcluster
```

If you don't have Python and `pip3`, use the procedure for your environment.

## Installing the AWS ParallelCluster UI

The AWS ParallelCluster UI is a web-based user interface that mirrors the AWS ParallelCluster `pccluster` CLI, while providing a console-like experience. You install and access the AWS ParallelCluster UI in your AWS account. When you run it, the AWS ParallelCluster UI accesses an instance of the AWS ParallelCluster API hosted on Amazon API Gateway in your AWS account. For more information about the AWS ParallelCluster UI, see [AWS ParallelCluster UI](#).

### Prerequisites:

- An AWS account
- Access to the AWS Management Console

### Topics

- [Install the AWS ParallelCluster UI](#)
- [Create a custom domain](#)
- [Amazon Cognito user pool options](#)
- [Identify the AWS ParallelCluster and AWS ParallelCluster UI version](#)
- [Update the AWS ParallelCluster UI to a new AWS ParallelCluster version](#)
- [AWS ParallelCluster UI costs](#)

## Install the AWS ParallelCluster UI

To install an instance of the AWS ParallelCluster UI, you choose an AWS CloudFormation quick-create link for the AWS Region that you create clusters in. The quick-create URL takes you to a **Create Stack Wizard** where you provide quick-create stack template inputs and deploy the stack. For more information about CloudFormation quick-create stacks, see [Creating quick-create links for stacks](#) in the *AWS CloudFormation User Guide*.

### Note

You can only create and edit clusters or build images with the same AWS ParallelCluster version that you use to install the AWS ParallelCluster UI.

## AWS ParallelCluster UI quick-create links by Region

### UI quick-create links

[us-east-1](#)

[us-east-2](#)

[us-west-1](#)

[us-west-2](#)

[eu-west-1](#)

[eu-west-2](#)

[eu-west-3](#)

[eu-central-1](#)

[eu-north-1](#)

[me-south-1](#)

[sa-east-1](#)

## UI quick-create links

[ca-central-1](#)

[ap-northeast-1](#)

[ap-northeast-2](#)

[ap-south-1](#)

[ap-southeast-1](#)

[ap-southeast-2](#)

[us-gov-west-1](#)

**Use an AWS CloudFormation quick-create link to deploy an AWS ParallelCluster UI stack with nested Amazon Cognito, API Gateway, and Amazon EC2 Systems Manager stacks.**

1. Sign in to the AWS Management Console.
2. Deploy the AWS ParallelCluster UI by choosing an AWS Region quick-create link from the table at the start of this section. This takes you to the CloudFormation **Create Stack Wizard** in the console.
3. Enter a valid email address for **Admin's Email**.

After deployment completes successfully, the AWS ParallelCluster UI sends you a temporary password to this email address. You use the temporary password to access the AWS ParallelCluster UI. If you delete the email before you save or use the temporary password, you must delete the stack and reinstall the AWS ParallelCluster UI.

4. Keep the rest of the form blank or enter values for (optional) parameters to customize the AWS ParallelCluster UI build.
5. Note the stack name for use in later steps.
6. Navigate to **Capabilities**. Agree to the CloudFormation capabilities.
7. Choose **Create**. It takes about 15 minutes to complete the AWS ParallelCluster API and AWS ParallelCluster UI deployment.
8. View the stack details as the stack is created.

9. After the deployment completes, open the admin email that was sent to the address you entered. It contains a temporary password that you use to access the AWS ParallelCluster UI. If you permanently delete the email and you haven't yet logged in to the AWS ParallelCluster UI, you must delete the AWS ParallelCluster UI stack you created and reinstall the AWS ParallelCluster UI.
10. In the AWS CloudFormation console list of stacks, choose the link to the stack name that you noted in a previous step.
11. In **Stack details**, choose **Outputs** and select the link for the key named ***Stackname*URL** to open the AWS ParallelCluster UI. ***Stackname*** is the name that you noted in a previous step.
12. Enter the temporary password. Follow the steps to create your own password and log in.
13. You are now on the home page of the AWS ParallelCluster UI in the AWS Region that you selected.
14. To get started using the AWS ParallelCluster UI, see [Configure and create a cluster with the AWS ParallelCluster UI](#).

#### Note

PCUI sessions have a default duration of 5 minutes, which is the minimum value provided by Cognito as of PCUI 2023.12.0. Hence, it is expected that a user removed from Cognito User Pools is still able to access the system until the session expires.

## Create a custom domain

Learn how to create a custom domain for the AWS ParallelCluster UI. The UI is hosted on Amazon API Gateway in your AWS account. You can create a custom domain in the API Gateway console.

### Prerequisites:

- You have an AWS account.
- You have an AWS ParallelCluster UI instance that you can access.
- You own a domain.
- You can change basic Domain Name System (DNS) settings.

## Step 1: Create a new domain in the Amazon API Gateway

1. In the AWS Management Console, navigate to [API Gateway](#) where you can see your AWS ParallelCluster UI API listed.
2. In the navigation pane, choose **Custom domain names**.
3. Choose **Create**.
4. In **Domain details**, enter your domain name.
5. In **Endpoint configuration**, choose an existing ACM certificate, or choose **Create a new ACM Certificate**.

### (Optional) Create a certificate

- a. In the ACM console, choose **Request**.
- b. In **Domain names**, enter your domain name.
- c. In **Validation method**, choose a validation method.

If you choose **Email validation**, an email is sent to the email address that is on file with the domain registrar.

- d. Select **I approve** to activate the certificate.

## Step 2: Set up API mappings

1. In [API Gateway](#), **Custom domain names, your-domain-name**, choose **Configure API mappings**.
2. Choose **Custom domain names**.
3. Choose **Add new mapping**.
4. Choose the AWS ParallelCluster UI **API**, the \$default **Stage**, and **Save**.
5. In **API Gateway domain name**, copy the value for use in the next steps.

## Step 3: Set up DNS

- Create a DNS CNAME rule that points your domain to the API Gateway domain. Enter only the domain. For example, don't add the stage, such as beta or prod. Replace *abcde12345* with your API Gateway API ID, and replace *us-east-2* with the API AWS Region.

Rule	Source	Destination
CNAME	<i>example.com</i>	d- <i>abcde12345</i> .execute- api. <i>us-east-2</i> .amazonaw s.com

## Step 4: Add the domain to your Amazon Cognito user pool

1. Navigate to the [Amazon Cognito console](#).
2. Select your user pool link.
3. Choose **App integration**.
4. In **Domain**, choose **Actions, Create custom domain**.
5. Enter your **Custom domain** and select your **ACM certificate**.
6. Choose **Create custom domain**.

## Step 5: Configure the API Gateway callback URL

1. Navigate to the [Amazon Cognito console](#).
2. In your Amazon Cognito user pool **App integration, App clients and analytics**, select the application link.
3. In **Hosted UI**, choose **Edit**.
4. In **Allowed callback URLs**, choose **Add another URL** and enter a callback URL such as `example.com/login`.

## Step 6: Configure the Lambda function

1. Navigate to the [Lambda console](#).
2. In the navigation pane, choose **Functions**.
3. Filter the list of functions to find the `ParallelClusterUIFunction` and select the link.
4. Choose **Configuration, Environment variables**.
5. Choose **Edit**.
6. For the `SITE_URL` value, enter your custom domain.



7. Navigate to your domain, such as `example.com`, and authenticate to connect to the AWS ParallelCluster UI.

## Amazon Cognito user pool options

The following sections refer to CloudFormation quick-create links or quick-create URLs. The quick-create URL takes you to a **Create Stack Wizard** where you provide quick-create stack template inputs and deploy the stack. For more information about CloudFormation quick-create stacks, see [Creating quick-create links for stacks](#) in the *AWS CloudFormation User Guide*.

To maintain an Amazon Cognito user pool that you can use with multiple AWS ParallelCluster UI instances, consider the following options:

- Use an existing AWS ParallelCluster UI instance that links to an Amazon Cognito user pool created from a nested CloudFormation stack. This is what is created when you deploy the AWS ParallelCluster UI by using the quick-create link and you keep all Amazon Cognito parameters blank.
- Use a standalone Amazon Cognito user pool that's deployed before the AWS ParallelCluster UI is deployed. Then, deploy a new AWS ParallelCluster UI instance that's linked to the standalone Amazon Cognito user pool that you have already deployed. This way, you separate the Amazon Cognito deployment from the AWS ParallelCluster UI deployment. Furthermore, non-nested AWS ParallelCluster UI CloudFormation stacks are easier to update.

### Use an existing Amazon Cognito user pool with a new AWS ParallelCluster UI instance

1. In the **CloudFormation console**, select the AWS ParallelCluster UI stack that contains the Amazon Cognito user pool that you want to use with multiple AWS ParallelCluster UI instances.
2. Navigate to the nested stack that created the Amazon Cognito userpool.
3. Select the **Outputs** tab.
4. Copy the values of the following parameters:
  - `UserPoolId`
  - `UserPoolAuthDomain`
  - `SNSRole`

5. Deploy a new AWS ParallelCluster UI instance by using the quick-create link, and fill in all External AWS ParallelCluster UI Amazon Cognito parameters with the outputs that you copied. This prevents the new AWS ParallelCluster UI stack from creating a new pool and links it to the existing Amazon Cognito user pool that was created from a nested stack. You can deploy subsequent new AWS ParallelCluster UI instances that have the same parameter values, and you can link them to the Amazon Cognito user pool.

## Create a standalone Amazon Cognito userpool

### AWS ParallelCluster UI Amazon Cognito quick-create links by Region

#### UI Amazon Cognito quick-create links

[us-east-1](#)

[us-east-2](#)

[us-west-1](#)

[us-west-2](#)

[eu-west-1](#)

[eu-west-2](#)

[eu-west-3](#)

[eu-central-1](#)

[eu-north-1](#)

[me-south-1](#)

[sa-east-1](#)

[ca-central-1](#)

[ap-northeast-1](#)

[ap-northeast-2](#)

## UI Amazon Cognito quick-create links

[ap-south-1](#)

[ap-southeast-1](#)

[ap-southeast-2](#)

[us-gov-west-1](#)

1. Launch an Amazon Cognito-only stack by choosing a quick-create link labeled with same AWS Region in which you deploy your AWS ParallelCluster UI instances. See the quick-create links at the beginning of this section.
2. After stack creation completes, select the **Outputs** tab and copy the values of the following parameters:
  - `UserPoolId`
  - `UserPoolAuthDomain`
  - `SNSRole`
3. Deploy a new AWS ParallelCluster UI instance by choosing an AWS ParallelCluster UI quick-start link and filling in all External AWS ParallelCluster UI Amazon Cognito parameters with the values that you copied. The new AWS ParallelCluster UI instance links to the standalone Amazon Cognito user pool and doesn't create a nested stack or a new user pool. You can deploy subsequent new AWS ParallelCluster UI instances that have the same parameter values, and you can link them to the standalone Amazon Cognito user pool.

## Identify the AWS ParallelCluster and AWS ParallelCluster UI version

1. In the CloudFormation console, select an AWS ParallelCluster UI stack.
2. Select the **Parameters** tab.
3. The AWS ParallelCluster version is the value of the parameter **Version**.
4. The AWS ParallelCluster UI version is at the end of the **PublicEcrImageUri** value. For example, if the value is `public.ecr.aws/pcui/parallelcluster-ui-awslambda:2023.02`, then the version is `2023.02`.

## Update the AWS ParallelCluster UI to a new AWS ParallelCluster version

To update the AWS ParallelCluster UI to the latest AWS ParallelCluster version, launch a new stack by choosing a [quick-create link](#).

### AWS ParallelCluster UI costs

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. The following table lists the AWS services that the AWS ParallelCluster UI depends on and their free-tier limits. Typical usage is estimated to cost less than one dollar each month.

Service	AWS Free Tier
Amazon Cognito	50,000 monthly active users
Amazon API Gateway	1 million rest API calls
AWS Lambda	1 million free requests each month and 400,000 GB-seconds of compute time each month
EC2 Image Builder	No cost, except EC2
Amazon Elastic Compute Cloud	15-minute one-time container image build
AWS CloudFormation	5 GB data (ingestion, archive storage, and data scanned by Logs Insights queries)

## Getting started with AWS ParallelCluster

Get started by configuring and creating a cluster by using the AWS ParallelCluster command line interface (CLI) or web-based user interface (UI). The AWS ParallelCluster UI was added in release 3.5.0.

### Topics

- [Configure and create a cluster with the AWS ParallelCluster command line interface](#)
- [Configure and create a cluster with the AWS ParallelCluster UI](#)

- [Connect to a cluster](#)

## Configure and create a cluster with the AWS ParallelCluster command line interface

After you install AWS ParallelCluster, complete the following configuration steps.

Verify that your AWS Account has a role that includes the permissions needed to run the `pcluster` CLI. For more information, see [AWS ParallelCluster example `pcluster` user policies](#).

Set up your AWS credentials. For more information, see [Configuring the AWS CLI](#) in the *AWS CLI user guide*.

```
$ aws configure
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxrFiCYEXAMPLEKEY
Default region name [us-east-1]: us-east-1
Default output format [None]:
```

The AWS Region where the cluster is launched must have at least one Amazon EC2 key pair. For more information, see [Amazon Elastic Compute Cloud key pairs](#) in the *Amazon Elastic Compute Cloud User Guide for Linux Instances*.

When using the AWS ParallelCluster command line interface (CLI), you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

### Configure and create your first cluster

Create your first cluster by using the `pcluster configure` CLI command to initiate a wizard that prompts you for all of the information that's required to configure and create your cluster. The details of the sequence differ when using AWS Batch as the scheduler compared to using Slurm.

Slurm

```
$ pcluster configure --config config-file.yaml
```

From the list of valid AWS Region identifiers, choose the AWS Region where you want your cluster to run.

**Note**

The list of AWS Regions shown is based on the partition of your account, and only includes AWS Regions that are enabled for your account. For more information about enabling AWS Regions for your account, see [Managing AWS Regions](#) in the *AWS General Reference*. The example shown is from the AWS Global partition. If your account is in the AWS GovCloud (US) partition, only AWS Regions in that partition are listed (gov-us-east-1 and gov-us-west-1). Similarly, if your account is in the AWS China partition, only cn-north-1 and cn-northwest-1 are shown. For the complete list of AWS Regions supported by AWS ParallelCluster, see [Supported Regions for AWS ParallelCluster](#).

Allowed values for AWS Region ID:

1. af-south-1
2. ap-east-1
3. ap-northeast-1
4. ap-northeast-2
5. ap-south-1
6. ap-southeast-1
7. ap-southeast-2
8. ca-central-1
9. eu-central-1
10. eu-north-1
11. eu-south-1
12. eu-west-1
13. eu-west-2
14. eu-west-3
15. me-south-1
16. sa-east-1
17. us-east-1
18. us-east-2
19. us-west-1
20. us-west-2

AWS Region ID [ap-northeast-1]:

The key pair is selected from the key pairs that are registered with Amazon Elastic Compute Cloud in the selected AWS Region. Choose the key pair:

Allowed values for Amazon EC2 Key Pair Name:

```
1. your-key-1
2. your-key-2
Amazon EC2 Key Pair Name [your-key-1]:
```

Choose the scheduler to use with your cluster.

```
Allowed values for Scheduler:
1. slurm
2. awsbatch
Scheduler [slurm]:
```

Choose the operating system.

```
Allowed values for Operating System:
1. alinux2
2. centos7
3. ubuntu2204
4. ubuntu2004
5. rhel8
Operating System [alinux2]:
```

Choose head node instance type:

```
Head node instance type [t2.micro]:
```

Choose the queue configuration. Note: Instance type can't be specified for multiple compute resources in the same queue.

```
Number of queues [1]:
Name of queue 1 [queue1]:
Number of compute resources for queue1 [1]: 2
Compute instance type for compute resource 1 in queue1 [t2.micro]:
Maximum instance count [10]:
```

Enable EFA to run applications that require high levels of inter-instance communication at scale on AWS at no additional charge:

- Choose an instance type that [supports Elastic Fabric Adapter \(EFA\)](#).
- Enable [EFA](#).

- Specify an existing [Placement Group](#) name. If you leave it blank, AWS ParallelCluster creates one for you.

```
Compute instance type for compute resource 2 in queue1 [t2.micro]: c5n.18xlarge
Enable EFA on c5n.18xlarge (y/n) [y]: y
Maximum instance count [10]:
Placement Group name []:
```

After the previous steps are completed, decide whether to use an existing VPC or let AWS ParallelCluster create a VPC for you. If you don't have a properly configured VPC, AWS ParallelCluster can create a new one for you. It either places both the head and compute nodes in the same public subnet, or only the head node in a public subnet with all compute nodes in a private subnet. If you let AWS ParallelCluster create a VPC, you must decide if all nodes are to be in a public subnet. For more information, see [Network configurations](#).

If you configure your cluster to use instance types that have multiple network interfaces or a network card, see [Network configurations](#) for additional networking requirements.

It's possible to reach your quota for the number of VPCs allowed in a AWS Region. The default quota is five VPCs for a AWS Region. For more information about this quota and how to request an increase, see [VPC and subnets](#) in the *Amazon VPC User Guide*.

### Important

VPCs created by AWS ParallelCluster do not enable VPC Flow Logs by default. VPC Flow Logs enable you to capture information about the IP traffic going to and from network interfaces in your VPCs. For more information, see [VPC Flow Logs](#) in the *Amazon VPC User Guide*.

If you let AWS ParallelCluster create a VPC, make sure that you decide whether all nodes are to be in a public subnet.

### Note

If you choose 1. Head node in a public subnet and compute fleet in a private subnet, AWS ParallelCluster creates a NAT gateway that results in additional cost, even if you specify free tier resources.



```

Automate VPC creation? (y/n) [n]: y
Allowed values for Availability Zone:
1. us-east-1a
2. us-east-1b
3. us-east-1c
4. us-east-1d
5. us-east-1e
6. us-east-1f
Availability Zone [us-east-1a]:
Allowed values for Network Configuration:
1. Head node in a public subnet and compute fleet in a private subnet
2. Head node and compute fleet in the same public subnet
Network Configuration [Head node in a public subnet and compute fleet in a private
subnet]: 1
Beginning VPC creation. Please do not leave the terminal until the creation is
finalized

```

If you don't create a new VPC, you must select an existing VPC.

If you choose to have AWS ParallelCluster create the VPC, make a note of the VPC ID so you can use the AWS CLI to delete it later.

```

Automate VPC creation? (y/n) [n]: n
Allowed values for VPC ID:
# id name number_of_subnets
---
1 vpc-0b4ad9c4678d3c7ad ParallelClusterVPC-20200118031893 2
2 vpc-0e87c753286f37eef ParallelClusterVPC-20191118233938 5
VPC ID [vpc-0b4ad9c4678d3c7ad]: 1

```

After the VPC has been selected, decide whether to use existing subnets or create new ones.

```
Automate Subnet creation? (y/n) [y]: y
```

```


Creating CloudFormation stack...
Do not leave the terminal until the process has finished

```

## AWS Batch

```
$ pcluster configure --config config-file.yaml
```

From the list of valid AWS Region identifiers, choose the AWS Region where you want your cluster to run.

 **Note**

The list of AWS Regions shown is based on the partition of your account. It only includes AWS Regions that are enabled for your account. For more information about enabling AWS Regions for your account, see [Managing AWS Regions](#) in the *AWS General Reference*. The example shown is from the AWS Global partition. If your account is in the AWS GovCloud (US) partition, only AWS Regions in that partition are listed (gov-us-east-1 and gov-us-west-1). Similarly, if your account is in the AWS China partition, only cn-north-1 and cn-northwest-1 are shown. For the complete list of AWS Regions supported by AWS ParallelCluster, see [Supported Regions for AWS ParallelCluster](#).

Allowed values for AWS Region ID:

1. af-south-1
2. ap-east-1
3. ap-northeast-1
4. ap-northeast-2
5. ap-south-1
6. ap-southeast-1
7. ap-southeast-2
8. ca-central-1
9. eu-central-1
10. eu-north-1
11. eu-south-1
12. eu-west-1
13. eu-west-2
14. eu-west-3
15. me-south-1
16. sa-east-1
17. us-east-1
18. us-east-2
19. us-west-1
20. us-west-2

AWS Region ID [us-east-1]:

The key pair is selected from the key pairs registered with Amazon EC2 in the selected AWS Region. Choose the key pair:

Allowed values for Amazon EC2 Key Pair Name:

1. your-key-1
2. your-key-2

Amazon EC2 Key Pair Name [your-key-1]:

Choose the scheduler to use with your cluster.

Allowed values for Scheduler:

1. slurm
2. awsbatch

Scheduler [slurm]: 2

When awsbatch is selected as the scheduler, alinux2 is used as the operating system. The head node instance type is entered:

Head node instance type [t2.micro]:

Choose the queue configuration. The AWS Batch scheduler only contains a single queue. The maximum size of the cluster of compute nodes is entered. This is measured in vCPUs.

Number of queues [1]:

Name of queue 1 [queue1]:

Maximum vCPU [10]:

Decide whether to use existing VPCs or let AWS ParallelCluster create VPCs for you. If you don't have a properly configured VPC, AWS ParallelCluster can create a new one. It either uses both the head and compute nodes in the same public subnet, or only the head node in a public subnet with all nodes in a private subnet. It's possible to reach your quota on the number of VPCs allowed in a Region. The default number of VPCs is five. For more information about this quota and how to request an increase, see [VPC and subnets](#) in the *Amazon VPC User Guide*.

### Important

VPCs created by AWS ParallelCluster do not enable VPC Flow Logs by default. VPC Flow Logs enable you to capture information about the IP traffic going to and from network

interfaces in your VPCs. For more information, see [VPC Flow Logs](#) in the *Amazon VPC User Guide*.

If you let AWS ParallelCluster create a VPC, make sure that you decide whether all nodes are to be in a public subnet.

### Note

If you choose 1. Head node in a public subnet and compute fleet in a private subnet, AWS ParallelCluster creates a NAT gateway that results in additional cost, even if you specify free tier resources.

```
Automate VPC creation? (y/n) [n]: y
Allowed values for Availability Zone:
1. us-east-1a
2. us-east-1b
3. us-east-1c
4. us-east-1d
5. us-east-1e
6. us-east-1f
Availability Zone [us-east-1a]:
Allowed values for Network Configuration:
1. Head node in a public subnet and compute fleet in a private subnet
2. Head node and compute fleet in the same public subnet
Network Configuration [Head node in a public subnet and compute fleet in a private
subnet]: *1*
Beginning VPC creation. Please do not leave the terminal until the creation is
finalized
```

If you don't create a new VPC, you must select an existing VPC.

If you choose to have AWS ParallelCluster create the VPC, make a note of the VPC ID so you can use the AWS CLI or AWS Management Console to delete it later.

```
Automate VPC creation? (y/n) [n]: n
Allowed values for VPC ID:
# id name number_of_subnets
---
1 vpc-0b4ad9c4678d3c7ad ParallelClusterVPC-20200118031893 2
```

```
2 vpc-0e87c753286f37eef ParallelClusterVPC-20191118233938
VPC ID [vpc-0b4ad9c4678d3c7ad]: 1
```

5

After the VPC has been selected, make sure that you decide whether to use existing subnets or create new ones.

```
Automate Subnet creation? (y/n) [y]: y
```

```
Creating CloudFormation stack...
Do not leave the terminal until the process has finished
```

When you have completed the preceding steps, a simple cluster launches into a VPC. The VPC uses an existing subnet that supports public IP addresses. The route table for the subnet is `0.0.0.0/0 => igw-xxxxxx`. Note the following conditions:

- The VPC must have DNS Resolution = yes and DNS Hostnames = yes.
- The VPC must also have DHCP options with the correct domain-name for the AWS Region. The default DHCP Option Set already specifies the required AmazonProvidedDNS. If specifying more than one domain name server, see [DHCP options sets](#) in the *Amazon VPC User Guide*. When using private subnets, use a NAT gateway or an internal proxy to enable web access for compute nodes. For more information, see [Network configurations](#).

When all settings contain valid values, you can launch the cluster by running the create command.

```
$ pcluster create-cluster --cluster-name test-cluster --cluster-configuration cluster-
config.yaml
{
  "cluster": {
    "clusterName": "test-cluster",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:xxx:stack/test-cluster/
abcdef0-f678-890a-5abc-021345abcdef",
    "region": "eu-west-1",
    "version": "3.7.0",
    "clusterStatus": "CREATE_IN_PROGRESS"
  },
  "validationMessages": []
}
```

Follow cluster progress:

```
$ pcluster describe-cluster --cluster-name test-cluster
```

or

```
$ pcluster list-clusters --query 'clusters[?clusterName==`test-cluster`]'
```

After the cluster reaches the "clusterStatus": "CREATE\_COMPLETE" status, you can connect to it by using your normal SSH client settings. For more information about connecting to Amazon EC2 instances, see the [Amazon EC2 User Guide](#) in the *Amazon EC2 User Guide*. Or you can connect the cluster through

```
$ pcluster ssh --cluster-name test-cluster -i ~/path/to/keyfile.pem
```

To delete the cluster, run the following command.

```
$ pcluster delete-cluster --region us-east-1 --cluster-name test-cluster
```

After the cluster is deleted, you can delete the network resources in the VPC by deleting the CloudFormation networking stack. The stack's name starts with "parallelclusternetworking-" and contains the creation time in "YYYYMMDDHHMMSS" format. You can list the stacks using the [list-stacks](#) command.

```
$ aws --region us-east-1 cloudformation list-stacks \  
  --stack-status-filter "CREATE_COMPLETE" \  
  --query "StackSummaries[].StackName" | \  
  grep -e "parallelclusternetworking-" \  
  "parallelclusternetworking-pubpriv-20191029205804"
```

The stack can be deleted using the [delete-stack](#) command.

```
$ aws --region us-east-1 cloudformation delete-stack \  
  --stack-name parallelclusternetworking-pubpriv-20191029205804
```

The VPC that [pcluster configure](#) creates for you *isn't* created in the CloudFormation networking stack. You can delete that VPC manually in the console or by using the AWS CLI.

```
$ aws --region us-east-1 Amazon EC2 delete-vpc --vpc-id vpc-0b4ad9c4678d3c7ad
```

## Configure and create a cluster with the AWS ParallelCluster UI

The AWS ParallelCluster UI is a web-based user interface that mirrors the AWS ParallelCluster `pccluster` CLI, while providing a console-like experience. You install and access the AWS ParallelCluster UI in your AWS account. When you run it, the AWS ParallelCluster UI accesses an instance of the AWS ParallelCluster API hosted on Amazon API Gateway in your AWS account.

### Note

The AWS ParallelCluster UI wizard may not have UI options for all the supported features in the latest supported AWS ParallelCluster version. You can manually edit the configuration file as needed or use the AWS ParallelCluster CLI.

In this section, we guide you through configuring and creating a cluster by using the AWS ParallelCluster UI.

### Prerequisites:

- Access to a running instance of AWS ParallelCluster UI. For more information, see [Installing the AWS ParallelCluster UI](#).

### Configure and create a cluster

1. In the AWS ParallelCluster UI **Clusters** view, choose **Create cluster, Step by step**.
2. In **Cluster, Name**, enter a name for your cluster.
3. Choose a **VPC** with a public subnet for your cluster, and choose **Next**.
4. In **Head node**, choose **Add SSM session**, and choose **Next**.
5. In **Queues, Compute resources**, choose **1** for **Static nodes**.
6. For **Instance type**, remove the selected default instance type, choose **t2.micro**, and choose **Next**.
7. In **Storage**, choose **Next**.
8. In **Cluster configuration**, review the cluster configuration YAML and choose **Dry run** to validate it.
9. Choose **Create** to create your cluster, based on the validated configuration.

10. After a few seconds, the AWS ParallelCluster UI automatically navigates you back to **Clusters**, where you can monitor the cluster create status and **Stack events**.
11. Choose **Details** to see cluster details, such as the version and status.
12. Choose **Instances** to see the list of Amazon EC2 instances and status.
13. Choose **Stack events** to view cluster stack events, and a AWS Management Console link to the CloudFormation stack that creates the cluster.
14. In **Details**, after cluster creation completes, choose **View YAML** to view or download the cluster configuration YAML file.
15. After cluster creation completes, choose **Shell** to access the cluster head node.

### Note

When you choose **Shell**, AWS ParallelCluster opens an Amazon EC2 Systems Manager session and adds an `ssm-user` to `/etc/sudoers`. For more information, see [Turn on or turn off ssm-user account administrative permissions](#) in the *Amazon EC2 Systems Manager User Guide*.

16. To clean up, in the **Clusters** view, select the cluster, and choose **Actions, Delete cluster**.

## Connect to a cluster

When using AWS ParallelCluster, you can connect to the cluster head node to run jobs, view results, manage users, and monitor the cluster and job status. Connect to the cluster head node instance by using the following methods:

- Log in by using `ssh` with a [key pair](#). Specify the private key in [HeadNode / KeyName](#) in the cluster configuration. For more information, see [Connect to your Linux instance using SSH](#) in the *Amazon EC2 User Guide for Linux Instances*.
- Log in by using the `pcluster ssh` command line interface (CLI) command. Specify the private key in the cluster configuration [HeadNode / KeyName](#). For more information, see [pcluster ssh](#).
- Connect to the cluster head node by using an SSM session. You must add the `AmazonSSMManagedInstanceCore` managed policy to [HeadNode / AdditionalIamPolicies](#) in the cluster configuration to connect by using an SSM session. For more information, see [SSM session manager](#) in the *SSM User Guide*.



- Connect to the cluster head node by using NICE DCV. For more information, see [Connect to the head node through NICE DCV](#).
- When you use the AWS ParallelCluster UI, you can also connect to the cluster head node by using an Amazon EC2 Connect command that the UI provides.

## Multiple user access to clusters

Learn to implement and manage multiple user access to a single cluster.

In this topic, an AWS ParallelCluster user refers to a system user for compute instances. An example is an `ec2-user` for an Amazon EC2 instance.

AWS ParallelCluster multi-user access support is available in all the AWS Regions where AWS ParallelCluster is currently available. It works with other AWS services, including [Amazon FSx for Lustre](#) and [Amazon Elastic File System](#).

You can use an [AWS Directory Service for Microsoft Active Directory](#) or [Simple AD](#) to manage cluster access. Make sure to check [AWS Region availability](#) for these services. To set up a cluster, specify an [AWS ParallelCluster DirectoryService](#) configuration. AWS Directory Service directories can be connected to multiple clusters. This allows for centralized management of identities across multiple environments and a unified login experience.

When you use AWS Directory Service for AWS ParallelCluster multiple user access, you can log in to the cluster with user credentials that are defined in the directory. These credentials consist of a user name and password. After you log in to the cluster for the first time, a user SSH key is automatically generated. You can use it to log in without a password.

You can create, delete, and modify a cluster's users or groups after your directory service is deployed. With AWS Directory Service, you can do this in the AWS Management Console or by using the *Active Directory Users and Computers* tool. This tool is accessible from any Amazon EC2 instance that's joined to your Active Directory. For more information, see [Installing the Active Directory administration tools](#).

If you plan to use AWS ParallelCluster in a single subnet with no internet access, see [AWS ParallelCluster in a single subnet with no internet access](#) for additional requirements.

### Topics

- [Create an Active Directory](#)

- [Create a cluster with an AD domain](#)
- [Log in to a cluster integrated with an AD domain](#)
- [Running MPI jobs](#)
- [Example AWS Managed Microsoft AD over LDAP\(S\) cluster configurations](#)

## Create an Active Directory

Make sure that you create an Active Directory (AD) before you create your cluster. For information about how to choose the type of active directory for your cluster, see [Which to choose](#) in the *AWS Directory Service Administration Guide*.

If the directory is empty, add users with user names and passwords. For more information, see the documentation that's specific to [AWS Directory Service for Microsoft Active Directory](#) or [Simple AD](#).

### Note

AWS ParallelCluster requires every Active Directory user directory to be in the `/home/$user` directory.

## Create a cluster with an AD domain

### Warning

This introductory section describes how to set up AWS ParallelCluster with a Managed Active Directory (AD) server over the Lightweight Directory Access Protocol (LDAP). LDAP is an insecure protocol. For production systems, we strongly recommended the use of TLS certificates (LDAPS) as described in the [Example AWS Managed Microsoft AD over LDAP\(S\) cluster configurations](#) section that follows.

Configure your cluster to integrate with a directory by specifying the relevant information in the `DirectoryService` section of the cluster configuration file. For more information, see the [DirectoryService](#) configuration section.

You can use this following example to integrate your cluster with an AWS Managed Microsoft AD over the Lightweight Directory Access Protocol (LDAP).

## Specific definitions that are required for an AWS Managed Microsoft AD over LDAP configuration:

- You must set the `ldap_auth_disable_tls_never_use_in_production` parameter to `True` under [DirectoryService](#) / [AdditionalSssdConfigs](#).
- You can specify either controller hostnames or IP addresses for [DirectoryService](#) / [DomainAddr](#).
- [DirectoryService](#) / [DomainReadOnlyUser](#) syntax must be as follows:

```
cn=ReadOnly,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
```

## Get your AWS Managed Microsoft AD configuration data:

```
$ aws ds describe-directories --directory-id "d-abcdef01234567890"
```

```
{
  "DirectoryDescriptions": [
    {
      "DirectoryId": "d-abcdef01234567890",
      "Name": "corp.example.com",
      "DnsIpAddrs": [
        "203.0.113.225",
        "192.0.2.254"
      ],
      "VpcSettings": {
        "VpcId": "vpc-021345abcdef6789",
        "SubnetIds": [
          "subnet-1234567890abcdef0",
          "subnet-abcdef01234567890"
        ],
        "AvailabilityZones": [
          "region-idb",
          "region-idd"
        ]
      }
    }
  ]
}
```

## Cluster configuration for an AWS Managed Microsoft AD:

```
Region: region-id
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-1234567890abcdef0
  Ssh:
    KeyName: pcluster
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
        - Name: t2micro
          InstanceType: t2.micro
          MinCount: 1
          MaxCount: 10
      Networking:
        SubnetIds:
          - subnet-abcdef01234567890
DirectoryService:
  DomainName: dc=corp,dc=example,dc=com
  DomainAddr: ldap://203.0.113.225,ldap://192.0.2.254
  PasswordSecretArn: arn:aws:secretsmanager:region-
id:123456789012:secret:MicrosoftAD.Admin.Password-1234
  DomainReadOnlyUser: cn=ReadOnly,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
  AdditionalSssdConfigs:
    ldap_auth_disable_tls_never_use_in_production: True
```

**To use this configuration for a Simple AD, change the `DomainReadOnlyUser` property value in the `DirectoryService` section:**

```
DirectoryService:
  DomainName: dc=corp,dc=example,dc=com
  DomainAddr: ldap://203.0.113.225,ldap://192.0.2.254
  PasswordSecretArn: arn:aws:secretsmanager:region-
id:123456789012:secret:SimpleAD.Admin.Password-1234
  DomainReadOnlyUser: cn=ReadOnlyUser,cn=Users,dc=corp,dc=example,dc=com
  AdditionalSssdConfigs:
```

```
ldap_auth_disable_tls_never_use_in_production: True
```

## Considerations:

- We recommend that you use LDAP over TLS/SSL (or LDAPS) rather than LDAP alone. TLS/SSL ensures that the connection is encrypted.
- The [DirectoryService / DomainAddr](#) property value matches the entries in the `DnsIpAddress` list from the `describe-directories` output.
- We recommend that your cluster use subnets that are located in the same Availability Zone that the [DirectoryService / DomainAddr](#) points to. If you use [custom Dynamic Host Configuration Protocol \(DHCP\) configuration](#) that's recommended for directory VPCs and your subnets *aren't* located in the [DirectoryService / DomainAddr](#) Availability Zone, cross traffic among Availability Zones is possible. The use of custom DHCP configurations *isn't* required to use the multi-user AD integration feature.
- The [DirectoryService / DomainReadOnlyUser](#) property value specifies a user that must be created in the directory. This user *isn't* created by default. We recommend that you *don't* give this user permission to modify directory data.
- The [DirectoryService / PasswordSecretArn](#) property value points to an AWS Secrets Manager secret that contains the password of the user that you specified for the [DirectoryService / DomainReadOnlyUser](#) property. If this user's password changes, update the secret value and update the cluster. To update the cluster for the new secret value, you must stop the compute fleet with the `pcluster update-compute-fleet` command. If you configured your cluster to use [LoginNodes](#), stop the [LoginNodes / Pools](#) and update the cluster after setting [LoginNodes / Pools / Count](#) to 0. Then, run the following command from within the cluster head node.

```
sudo /opt/parallelcluster/scripts/directory_service/  
update_directory_service_password.sh
```

For another example, see also [Integrating Active Directory](#).

## Log in to a cluster integrated with an AD domain

If you enabled the Active Directory (AD) domain integration feature, authentication by password is enabled on the cluster head node. The home directory of an AD user is created at the first user login to the head node or the first time a `sudo`-user switches to the AD user on the head node.

Password authentication isn't enabled for cluster compute nodes. AD users must log in to compute nodes with SSH keys.

By default, SSH keys are set up in the AD user `/${HOME}/.ssh` directory at the first SSH login to the head node. This behavior can be disabled by setting [DirectoryService / GenerateSshKeysForUsers](#) boolean property to `false` in the cluster configuration. By default, [DirectoryService / GenerateSshKeysForUsers](#) is set to `true`.

If an AWS ParallelCluster application requires passwordless SSH between cluster nodes, make sure that the SSH keys are correctly set up in the user's home directory.

AWS Managed Microsoft AD passwords expire after 42 days. For more information, see [Manage password policies for AWS Managed Microsoft AD](#) in the *AWS Directory Service Administration Guide*. If your password expires, it must be reset to restore cluster access. For more information, see [How to reset a user password and expired passwords](#).

#### Note

If the AD integration feature doesn't work as expected, the SSSD logs can provide useful diagnostic information for troubleshooting the issue. These logs are located in the `/var/log/sss` directory on cluster nodes. By default, they're also stored in a cluster's Amazon CloudWatch log group.

For more information, see [Troubleshooting multi-user integration with Active Directory](#).

## Running MPI jobs

As suggested in SchedMD, bootstrap MPI jobs using Slurm as the MPI bootstrapping method. For more information, refer to the official [Slurm documentation](#) or the official documentation for your MPI library.

For example, in the [IntelMPI official documentation](#), you learn that when running a StarCCM job, you must set Slurm as process orchestrator by exporting the environment variable `I_MPI_HYDRA_BOOTSTRAP=slurm`.

#### Note

Known issue

In the case where your MPI application relies on SSH as mechanism to spawn MPI jobs, it's possible to incur in a [known bug in Slurm](#) that causes the wrong resolution of the directory user name to "nobody".

Either configure your application to use Slurm as the MPI bootstrapping method or refer to [Known issues with username resolution](#) in the Troubleshooting section for further details and possible workarounds.

## Example AWS Managed Microsoft AD over LDAP(S) cluster configurations

AWS ParallelCluster supports multiple user access by integrating with an AWS Directory Service over the Lightweight Directory Access Protocol (LDAP), or LDAP over TLS/SSL (LDAPS).

The following examples show how to create cluster configurations to integrate with an AWS Managed Microsoft AD over LDAP(S).

### AWS Managed Microsoft AD over LDAPS with certificate verification

You can use this example to integrate your cluster with an AWS Managed Microsoft AD over LDAPS, with certificate verification.

#### Specific definitions for an AWS Managed Microsoft AD over LDAPS with certificates configuration:

- [DirectoryService](#) / [LdapTlsReqCert](#) must be set to hard (default) for LDAPS with certificate verification.
- [DirectoryService](#) / [LdapTlsCaCert](#) must specify the path to your certificate of authority (CA) certificate.

The CA certificate is a certificate bundle that contains the certificates of the entire CA chain that issued certificates for the AD domain controllers.

Your CA certificate and certificates must be installed on the cluster nodes.

- Controllers hostnames must be specified for [DirectoryService](#) / [DomainAddr](#), not IP addresses.
- [DirectoryService](#) / [DomainReadOnlyUser](#) syntax must be as follows:

```
cn=ReadOnly,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
```

## Example cluster configuration file for using AD over LDAPS:

```
Region: region-id
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-1234567890abcdef0
  Ssh:
    KeyName: pcluster
  Iam:
    AdditionalIamPolicies:
      - Policy: arn:aws:iam::aws:policy/AmazonS3ReadOnlyAccess
  CustomActions:
    OnNodeConfigured:
      Script: s3://aws-parallelcluster/scripts/pcluster-dub-msad-ldaps.post.sh
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
        - Name: t2micro
          InstanceType: t2.micro
          MinCount: 1
          MaxCount: 10
      Networking:
        SubnetIds:
          - subnet-abcdef01234567890
      Iam:
        AdditionalIamPolicies:
          - Policy: arn:aws:iam::aws:policy/AmazonS3ReadOnlyAccess
      CustomActions:
        OnNodeConfigured:
          Script: s3://aws-parallelcluster-pcluster/scripts/pcluster-dub-msad-ldaps.post.sh
  DirectoryService:
    DomainName: dc=corp,dc=example,dc=com
```



```

DomainAddr: ldaps://win-abcdef01234567890.corp.example.com,ldaps://win-
abcdef01234567890.corp.example.com
PasswordSecretArn: arn:aws:secretsmanager:region-
id:123456789012:secret:MicrosoftAD.Admin.Password-1234
DomainReadOnlyUser: cn=ReadOnly,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
LdapTlsCaCert: /etc/openldap/cacerts/corp.example.com.bundleca.cer
LdapTlsReqCert: hard

```

## Add certificates and configure domain controllers in post install script:

```

#!/bin/bash*
set -e

AD_CERTIFICATE_S3_URI="s3://corp.example.com/bundle/corp.example.com.bundleca.cer"
AD_CERTIFICATE_LOCAL="/etc/openldap/cacerts/corp.example.com.bundleca.cer"

AD_HOSTNAME_1="win-abcdef01234567890.corp.example.com"
AD_IP_1="192.0.2.254"

AD_HOSTNAME_2="win-abcdef01234567890.corp.example.com"
AD_IP_2="203.0.113.225"

# Download CA certificate
mkdir -p $(dirname "${AD_CERTIFICATE_LOCAL}")
aws s3 cp "${AD_CERTIFICATE_S3_URI}" "${AD_CERTIFICATE_LOCAL}"
chmod 644 "${AD_CERTIFICATE_LOCAL}"

# Configure domain controllers reachability
echo "${AD_IP_1} ${AD_HOSTNAME_1}" >> /etc/hosts
echo "${AD_IP_2} ${AD_HOSTNAME_2}" >> /etc/hosts

```

You can retrieve the domain controllers hostnames from instances joined to the domain as shown in the following examples.

### From Windows instance

```
$ nslookup 192.0.2.254
```

```

Server: corp.example.com
Address: 192.0.2.254

Name: win-abcdef01234567890.corp.example.com

```

```
Address: 192.0.2.254
```

## From Linux instance

```
$ nslookup 192.0.2.254
```

```
192.0.2.254.in-addr.arpa    name = corp.example.com
192.0.2.254.in-addr.arpa    name = win-abcdef01234567890.corp.example.com
```

## AWS Managed Microsoft AD over LDAPS without certificate verification

You can use this example to integrate your cluster with an AWS Managed Microsoft AD over LDAPS, without certificate verification.

### Specific definitions for an AWS Managed Microsoft AD over LDAPS without certificate verification configuration:

- [DirectoryService](#) / [LdapTlsReqCert](#) must be set to never.
- Either controller hostnames or IP addresses can be specified for [DirectoryService](#) / [DomainAddr](#).
- [DirectoryService](#) / [DomainReadOnlyUser](#) syntax must be as follows:

```
cn=ReadOnly,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
```

### Example cluster configuration file for using AWS Managed Microsoft AD over LDAPS without certificate verification:

```
Region: region-id
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-1234567890abcdef0
  Ssh:
    KeyName: pcluster
Scheduling:
  Scheduler: slurm
```

```
SlurmQueues:
  - Name: queue1
    ComputeResources:
      - Name: t2micro
        InstanceType: t2.micro
        MinCount: 1
        MaxCount: 10
    Networking:
      SubnetIds:
        - subnet-abcdef01234567890
DirectoryService:
  DomainName: dc=corp,dc=example,dc=com
  DomainAddr: ldaps://203.0.113.225,ldaps://192.0.2.254
  PasswordSecretArn: arn:aws:secretsmanager:region-
id:123456789012:secret:MicrosoftAD.Admin.Password-1234
  DomainReadOnlyUser: cn=ReadOnly,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
  LdapTlsReqCert: never
```

## Best practices

### Best practices: head node instance type selection

Even though the head node doesn't run a job, its functions and its sizing are crucial to the overall performance of the cluster. When you choose the instance type to use for your head node, consider the following characteristics:

**Cluster size:** The head node orchestrates the scaling logic of the cluster and is responsible of attaching new nodes to the scheduler. To scale up and down a cluster that has a large number nodes, provide the head node some extra compute capacity.

**Shared file systems:** When you use shared file systems, choose an instance type with enough network bandwidth, and enough Amazon EBS bandwidth, to handle your workflows. Ensure that the head node is able to both expose sufficient NFS server directories for the cluster and handle the artifacts that need to be shared between the compute nodes and head node.

### Best practices: network performance

Network performance is critical for high performance computing (HPC) applications. Without reliable network performance, these applications can't perform as expected. To optimize network performance, consider the following best practices.

- **Placement group:** If you're using Slurm, consider configuring each Slurm queue to use a cluster placement group . A cluster's *placement group* is a logical grouping of instances within a single Availability Zone. For more information, see [placement groups](#) in the *Amazon EC2 User Guide*. You can specify a [PlacementGroup](#) in the queue's [Networking](#) section, each compute resource is assigned to the queue's placement group. When specifying a [PlacementGroup](#) in the compute resource's [Networking](#) section, that specific compute resource is assigned to that placement group. The compute resource placement group specification overrides the queue specification for the compute resource. For more information, see [SlurmQueues / Networking / PlacementGroup](#) and [SlurmQueues / ComputeResources / Networking / PlacementGroup](#).

```
Networking:
  PlacementGroup:
    Enabled: true
    Id: your-placement-group-name
```

Alternatively, have AWS ParallelCluster create a placement group for you.

```
Networking:
  PlacementGroup:
    Enabled: true
```

Starting with AWS ParallelCluster version 3.3.0, placement group creation and management is modified. When you specify the placement group to be enabled, without a name or Id, in the queue, each compute resource is assigned its own managed placement group, instead of one managed group for the entire queue. This helps to reduce insufficient capacity errors. If you need to have one placement group for the entire queue, you can use a named placement group.

[SlurmQueues / Networking / PlacementGroup / Name](#) was added as a preferred alternative to [SlurmQueues / Networking / PlacementGroup / Id](#).

For more information, see [Networking](#).

- **Enhanced networking:** Consider choosing an instance type that supports enhanced networking. This recommendation applies to all [current generation instances](#). For more information, see [enhanced networking on Linux](#) in the *Amazon EC2 User Guide*.
- **Elastic Fabric Adapter:** To support high levels of scalable instance to instance communication, consider choosing EFA network interfaces for your network. The EFA's custom-built operating system (OS) bypass hardware enhances instance to instance communications with the on-

demand elasticity and flexibility of the AWS Cloud. You can configure each Slurm queue [ComputeResource](#) to use [Efa](#). For more information about using EFA with AWS ParallelCluster, see [Elastic Fabric Adapter](#).

```
ComputeResources:
  - Name: your-compute-resource-name
    Efa:
      Enabled: true
```

For more information about EFA, see [Elastic Fabric Adapter](#) in the *Amazon EC2 User Guide for Linux Instances*.

- **Instance bandwidth:** The bandwidth scales with instance size. For information about the different instance types, see [Amazon EBS-optimized instances](#) and [Amazon EBS volume types](#) in the *Amazon EC2 User Guide*.

## Best practices: budget alerts

To manage resource costs in AWS ParallelCluster, we recommend that you use AWS Budgets actions to create a budget. You can also create defined budget threshold alerts for selected AWS resources. For more information, see [Configuring a budget action](#) in the *AWS Budgets User Guide*. Similarly, you can also use Amazon CloudWatch to create a billing alarm. For more information, see [Creating a billing alarm to monitor your estimated AWS charges](#).

## Best practices: moving a cluster to a new AWS ParallelCluster minor or patch version

Currently each AWS ParallelCluster minor version is self-contained along with its `pccluster` CLI. To move a cluster to a new minor or patch version, you must re-create the cluster using the new version's CLI.

To optimize the process of moving a cluster to a new minor or patch version, we recommend that you do the following:

- Save personal data in external volumes that are created outside the cluster, such as Amazon EFS and FSx for Lustre. By doing this, you can easily move the data from one cluster to another in the future.

- Create shared storage systems using the following types. You can create these systems using the AWS CLI or AWS Management Console.
  - [SharedStorage](#) / [EbsSettings](#) / [VolumeId](#)
  - [SharedStorage](#) / [EfsSettings](#) / [FileSystemId](#)
  - [SharedStorage](#) / [FsxLustreSettings](#) / [FileSystemId](#)

Define a file system or volume in a cluster configuration as existing file system or volume. This way, they're preserved when you delete the cluster and can be attached to a new cluster.

We recommend that you use Amazon EFS or FSx for Lustre file systems. Both of these systems can be attached to multiple clusters at the same time. Moreover, you can attach either of these systems to a new cluster before you delete your existing cluster.

- Use [custom bootstrap actions](#) to customize your instances rather than using a custom AMI. If instead, you use a custom AMI, then you need to delete and recreate that AMI for each new version release.
- We recommend that you apply the preceding recommendations in the following sequence:
  1. Update the existing cluster configuration to use existing file system definitions.
  2. Verify the `pcluster` version and update it if needed.
  3. Create and test the new cluster. When you test the new cluster, check the following:
    - Make sure that your data is available in the new cluster.
    - Make sure that your application works in the new cluster.
  4. After your new cluster is fully tested and operational and you no longer need the existing cluster, delete it.

## Moving from AWS ParallelCluster 2.x to 3.x

### Custom Bootstrap Actions

With AWS ParallelCluster 3, you can specify different custom bootstrap actions scripts for the head node and compute nodes using `OnNodeStart` (`pre_install` in AWS ParallelCluster version 2) and `OnNodeConfigured` (`post_install` in AWS ParallelCluster version 2) parameters in the [HeadNode](#) and [Scheduling](#) / [SlurmQueues](#) sections. For more information, see [Custom bootstrap actions](#).

Custom bootstrap actions scripts that are developed for AWS ParallelCluster 2 must be adapted to be used in AWS ParallelCluster 3:

- We don't recommend using `/etc/parallelcluster/cfnconfig` and `cfn_node_type` to differentiate between head and compute nodes. Instead, we recommend that you specify two different scripts in the [HeadNode](#) and [Scheduling / SlurmQueues](#).
- If you prefer to continue loading `/etc/parallelcluster/cfnconfig` for use in your bootstrap actions script, note the value of `cfn_node_type` is changed from "MasterServer" to "HeadNode" (see: [Inclusive language](#)).
- On AWS ParallelCluster 2, the first input argument to bootstrap action scripts was the S3 URL to the script and was reserved. In AWS ParallelCluster 3, only the arguments configured in the configuration are passed to the scripts.

### Warning

Using internal variables provided through the `/etc/parallelcluster/cfnconfig` file isn't officially supported. This file might be removed as part of a future release.

## AWS ParallelCluster 2.x and 3.x use different configuration file syntax

AWS ParallelCluster 3.x configuration uses YAML syntax. The full reference can be found at [Configuration files](#).

In addition to requiring a YAML file format, a number of configuration sections, settings, and parameter values have been updated in AWS ParallelCluster 3.x. In this section, we note key changes to the AWS ParallelCluster configuration along with side-by-side examples illustrating these differences across each version of AWS ParallelCluster.

### Example of multiple scheduler queues configuration with hyperthreading enabled and disabled

AWS ParallelCluster 2:

```
[cluster default]
queue_settings = ht-enabled, ht-disabled
...

[queue ht-enabled]
compute_resource_settings = ht-enabled-i1
```

```

disable_hyperthreading = false

[queue ht-disabled]
compute_resource_settings = ht-disabled-i1
disable_hyperthreading = true

[compute_resource ht-enabled-i1]
instance_type = c5n.18xlarge
[compute_resource ht-disabled-i1]
instance_type = c5.xlarge

```

### AWS ParallelCluster 3:

```

...
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: ht-enabled
      Networking:
        SubnetIds:
          - compute_subnet_id
      ComputeResources:
        - Name: ht-enabled-i1
          DisableSimultaneousMultithreading: true
          InstanceType: c5n.18xlarge
    - Name: ht-disabled
      Networking:
        SubnetIds:
          - compute_subnet_id
      ComputeResources:
        - Name: ht-disabled-i1
          DisableSimultaneousMultithreading: false
          InstanceType: c5.xlarge

```

### Example of new FSx for Lustre file-system configuration

#### AWS ParallelCluster 2:

```

[cluster default]
fsx_settings = fsx
...

[fsx fsx]

```



```

shared_dir = /shared-fsx
storage_capacity = 1200
imported_file_chunk_size = 1024
import_path = s3://bucket
export_path = s3://bucket/export_dir
weekly_maintenance_start_time = 3:02:30
deployment_type = PERSISTENT_1
data_compression_type = LZ4

```

### AWS ParallelCluster 3:

```

...
SharedStorage:
  - Name: fsx
    MountDir: /shared-fsx
    StorageType: FsxLustre
    FsxLustreSettings:
      StorageCapacity: 1200
      ImportedFileChunkSize: 1024
      ImportPath: s3://bucket
      ExportPath: s3://bucket/export_dir
      WeeklyMaintenanceStartTime: "3:02:30"
      DeploymentType: PERSISTENT_1
      DataCompressionType: LZ4

```

### Example of a cluster configuration mounting an existing FSx for Lustre file-system

#### AWS ParallelCluster 2:

```

[cluster default]
fsx_settings = fsx
...

[fsx fsx]
shared_dir = /shared-fsx
fsx_fs_id = fsx_fs_id

```

#### AWS ParallelCluster 3:

```

...
SharedStorage:
  - Name: fsx

```

```
MountDir: /shared-fsx
StorageType: FsxLustre
FsxLustreSettings:
  FileSystemId: fsx_fs_id
```

## Example of a cluster with the Intel HPC Platform Specification software stack

### AWS ParallelCluster 2:

```
[cluster default]
enable_intel_hpc_platform = true
...
```

### AWS ParallelCluster 3:

```
...
AdditionalPackages:
  IntelSoftware:
    IntelHpcPlatform: true
```

### Notes:

- The installation of Intel HPC Platform Specification software is subject to the terms and conditions of the applicable [Intel End User License Agreement](#).

## Example of custom IAM configurations including: instance profile, instance role, additional policies for instances and the role for the lambda functions associated with the cluster

### AWS ParallelCluster 2:

```
[cluster default]
additional_iam_policies = arn:aws:iam::aws:policy/
AmazonS3ReadOnlyAccess,arn:aws:iam::aws:policy/AmazonDynamoDBReadOnlyAccess
ec2_iam_role = ec2_iam_role
iam_lambda_role = lambda_iam_role
...
```

### AWS ParallelCluster 3:

```
...
Iam:
```

```

Roles:
  CustomLambdaResources: lambda_iam_role
HeadNode:
  ...
  Iam:
    InstanceRole: ec2_iam_role
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      ...
      Iam:
        InstanceProfile: iam_instance_profile
    - Name: queue2
      ...
      Iam:
        AdditionalIamPolicies:
          - Policy: arn:aws:iam::aws:policy/AmazonS3ReadOnlyAccess
          - Policy: arn:aws:iam::aws:policy/AmazonDynamoDBReadOnlyAccess

```

## Notes:

- For AWS ParallelCluster 2, the IAM settings are applied to all the instances of a cluster and `additional_iam_policies` can't be used in conjunction with `ec2_iam_role`.
- For AWS ParallelCluster 3, you can have different IAM settings for head and compute nodes and even specify different IAM settings for each compute queue.
- For AWS ParallelCluster 3, you can use an IAM instance profile as an alternative to an IAM role. `InstanceProfile`, `InstanceRole` or `AdditionalIamPolicies` can't be configured together.

## Example of custom bootstrap actions

### AWS ParallelCluster 2:

```

[cluster default]
s3_read_resource = arn:aws:s3:::bucket_name/*
pre_install = s3://bucket_name/scripts/pre_install.sh
pre_install_args = 'R curl wget'
post_install = s3://bucket_name/scripts/post_install.sh
post_install_args = "R curl wget"
...

```

## AWS ParallelCluster 3:

```

...
HeadNode:
  ...
  CustomActions:
    OnNodeStart:
      Script: s3://bucket_name/scripts/pre_install.sh
      Args:
        - R
        - curl
        - wget
    OnNodeConfigured:
      Script: s3://bucket_name/scripts/post_install.sh
      Args: ['R', 'curl', 'wget']
  Iam:
    S3Access:
      - BucketName: bucket_name
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
    ...
    CustomActions:
      OnNodeStart:
        Script: s3://bucket_name/scripts/pre_install.sh
        Args: ['R', 'curl', 'wget']
      OnNodeConfigured:
        Script: s3://bucket_name/scripts/post_install.sh
        Args: ['R', 'curl', 'wget']
    Iam:
      S3Access:
        - BucketName: bucket_name

```

## Example of a cluster with read and write access to the S3 bucket resources

### AWS ParallelCluster 2:

```

[cluster default]
s3_read_resource = arn:aws:s3:::bucket/read_only/*
s3_read_write_resource = arn:aws:s3:::bucket/read_and_write/*
...

```

## AWS ParallelCluster 3:

```
...
HeadNode:
  ...
  Iam:
    S3Access:
      - BucketName: bucket_name
        KeyName: read_only/
        EnableWriteAccess: False
      - BucketName: bucket_name
        KeyName: read_and_write/
        EnableWriteAccess: True
  Scheduling:
    Scheduler: slurm
    SlurmQueues:
      - Name: queue1
      ...
    Iam:
      S3Access:
        - BucketName: bucket_name
          KeyName: read_only/
          EnableWriteAccess: False
        - BucketName: bucket_name
          KeyName: read_and_write/
          EnableWriteAccess: True
```

## Inclusive language

AWS ParallelCluster 3 uses the words "head node" in places where "master" was used in AWS ParallelCluster 2. This includes the following:

- Variable exported in the AWS Batch job environment changed: from MASTER\_IP to PCLUSTER\_HEAD\_NODE\_IP.
- All AWS CloudFormation outputs changed from Master\* to HeadNode\*.
- All NodeType and tags changed from Master to HeadNode.

## Scheduler Support

AWS ParallelCluster 3.x doesn't support Son of Grid Engine (SGE) and Torque schedulers.

The AWS Batch commands `awsbhosts`, `awsbkill`, `awsbout`, `awsbqueues`, `awsbstat`, and `awsbsub` are distributed as a separate `aws-parallelcluster-awsbatch-cli` PyPI package. This package is installed by AWS ParallelCluster on the head node. You can still use these AWS Batch commands from the cluster's head node. However, if you wish to use AWS Batch commands from a location other than the head node, you must first install the `aws-parallelcluster-awsbatch-cli` PyPI package.

## AWS ParallelCluster CLI

The AWS ParallelCluster command line interface (CLI) has been changed. The new syntax is described in [AWS ParallelCluster CLI commands](#). The output format for the CLI is a [JSON](#) string.

### Configuring a new cluster

The `pcluster configure` command includes different parameters in AWS ParallelCluster 3 as compared to AWS ParallelCluster 2. For more information, see [pcluster configure](#).

Note also that the configuration file syntax has changed from AWS ParallelCluster 2. For a full reference of the cluster configuration settings, see [Cluster configuration file](#).

### Creating a new cluster

AWS ParallelCluster 2's `pcluster create` command has been replaced by the [pcluster create-cluster](#) command.

Note the default behavior in AWS ParallelCluster 2.x, without the `-nw` option, is to wait on cluster creation events, while AWS ParallelCluster 3.x command returns immediately. The progress of the cluster creation can be monitored using [pcluster describe-cluster](#).

An AWS ParallelCluster 3 configuration file contains a single cluster definition, so the `-t` parameter is no more needed.

The following is an example configuration file.

```
# AWS ParallelCluster v2
$ pcluster create \
  -r REGION \
  -c V2_CONFIG_FILE \
  -nw \
  -t CLUSTER_TEMPLATE \
```

***CLUSTER\_NAME***

```
# AWS ParallelCluster v3
$ pcluster create-cluster \
  --region REGION \
  --cluster-configuration V3_CONFIG_FILE \
  --cluster-name CLUSTER_NAME
```

## Listing clusters

The `pcluster list` AWS ParallelCluster 2.x command must be replaced with [pcluster list-clusters](#) command.

Note: You need AWS ParallelCluster v2 CLI to list clusters created with 2.x versions of AWS ParallelCluster. See [Install AWS ParallelCluster in a virtual environment \(recommended\)](#) for how to install multiple versions of AWS ParallelCluster using virtual environments.

```
# AWS ParallelCluster v2
$ pcluster list -r REGION

# AWS ParallelCluster v3
$ pcluster list-clusters --region REGION
```

## Starting and Stopping a cluster

The `pcluster start` and `pcluster stop` AWS ParallelCluster 2.x commands must be replaced with [pcluster update-compute-fleet](#) commands.

Starting a compute fleet:

```
# AWS ParallelCluster v2
$ pcluster start \
  -r REGION \
  CLUSTER_NAME

# AWS ParallelCluster v3 - Slurm fleets
$ pcluster update-compute-fleet \
  --region REGION \
  --cluster-name CLUSTER_NAME \
  --status START_REQUESTED

# AWS ParallelCluster v3 - AWS Batch fleets
```

```
$ pcluster update-compute-fleet \  
  --region REGION \  
  --cluster-name CLUSTER_NAME \  
  --status ENABLED
```

Stopping a compute fleet:

```
# AWS ParallelCluster v2  
$ pcluster stop \  
  -r REGION \  
  CLUSTER_NAME  
  
# AWS ParallelCluster v3 - Slurm fleets  
$ pcluster update-compute-fleet \  
  --region REGION \  
  --cluster-name CLUSTER_NAME \  
  --status STOP_REQUESTED  
  
# AWS ParallelCluster v3 - AWS Batch fleets  
$ pcluster update-compute-fleet \  
  --region REGION \  
  --cluster-name CLUSTER_NAME \  
  --status DISABLED
```

## Connecting to a cluster

The `pcluster ssh` AWS ParallelCluster 2.x command has different parameters names in AWS ParallelCluster 3.x. See [pcluster ssh](#).

Connecting to a cluster:

```
# AWS ParallelCluster v2  
$ pcluster ssh \  
  -r REGION \  
  CLUSTER_NAME \  
  -i ~/.ssh/id_rsa  
  
# AWS ParallelCluster v3  
$ pcluster ssh \  
  --region REGION \  
  --cluster-name CLUSTER_NAME \  
  -i ~/.ssh/id_rsa
```



## IMDS configuration update

Starting with version 3.0.0, AWS ParallelCluster introduced support for restricting access to the head node's IMDS (and the instance profile credentials) to a subset of superusers, by default. For more information, see [Imds properties](#).

## Supported Regions for AWS ParallelCluster

AWS ParallelCluster version 3 is available in the following AWS Regions:

Region Name	Region
US East (Ohio)	us-east-2
US East (N. Virginia)	us-east-1
US West (N. California)	us-west-1
US West (Oregon)	us-west-2
Africa (Cape Town)	af-south-1
Asia Pacific (Hong Kong)	ap-east-1
Asia Pacific (Mumbai)	ap-south-1
Asia Pacific (Seoul)	ap-northeast-2
Asia Pacific (Singapore)	ap-southeast-1
Asia Pacific (Sydney)	ap-southeast-2
Asia Pacific (Tokyo)	ap-northeast-1
Canada (Central)	ca-central-1
China (Beijing)	cn-north-1
China (Ningxia)	cn-northwest-1
Europe (Frankfurt)	eu-central-1

Region Name	Region
Europe (Ireland)	eu-west-1
Europe (London)	eu-west-2
Europe (Milan)	eu-south-1
Europe (Paris)	eu-west-3
Europe (Stockholm)	eu-north-1
Middle East (Bahrain)	me-south-1
South America (São Paulo)	sa-east-1
AWS GovCloud (US-East)	us-gov-east-1
AWS GovCloud (US-West)	us-gov-west-1
Israel (Tel Aviv)	il-central-1

# Using AWS ParallelCluster

## Topics

- [AWS ParallelCluster UI](#)
- [AWS Lambda VPC configuration in AWS ParallelCluster](#)
- [AWS Identity and Access Management permissions in AWS ParallelCluster](#)
- [Network configurations](#)
- [Login nodes](#)
- [Custom bootstrap actions](#)
- [Working with Amazon S3](#)
- [Working with Spot Instances](#)
- [Schedulers supported by AWS ParallelCluster](#)
- [Shared storage](#)
- [AWS ParallelCluster resources and tagging](#)
- [Monitoring AWS ParallelCluster and logs](#)
- [AWS CloudFormation custom resource](#)
- [Elastic Fabric Adapter](#)
- [Enable Intel MPI](#)
- [AWS ParallelCluster API](#)
- [AWS ParallelCluster for Terraform](#)
- [Connect to the head node through NICE DCV](#)
- [Using pcluster update-cluster](#)
- [AWS ParallelCluster AMI customization](#)
- [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#)
- [Launch instances with Capacity Blocks \(CB\)](#)
- [AMI patching and Amazon EC2 instance replacement](#)
- [Operating Systems](#)

# AWS ParallelCluster UI

The AWS ParallelCluster UI is a web-based user interface that serves as a dashboard for creating, monitoring, and managing clusters. You install and access the AWS ParallelCluster UI in your AWS account. The AWS ParallelCluster UI is added with AWS ParallelCluster version 3.5.0.

To install the AWS ParallelCluster UI and get started, see [Installing the AWS ParallelCluster UI](#) and [Configure and create a cluster with the AWS ParallelCluster UI](#).

The screenshot displays the AWS ParallelCluster UI interface. At the top, the header shows 'AWS ParallelCluster' with a user profile 'user@domain.com' and the region 'eu-west-1'. The main navigation menu on the left includes 'Clusters', 'Images', and 'Users'. The central area is titled 'Clusters (2) Info' and contains a search bar 'Find clusters' and several action buttons: 'Shell', 'DCV', 'Stop fleet', 'Actions', and 'Create cluster'. Below this is a table listing clusters:

Name	Status	Version
hpc-cluster-1	CREATE COMPLETE	3.5.0
hpc-cluster-2	DELETE IN PROGRESS	3.5.0

Below the table, the details for 'Cluster: hpc-cluster-1' are shown. The 'Details' tab is active, displaying the following properties:

Property	Value
Cluster configuration	<a href="#">VIEW</a>
SSH command	ssh ec2-user@54.78.245.22
EC2 Instance Connect	mssh -r eu-west-1 ec2-user@i-0b14dc1a2f5dc048e
Cluster status	CREATE COMPLETE
Compute fleet status	RUNNING
Version	3.5.0
Region	eu-west-1
Created time	March 10, 2023 at 09:39 (UTC+1:00)
Latest update time	March 10, 2023 at 09:39 (UTC+1:00)

The AWS ParallelCluster UI supports the following features:

- Displays the following:
  - The list of clusters you've created in your AWS account with AWS ParallelCluster.
  - The available status and details for your listed clusters.
  - CloudFormation stack event and AWS ParallelCluster logs that you can use for monitoring.

- The status of jobs that are running on your clusters.
- The list of custom images that you can use to build clusters.
- The list of official images that the UI uses to create clusters.
- The list of users that have access to the AWS ParallelCluster UI. You can add and remove users.
- Provides step-by-step guidance for creating and editing (updating) a cluster and selecting supported cluster features to add, edit, or remove. Inaccessible input fields can't be changed for the cluster configuration being edited. You have the option to perform a dry run validation of your cluster configuration before cluster deployment.
- Features direct shell links to access the head node in the **Clusters** view. Choose **Add SSM session** during the step-by-step guidance to add the direct shell access, and the **SSM Managed Instance Core** policy on the head node.

### Consider the following when using the AWS ParallelCluster UI to create and manage your clusters:

- You can only create and edit clusters or build images with the same AWS ParallelCluster version that was used to create the AWS ParallelCluster UI. Earlier version clusters or images can only be viewed. If you manage multiple versions of clusters and images, we recommend that you create an AWS ParallelCluster UI instance to support each version.
- The AWS ParallelCluster UI is designed to mirror the `pcluster` CLI functionality. There are some differences. If you align with the step-by-step guidance, then you are using all of the supported features. Before deployment, you have the option to edit the cluster or image configuration manually. If you do this, we recommend that you validate the configuration by choosing **Dry run** to verify that your edits are fully supported.

#### Note

AWS ParallelCluster UI doesn't support AWS Batch.

## AWS Lambda VPC configuration in AWS ParallelCluster

AWS ParallelCluster uses AWS Lambda to perform operations during the lifecycle of the cluster. An [AWS Lambda function always runs in a VPC](#) owned by the Lambda service. This Lambda

function can also be connected to private subnets in a virtual private cloud (VPC) to access private resources.

**Note**

Lambda functions can't connect directly to a VPC with dedicated instance tenancy. To connect to resources in a dedicated VPC, peer the dedicated VPC to a second VPC with a default tenancy that can connect to a dedicated VPC.

For more information, see [Dedicated Instances](#) in the *Amazon EC2 User Guide for Linux Instances* and [How do I connect a Lambda function to a dedicated VPC?](#) from the *AWS Knowledge Center*.

Lambda functions that are created by AWS ParallelCluster can be connected to a private VPC. These Lambda functions need to access AWS services. You can provide access through the internet or VPC endpoints by using the following methods.

- **Internet access**

To access the internet and AWS services, a Lambda function requires network address translation (NAT). Route outbound traffic from your private subnet to a [NAT gateway](#) in a public subnet.

- **VPC endpoints**

Several AWS services offer [VPC endpoints](#). You can use VPC endpoints to connect to AWS services from a VPC that doesn't have internet access. To view the list of AWS ParallelCluster VPC endpoints, see [Networking](#).

**Note**

Every combination of subnets and security groups must provide access to AWS services using one these methods. Subnets and security groups must be in the same VPC.

For more information, see [VPC endpoints](#) in the *Amazon Virtual Private Cloud User Guide* and [Internet and service access for VPC-connected functions](#) in the *AWS Lambda Developer Guide*.

To configure the use of Lambda functions and VPCs, see [DeploymentSettings / LambdaFunctionsVpcConfig](#) for clusters or [DeploymentSettings / LambdaFunctionsVpcConfig](#) for images.

## AWS Identity and Access Management permissions in AWS ParallelCluster

AWS ParallelCluster uses IAM permissions to control access to resources when creating and managing clusters.

**To create and manage clusters in an AWS account, AWS ParallelCluster requires permissions at two levels:**

- Permissions that the `pcluster` user requires to invoke the `pcluster` CLI commands for creating and managing clusters.
- Permissions that the cluster resources require to perform cluster actions.

**AWS ParallelCluster uses an [Amazon EC2 instance profile and role](#) to provide cluster resource permissions. To manage cluster resource permissions, AWS ParallelCluster also requires permissions to IAM resources. For more information, see [AWS ParallelCluster user example policies for managing IAM resources](#).**

**`pcluster` users require IAM permissions to use the `pcluster` CLI to create and manage a cluster and its resources. These permissions are included in IAM policies that can be added to a user or role. For more information on IAM roles, see [Creating a user role](#) in the *AWS Identity and Access Management User Guide*.**

You can also use [AWS ParallelCluster configuration parameters to manage IAM permissions](#).

The following sections contain the required permissions with examples.

To use the example policies, replace `<REGION>`, `<AWS ACCOUNT ID>`, and similar strings with the appropriate values.

The following example policies include Amazon Resource Names (ARNs) for the resources. If you're working in the AWS GovCloud (US) or AWS China partitions, the ARNs must be changed. Specifically, they must be changed from "arn:aws" to "arn:aws-us-gov" for the AWS GovCloud (US) partition or "arn:aws-cn" for the AWS China partition. For more information, see [Amazon Resource](#)

[Names \(ARNs\) in AWS GovCloud \(US\) Regions](#) in the *AWS GovCloud (US) User Guide* and [ARNs for AWS services in China](#) in *Getting Started with AWS services in China*.

You can track changes to the example policies in [AWS ParallelCluster documentation on GitHub](#).

## Topics

- [AWS ParallelCluster Amazon EC2 instance roles](#)
- [AWS ParallelCluster example pcluster user policies](#)
- [AWS ParallelCluster user example policies for managing IAM resources](#)
- [AWS ParallelCluster configuration parameters to manage IAM permissions](#)

## AWS ParallelCluster Amazon EC2 instance roles

When you create a cluster with the default configuration settings, AWS ParallelCluster uses Amazon EC2 [instance profiles](#) to automatically create a default cluster Amazon EC2 [instance role](#) that provides the permissions required to create and manage the cluster and its resources.

### Alternatives to using the default AWS ParallelCluster instance role

In place of the default AWS ParallelCluster instance role, you can use the `InstanceRole` cluster configuration setting to specify your own existing IAM role for EC2. For more information, see [AWS ParallelCluster configuration parameters to manage IAM permissions](#). Typically, you specify existing IAM roles to fully control the permissions granted to EC2.

If your intent is to add extra policies to the default instance role, we recommend that you pass the additional IAM policies by using the [AdditionalIamPolicies](#) configuration setting instead of [InstanceProfile](#) or [InstanceRole](#) settings. You can update `AdditionalIamPolicies` when you update your cluster, however, you can't update the `InstanceRole` when you update your cluster.

## AWS ParallelCluster example pcluster user policies

The following examples show the user policies required to create and manage AWS ParallelCluster and its resources by using the `pcluster` CLI. You can attach policies to a user or role.

## Topics

- [Base AWS ParallelCluster pcluster user policy](#)
- [Additional AWS ParallelCluster pcluster user policy when using AWS Batch scheduler](#)



- [Additional AWS ParallelCluster pcluster user policy when using Amazon FSx for Lustre](#)
- [AWS ParallelCluster image build pcluster user policy](#)

## Base AWS ParallelCluster pcluster user policy

The following policy shows the permissions required to run AWS ParallelCluster `pcluster` commands.

The last action listed in the policy is included to provide validation of any secrets specified in the cluster configuration. For example, an AWS Secrets Manager secret is used to configure the [DirectoryService](#) integration. In this case, a cluster is created only if a valid secret exists in the [PasswordSecretArn](#). If this action is omitted, secret validation is skipped. To improve your security posture, we recommend that you scope down this policy statement by adding only the secrets specified in your cluster configuration.

### Note

If existing Amazon EFS file systems are the only file systems used in your cluster, you can scope down the example Amazon EFS policy statements to the specific file systems referenced in the [SharedStorage section](#) of the cluster configuration file.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "ec2:Describe*"
      ],
      "Resource": "*",
      "Effect": "Allow",
      "Sid": "EC2Read"
    },
    {
      "Action": [
        "ec2:AllocateAddress",
        "ec2:AssociateAddress",
        "ec2:AttachNetworkInterface",
        "ec2:AuthorizeSecurityGroupEgress",
        "ec2:AuthorizeSecurityGroupIngress",
```

```

    "ec2:CreateFleet",
    "ec2:CreateLaunchTemplate",
    "ec2:CreateLaunchTemplateVersion",
    "ec2:CreateNetworkInterface",
    "ec2:CreatePlacementGroup",
    "ec2:CreateSecurityGroup",
    "ec2:CreateSnapshot",
    "ec2:CreateTags",
    "ec2>DeleteTags",
    "ec2:CreateVolume",
    "ec2>DeleteLaunchTemplate",
    "ec2>DeleteNetworkInterface",
    "ec2>DeletePlacementGroup",
    "ec2>DeleteSecurityGroup",
    "ec2>DeleteVolume",
    "ec2:DisassociateAddress",
    "ec2:ModifyLaunchTemplate",
    "ec2:ModifyNetworkInterfaceAttribute",
    "ec2:ModifyVolume",
    "ec2:ModifyVolumeAttribute",
    "ec2:ReleaseAddress",
    "ec2:RevokeSecurityGroupEgress",
    "ec2:RevokeSecurityGroupIngress",
    "ec2:RunInstances",
    "ec2:TerminateInstances"
  ],
  "Resource": "*",
  "Effect": "Allow",
  "Sid": "EC2Write"
},
{
  "Action": [
    "dynamodb:DescribeTable",
    "dynamodb:ListTagsOfResource",
    "dynamodb:CreateTable",
    "dynamodb>DeleteTable",
    "dynamodb:GetItem",
    "dynamodb:PutItem",
    "dynamodb:UpdateItem",
    "dynamodb:Query",
    "dynamodb:TagResource"
  ],
  "Resource": "arn:aws:dynamodb:*:<AWS ACCOUNT ID>:table/parallelcluster-*",
  "Effect": "Allow",

```

```

    "Sid": "DynamoDB"
  },
  {
    "Action": [
      "route53:ChangeResourceRecordSets",
      "route53:ChangeTagsForResource",
      "route53:CreateHostedZone",
      "route53>DeleteHostedZone",
      "route53:GetChange",
      "route53:GetHostedZone",
      "route53:ListResourceRecordSets",
      "route53:ListQueryLoggingConfigs"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "Route53HostedZones"
  },
  {
    "Action": [
      "cloudformation:*"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "CloudFormation"
  },
  {
    "Action": [
      "cloudwatch:PutDashboard",
      "cloudwatch:ListDashboards",
      "cloudwatch>DeleteDashboards",
      "cloudwatch:GetDashboard",
      "cloudwatch:PutMetricAlarm",
      "cloudwatch>DeleteAlarms",
      "cloudwatch:DescribeAlarms",
      "cloudwatch:PutCompositeAlarm"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "CloudWatch"
  },
  {
    "Action": [
      "iam:GetRole",
      "iam:GetRolePolicy",

```

```

        "iam:GetPolicy",
        "iam:SimulatePrincipalPolicy",
        "iam:GetInstanceProfile"
    ],
    "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/*",
        "arn:aws:iam::<AWS ACCOUNT ID>:policy/*",
        "arn:aws:iam::aws:policy/*",
        "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/*"
    ],
    "Effect": "Allow",
    "Sid": "IamRead"
},
{
    "Action": [
        "iam:CreateInstanceProfile",
        "iam>DeleteInstanceProfile",
        "iam:AddRoleToInstanceProfile",
        "iam:RemoveRoleFromInstanceProfile"
    ],
    "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/parallelcluster/*"
    ],
    "Effect": "Allow",
    "Sid": "IamInstanceProfile"
},
{
    "Condition": {
        "StringEqualsIfExists": {
            "iam:PassedToService": [
                "lambda.amazonaws.com",
                "ec2.amazonaws.com",
                "spotfleet.amazonaws.com"
            ]
        }
    },
    "Action": [
        "iam:PassRole"
    ],
    "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
    ],
    "Effect": "Allow",
    "Sid": "IamPassRole"
}

```

```

    },
    {
      "Action": [
        "lambda:CreateFunction",
        "lambda:DeleteFunction",
        "lambda:GetFunctionConfiguration",
        "lambda:GetFunction",
        "lambda:InvokeFunction",
        "lambda:AddPermission",
        "lambda:RemovePermission",
        "lambda:UpdateFunctionConfiguration",
        "lambda:TagResource",
        "lambda:ListTags",
        "lambda:UntagResource"
      ],
      "Resource": [
        "arn:aws:lambda:*:<AWS ACCOUNT ID>:function:parallelcluster-*",
        "arn:aws:lambda:*:<AWS ACCOUNT ID>:function:pcluster-*"
      ],
      "Effect": "Allow",
      "Sid": "Lambda"
    },
    {
      "Action": [
        "s3:*"
      ],
      "Resource": [
        "arn:aws:s3:::parallelcluster-*",
        "arn:aws:s3:::aws-parallelcluster-*"
      ],
      "Effect": "Allow",
      "Sid": "S3ResourcesBucket"
    },
    {
      "Action": [
        "s3:Get*",
        "s3:List*"
      ],
      "Resource": "arn:aws:s3:::*-aws-parallelcluster*",
      "Effect": "Allow",
      "Sid": "S3ParallelClusterReadOnly"
    },
    {
      "Action": [

```

```

        "elasticfilesystem:*"
    ],
    "Resource": [
        "arn:aws:elasticfilesystem:*:<AWS ACCOUNT ID>:*"
    ],
    "Effect": "Allow",
    "Sid": "EFS"
},
{
    "Action": [
        "logs:DeleteLogGroup",
        "logs:PutRetentionPolicy",
        "logs:DescribeLogGroups",
        "logs:CreateLogGroup",
        "logs:TagResource",
        "logs:UntagResource",
        "logs:FilterLogEvents",
        "logs:GetLogEvents",
        "logs:CreateExportTask",
        "logs:DescribeLogStreams",
        "logs:DescribeExportTasks",
        "logs:DescribeMetricFilters",
        "logs:PutMetricFilter",
        "logs>DeleteMetricFilter"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "CloudWatchLogs"
},
{
    "Action": [
        "resource-groups:ListGroupResources"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "ResourceGroupRead"
},
{
    "Sid": "AllowDescribingFileCache",
    "Effect": "Allow",
    "Action": [
        "fsx:DescribeFileCaches"
    ],
    "Resource": "*"
}

```

```

    },
    {
      "Action": "secretsmanager:DescribeSecret",
      "Resource": "arn:aws:secretsmanager:<REGION>:<AWS ACCOUNT ID>:secret:<SECRET
NAME>",
      "Effect": "Allow"
    }
  ]
}

```

## Additional AWS ParallelCluster `pcluster` user policy when using AWS Batch scheduler

In case you need to create and manage a cluster with AWS Batch scheduler, the following additional policy is required.

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Condition": {
        "StringEqualsIfExists": {
          "iam:PassedToService": [
            "ecs-tasks.amazonaws.com",
            "batch.amazonaws.com",
            "codebuild.amazonaws.com"
          ]
        }
      },
      "Action": [
        "iam:PassRole"
      ],
      "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
      ],
      "Effect": "Allow",
      "Sid": "IamPassRole"
    },
    {
      "Condition": {
        "StringEquals": {
          "iam:AWSServiceName": [
            "batch.amazonaws.com"
          ]
        }
      }
    }
  ]
}

```

```

        ]
    }
},
"Action": [
    "iam:CreateServiceLinkedRole",
    "iam>DeleteServiceLinkedRole"
],
"Resource": [
    "arn:aws:iam::<AWS ACCOUNT ID>:role/aws-service-role/
batch.amazonaws.com/*"
],
"Effect": "Allow"
},
{
    "Action": [
        "codebuild:*"
    ],
    "Resource": "arn:aws:codebuild:*:<AWS ACCOUNT ID>:project/pcluster-*",
    "Effect": "Allow"
},
{
    "Action": [
        "ecr:*"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "ECR"
},
{
    "Action": [
        "batch:*"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "Batch"
},
{
    "Action": [
        "events:*"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "AmazonCloudWatchEvents"
},

```



```

    {
      "Action": [
        "ecs:DescribeContainerInstances",
        "ecs:ListContainerInstances"
      ],
      "Resource": "*",
      "Effect": "Allow",
      "Sid": "ECS"
    }
  ]
}

```

## Additional AWS ParallelCluster `pcluster` user policy when using Amazon FSx for Lustre

In case you need to create and manage a cluster with Amazon FSx for Lustre, the following additional policy is required.

### Note

If existing Amazon FSx file systems are the only file systems used in your cluster, you can scope down the example Amazon FSx policy statements to the specific file systems referenced in the [SharedStorage section](#) of the cluster configuration file.

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Condition": {
        "StringEquals": {
          "iam:AWSServiceName": [
            "fsx.amazonaws.com",
            "s3.data-source.lustre.fsx.amazonaws.com"
          ]
        }
      },
      "Action": [
        "iam:CreateServiceLinkedRole",
        "iam>DeleteServiceLinkedRole"
      ],
    }
  ]
}

```

```

    "Resource": "*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "fsx:*"
    ],
    "Resource": [
      "arn:aws:fsx:*:<AWS ACCOUNT ID>:*"
    ],
    "Effect": "Allow",
    "Sid": "FSx"
  },
  {
    "Action": [
      "iam:CreateServiceLinkedRole",
      "iam:AttachRolePolicy",
      "iam:PutRolePolicy"
    ],
    "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:role/aws-service-role/s3.data-
source.lustre.fsx.amazonaws.com/*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "s3:Get*",
      "s3:List*",
      "s3:PutObject"
    ],
    "Resource": "arn:aws:s3:::<S3 NAME>",
    "Effect": "Allow"
  }
]
}

```

## AWS ParallelCluster image build pcluster user policy

Users that intend to create custom Amazon EC2 images with AWS ParallelCluster must have the following set of permissions.

```

{
  "Version": "2012-10-17",
  "Statement": [

```

```
{
  "Action": [
    "ec2:DescribeImages",
    "ec2:DescribeInstanceTypeOfferings",
    "ec2:DescribeInstanceTypes",
    "ec2:DeregisterImage",
    "ec2:DeleteSnapshot"
  ],
  "Resource": "*",
  "Effect": "Allow",
  "Sid": "EC2"
},
{
  "Action": [
    "iam:CreateInstanceProfile",
    "iam:AddRoleToInstanceProfile",
    "iam:GetRole",
    "iam:GetRolePolicy",
    "iam:GetInstanceProfile",
    "iam:RemoveRoleFromInstanceProfile"
  ],
  "Resource": [
    "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/parallelcluster/*",
    "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/ParallelClusterImage*",
    "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
  ],
  "Effect": "Allow",
  "Sid": "IAM"
},
{
  "Condition": {
    "StringEquals": {
      "iam:PassedToService": [
        "lambda.amazonaws.com",
        "ec2.amazonaws.com"
      ]
    }
  },
  "Action": [
    "iam:PassRole"
  ],
  "Resource": [
    "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/parallelcluster/*",
    "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
  ]
}
```

```

    ],
    "Effect": "Allow",
    "Sid": "IAMPassRole"
  },
  {
    "Action": [
      "logs:CreateLogGroup",
      "logs:TagResource",
      "logs:UntagResource",
      "logs>DeleteLogGroup"
    ],
    "Resource": [
      "arn:aws:logs:*:<AWS ACCOUNT ID>:log-group:/aws/imagebuilder/
ParallelClusterImage-*",
      "arn:aws:logs:*:<AWS ACCOUNT ID>:log-group:/aws/lambda/
ParallelClusterImage-*"
    ],
    "Effect": "Allow",
    "Sid": "CloudWatch"
  },
  {
    "Action": [
      "cloudformation:DescribeStacks",
      "cloudformation:CreateStack",
      "cloudformation>DeleteStack"
    ],
    "Resource": [
      "arn:aws:cloudformation:*:<AWS ACCOUNT ID>:stack/*"
    ],
    "Effect": "Allow",
    "Sid": "CloudFormation"
  },
  {
    "Action": [
      "lambda:CreateFunction",
      "lambda:GetFunction",
      "lambda:AddPermission",
      "lambda:RemovePermission",
      "lambda>DeleteFunction",
      "lambda:TagResource",
      "lambda:ListTags",
      "lambda:UntagResource"
    ],
    "Resource": [

```

```

        "arn:aws:lambda:*:<AWS ACCOUNT ID>:function:ParallelClusterImage-*"
    ],
    "Effect": "Allow",
    "Sid": "Lambda"
  },
  {
    "Action": [
      "imagebuilder:Get*"
    ],
    "Resource": "*",
    "Effect": "Allow",
    "Sid": "ImageBuilderGet"
  },
  {
    "Action": [
      "imagebuilder:CreateImage",
      "imagebuilder:TagResource",
      "imagebuilder:CreateImageRecipe",
      "imagebuilder:CreateComponent",
      "imagebuilder:CreateDistributionConfiguration",
      "imagebuilder:CreateInfrastructureConfiguration",
      "imagebuilder>DeleteImage",
      "imagebuilder>DeleteComponent",
      "imagebuilder>DeleteImageRecipe",
      "imagebuilder>DeleteInfrastructureConfiguration",
      "imagebuilder>DeleteDistributionConfiguration"
    ],
    "Resource": [
      "arn:aws:imagebuilder:*:<AWS ACCOUNT ID>:image/parallelclusterimage-*",
      "arn:aws:imagebuilder:*:<AWS ACCOUNT ID>:image-recipe/
parallelclusterimage-*",
      "arn:aws:imagebuilder:*:<AWS ACCOUNT ID>:component/
parallelclusterimage-*",
      "arn:aws:imagebuilder:*:<AWS ACCOUNT ID>:distribution-configuration/
parallelclusterimage-*",
      "arn:aws:imagebuilder:*:<AWS ACCOUNT ID>:infrastructure-configuration/
parallelclusterimage-*"
    ],
    "Effect": "Allow",
    "Sid": "ImageBuilder"
  },
  {
    "Action": [
      "s3:CreateBucket",

```

```

        "s3:ListBucket",
        "s3:ListBucketVersions"
    ],
    "Resource": [
        "arn:aws:s3:::parallelcluster-*"
    ],
    "Effect": "Allow",
    "Sid": "S3Bucket"
},
{
    "Action": [
        "sns:GetTopicAttributes",
        "sns:TagResource",
        "sns:CreateTopic",
        "sns:Subscribe",
        "sns:Publish",
        "SNS:DeleteTopic",
        "SNS:Unsubscribe"
    ],
    "Resource": [
        "arn:aws:sns:*:<AWS ACCOUNT ID>:ParallelClusterImage-*"
    ],
    "Effect": "Allow",
    "Sid": "SNS"
},
{
    "Action": [
        "s3:PutObject",
        "s3:GetObject",
        "s3:GetObjectVersion",
        "s3:DeleteObject",
        "s3:DeleteObjectVersion"
    ],
    "Resource": [
        "arn:aws:s3:::parallelcluster-*/*"
    ],
    "Effect": "Allow",
    "Sid": "S3Objects"
},
{
    "Action": "iam:CreateServiceLinkedRole",
    "Effect": "Allow",
    "Resource": "arn:aws:iam::*:role/aws-service-role/
imagebuilder.amazonaws.com/AWSServiceRoleForImageBuilder",

```

```
        "Condition": {
            "StringLike": {
                "iam:AWSServiceName": "imagebuilder.amazonaws.com"
            }
        }
    ]
}
```

## AWS ParallelCluster user example policies for managing IAM resources

When using AWS ParallelCluster to create clusters or custom AMIs, IAM policies must be provided that contain permissions to grant the required set of permissions to AWS ParallelCluster components. These IAM resources can be either automatically created by AWS ParallelCluster or be provided as input when creating a cluster or a custom image.

You can use the following modes to provide the AWS ParallelCluster user with the permissions required to access IAM resources by using additional IAM policies in the configuration.

### Topics

- [Privileged IAM access mode](#)
- [Restricted IAM access mode](#)
- [PermissionsBoundary mode](#)

### Privileged IAM access mode

With this mode, AWS ParallelCluster automatically creates all necessary IAM resources. These IAM policies are scoped down to enable access to cluster resources only.

To enable Privileged IAM access mode, add the following policy to the user role.

#### Note

If you configure [HeadNode / Iam / AdditionalPolicies](#) or [Scheduling / SlurmQueues / Iam / AdditionalPolicies](#) parameters, you must provide the AWS ParallelCluster user with permission to attach and detach role policies for each additional policy as shown in the following policy. Add the additional policy ARNs to the condition for attaching and detaching role policies.

**⚠ Warning**

This mode enables the user to have IAM Administrator privileges in the AWS account

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "iam:CreateServiceLinkedRole",
        "iam:DeleteRole",
        "iam:TagRole"
      ],
      "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
      ],
      "Effect": "Allow",
      "Sid": "IamRole"
    },
    {
      "Action": [
        "iam:CreateRole"
      ],
      "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
      ],
      "Effect": "Allow",
      "Sid": "IamCreateRole"
    },
    {
      "Action": [
        "iam:PutRolePolicy",
        "iam>DeleteRolePolicy"
      ],
      "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
      "Effect": "Allow",
      "Sid": "IamInlinePolicy"
    },
    {
      "Condition": {
        "ArnLike": {
```



```

        "iam:PolicyARN": [
            "arn:aws:iam::<AWS ACCOUNT ID>:policy/parallelcluster*",
            "arn:aws:iam::<AWS ACCOUNT ID>:policy/parallelcluster/*",
            "arn:aws:iam::aws:policy/CloudWatchAgentServerPolicy",
            "arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore",
            "arn:aws:iam::aws:policy/AWSBatchFullAccess",
            "arn:aws:iam::aws:policy/AmazonS3ReadOnlyAccess",
            "arn:aws:iam::aws:policy/service-role/AWSBatchServiceRole",
            "arn:aws:iam::aws:policy/service-role/
AmazonEC2ContainerServiceforEC2Role",
            "arn:aws:iam::aws:policy/service-role/
AmazonECSTaskExecutionRolePolicy",
            "arn:aws:iam::aws:policy/service-role/
AmazonEC2SpotFleetTaggingRole",
            "arn:aws:iam::aws:policy/EC2InstanceProfileForImageBuilder",
            "arn:aws:iam::aws:policy/service-role/
AWSLambdaBasicExecutionRole"
        ]
    },
    "Action": [
        "iam:AttachRolePolicy",
        "iam:DetachRolePolicy"
    ],
    "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
    "Effect": "Allow",
    "Sid": "IamPolicy"
}
]
}

```

## Restricted IAM access mode

When no additional IAM policies are granted to the user, IAM roles required by clusters or custom image build need to be manually created by an administrator and passed as part of the cluster configuration.

When creating a cluster the following parameters are required:

- [Iam / Roles / LambdaFunctionsRole](#)
- [HeadNode / Iam / InstanceRole | InstanceProfile](#)
- [Scheduling / SlurmQueues / Iam / InstanceRole | InstanceProfile](#)

When building a custom image the following parameters are required:

- [Build](#) / [Iam](#) / [InstanceRole](#) | [InstanceProfile](#)
- [Build](#) / [Iam](#) / [CleanupLambdaRole](#)

The IAM roles passed as part of the above listed parameters must be created on the `/parallelcluster/` path prefix. If this isn't possible, the user policy needs to be updated to grant `iam:PassRole` permission on the specific custom roles, as in the following example.

```
{
  "Condition": {
    "StringEqualsIfExists": {
      "iam:PassedToService": [
        "ecs-tasks.amazonaws.com",
        "lambda.amazonaws.com",
        "ec2.amazonaws.com",
        "spotfleet.amazonaws.com",
        "batch.amazonaws.com",
        "codebuild.amazonaws.com"
      ]
    }
  },
  "Action": [
    "iam:PassRole"
  ],
  "Resource": [
    <list all custom IAM roles>
  ],
  "Effect": "Allow",
  "Sid": "IamPassRole"
}
```

### Warning

Currently this mode does not allow the management of AWS Batch clusters because not all IAM roles can be passed in the cluster configuration.

## PermissionsBoundary mode

This mode delegates to AWS ParallelCluster the creation of IAM roles that are bound to the configured IAM permissions boundary. For more information on IAM permissions boundaries, see [Permissions boundaries for IAM entities](#) in the *IAM User Guide*.

The following policy needs to be added to the user role.

In the policy, replace `<permissions-boundary-arn>` with the IAM policy ARN to be enforced as permissions boundary.

### Warning

If you configure the [HeadNode / Iam / AdditionalPolicies](#) or [Scheduling / SlurmQueues / Iam / AdditionalPolicies](#) parameters, you must grant the user permission to attach and detach role policies for each additional policy as shown in the following policy. Add the additional policy ARNs to the condition for attaching and detaching role policies.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "iam:CreateServiceLinkedRole",
        "iam>DeleteRole",
        "iam:TagRole"
      ],
      "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
      ],
      "Effect": "Allow",
      "Sid": "IamRole"
    },
    {
      "Condition": {
        "StringEquals": {
          "iam:PermissionsBoundary": [
            <permissions-boundary-arn>
          ]
        }
      }
    }
  ]
}
```

```

    }
  },
  "Action": [
    "iam:CreateRole"
  ],
  "Resource": [
    "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*"
  ],
  "Effect": "Allow",
  "Sid": "IamCreateRole"
},
{
  "Condition": {
    "StringEquals": {
      "iam:PermissionsBoundary": [
        <permissions-boundary-arn>
      ]
    }
  },
  "Action": [
    "iam:PutRolePolicy",
    "iam>DeleteRolePolicy"
  ],
  "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
  "Effect": "Allow",
  "Sid": "IamInlinePolicy"
},
{
  "Condition": {
    "StringEquals": {
      "iam:PermissionsBoundary": [
        <permissions-boundary-arn>
      ]
    }
  },
  "ArnLike": {
    "iam:PolicyARN": [
      "arn:aws:iam::<AWS ACCOUNT ID>:policy/parallelcluster*",
      "arn:aws:iam::<AWS ACCOUNT ID>:policy/parallelcluster/*",
      "arn:aws:iam::aws:policy/CloudWatchAgentServerPolicy",
      "arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore",
      "arn:aws:iam::aws:policy/AWSBatchFullAccess",
      "arn:aws:iam::aws:policy/AmazonS3ReadOnlyAccess",
      "arn:aws:iam::aws:policy/service-role/AWSBatchServiceRole",

```

```

                "arn:aws:iam::aws:policy/service-role/
AmazonEC2ContainerServiceforEC2Role",
                "arn:aws:iam::aws:policy/service-role/
AmazonECSTaskExecutionRolePolicy",
                "arn:aws:iam::aws:policy/service-role/
AmazonEC2SpotFleetTaggingRole",
                "arn:aws:iam::aws:policy/EC2InstanceProfileForImageBuilder",
                "arn:aws:iam::aws:policy/service-role/
AWSLambdaBasicExecutionRole"
            ]
        },
        "Action": [
            "iam:AttachRolePolicy",
            "iam:DetachRolePolicy"
        ],
        "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
        "Effect": "Allow",
        "Sid": "IamPolicy"
    }
}

```

When this mode is enabled, you must specify the permissions boundary ARN in the [Iam / PermissionsBoundary](#) configuration parameter when creating or updating a cluster and in the [Build / Iam / PermissionBoundary](#) parameter when building a custom image.

## AWS ParallelCluster configuration parameters to manage IAM permissions

AWS ParallelCluster exposes a series of configuration options to customize and manage the IAM permissions and roles that are used in a cluster or during the custom AMI creation process.

### Topics

- [Cluster configuration](#)
- [Custom Image configuration](#)

## Cluster configuration

### Topics

- [Head node IAM role](#)
- [Amazon S3 access](#)
- [Additional IAM policies](#)
- [AWS Lambda functions role](#)
- [Compute nodes IAM role](#)
- [Permissions boundary](#)

## Head node IAM role

[HeadNode](#) / [Iam](#) / [InstanceRole](#) | [InstanceProfile](#)

With this option, you override the default IAM role that's assigned to the head node of the cluster. For additional details, please refer to the [InstanceProfile](#) reference.

Here is the minimal set of policies to be used as part of this role when the scheduler is Slurm:

- `arn:aws:iam::aws:policy/CloudWatchAgentServerPolicy` managed IAM policy. For more information, see [Create IAM roles and users for use with the CloudWatch agent](#) in the *Amazon CloudWatch User Guide*.
- `arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore` managed IAM policy. For more information, see [AWS managed policies for AWS Systems Manager](#) in the *AWS Systems Manager User Guide*.
- Additional IAM policy:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "s3:GetObject",
        "s3:GetObjectVersion"
      ],
      "Resource": [
        "arn:aws:s3:::<REGION>-aws-parallelcluster/*",
        "arn:aws:s3:::dcv-license.<REGION>/*",
        "arn:aws:s3:::parallelcluster-* -v1-do-not-delete/*"
      ],
      "Effect": "Allow"
    }
  ],
}
```

```

    {
      "Action": [
        "dynamodb:GetItem",
        "dynamodb:PutItem",
        "dynamodb:UpdateItem",
        "dynamodb:BatchWriteItem",
        "dynamodb:BatchGetItem"
      ],
      "Resource": "arn:aws:dynamodb:<REGION>:<AWS ACCOUNT ID>:table/
parallelcluster-*",
      "Effect": "Allow"
    },
    {
      "Condition": {
        "StringEquals": {
          "ec2:ResourceTag/parallelcluster:node-type": "Compute"
        }
      },
      "Action": "ec2:TerminateInstances",
      "Resource": "*",
      "Effect": "Allow"
    },
    {
      "Action": [
        "ec2:RunInstances",
        "ec2:CreateFleet"
      ],
      "Resource": "*",
      "Effect": "Allow"
    },
    {
      "Condition": {
        "StringEquals": {
          "iam:PassedToService": [
            "ec2.amazonaws.com"
          ]
        }
      },
      "Action": [
        "iam:PassRole"
      ],
      "Resource": [
        "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
        "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/parallelcluster/*"
      ]
    }
  ]
}

```

```

    ],
    "Effect": "Allow"
  },
  {
    "Action": [
      "ec2:DescribeInstances",
      "ec2:DescribeInstanceStatus",
      "ec2:DescribeVolumes",
      "ec2:DescribeInstanceAttribute",
      "ec2:DescribeCapacityReservations"
    ],
    "Resource": "*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "ec2:CreateTags",
      "ec2:AttachVolume"
    ],
    "Resource": [
      "arn:aws:ec2:<REGION>:<AWS ACCOUNT ID>:instance/*",
      "arn:aws:ec2:<REGION>:<AWS ACCOUNT ID>:volume/*"
    ],
    "Effect": "Allow"
  },
  {
    "Action": [
      "cloudformation:DescribeStacks",
      "cloudformation:DescribeStackResource",
      "cloudformation:SignalResource"
    ],
    "Resource": "*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "route53:ChangeResourceRecordSets"
    ],
    "Resource": "*",
    "Effect": "Allow"
  },
  {
    "Action": "secretsmanager:GetSecretValue",

```



```

        "Resource": "arn:aws:secretsmanager:<REGION>:<AWS ACCOUNT
    ID>:secret:<SECRET_ID>",
        "Effect": "Allow"
    }
]
}

```

Note that in case [Scheduling](#) / [SlurmQueues](#) / [Iam](#) / [InstanceRole](#) is used to override the compute IAM role, the head node policy reported above needs to include such role in the Resource section of the iam:PassRole permission.

Here is the minimal set of policies to be used as part of this role when the scheduler is AWS Batch:

- arn:aws:iam::aws:policy/CloudWatchAgentServerPolicy managed IAM policy. For more information, see [Create IAM roles and users for use with the CloudWatch agent](#) in the *Amazon CloudWatch User Guide*.
- arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore managed IAM policy. For more information, see [AWS managed policies for AWS Systems Manager](#) in the *AWS Systems Manager User Guide*.
- Additional IAM policy:

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "s3:GetObject",
        "s3:PutObject",
        "s3:GetObjectVersion"
      ],
      "Resource": [
        "arn:aws:s3:::parallelcluster-* -v1-do-not-delete/*"
      ],
      "Effect": "Allow"
    },
    {
      "Action": "s3:GetObject",
      "Resource": [
        "arn:aws:s3:::dcv-license.<REGION>/*",
        "arn:aws:s3:::<REGION>-aws-parallelcluster/*"
      ],
    }
  ]
}

```

```

    "Effect": "Allow"
  },
  {
    "Condition": {
      "StringEquals": {
        "iam:PassedToService": [
          "batch.amazonaws.com"
        ]
      }
    },
    "Action": [
      "iam:PassRole"
    ],
    "Resource": [
      "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
      "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/parallelcluster/*"
    ],
    "Effect": "Allow"
  },
  {
    "Action": [
      "batch:DescribeJobQueues",
      "batch:DescribeJobs",
      "batch:ListJobs",
      "batch:DescribeComputeEnvironments"
    ],
    "Resource": "*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "batch:SubmitJob",
      "batch:TerminateJob",
      "logs:GetLogEvents",
      "ecs:ListContainerInstances",
      "ecs:DescribeContainerInstances",
    ],
    "Resource": [
      "arn:aws:logs:<REGION>:<AWS ACCOUNT ID>:log-group:/aws/batch/job:log-stream:PclusterJobDefinition*",
      "arn:aws:ecs:<REGION>:<AWS ACCOUNT ID>:container-instance/AWSBatch-PclusterComputeEnviron*",
      "arn:aws:ecs:<REGION>:<AWS ACCOUNT ID>:cluster/AWSBatch-Pcluster*",
    ],
  }
}

```

```

        "arn:aws:batch:<REGION>:<AWS ACCOUNT ID>:job-queue/
PclusterJobQueue*",
        "arn:aws:batch:<REGION>:<AWS ACCOUNT ID>:job-definition/
PclusterJobDefinition*:*",
        "arn:aws:batch:<REGION>:<AWS ACCOUNT ID>:job/*"
    ],
    "Effect": "Allow"
},
{
    "Action": [
        "ec2:DescribeInstances",
        "ec2:DescribeInstanceStatus",
        "ec2:DescribeVolumes",
        "ec2:DescribeInstanceAttribute"
    ],
    "Resource": "*",
    "Effect": "Allow"
},
{
    "Action": [
        "ec2:CreateTags",
        "ec2:AttachVolume"
    ],
    "Resource": [
        "arn:aws:ec2:<REGION>:<AWS ACCOUNT ID>:instance/*",
        "arn:aws:ec2:<REGION>:<AWS ACCOUNT ID>:volume/*"
    ],
    "Effect": "Allow"
},
{
    "Action": [
        "cloudformation:DescribeStackResource",
        "cloudformation:DescribeStacks",
        "cloudformation:SignalResource"
    ],
    "Resource": "*",
    "Effect": "Allow"
},
{
    "Action": "secretsmanager:GetSecretValue",
    "Resource": "arn:aws:secretsmanager:<REGION>:<AWS ACCOUNT
ID>:secret:<SECRET_ID>",
    "Effect": "Allow"
}

```

```
]
}
```

## Amazon S3 access

[HeadNode / Iam / S3Access](#) or [Scheduling / SlurmQueues / S3Access](#)

In these configuration sections, you can customize the Amazon S3 access by granting additional Amazon S3 policies to the IAM roles associated with the head node or compute nodes of the cluster when such roles are created by AWS ParallelCluster. For more information, see the reference documentation for each of the configuration parameter.

This parameter can be only used when the user is configured with [Privileged IAM access mode](#) or [PermissionsBoundary mode](#).

## Additional IAM policies

[HeadNode / Iam / AdditionalIamPolicies](#) or [SlurmQueues / Iam / AdditionalIamPolicies](#)

Use this option to attach additional managed IAM policies to the IAM roles associated with the head node or compute nodes of the cluster when such roles are created by AWS ParallelCluster.

### Warning

To use this option, make sure the [AWS ParallelCluster user](#) is granted `iam:AttachRolePolicy` and `iam:DetachRolePolicy` permissions for the IAM policies that need to be attached.

## AWS Lambda functions role

[Iam / Roles / LambdaFunctionsRole](#)

This option overrides the role attached to all AWS Lambda functions that are used during the cluster creation process. AWS Lambda needs to be configured as the principal allowed to assume the role.

**Note**

If [DeploymentSettings / LambdaFunctionsVpcConfig](#) is set, the `LambdaFunctionsRole` must include the [AWS Lambda role permission](#) to set the VPC configuration.

Here is the minimal set of policies to be used as part of this role:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "route53:ListResourceRecordSets",
        "route53:ChangeResourceRecordSets"
      ],
      "Resource": "arn:aws:route53::hostedzone/*",
      "Effect": "Allow"
    },
    {
      "Action": ["logs:CreateLogStream", "logs:PutLogEvents"],
      "Effect": "Allow",
      "Resource": "arn:aws:logs:<REGION>:<AWS ACCOUNT ID>:log-group:/aws/lambda/
pcluster-*"
    },
    {
      "Action": "ec2:DescribeInstances",
      "Effect": "Allow",
      "Resource": "*"
    },
    {
      "Action": "ec2:TerminateInstances",
      "Condition": {
        "StringEquals": {
          "ec2:ResourceTag/parallelcluster:node-type": "Compute"
        }
      },
      "Effect": "Allow",
      "Resource": "*"
    }
  ]
}
```

```

    "Action": [
      "s3:DeleteObject",
      "s3:DeleteObjectVersion",
      "s3:ListBucket",
      "s3:ListBucketVersions"
    ],
    "Effect": "Allow",
    "Resource": [
      "arn:aws:s3:::parallelcluster-*-v1-do-not-delete",
      "arn:aws:s3:::parallelcluster-*-v1-do-not-delete/*"
    ]
  }
]
}

```

## Compute nodes IAM role

[Scheduling](#) / [SlurmQueues](#) / [Iam](#) / [InstanceRole](#) | [InstanceProfile](#)

This option allows to override the IAM role that is assigned to the compute nodes of the cluster. For more information, see [InstanceProfile](#).

Here is the minimal set of policies to be used as part of this role:

- `arn:aws:iam::aws:policy/CloudWatchAgentServerPolicy` managed IAM policy. For more information, see [Create IAM roles and users for use with the CloudWatch agent](#) in the *Amazon CloudWatch User Guide*.
- `arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore` managed IAM policy. For more information, see [AWS managed policies for AWS Systems Manager](#) in the *AWS Systems Manager User Guide*.
- Additional IAM policy:

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "dynamodb:Query",
        "dynamodb:UpdateItem",
        "dynamodb:PutItem",
        "dynamodb:GetItem"
      ],
    }
  ],
}

```

```

        "Resource": "arn:aws:dynamodb:<REGION>:<AWS ACCOUNT ID>:table/
parallelcluster-*",
        "Effect": "Allow"
    },
    {
        "Action": "s3:GetObject",
        "Resource": [
            "arn:aws:s3:::<REGION>-aws-parallelcluster/*"
        ],
        "Effect": "Allow"
    },
    {
        "Action": "ec2:DescribeInstanceAttribute",
        "Resource": "*",
        "Effect": "Allow"
    },
    {
        "Action": "cloudformation:DescribeStackResource",
        "Resource":
            [ "arn:aws:cloudformation:<REGION>:<AWS ACCOUNT ID>:stack/*/*" ],
        "Effect": "Allow"
    }
]
}

```

## Permissions boundary

### [Iam / PermissionsBoundary](#)

This parameter forces AWS ParallelCluster to attach the given IAM policy as a `PermissionsBoundary` to all IAM roles that are created as part of a cluster deployment.

See [PermissionsBoundary mode](#) for the list of policies required by the user when this setting is defined.

## Custom Image configuration

### Topics

- [Instance role for EC2 Image Builder](#)
- [AWS Lambda cleanup role](#)

- [Additional IAM policies](#)
- [Permissions boundary](#)

## Instance role for EC2 Image Builder

[Build](#) / [Iam](#) / [InstanceRole](#) | [InstanceProfile](#)

With this option you override the IAM role that is assigned to the Amazon EC2 instance launched by EC2 Image Builder to create a custom AMI.

Here is the minimal set of policies to be used as part of this role:

- `arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore` managed IAM policy. For more information, see [AWS managed policies for AWS Systems Manager](#) in the *AWS Systems Manager User Guide*.
- `arn:aws:iam::aws:policy/EC2InstanceProfileForImageBuilder` managed IAM policy. For more information, see [EC2InstanceProfileForImageBuilder policy](#) in the *Image Builder User Guide*.
- Additional IAM policy:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "ec2:CreateTags",
        "ec2:ModifyImageAttribute"
      ],
      "Resource": "arn:aws:ec2:<REGION>::image/*",
      "Effect": "Allow"
    }
  ]
}
```

## AWS Lambda cleanup role

[Build](#) / [Iam](#) / [CleanupLambdaRole](#)



This option overrides the role attached to all AWS Lambda functions that are used during the custom image build process. AWS Lambda needs to be configured as the principal allowed to assume the role.

### Note

If [DeploymentSettings / LambdaFunctionsVpcConfig](#) is set, the `CleanupLambdaRole` must include the [AWS Lambda role permission](#) to set the VPC configuration.

Here is the minimal set of policies to be used as part of this role:

- `arn:aws:iam::aws:policy/service-role/AWSLambdaBasicExecutionRole` managed IAM policy. For more information, see [AWS managed policies for Lambda features](#) in the *AWS Lambda Developer Guide*.
- Additional IAM policy:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "iam:DetachRolePolicy",
        "iam>DeleteRole",
        "iam>DeleteRolePolicy"
      ],
      "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:role/parallelcluster/*",
      "Effect": "Allow"
    },
    {
      "Action": [
        "iam>DeleteInstanceProfile",
        "iam:RemoveRoleFromInstanceProfile"
      ],
      "Resource": "arn:aws:iam::<AWS ACCOUNT ID>:instance-profile/parallelcluster/*",
      "Effect": "Allow"
    },
    {
      "Action": "imagebuilder:DeleteInfrastructureConfiguration",
```

```

        "Resource": "arn:aws:imagebuilder:<REGION>:<AWS ACCOUNT
ID>:infrastructure-configuration/parallelclusterimage-*",
        "Effect": "Allow"
    },
    {
        "Action": [
            "imagebuilder:DeleteComponent"
        ],
        "Resource": [
            "arn:aws:imagebuilder:<REGION>:<AWS ACCOUNT ID>:component/
parallelclusterimage-*/*"
        ],
        "Effect": "Allow"
    },
    {
        "Action": "imagebuilder:DeleteImageRecipe",
        "Resource": "arn:aws:imagebuilder:<REGION>:<AWS ACCOUNT ID>:image-recipe/
parallelclusterimage-*/*",
        "Effect": "Allow"
    },
    {
        "Action": "imagebuilder:DeleteDistributionConfiguration",
        "Resource": "arn:aws:imagebuilder:<REGION>:<AWS ACCOUNT ID>:distribution-
configuration/parallelclusterimage-*",
        "Effect": "Allow"
    },
    {
        "Action": [
            "imagebuilder:DeleteImage",
            "imagebuilder:GetImage",
            "imagebuilder:CancelImageCreation"
        ],
        "Resource": "arn:aws:imagebuilder:<REGION>:<AWS ACCOUNT ID>:image/
parallelclusterimage-*/*",
        "Effect": "Allow"
    },
    {
        "Action": "cloudformation:DeleteStack",
        "Resource": "arn:aws:cloudformation:<REGION>:<AWS ACCOUNT ID>:stack/*/*",
        "Effect": "Allow"
    },
    {
        "Action": "ec2:CreateTags",
        "Resource": "arn:aws:ec2:<REGION>::image/*",

```

```

    "Effect": "Allow"
  },
  {
    "Action": "tag:TagResources",
    "Resource": "*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "lambda:DeleteFunction",
      "lambda:RemovePermission"
    ],
    "Resource": "arn:aws:lambda:<REGION>:<AWS ACCOUNT
ID>:function:ParallelClusterImage-*",
    "Effect": "Allow"
  },
  {
    "Action": "logs:DeleteLogGroup",
    "Resource": "arn:aws:logs:<REGION>:<AWS ACCOUNT ID>:log-group:/aws/
lambda/ParallelClusterImage-*:*",
    "Effect": "Allow"
  },
  {
    "Action": [
      "SNS:GetTopicAttributes",
      "SNS:DeleteTopic",
      "SNS:GetSubscriptionAttributes",
      "SNS:Unsubscribe"
    ],
    "Resource": "arn:aws:sns:<REGION>:<AWS ACCOUNT ID>:ParallelClusterImage-
*",
    "Effect": "Allow"
  }
]
}

```

## Additional IAM policies

### [Build / Iam / AdditionalIamPolicies](#)

You use this option to attach additional managed IAM policies to the role associated with the Amazon EC2 instance used by EC2 Image Builder to produce the custom AMI.

**⚠ Warning**

To use this option, make sure the [AWS ParallelClusteruser](#) is granted `iam:AttachRolePolicy` and `iam:DetachRolePolicy` permissions for the IAM policies that need to be attached.

## Permissions boundary

[Build](#) / [Iam](#) / [PermissionsBoundary](#)

This parameter forces AWS ParallelCluster to attach the given IAM policy as a `PermissionsBoundary` to all IAM roles that are created as part of custom AMI build.

See [PermissionsBoundary mode](#) for the list of policies required to use such functionality.

## Network configurations

AWS ParallelCluster uses Amazon Virtual Private Cloud (VPC) for networking. VPC provides a flexible and configurable networking platform where you can deploy clusters.

The VPC must have `DNS Resolution = yes`, `DNS Hostnames = yes` and DHCP options with the correct domain-name for the Region. The default DHCP Option Set already specifies the required *AmazonProvidedDNS*. If specifying more than one domain name server, see [DHCP options sets](#) in the *Amazon VPC User Guide*.

AWS ParallelCluster supports the following high-level configurations:

- One subnet for both head and compute nodes.
- Two subnets, with the head node in one public subnet, and compute nodes in a private subnet. The subnets can be either new or existing ones.

All of these configurations can operate with or without public IP addressing. AWS ParallelCluster can also be deployed to use an HTTP proxy for all AWS requests. The combinations of these configurations result in many deployment scenarios. For example, you can configure a single public subnet with all access over the internet. Or, you can configure a fully private network using AWS Direct Connect and HTTP proxy for all traffic.

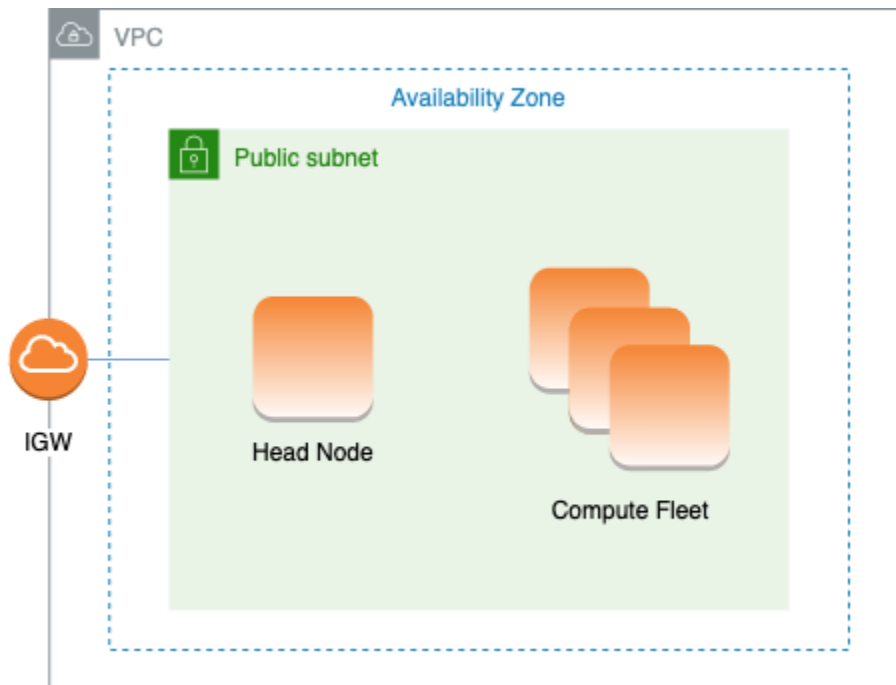
Starting from AWS ParallelCluster 3.0.0 it is possible to configure different SecurityGroups, AdditionalSecurityGroups and PlacementGroup settings for each queue. For more information, see [HeadNode / Networking](#) and [SlurmQueues / Networking](#) and [AwsBatchQueues / Networking](#).

For illustrations of some networking scenarios, see the following architecture diagrams.

## Topics

- [AWS ParallelCluster in a single public subnet](#)
- [AWS ParallelCluster using two subnets](#)
- [AWS ParallelCluster in a single private subnet connected using AWS Direct Connect](#)
- [AWS ParallelCluster with AWS Batch scheduler](#)
- [AWS ParallelCluster in a single subnet with no internet access](#)

## AWS ParallelCluster in a single public subnet



The configuration for this architecture requires the following settings:

```
# Note that all values are only provided as examples
HeadNode:
```

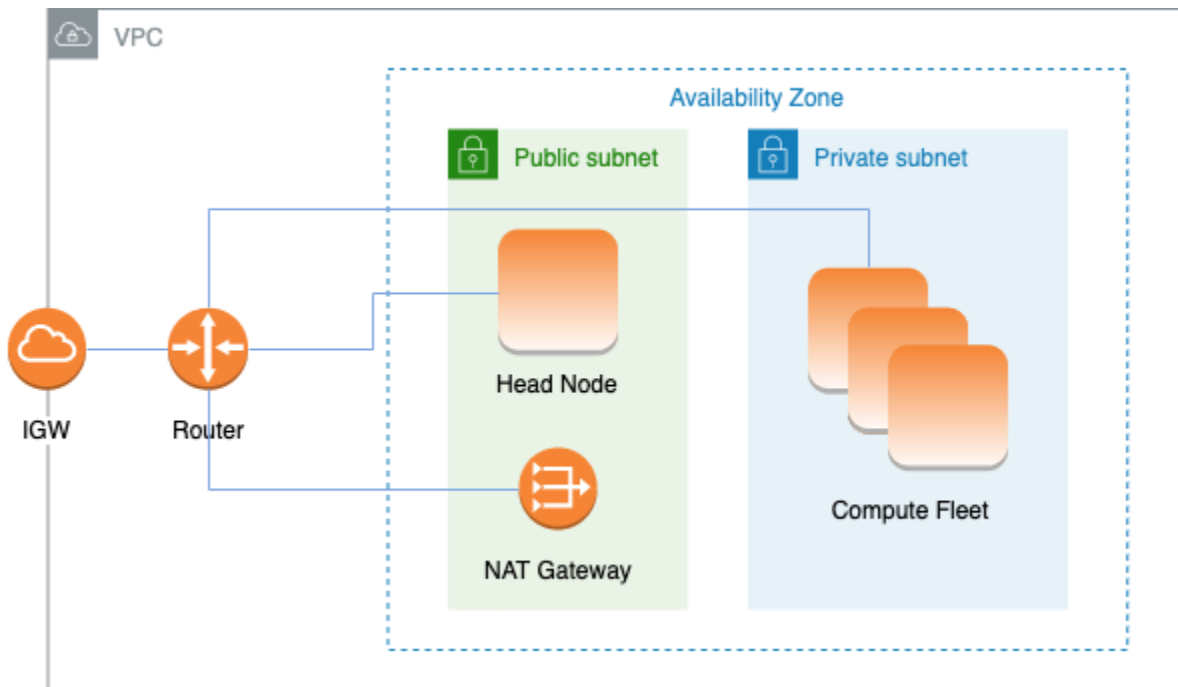
```
...
Networking:
  SubnetId: subnet-12345678 # subnet with internet gateway
  #ElasticIp: true | false | eip-12345678
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - ...
    Networking:
      SubnetIds:
        - subnet-12345678 # subnet with internet gateway
      #AssignPublicIp: true
```

In this configuration, all instances of the cluster must be assigned a public IP in order to get internet access. To achieve this, do the following:

- Make sure the head node is assigned a public IP address by either turning on the "Enable auto-assign public IPv4 address" setting for the subnet used in [HeadNode / Networking / SubnetId](#) or by assigning an Elastic IP in [HeadNode / Networking / ElasticIp](#).
- Make sure the compute nodes are assigned a public IP address by either turning on the "Enable auto-assign public IPv4 address" setting for the subnet used in [Scheduling / SlurmQueues / Networking / SubnetIds](#) or by setting `AssignPublicIp: true` in [Scheduling / SlurmQueues / Networking](#).
- If you define a p4d instance type, or another instance type that has multiple network interfaces or a network interface card to the head node, you must set [HeadNode / Networking / ElasticIp](#) to `true` to provide public access. AWS public IPs can only be assigned to instances launched with a single network interface. For this case, we recommend that you use a [NAT gateway](#) to provide public access to the cluster compute nodes. For more information on IP addresses, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.
- You can't define a p4d or hp6id instance type, or another instance type that has multiple network interfaces or a network interface card to compute nodes because AWS public IPs can only be assigned to instances launched with a single network interface. For more information on IP addresses, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.

For more information, see [Enabling internet access](#) in *Amazon VPC User Guide*.

## AWS ParallelCluster using two subnets



The configuration to use an existing private subnet for compute instances requires the following settings:

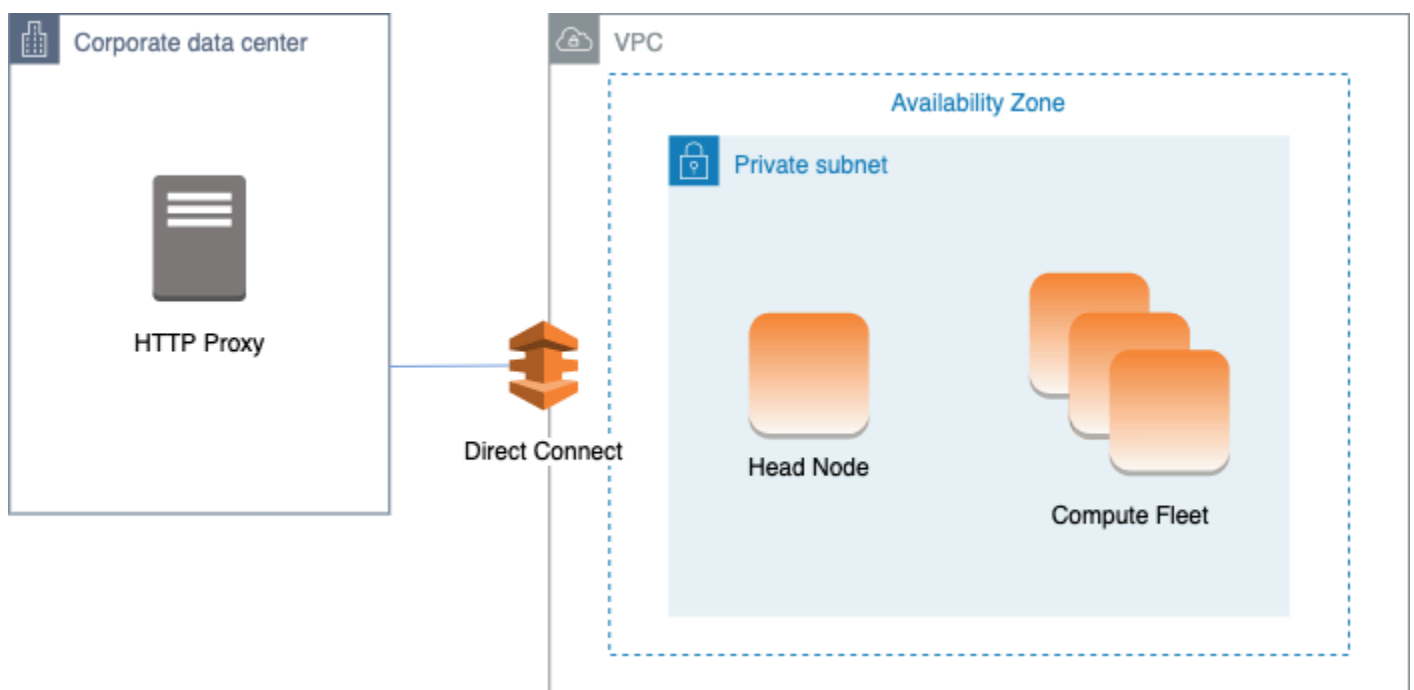
```
# Note that all values are only provided as examples
HeadNode:
  ...
  Networking:
    SubnetId: subnet-12345678 # subnet with internet gateway
    #ElasticIp: true | false | eip-12345678
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - ...
      Networking:
        SubnetIds:
          - subnet-23456789 # subnet with NAT gateway
        #AssignPublicIp: false
```

In this configuration, only the head node of the cluster is required to have a public IP assigned. You can achieve this by either turning on the "Enable auto-assign public IPv4 address" setting for the subnet used in [HeadNode](#) / [Networking](#) / [SubnetId](#) or by assigning an Elastic IP in [HeadNode](#) / [Networking](#) / [ElasticIp](#).

If you define a p4d instance type or another instance type that has multiple network interfaces or a network interface card to the head node, you must set [HeadNode / Networking / ElasticIp](#) to true to provide public access. AWS public IPs can only be assigned to instances launched with a single network interface. For more information on IP addresses, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.

This configuration requires a [NAT gateway](#) or an internal proxy in the subnet used for the queues, to give internet access to the compute instances.

## AWS ParallelCluster in a single private subnet connected using AWS Direct Connect



The configuration for this architecture requires the following settings:

```
# Note that all values are only provided as examples
HeadNode:
  ...
  Networking:
    SubnetId: subnet-34567890 # subnet with proxy
  Proxy:
    HttpProxyAddress: http://proxy-address:port
  Ssh:
    KeyName: ec2-key-name
Scheduling:
```



```
Scheduler: slurm
SlurmQueues:
- ...
  Networking:
    SubnetIds:
      - subnet-34567890 # subnet with proxy
    AssignPublicIp: false
    Proxy:
      HttpProxyAddress: http://proxy-address:port
```

When [Scheduling](#) / [SlurmQueues](#) / [Networking](#) / [AssignPublicIp](#) is set to false, the subnets must be correctly set up to use the Proxy for all traffic. Web access is required for both head and compute nodes.

## AWS ParallelCluster with AWS Batch scheduler

When you use `awsbatch` as the scheduler type, AWS ParallelCluster creates an AWS Batch managed compute environment. The AWS Batch environment manages Amazon Elastic Container Service (Amazon ECS) container instances. These instances are launched in the subnet configured in the [AwsBatchQueues](#) / [Networking](#) / [SubnetIds](#) parameter. For AWS Batch to function correctly, Amazon ECS container instances need external network access to communicate with the Amazon ECS service endpoint. This translates into the following scenarios:

- The Subnet ID specified for the queue uses a [NAT gateway](#) to access the internet. We recommended this approach.
- Instances launched in the queue subnet have public IP addresses and can reach the internet through an Internet Gateway.

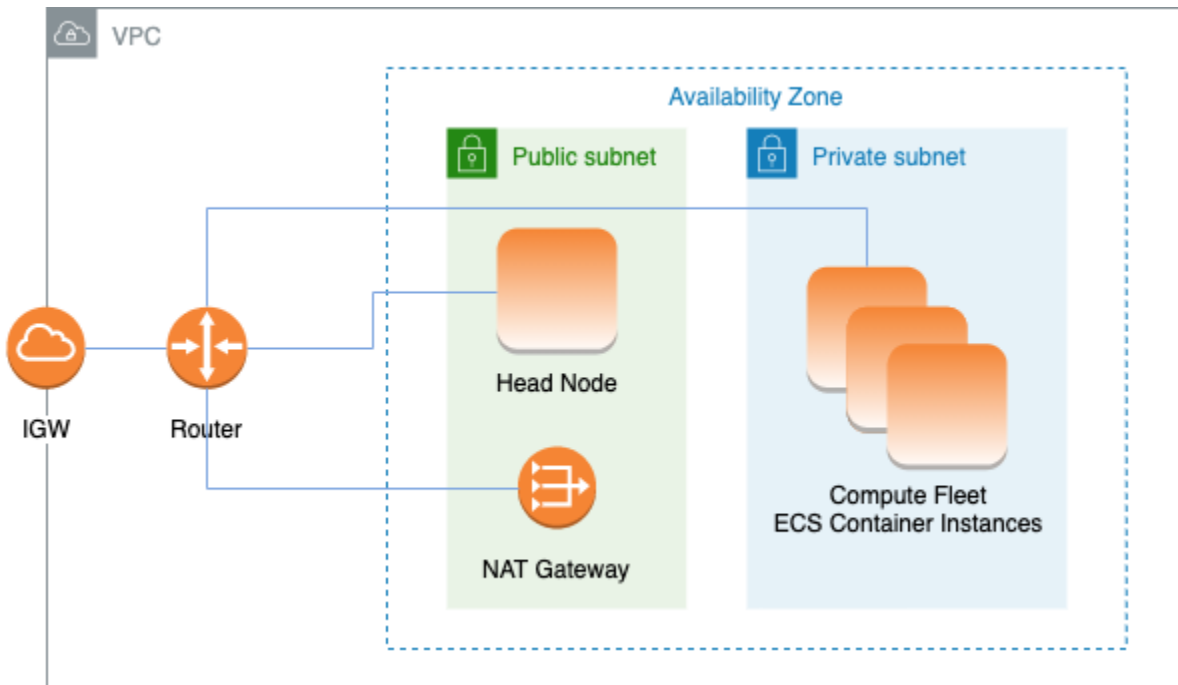
Additionally, if you're interested in multi-node parallel jobs (from the [AWS Batch docs](#)):

AWS Batch multi-node parallel jobs use the Amazon ECS `awsvpc` network mode. This gives your multi-node parallel job containers the same networking properties as Amazon EC2 instances. Each multi-node parallel job container gets its own elastic network interface, a primary private IP address, and an internal DNS hostname. The network interface is created in the same Amazon VPC subnet as its host compute resource. Any security groups that are applied to your compute resources are also applied to it.

When using Amazon ECS Task Networking, the `awsvpc` network mode doesn't provide elastic network interfaces with public IP addresses for tasks that use the Amazon EC2 launch type. To

access the internet, tasks that use the Amazon EC2 launch type must be launched in a private subnet that's configured to use a NAT gateway.

You must configure a [NAT gateway](#) in order to enable the cluster to run multi-node parallel jobs.



All the previous configuration and considerations are valid for AWS Batch, too. The following is an example of a AWS Batch networking configuration.

```
# Note that all values are only provided as examples
HeadNode:
  ...
  Networking:
    SubnetId: subnet-12345678 # subnet with internet gateway, NAT gateway or proxy
    #ElasticIp: true | false | eip-12345678
    #Proxy:
      #HttpProxyAddress: http://proxy-address:port
  Ssh:
    KeyName: ec2-key-name
  Scheduling:
    Scheduler: awsbatch
  AwsBatchQueues:
    - ...
      Networking:
        SubnetIds:
          - subnet-23456789 # subnet with internet gateway, NAT gateway or proxy
```

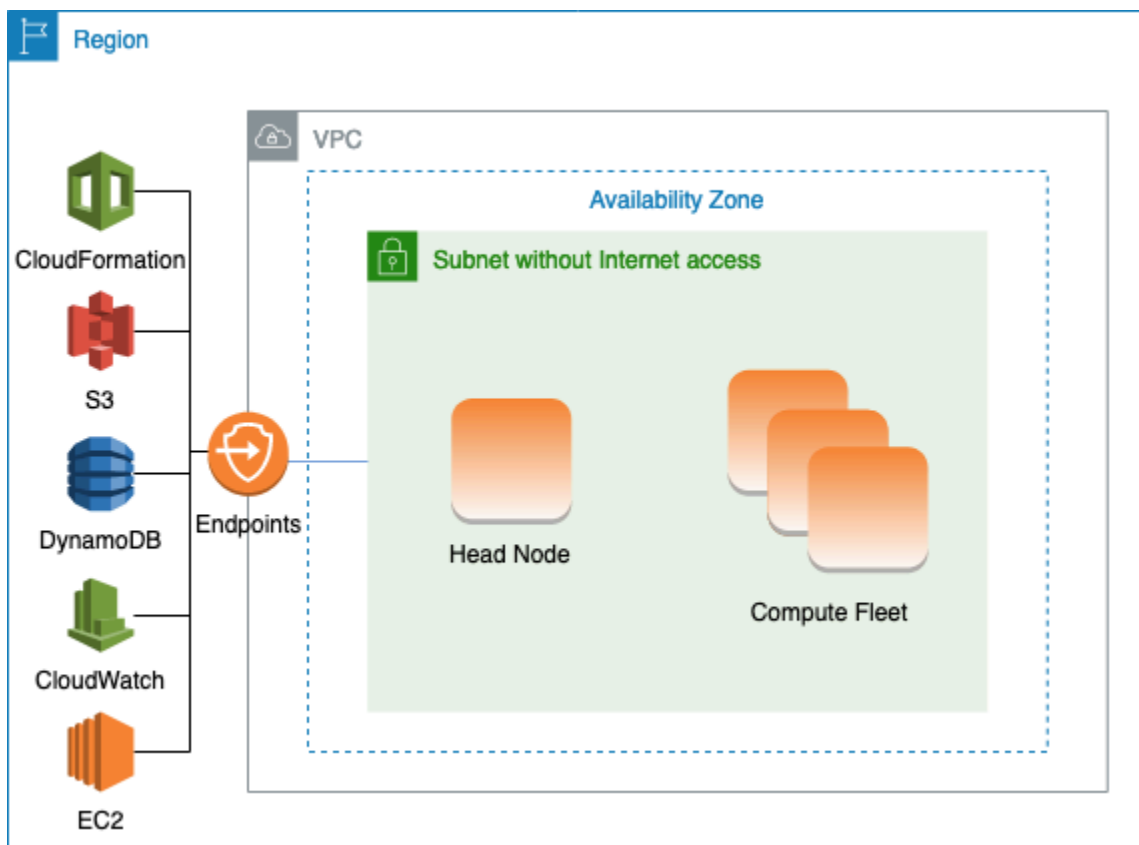
```
#AssignPublicIp: true | false
```

In the [Scheduling](#) / [AwsBatchQueues](#) / [Networking](#) section, the [SubnetIds](#) is a list type but, currently, only one subnet is supported.

For more information, see the following topics:

- [AWS Batch managed compute environments](#)
- [AWS Batch multi-node parallel jobs](#)
- [Amazon ECS task networking with the awsvpc network mode](#)

## AWS ParallelCluster in a single subnet with no internet access



A subnet without internet access doesn't allow inbound or outbound connections to the internet. This AWS ParallelCluster configuration can help security-concerned customers further enhance the security of their AWS ParallelCluster resources. AWS ParallelCluster nodes are built from AWS ParallelCluster AMIs that include all of the software that's required to run a cluster with no internet access. This way, AWS ParallelCluster can create and manage clusters with nodes that don't have internet access.

In this section, you learn about how to configure the cluster. You also learn about limitations in running clusters without internet access.

## Configuring VPC endpoints

To ensure the proper functioning of the cluster, the cluster nodes must be able to interact with a number of AWS Services.

Create and configure the following [VPC endpoints](#) so that cluster nodes can interact with the AWS Services, without internet access:

### Commercial and AWS GovCloud (US) partitions

Service	Service name	Type
Amazon CloudWatch	com.amazonaws. <i>region-id</i> .logs	Interface
AWS CloudFormation	com.amazonaws. <i>region-id</i> .cloudformation	Interface
Amazon EC2	com.amazonaws. <i>region-id</i> .ec2	Interface
Amazon S3	com.amazonaws. <i>region-id</i> .s3	Gateway
Amazon DynamoDB	com.amazonaws. <i>region-id</i> .dynamodb	Gateway
AWS Secrets Manager**	com.amazonaws. <i>region-id</i> .secretsmanager	Interface

### China partition

Service	Service name	Type
Amazon CloudWatch	com.amazonaws. <i>region-id</i> .logs	Interface

Service	Service name	Type
AWS CloudFormation	cn.com.amazonaws. <i>region-id</i> .cloudformation	Interface
Amazon EC2	cn.com.amazonaws. <i>region-id</i> .ec2	Interface
Amazon S3	com.amazonaws. <i>region-id</i> .s3	Gateway
Amazon DynamoDB	com.amazonaws. <i>region-id</i> .dynamodb	Gateway
AWS Secrets Manager**	com.amazonaws. <i>region-id</i> .secretsmanager	Interface

\*\* This endpoint is only required when [DirectoryService](#) is enabled, otherwise it is optional.

All instances in the VPC must have proper security groups to communicate with the endpoints. You can do this by adding security groups to [AdditionalSecurityGroups](#) under the [HeadNode](#) and [AdditionalSecurityGroups](#) under the [SlurmQueues](#) configurations. For example, if the VPC endpoints are created without explicitly specifying a security group, the default security group is associated with the endpoints. By adding the default security group to [AdditionalSecurityGroups](#), you enable the communication between the cluster and the endpoints.

### Note

When you use IAM policies to restrict access to VPC endpoints, you must add the following to the Amazon S3 VPC endpoint:

```
PolicyDocument:
  Version: 2012-10-17
  Statement:
    - Effect: Allow
      Principal: "*"
      Action:
        - "s3:PutObject"
```

```
Resource:
  - !Sub "arn:${AWS::Partition}:s3::cloudformation-waitcondition-
    ${AWS::Region}/*"
```

## Disable Route 53 and use Amazon EC2 hostnames

When creating a Slurm cluster, AWS ParallelCluster creates a private Route 53 hosted zone that is used to resolve the custom compute node hostnames, such as `{queue_name}-{st|dy}-{compute_resource}-{N}`. Because Route 53 doesn't support VPC endpoints, this feature must be disabled. Additionally, AWS ParallelCluster must be configured to use the default Amazon EC2 hostnames, such as `ip-1-2-3-4`. Apply the following settings to your cluster configuration:

```
...
Scheduling:
  ...
SlurmSettings:
  Dns:
    DisableManagedDns: true
    UseEc2Hostnames: true
```

### Warning

For clusters created with [SlurmSettings](#) / [Dns](#) / [DisableManagedDns](#) and [UseEc2Hostnames](#) set to `true`, the Slurm `NodeName` isn't resolved by the DNS. Use the Slurm `NodeHostName` instead.

### Note

**This note isn't relevant starting with AWS ParallelCluster version 3.3.0.**

For AWS ParallelCluster supported versions prior to 3.3.0:

When `UseEc2Hostnames` is set to `true`, the Slurm configuration file is set with the AWS ParallelCluster prolog and epilog scripts:

- `prolog` runs to add nodes info to `/etc/hosts` on compute nodes when each job is allocated.
- `epilog` runs to clean contents written by `prolog`.

To add custom prolog or epilog scripts, add them to the `/opt/slurm/etc/pcluster/prolog.d/` or `/opt/slurm/etc/pcluster/epilog.d/` folders respectively.

## Cluster configuration

Learn how to configure your cluster to run in a subnet with no connection to the internet.

The configuration for this architecture requires the following settings:

```
# Note that all values are only provided as examples
...
HeadNode:
  ...
  Networking:
    SubnetId: subnet-1234567890abcdef0 # the VPC of the subnet needs to have VPC
    endpoints
    AdditionalSecurityGroups:
      - sg-abcdef01234567890 # optional, the security group that enables the
      communication between the cluster and the VPC endpoints
Scheduling:
  Scheduler: Slurm # Cluster in a subnet without internet access is supported only when
  the scheduler is Slurm.
  SlurmSettings:
    Dns:
      DisableManagedDns: true
      UseEc2Hostnames: true
  SlurmQueues:
    - ...
      Networking:
        SubnetIds:
          - subnet-1234567890abcdef0 # the VPC of the subnet needs to have VPC
          endpoints attached
          AdditionalSecurityGroups:
            - sg-1abcdef01234567890 # optional, the security group that enables the
            communication between the cluster and the VPC endpoints
```

- [SubnetId\(s\)](#): The subnet without internet access.

To enable communication between AWS ParallelCluster and AWS Services, the VPC of the subnet must have the VPC endpoints attached. Before you create your cluster, verify that [auto-assign](#)

[public IPv4 address is disabled](#) in the subnet to ensure that the `pcluster` commands have access to the cluster.

- [AdditionalSecurityGroups](#): The security group that enables the communication between the cluster and the VPC endpoints.

Optional:

- If the VPC endpoints are created without explicitly specifying a security group, the default security group of the VPC is associated. Therefore, provide the default security group to `AdditionalSecurityGroups`.
- If custom security groups are used when creating the cluster and/or the VPC endpoints, `AdditionalSecurityGroups` is unnecessary as long as the custom security groups enable communication between the cluster and the VPC endpoints.
- [Scheduler](#): The cluster scheduler.

`slurm` is the only valid value. Only the Slurm scheduler supports a cluster in a subnet without internet access.

- [SlurmSettings](#): The Slurm settings.

See the preceding section *Disable Route53 and use Amazon EC2 hostnames*.

## Limitations

- *Connecting to the head node over SSH or NICE DCV*: When connecting to a cluster, make sure the client of the connection can reach the head node of the cluster through its private IP address. If the client isn't in the same VPC as the head node, use a proxy instance in a public subnet of the VPC. This requirement applies to both SSH and DCV connections. The public IP of a head node isn't accessible if the subnet doesn't have internet access. The `pcluster ssh` and `dcv-connect` commands use the public IP if it exists or the private IP. Before you create your cluster, verify that [auto-assign public IPv4 address is disabled](#) in the subnet to ensure that the `pcluster` commands have access to the cluster.

The following example shows how you can connect to a DCV session running in the head node of your cluster. You connect through a proxy Amazon EC2 instance. The instance functions as a NICE DCV server for your PC and as the client for the head node in the private subnet.

Connect over DCV through a proxy instance in a public subnet:



1. Create an Amazon EC2 instance in a public subnet, which is in the same VPC as the cluster's subnet.
  2. Ensure that the NICE DCV client and server are installed on your Amazon EC2 instance.
  3. Attach an AWS ParallelCluster User Policy to the proxy Amazon EC2 instance. For more information, see [AWS ParallelCluster example `pcluster` user policies](#).
  4. Install AWS ParallelCluster on the proxy Amazon EC2 instance.
  5. Connect over DCV to the proxy Amazon EC2 instance.
  6. Use the `pcluster dcv-connect` command on the proxy instance to connect to the cluster inside the subnet without internet access.
- *Interacting with other AWS services:* Only services strictly required by AWS ParallelCluster are listed above. If your cluster must interact with other services, create the corresponding VPC endpoints.

## Login nodes

Starting from version 3.7.0, AWS ParallelCluster cluster administrators can provision login nodes that can be used to provide access to users to run jobs vs directly accessing the cluster head node.

Cluster users with appropriate permissions can use Active Directory or their ssh credential to login, submit and manage their jobs. As a result, cluster management can be improved and the chances of depleting the resources of the head node required by Slurm to manage the cluster can be minimized. Logged in users will also have access to all shared storage of the cluster mounted on login nodes. If a login nodes needs to be stopped logged in users will be notified in advance through the active shell session they are using.

Login nodes are specified as pools where a pool defines a group of login nodes that have the same resource configuration. All the login nodes in a pool are configured to be part of a [network load balancer](#) that enables distributing sessions across login nodes in a round-robin fashion. The present implementation allows for specifying one pool of login nodes containing multiple Login nodes.

### Security

Login nodes inherit the AllowedIPs settings [AllowedIps](#) from the head node. In this manner, cluster administrators can restrict the security posture of the cluster by specifying the source CIDR or a prefix-list from where SSH connections are allowed.

In the present implementation the access to the head node is not automatically restricted when enabling login nodes. If needed, a cluster administrator can restrict this access updating the head nodes ssh configuration using standard Linux commands. This can be also be accomplished by specifying custom Security Groups on the head node by using the `AdditionalSecurityGroups` setting in the head node section of the ParallelCluster YAML file to deny connections from unauthorized users.

## Networking

Login nodes are provisioned with a single connection address to the network load balancer configured for the pool of login nodes. The connectivity settings of the address are based on the type of subnet specified in the Login nodes Pool configuration.

- If the subnet is private, the address will be private and, in order to grant access to the login nodes, the cluster administrator must provision a bastion host.
- If the subnet is public, the address will be public

All connection requests are managed by the Network Load Balancer using round-robin routing.

## Storage

All shared storage configured on the cluster using ParallelCluster including managed storage will be mounted on all the login nodes.

## Retrieve login nodes information

To retrieve the address of the single connection provisioned to access the login nodes, the cluster administrator can run the [describe-cluster](#) command. The command will also provide more information about the status of the login nodes.

Login nodes are a new node type supported by ParallelCluster that can be specified with the [describe-cluster-instances](#) command when querying the status of a specific node type.

The availability of a single connection address to the Login nodes pool doesn't prevent direct access to a specific login node. However, it is not recommended to use the direct connection to avoid warnings from the ssh client. The ssh client stores host identifiers locally for each target address. Since the host identifier is specific per pool, use of different IPs and/or the single connection address may have the same host identifier associated with different target addresses: this may cause warning from the ssh client since the same host identifier is associated multiple targets.

## Imds properties

Access to the login node's IMDS (and the instance profile credentials) is restricted to root user, cluster administrative user (`pc-cluster-admin` by default) and operating system specific default user (`ec2-user` on Amazon Linux 2 and RedHat, `ubuntu` on Ubuntu 18.04, `centos` on CentOS 7).

To restrict IMDS access, AWS ParallelCluster manages a chain of `iptables`.

### Note

Any customization of `iptables` or `ip6tables` rules can interfere with the mechanism used to restrict IMDS access on the login node. See also [Imds property setting](#).

## Login Nodes lifecycle

Currently, there is no dedicated command to stop and start the login nodes in a pool. In order to stop the login nodes in a pool the cluster administrator has to update the cluster configuration specifying zero on the count of login nodes (`Count: 0`) and then run an [`pcluster.update-cluster-v3`](#) command.

### Note

Logged in users are notified about the termination of the specific instance and about the related `gracetime` period. During the `gracetime` period no new connections will be allowed except for the ones from the [cluster default user](#). The message shown is customizable by the cluster administrator from the head node or from a login node editing the file `/opt/parallelcluster/shared_login_nodes/loginmgt_config.json`.

In order to start the login nodes pool the cluster administrator has to restore the previous `Count` value in the cluster configuration and then run an [`update-cluster`](#) command.

## Permissions required to run the login nodes pool

In order to manage the login nodes pool the cluster administrator must have the following additional permissions:

```

- Action:
  - autoscaling:DeleteAutoScalingGroup
  - autoscaling:DeleteLifecycleHook
  - autoscaling:Describe*
  - autoscaling:PutLifecycleHook
  - autoscaling:UpdateAutoScalingGroup
  - elasticloadbalancing:CreateListener
  - elasticloadbalancing:CreateTargetGroup
  - elasticloadbalancing>DeleteListener
  - elasticloadbalancing>DeleteLoadBalancer
  - elasticloadbalancing>DeleteTargetGroup
  - elasticloadbalancing:Describe*
  - elasticloadbalancing:ModifyLoadBalancerAttributes
Resource: '*'
Condition:
  ForAllValues:StringEquals:
    aws:TagKeys: [ "parallelcluster:cluster-name" ]
- Action:
  - autoscaling:CreateAutoScalingGroup
  - elasticloadbalancing:AddTags
  - elasticloadbalancing:CreateLoadBalancer
Resource: '*'
Effect: Allow

```

## Custom bootstrap actions

If you define the [HeadNode](#) / [CustomActions](#) / [OnNodeStart](#) configuration settings, AWS ParallelCluster runs arbitrary code immediately after the node starts. If you define the [HeadNode](#) / [CustomActions](#) / [OnNodeConfigured](#) configuration settings, AWS ParallelCluster runs the code after the node configuration is correctly completed.

Starting with AWS ParallelCluster version 3.4.0, the code can be run after the head node update, if you define the [HeadNode](#) / [CustomActions](#) / [OnNodeUpdated](#) configuration settings.

In most cases, this code is stored in Amazon Simple Storage Service (Amazon S3) and accessed through an HTTPS connection. The code is run as `root` and can be in any script language that's supported by the cluster OS. Often the code is in *Bash* or *Python*.

**Note**

Starting with AWS ParallelCluster version 3.7.0, the cluster [Imds](#) / [ImdsSupport](#) setting default is v2.0.

When you create a new cluster to upgrade to version 3.7.0 and later versions, either update your custom bootstrap action scripts to be compatible with IMDSv2 or set [Imds](#) / [ImdsSupport](#) to v1.0 in your cluster configuration file.

**Warning**

You are responsible for configuring the custom scripts and arguments as described in the [Shared responsibility model](#). Verify that your custom bootstrap scripts and arguments are from sources that you trust to have full access to your cluster nodes.

**Warning**

AWS ParallelCluster doesn't support the use of internal variables that are provided through the `/etc/parallelcluster/cfnconfig` file. This file might be removed as part of a future release.

`OnNodeStart` actions are called before any node deployment bootstrap action is started, such as configuring NAT, Amazon Elastic Block Store (Amazon EBS) or the scheduler. `OnNodeStart` bootstrap actions may include modifying storage, adding extra users, and adding packages.

**Note**

If you configure [DirectoryService](#) and a [HeadNode](#) / [CustomActions](#) / [OnNodeStart](#) script for your cluster, AWS ParallelCluster configures `DirectoryService` and restarts the `sssd`, before it runs the `OnNodeStart` script.

`OnNodeConfigured` actions are called after the node bootstrap processes are complete. `OnNodeConfigured` actions serve the last actions to occur before an instance is considered fully configured and complete. Some `OnNodeConfigured` actions include changing scheduler settings,

modifying storage, and modifying packages. You can pass argument to scripts by specifying them during configuration.

OnNodeUpdated actions are called after the head node update is completed and the scheduler and shared storage are aligned with the latest cluster configuration changes.

When OnNodeStart or OnNodeConfigured custom actions succeed, success is indicated with exit code zero (0). Any other exit code indicates the instance bootstrap failed.

When OnNodeUpdated custom actions succeed, success is signaled with exit code zero (0). Any other exit code indicates the update failed.

### Note

If you configure [OnNodeUpdated](#), you must manually restore the OnNodeUpdated actions to the previous state on update failures.

If an OnNodeUpdated custom action fails, the update rolls back to the previous state.

However, the OnNodeUpdated action is only run at update time and not at stack rollback time.

You can specify different scripts for the head node and for each queue, in the [HeadNode / CustomActions](#) and [Scheduling / SlurmQueues / CustomActions](#) configuration sections. [OnNodeUpdated](#) can only be configured in the HeadNode section.

### Note

Before AWS ParallelCluster version 3.0, it was not possible to specify different scripts for head and compute nodes. Please refer to [Moving from AWS ParallelCluster 2.x to 3.x](#).

## Topics

- [Configuration](#)
- [Arguments](#)
- [Example cluster with custom bootstrap actions](#)
- [Example of updating a custom bootstrap script for IMDSv2](#)
- [Example of updating a configuration for IMDSv1](#)

## Configuration

The following configuration settings are used to define [HeadNode](#) / [CustomActions](#) / [OnNodeStart](#) & [OnNodeConfigured](#) & [OnNodeUpdated](#) and [Scheduling](#) / [CustomActions](#) / [OnNodeStart](#) & [OnNodeConfigured](#) actions and arguments.

```
HeadNode:
  [...]
CustomActions:
  OnNodeStart:
    # Script URL. This is run before any of the bootstrap scripts are run
    Script: s3://bucket-name/on-node-start.sh
    Args:
      - arg1
  OnNodeConfigured:
    # Script URL. This is run after all the bootstrap scripts are run
    Script: s3://bucket-name/on-node-configured.sh
    Args:
      - arg1
  OnNodeUpdated:
    # Script URL. This is run after the head node update is completed.
    Script: s3://bucket-name/on-node-updated.sh
    Args:
      - arg1
# Bucket permissions
Iam:
  S3Access:
    - BucketName: bucket_name
      EnableWriteAccess: false
Scheduling:
  Scheduler: slurm
  [...]
SlurmQueues:
  - Name: queue1
  [...]
CustomActions:
  OnNodeStart:
    Script: s3://bucket-name/on-node-start.sh
    Args:
      - arg1
  OnNodeConfigured:
    Script: s3://bucket-name/on-node-configured.sh
    Args:
```

```
    - arg1
Iam:
  S3Access:
    - BucketName: bucket_name
      EnableWriteAccess: false
```

Using the Sequence setting (added in AWS ParallelCluster version 3.6.0):

```
HeadNode:
  [...]
  CustomActions:
    OnNodeStart:
      # Script URLs. The scripts are run in the same order as listed in the
      # configuration, before any of the bootstrap scripts are run.
      Sequence:
        - Script: s3://bucket-name/on-node-start1.sh
          Args:
            - arg1
        - Script: s3://bucket-name/on-node-start2.sh
          Args:
            - arg1
      [...]
    OnNodeConfigured:
      # Script URLs. The scripts are run in the same order as listed in the
      # configuration, after all the bootstrap scripts are run.
      Sequence:
        - Script: s3://bucket-name/on-node-configured1.sh
          Args:
            - arg1
        - Script: s3://bucket-name/on-node-configured2.sh
          Args:
            - arg1
      [...]
    OnNodeUpdated:
      # Script URLs. The scripts are run in the same order as listed in the
      # configuration, after the head node update is completed.
      Sequence:
        - Script: s3://bucket-name/on-node-updated1.sh
          Args:
            - arg1
        - Script: s3://bucket-name/on-node-updated2.sh
          Args:
            - arg1
```



```
[...]
# Bucket permissions
Iam:
  S3Access:
    - BucketName: bucket_name
      EnableWriteAccess: false
Scheduling:
  Scheduler: slurm
  [...]
  SlurmQueues:
    - Name: queue1
      [...]
    CustomActions:
      OnNodeStart:
        # Script URLs. The scripts are run in the same order as listed in the
        configuration, before any of the bootstrap scripts are run
        Sequence:
          - Script: s3://bucket-name/on-node-start1.sh
            Args:
              - arg1
          - Script: s3://bucket-name/on-node-start2.sh
            Args:
              - arg1
          [...]
      OnNodeConfigured:
        # Script URLs. The scripts are run in the same order as listed in the
        configuration, after all the bootstrap scripts are run
        Sequence:
          - Script: s3://bucket-name/on-node-configured1.sh
            Args:
              - arg1
          - Script: s3://bucket-name/on-node-configured2.sh
            Args:
              - arg1
          [...]
  Iam:
    S3Access:
      - BucketName: bucket_name
        EnableWriteAccess: false
```

The Sequence setting is added starting with AWS ParallelCluster version 3.6.0. When you specify Sequence, you can list multiple scripts for a custom action. AWS ParallelCluster continues to support configuring a custom action with a single script, without including Sequence.

AWS ParallelCluster doesn't support including both a single script and Sequence for the same custom action. For example, AWS ParallelCluster fails if you specify the following configuration.

```
[...]
CustomActions:
  OnNodeStart:
    # Script URL. This is run before any of the bootstrap scripts are run
    Script: s3://bucket-name/on-node-start.sh
    Args:
      - arg1
    # Script URLs. The scripts are run in the same order as listed in the
    configuration, before any of the bootstrap scripts are run.
    Sequence:
      - Script: s3://bucket-name/on-node-start1.sh
        Args:
          - arg1
      - Script: s3://bucket-name/on-node-start2.sh
        Args:
          - arg1
[...]
```

## Arguments

### Note

In AWS ParallelCluster 2.x the \$1 arguments was a reserved one, to store the URL of the custom script. If you want to re-use the custom bootstrap scripts created for AWS ParallelCluster 2.x with AWS ParallelCluster 3.x you need to adapt them by considering the shift of the arguments. Please refer to [Moving from AWS ParallelCluster 2.x to 3.x](#).

## Example cluster with custom bootstrap actions

The following steps create a simple script to be executed after the node is configured, that installs the R, curl and wget packages in the nodes of the cluster.

### 1. Create a script.

```
#!/bin/bash
echo "The script has $# arguments"
for arg in "$@"
```

```
do
    echo "arg: ${arg}"
done
yum -y install "${@:1}"
```

2. Upload the script with the correct permissions to Amazon S3. If public read permissions aren't appropriate for you, use [HeadNode / Iam / S3Access](#) and [Scheduling / SlurmQueues](#) configuration sections. For more information, see [Working with Amazon S3](#).

```
$ aws s3 cp --acl public-read /path/to/myscript.sh s3://<bucket-name>/myscript.sh
```

### Important

If the script was edited on Windows, line endings must be changed from CRLF to LF before the script is uploaded to Amazon S3.

3. Update the AWS ParallelCluster configuration to include the new OnNodeConfigured action.

```
CustomActions:
OnNodeConfigured:
  Script: https://<bucket-name>.s3.<region>.amazonaws.com/myscript.sh
  Args:
    - "R"
    - "curl"
    - "wget"
```

If the bucket doesn't have public-read permission, use s3 as the URL protocol.

```
CustomActions:
OnNodeConfigured:
  Script: s3://<bucket-name>/myscript.sh
  Args:
    - "R"
    - "curl"
    - "wget"
```

4. Launch the cluster.

```
$ pcluster create-cluster --cluster-name mycluster \
  --region <region> --cluster-configuration config-file.yaml
```

## 5. Verify the output.

- If you added custom actions to the HeadNode configuration, log in to the head node and check the `cfn-init.log` file located at `/var/log/cfn-init.log` by running following command:

```
$ less /var/log/cfn-init.log
2021-09-03 10:43:54,588 [DEBUG] Command run
postinstall output: The script has 3 arguments
arg: R
arg: curl
arg: wget
Loaded plugins: dkms-build-requires, priorities, update-motd, upgrade-helper
Package R-3.4.1-1.52.amzn1.x86_64 already installed and latest version
Package curl-7.61.1-7.91.amzn1.x86_64 already installed and latest version
Package wget-1.18-4.29.amzn1.x86_64 already installed and latest version
Nothing to do
```

- If you added custom actions to the SlurmQueues setting, check the `cloud-init.log` located at `/var/log/cloud-init.log` in a compute node. Use CloudWatch to view these logs.

You can view both of these logs in the Amazon CloudWatch console. For more information, see [Integration with Amazon CloudWatch Logs](#).

## Example of updating a custom bootstrap script for IMDSv2

In the following example, we update a custom bootstrap action script that was used with IMDSv1 for use with IMDSv2. The IMDSv1 script retrieves Amazon EC2 instance AMI ID metadata.

```
#!/bin/bash
AMI_ID=$(curl http://169.254.169.254/latest/meta-data/ami-id)
echo $AMI_ID >> /home/ami_id.txt
```

The following shows the custom bootstrap action script modified to be compatible with IMDSv2.

```
#!/bin/bash
AMI_ID=$(TOKEN=`curl -X PUT "http://169.254.169.254/latest/api/token" -H "X-aws-ec2-
metadata-token-ttl-seconds: 21600" ` \
    && curl -H "X-aws-ec2-metadata-token: $TOKEN" -v http://169.254.169.254/
latest/meta-data/ami-id)
```

```
echo $AMI_ID >> /home/ami_id.txt
```

For more information, see [Retrieve instance metadata](#) in the *Amazon EC2 User Guide for Linux Instances*.

## Example of updating a configuration for IMDSv1

The following is an example of a cluster configuration that supports IMDSv1 when using AWS ParallelCluster versions 3.7.0 and older.

```
Region: us-east-1
Imds:
  ImdsSupport: v1.0
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-abcdef01234567890
  Ssh
    KeyName: key-name
  CustomActions:
    OnNodeConfigured:
      Script: Script-path
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      CustomActions:
        OnNodeConfigured:
          Script: Script-path
  ComputeResources:
    - Name: t2micro
      Instances:
        - InstanceType: t2.micro
      MinCount: 11
  Networking:
    SubnetIds:
      - subnet-abcdef01234567890
```

## Working with Amazon S3

You can configure AWS ParallelCluster's access to Amazon S3 through the [HeadNode / `Iam / S3Access`](#) and [Scheduling / `SlurmQueues / - Name / Iam / S3Access`](#) parameters in the AWS ParallelCluster configuration.

### Examples

The following example configures read-only access to all objects in *firstbucket/read\_only/* and read/write access to all objects in *secondbucket/read\_and\_write/*.

```
...
HeadNode:
  ...
  Iam:
    S3Access:
      - BucketName: firstbucket
        KeyName: read_only/*
        EnableWriteAccess: false
      - BucketName: secondbucket
        KeyName: read_and_write/*
        EnableWriteAccess: true
  ...
```

The next example configures read-only access to all objects in folder *read\_only/* in any bucket (\*) in the account.

```
...
HeadNode:
  ...
  Iam:
    S3Access:
      - BucketName: *
        KeyName: read_only/*
        EnableWriteAccess: false
  ...
```

The final example configures *read\_only* access to all buckets and objects in the account.

```
...
```

```
HeadNode:
  ...
  Iam:
    S3Access:
      - BucketName: *
  ...
```

## Working with Spot Instances

AWS ParallelCluster uses Spot Instances if you have set [SlurmQueues](#) / [CapacityType](#) or [AwsBatchQueues](#) / [CapacityType](#) to SPOT in the cluster configuration file. Spot Instances are more cost effective than On-Demand Instances, but they might be interrupted. It might help to take advantage of *Spot Instance interruption notices*, which provide a two-minute warning before Amazon EC2 must stop or terminate your Spot Instance. For more information, see [Spot Instance interruptions](#) in *Amazon EC2 User Guide*. To learn how [AwsBatchQueues](#) works with Spot Instances, see [Compute Resources](#) in the *AWS Batch User Guide*.

The AWS ParallelCluster configured scheduler assigns jobs to compute resources in queues with spot instances in the same way it assigns jobs to compute resources in queues with on-demand instances.

When using Spot Instances, an `AWSServiceRoleForEC2Spot` service-linked role must exist in your account. To create this role in your account using the AWS CLI, run the following command:

```
$ aws iam create-service-linked-role --aws-service-name spot.amazonaws.com
```

For more information, see [Service-linked role for Spot Instance requests](#) in the *Amazon EC2 User Guide*.

The following sections describe three scenarios in which Spot Instances can be interrupted when using [SlurmQueues](#).

### Scenario 1: Spot Instance with no running jobs is interrupted

When this interruption occurs, AWS ParallelCluster tries to replace the instance if the scheduler queue has pending jobs that require additional instances, or if the number of active instances is lower than the [SlurmQueues](#) / [ComputeResources](#) / [MinCount](#). If AWS ParallelCluster can't provision new instances, then a request for new instances is periodically repeated.

## Scenario 2: Spot Instance running single node jobs is interrupted

The job fails with a state code of `NODE_FAIL`, and the job is requeued (unless `--no-requeue` is specified when the job is submitted). If the node is a static node, it's replaced. If the node is a dynamic node, the node is terminated and reset. For more information about `sbatch`, including the `--no-requeue` parameter, see [sbatch](#) in the *Slurm documentation*.

## Scenario 3: Spot Instance running multi-node jobs is interrupted

The job fails with a state code of `NODE_FAIL`, and the job is requeued (unless `--no-requeue` was specified when the job was submitted). If the node is a static node, it's replaced. If the node is a dynamic node, the node is terminated and reset. Other nodes that were running the terminated jobs might be allocated to other pending jobs, or scaled down after the configured [SlurmSettings](#) / [ScaledownIdleTime](#) time has passed.

For more information about Spot Instances, see [Spot Instances](#) in the *Amazon EC2 User Guide*.

## Schedulers supported by AWS ParallelCluster

### Schedulers supported by AWS ParallelCluster

AWS ParallelCluster supports Slurm and AWS Batch schedulers, set using the [Scheduler](#) setting.

### Topics

- [Slurm Workload Manager \(slurm\)](#)
- [AWS Batch \(awsbatch\)](#)

## Slurm Workload Manager (slurm)

### Cluster capacity size and update

The capacity of the cluster is defined by the number of compute nodes the cluster can scale. Compute nodes are backed by Amazon EC2 instances defined within compute resources in the AWS ParallelCluster configuration (`Scheduling/SlurmQueues/ComputeResources`), and are organized into queues (`Scheduling/SlurmQueues`) that map 1:1 to Slurm partitions.

Within a compute resource it's possible to configure the minimum number of compute nodes (instances) that must always be kept running in the cluster ([MinCount](#)), and the maximum number of instances the compute resource can scale to ([MaxCount3](#)).



At cluster creation time, or upon a cluster update, AWS ParallelCluster launches as many Amazon EC2 instances as configured in `MinCount` for each compute resource (`Scheduling/SlurmQueues/ ComputeResources`) defined in the cluster. The instances launched to cover the minimal amount of nodes for a compute resources in the cluster are called **static nodes**. Once started, static nodes are meant to be persistent in the cluster and they are not terminated by the system, unless a particular event or condition occurs. Such events include, for example, the failure of Slurm or Amazon EC2 health checks and the change of the Slurm node status to DRAIN or DOWN.

The Amazon EC2 instances, in the range of 1 to '`MaxCount - MinCount`' (`MaxCount minus MinCount`), launched on-demand to deal with the increased load of the cluster, are referred to as **dynamic nodes**. Their nature is ephemeral, they are launched to serve pending jobs and are terminated once they stay idle for a period of time defined by `Scheduling/SlurmSettings/ScaledownIdleTime` in the cluster configuration (default: 10 minutes).

Static nodes and dynamic node comply to the following naming schema:

- Static nodes `<Queue/Name>-st-<ComputeResource/Name>-<num>` where `<num> = 1..ComputeResource/MinCount`
- Dynamic nodes `<Queue/Name>-dy-<ComputeResource/Name>-<num>` where `<num> = 1..(ComputeResource/MaxCount - ComputeResource/MinCount)`

For example given the following AWS ParallelCluster configuration:

```
Scheduling:
  Scheduler: Slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
        - Name: c5xlarge
          Instances:
            - InstanceType: c5.xlarge
              MinCount: 100
              MaxCount: 150
```

The following nodes will be defined in Slurm

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*    up    infinite  100    idle queue1-st-c5xlarge-[1-100]
```

When a compute resource has `MinCount == MaxCount`, all the corresponding compute nodes will be static and all the instances will be launched at cluster creation/update time and kept up and running. For example:

```
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
        - Name: c5xlarge
          Instances:
            - InstanceType: c5.xlarge
          MinCount: 100
          MaxCount: 100
```

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   100    idle queue1-st-c5xlarge-[1-100]
```

## Cluster capacity update

The update of the cluster capacity includes adding or removing queues, compute resources or changing the `MinCount/MaxCount` of a compute resource. Starting from AWS ParallelCluster version 3.9.0, reducing the size of a queue requires the compute fleet to be stopped or [QueueUpdateStrategy](#) set to `TERMINATE` for before a cluster update to take place. It's not required to stop the compute fleet or to set [QueueUpdateStrategy](#) to `TERMINATE` when:

- Adding new queues to Scheduling/[SlurmQueues](#)
- Adding new compute resources Scheduling/[SlurmQueues/ComputeResources](#) to a queue

- Increasing the [MaxCount](#) of a compute resource
- Increasing MinCount of a compute resource and increasing MaxCount of the same compute resource of at least the same amount

## Considerations and limitations

This section is meant to outline any important factors, constraints, or limitations that should be taken into account when resizing the cluster capacity.

- When removing a queue from Scheduling/<https://docs.aws.amazon.com/parallelcluster/latest/ug/Scheduling-v3.html#Scheduling-v3-SlurmQueues> all the compute nodes with name `<Queue/Name>-*`, both static and dynamic, will be removed from the Slurm configuration and the corresponding Amazon EC2 instances will be terminated.
- When removing a compute resource Scheduling/SlurmQueues/<https://docs.aws.amazon.com/parallelcluster/latest/ug/Scheduling-v3.html#Scheduling-v3-SlurmQueues-ComputeResources> from a queue, all the compute nodes with name `<Queue/Name>-*-<ComputeResource/Name>-*`, both static and dynamic, will be removed from the Slurm configuration and the corresponding Amazon EC2 instances will be terminated.

When changing the MinCount parameter of a compute resource we can distinguish two different scenarios, if MaxCount is kept equal to MinCount (static capacity only), and if MaxCount is greater than MinCount (mixed static and dynamic capacity).

### Capacity changes with static nodes only

- If `MinCount == MaxCount`, when increasing MinCount (and MaxCount), the cluster will be configured by extending the number of static nodes to the new value of MinCount `<Queue/Name>-st-<ComputeResource/Name>-<new_MinCount>` and the system will keep trying to launch Amazon EC2 instances to fulfill the new required static capacity.
- If `MinCount == MaxCount`, when decreasing MinCount (and MaxCount) of the amount `N`, the cluster will be configured by removing the last `N` static nodes `<Queue/Name>-st-<ComputeResource/Name>-<old_MinCount - N>...<old_MinCount>` and the system will terminate the corresponding Amazon EC2 instances.
  - Initial state `MinCount = MaxCount = 100`

- ```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up        infinite   100    idle queue1-st-c5xlarge-[1-100]

```

- Update `-30` on MinCount and MaxCount: `MinCount = MaxCount = 70`

- ```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up        infinite    70    idle queue1-st-c5xlarge-[1-70]

```

## Capacity changes with mixed nodes

If `MinCount < MaxCount`, when increasing `MinCount` by an amount `N` (assuming `MaxCount` will be kept unchanged), the cluster will be configured by extending the number static nodes to the new value of `MinCount` (`old_MinCount + N`): `<Queue/Name>-st-<ComputeResource/Name>-<old_MinCount + N>` and the system will keep trying to launch Amazon EC2 instances to fulfill the new required static capacity. Moreover, to honor the `MaxCount` capacity of the compute resource, the cluster configuration is updated by *removing the last `N` dynamic nodes*: `<Queue/Name>-dy-<ComputeResource/Name>-[<MaxCount - old_MinCount - N>...<MaxCount - old_MinCount>]` and the system will terminate the corresponding Amazon EC2 instances.

- Initial state: `MinCount = 100`; `MaxCount = 150`

- ```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up        infinite    50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*    up        infinite   100    idle queue1-st-c5xlarge-[1-100]

```

- Update `+30` to MinCount : `MinCount = 130` (`MaxCount = 150`)

- ```

$ sinfo

```

```

PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   20    idle~ queue1-dy-c5xlarge-[1-20]
queue1*   up    infinite  130    idle queue1-st-c5xlarge-[1-130]

```

If  $\text{MinCount} < \text{MaxCount}$ , when increasing  $\text{MinCount}$  and  $\text{MaxCount}$  of the same amount  $N$ , the cluster will be configured by extending the number static nodes to the new value of  $\text{MinCount}$  ( $\text{old\_MinCount} + N$ ): `<Queue/Name>-st-<ComputeResource/Name>-<old\_MinCount + N>` and the system will keep trying to launch Amazon EC2 instances to fulfill the new required static capacity. Moreover, no changes will be done on the number of dynamic nodes to honor the new  $\text{MaxCount}$  value.

- Initial state:  $\text{MinCount} = 100$ ;  $\text{MaxCount} = 150$

```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite  100    idle queue1-st-c5xlarge-[1-100]

```

- Update +30 to  $\text{MinCount}$  :  $\text{MinCount} = 130$  ( $\text{MaxCount} = 180$ )

```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   20    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite  130    idle queue1-st-c5xlarge-[1-130]

```

If  $\text{MinCount} < \text{MaxCount}$ , when decreasing  $\text{MinCount}$  of the amount  $N$  (assuming  $\text{MaxCount}$  will be kept unchanged), the cluster will be configured by removing the last  $N$  static nodes `<Queue/Name>-st-<ComputeResource/Name>-[<old\_MinCount - N> . . . <old\_MinCount>` and the system will terminate the corresponding Amazon EC2 instances. Moreover, to honor the  $\text{MaxCount}$  capacity of the compute resource, the cluster configuration is updated by extending the number of the dynamic nodes to fill the gap  $\text{MaxCount}$

- new\_MinCount: <Queue/Name>-dy-<ComputeResource/Name>-[1..<MaxCount - new\_MinCount>] In this case, since those are dynamic nodes, no new Amazon EC2 instances will be launched unless the scheduler has jobs in pending on the new nodes.

- Initial state: MinCount = 100; MaxCount = 150

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite  100    idle queue1-st-c5xlarge-[1-100]
```

- Update -30 on MinCount : MinCount = 70 (MaxCount = 120)

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   80    idle~ queue1-dy-c5xlarge-[1-80]
queue1*   up    infinite   70    idle queue1-st-c5xlarge-[1-70]
```

If  $\text{MinCount} < \text{MaxCount}$ , when decreasing MinCount and MaxCount of the same amount  $N$ , the cluster will be configured by removing the last  $N$  static nodes <Queue/Name>-st-<ComputeResource/Name>-<old\_MinCount - N>...<oldMinCount>] and the system will terminate the corresponding Amazon EC2 instances.

Moreover, no changes will be done on the number of dynamic nodes to honor the new MaxCount value.

- Initial state: MinCount = 100; MaxCount = 150

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite  100    idle queue1-st-c5xlarge-[1-100]
```

- Update -30 on MinCount : MinCount = 70 (MaxCount = 120)

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   80    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite   70    idle  queue1-st-c5xlarge-[1-70]
```

If  $\text{MinCount} < \text{MaxCount}$ , when decreasing MaxCount of the amount N (assuming MinCount will be kept unchanged), the cluster will be configured by removing the last N dynamic nodes `<Queue/Name>-dy-<ComputeResource/Name>-<old_MaxCount - N...<oldMaxCount>]` and the system will terminate the corresponding Amazon EC2 instances in the case they were running. No impact is expected on the static nodes.

- Initial state: MinCount = 100; MaxCount = 150

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite  100    idle  queue1-st-c5xlarge-[1-100]
```

- Update -30 on MaxCount : MinCount = 100 (MaxCount = 120)

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   20    idle~ queue1-dy-c5xlarge-[1-20]
queue1*   up    infinite  100    idle  queue1-st-c5xlarge-[1-100]
```

## Impacts on the Jobs

In all the cases where nodes are removed and Amazon EC2 instances terminated, a sbatch job running on the removed nodes will be re-queued, unless there are no other nodes satisfying the

job requirements. In this last case the job will fail with status `NODE_FAIL` and disappears from the queue; if the case, it'll require to be re-submitted manually.

If you are planning to perform a cluster resize update, you can prevent jobs to go running in the nodes that are going to be removed during the planned update. This is possible by setting the nodes to be removed in maintenance. Please be aware that setting a node in maintenance would not impact jobs that are eventually already running in the node.

Suppose that with the planned cluster resize update you are going to remove the node `queue-st-computeresource-[9-10]`. You can create a Slurm reservation with the following command

```
sudo -i scontrol create reservation ReservationName=maint_for_update user=root
starttime=now duration=infinite flags=maint,ignore_jobs nodes=queue-st-
computeresource-[9-10]
```

This will create a Slurm reservation named `maint_for_update` on the nodes `queue-st-computeresource-[9-10]`. From the time when the reservation is created, no more jobs can go running into the nodes `queue-st-computeresource-[9-10]`. Please be aware that the reservation will not prevent jobs to be eventually allocated on the nodes `queue-st-computeresource-[9-10]`.

After the cluster resize update, if the Slurm reservation was set only on nodes that were removed during the resize update, the maintenance reservation will be automatically deleted. If instead you had created a Slurm reservation on nodes that are still present after the cluster resize update, we may want to remove the maintenance reservation on the nodes after the resize update is performed, by using the following command

```
sudo -i scontrol delete ReservationName=maint_for_update
```

For additional details on Slurm reservation, see the official SchedMD doc [here](#).

## Cluster update process on capacity changes

Upon a scheduler configuration change, the following steps are executed during the cluster update process:

- Stop AWS ParallelCluster `clustermgtd` (`supervisorctl stop clustermgtd`)
- Generate updated Slurm partitions configuration from AWS ParallelCluster configuration
- Restart `slurmctld` (done through Chef service recipe)



- Check `slurmctld` status (`systemctl is-active --quiet slurmctld.service`)
- Reload Slurm configuration (`scontrol reconfigure`)
- Start `clustermgtd` (`supervisorctl start clustermgtd`)

For information about Slurm, see <https://slurm.schedmd.com>. For downloads, see <https://github.com/SchedMD/slurm/tags>. For the source code, see <https://github.com/SchedMD/slurm>.

AWS ParallelCluster version(s)	Supported Slurm version
3.9.2, 3.9.3, 3.10.0	23.11.7
3.9.0, 3.9.1	23.11.4
3.8.0	23.02.7
3.7.2	23.02.6
3.7.1	23.02.5
3.7.0	23.02.4
3.6.0, 3.6.1	23.02.2
3.5.0, 3.5.1	22.05.8
3.4.0, 3.4.1	22.05.7
3.3.0, 3.3.1	22.05.5
3.1.4, 3.1.5, 3.2.0, 3.2.1	21.08.8-2
3.1.2, 3.1.3	21.08.6
3.1.1	21.08.5
3.0.0	20.11.8

## Topics

- [Configuration of multiple queues](#)

- [Slurm guide for multiple queue mode](#)
- [Slurm cluster protected mode](#)
- [Slurm cluster fast insufficient capacity fail-over](#)
- [Slurm memory-based scheduling](#)
- [Multiple instance type allocation with Slurm](#)
- [Cluster scaling for dynamic nodes](#)
- [Slurm accounting with AWS ParallelCluster](#)
- [Slurm configuration customization](#)
- [Slurmprolog and epilog](#)
- [Cluster capacity size and update](#)

## Configuration of multiple queues

### Configuration of multiple queues

With AWS ParallelCluster version 3, you can configure multiple queues by setting the [Scheduler](#) to `slurm` and specifying more than one queue for [SlurmQueues](#) in the configuration file. In this mode, different instance types coexist in the compute nodes that are specified in the [ComputeResources](#) section of the configuration file. [ComputeResources](#) with different instance types are scaled up or down as needed for the [SlurmQueues](#).

### Cluster queue and compute resource quotas

Resource	Quota
<a href="#">Slurm queues</a>	50 queues per cluster
<a href="#">Compute resources</a>	50 compute resources per queue 50 compute resources per cluster

### Node Counts

Each compute resource in [ComputeResources](#) for a queue must have a unique [Name](#), [InstanceType](#), [MinCount](#), and [MaxCount](#). [MinCount](#) and [MaxCount](#) have default values that define the range of instances for a compute resource in [ComputeResources](#) for a queue. You can also specify your own values for [MinCount](#) and [MaxCount](#). Each compute resource in

[ComputeResources](#) is composed of static nodes numbered from 1 to the value of [MinCount](#) and dynamic nodes numbered from the value of [MinCount](#) to the value of [MaxCount](#).

## Example Configuration

The following is an example of a [Scheduling](#) section for a cluster configuration file. In this configuration there are two queues named queue1 and queue2 and each of the queues has [ComputeResources](#) with a specified [MaxCount](#).

```
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
        - InstanceType: c5.xlarge
          MaxCount: 5
          Name: c5xlarge
        - InstanceType: c4.xlarge
          MaxCount: 5
          Name: c4xlarge
    - Name: queue2
      ComputeResources:
        - InstanceType: c5.xlarge
          MaxCount: 5
          Name: c5xlarge
```

## Hostnames

The instances that are launched into the compute fleet are dynamically assigned. Hostnames are generated for each node. By default AWS ParallelCluster will use the following format of the hostname :

```
$HOSTNAME=$QUEUE-$STATDYN-$COMPUTE_RESOURCE-$NODENUM
```

- \$QUEUE is the name of the queue. For example, if the [SlurmQueues](#) section has an entry with the [Name](#) set to "queue-name" then "\$QUEUE" is "queue-name".
- \$STATDYN is st for static nodes or dy for dynamic nodes.
- \$COMPUTE\_RESOURCE is the [Name](#) of the [ComputeResources](#) compute resource corresponding to this node.
- \$NODENUM is the number of the node. \$NODENUM is between one (1) and the value of [MinCount](#) for static nodes and between one (1) and [MaxCount](#)-[MinCount](#) for dynamic nodes.

From the example configuration file above, a given node from queue1 and compute resource c5xlarge has a hostname: queue1-dy-c5xlarge-1.

Both hostnames and fully-qualified domain names (FQDN) are created using Amazon Route 53 hosted zones. The FQDN is `$HOSTNAME.$CLUSTERNAME.pcluster`, where `$CLUSTERNAME` is the name of the cluster.

Note that the same format will be used for the Slurm node names as well.

Users can choose to use the default Amazon EC2 hostname of the instance powering the compute node instead of the default host name format used by AWS ParallelCluster. This can be done by setting the [UseEc2Hostnames](#) parameter to be true. However, Slurm node names will continue to use the default AWS ParallelCluster format.

## Slurm guide for multiple queue mode

Here you can learn how AWS ParallelCluster and Slurm manage queue (partition) nodes and how you can monitor the queue and node states.

### Overview

The scaling architecture is based on Slurm's [Cloud Scheduling Guide](#) and power saving plugin. For more information about the power saving plugin, see [Slurm Power Saving Guide](#). In the architecture, resources that can potentially be made available for a cluster are typically predefined in the Slurm configuration as cloud nodes.

### Cloud node lifecycle

Throughout their lifecycle, cloud nodes enter several if not all of the following states: `POWER_SAVING`, `POWER_UP` (`pow_up`), `ALLOCATED` (`alloc`), and `POWER_DOWN` (`pow_dn`). In some cases, a cloud node might enter the `OFFLINE` state. The following list details several aspects of these states in the cloud node lifecycle.

- **A node in a `POWER_SAVING` state** appears with a `~` suffix (for example `idle~`) in `sinfo`. In this state, no EC2 instances are backing the node. However, Slurm can still allocate jobs to the node.
- **A node transitioning to a `POWER_UP` state** appears with a `#` suffix (for example `idle#`) in `sinfo`. A node automatically transitions to a `POWER_UP` state, when Slurm allocates a job to a node in a `POWER_SAVING` state.

Alternatively, you can transition the nodes to the `POWER_UP` state manually as an `su root` user with the command:

```
$ scontrol update nodename=nodename state=power_up
```

In this stage, the ResumeProgram is invoked, EC2 instances are launched and configured, and the node transitions to the POWER\_UP state.

- **A node that is currently available for use** appears without a suffix (for example `idle`) in `sinfo`. After the node is set up and has joined the cluster, it becomes available to run jobs. In this stage, the node is properly configured and ready for use.

As a general rule, we recommend that the number of Amazon EC2 instances be the same as the number of available nodes. In most cases, static nodes are available after the cluster is created.

- **A node that is transitioning to a POWER\_DOWN state** appears with a `%` suffix (for example `idle%`) in `sinfo`. Dynamic nodes automatically enter the POWER\_DOWN state after [ScaledownIdleTime](#). In contrast, static nodes in most cases aren't powered down. However, you can place the nodes in the POWER\_DOWN state manually as an `su root` user with the command:

```
$ scontrol update nodename=nodename state=down reason="manual draining"
```

In this state, the instances associated with a node are terminated, and the node is set back to the POWER\_SAVING state and available for use after [ScaledownIdleTime](#).

The [ScaledownIdleTime](#) setting is saved to the Slurm configuration `SuspendTimeout` setting.

- **A node that is offline** appears with a `*` suffix (for example `down*`) in `sinfo`. A node goes offline if the Slurm controller can't contact the node or if the static nodes are disabled and the backing instances are terminated.

Consider the node states shown in the following `sinfo` example.

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
efa       up    infinite   4    idle~ efa-dy-efacompute1-[1-4]
efa       up    infinite   1    idle  efa-st-efacompute1-1
gpu       up    infinite   1    idle% gpu-dy-gpucompute1-1
gpu       up    infinite   9    idle~ gpu-dy-gpucompute1-[2-10]
ondemand  up    infinite   2    mix#  ondemand-dy-ondemandcompute1-[1-2]
ondemand  up    infinite  18    idle~ ondemand-dy-ondemandcompute1-
[3-10],ondemand-dy-ondemandcompute2-[1-10]
```

```
spot*      up    infinite    13  idle~ spot-dy-spotcompute1-[1-10],spot-dy-
spotcompute2-[1-3]
spot*      up    infinite    2   idle spot-st-spotcompute2-[1-2]
```

The `spot-st-spotcompute2-[1-2]` and `efa-st-efacompute1-1` nodes already have backing instances set up and are available for use. The `ondemand-dy-ondemandcompute1-[1-2]` nodes are in the `POWER_UP` state and should be available within a few minutes. The `gpu-dy-gpucompute1-1` node is in the `POWER_DOWN` state, and it transitions into `POWER_SAVING` state after [ScaledownIdletime](#) (defaults to 10 minutes).

All of the other nodes are in `POWER_SAVING` state with no EC2 instances backing them.

### Working with an available node

An available node is backed by an Amazon EC2 instance. By default, the node name can be used to directly SSH into the instance (for example `ssh efa-st-efacompute1-1`). The private IP address of the instance can be retrieved using the command:

```
$ scontrol show nodes nodename
```

Check for IP address in the returned `NodeAddr` field.

For nodes that aren't available, the `NodeAddr` field shouldn't point to a running Amazon EC2 instance. Rather, it should be the same as the node name.

### Job states and submission

Jobs submitted in most cases are immediately allocated to nodes in the system, or placed in pending if all the nodes are allocated.

If nodes allocated for a job include any nodes in a `POWER_SAVING` state, the job starts out with a `CF`, or `CONFIGURING` state. At this time, the job waits for the nodes in the `POWER_SAVING` state to transition to the `POWER_UP` state and become available.

After all nodes allocated for a job are available, the job enters the `RUNNING (R)` state.

By default, all jobs are submitted to the default queue (known as a partition in Slurm). This is signified by a `*` suffix after the queue name. You can select a queue using the `-p` job submission option.

All nodes are configured with the following features, which can be used in job submission commands:

- An instance type (for example `c5.xlarge`)
- A node type (This is either `dynamic` or `static`.)

You can see the features for a particular node by using the command:

```
$ scontrol show nodes nodename
```

In the return, check the `AvailableFeatures` list.

Consider the initial state of the cluster, which you can view by running the `sinfo` command.

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
efa        up    infinite   4  idle~ efa-dy-efacompute1-[1-4]
efa        up    infinite   1  idle  efa-st-efacompute1-1
gpu        up    infinite  10  idle~ gpu-dy-gpucompute1-[1-10]
ondemand   up    infinite  20  idle~ ondemand-dy-ondemandcompute1-
[1-10],ondemand-dy-ondemandcompute2-[1-10]
spot*      up    infinite  13  idle~ spot-dy-spotcompute1-[1-10],spot-dy-
spotcompute2-[1-3]
spot*      up    infinite   2  idle  spot-st-spotcompute2-[1-2]
```

Note that `spot` is the default queue. It is indicated by the `*` suffix.

Submit a job to one static node in the default queue (`spot`).

```
$ sbatch --wrap "sleep 300" -N 1 -C static
```

Submit a job to one dynamic node in the EFA queue.

```
$ sbatch --wrap "sleep 300" -p efa -C dynamic
```

Submit a job to eight (8) `c5.2xlarge` nodes and two (2) `t2.xlarge` nodes in the `ondemand` queue.

```
$ sbatch --wrap "sleep 300" -p ondemand -N 10 -C "[c5.2xlarge*8&t2.xlarge*2]"
```

Submit a job to one GPU node in the gpu queue.

```
$ sbatch --wrap "sleep 300" -p gpu -G 1
```

Consider the state of the jobs using the squeue command.

```
$ squeue
JOBID PARTITION NAME USER ST TIME NODES NODELIST(REASON)
12 ondemand wrap ubuntu CF 0:36 10 ondemand-dy-ondemandcompute1-
[1-8],ondemand-dy-ondemandcompute2-[1-2]
13 gpu wrap ubuntu CF 0:05 1 gpu-dy-gpucompute1-1
7 spot wrap ubuntu R 2:48 1 spot-st-spotcompute2-1
8 efa wrap ubuntu R 0:39 1 efa-dy-efacompute1-1
```

Jobs 7 and 8 (in the spot and efa queues) are already running (R). Jobs 12 and 13 are still configuring (CF), probably waiting for instances to become available.

```
# Nodes states corresponds to state of running jobs
$ sinfo
PARTITION AVAIL TIMELIMIT NODES STATE NODELIST
efa up infinite 3 idle~ efa-dy-efacompute1-[2-4]
efa up infinite 1 mix efa-dy-efacompute1-1
efa up infinite 1 idle efa-st-efacompute1-1
gpu up infinite 1 mix~ gpu-dy-gpucompute1-1
gpu up infinite 9 idle~ gpu-dy-gpucompute1-[2-10]
ondemand up infinite 10 mix# ondemand-dy-ondemandcompute1-[1-8],ondemand-
dy-ondemandcompute2-[1-2]
ondemand up infinite 10 idle~ ondemand-dy-ondemandcompute1-[9-10],ondemand-
dy-ondemandcompute2-[3-10]
spot* up infinite 13 idle~ spot-dy-spotcompute1-[1-10],spot-dy-
spotcompute2-[1-3]
spot* up infinite 1 mix spot-st-spotcompute2-1
spot* up infinite 1 idle spot-st-spotcompute2-2
```

## Node state and features

In most cases, node states are fully managed by AWS ParallelCluster according to the specific processes in the cloud node lifecycle described earlier in this topic.

However, AWS ParallelCluster also replaces or terminates unhealthy nodes in DOWN and DRAINED states and nodes that have unhealthy backing instances. For more information, see [clustermgtd](#).



## Partition states

AWS ParallelCluster supports the following partition states. A Slurm partition is a queue in AWS ParallelCluster.

- **UP:** Indicates that the partition is in an active state. This is the default state of a partition. In this state, all nodes in the partition are active and available for use.
- **INACTIVE:** Indicates that the partition is in the inactive state. In this state, all instances backing nodes of an inactive partition are terminated. New instances aren't launched for nodes in an inactive partition.

### pcluster update-compute-fleet

- **Stopping the compute fleet** - When the following command is executed, all partitions transition to the INACTIVE state, and AWS ParallelCluster processes keep the partitions in the INACTIVE state.

```
$ pcluster update-compute-fleet --cluster-name testSlurm \  
  --region eu-west-1 --status STOP_REQUESTED
```

- **Starting the compute fleet** - When the following command is executed, all partitions initially transition to the UP state. However, AWS ParallelCluster processes don't keep the partition in an UP state. You need to change partition states manually. All static nodes become available after a few minutes. Note that setting a partition to UP doesn't power up any dynamic capacity.

```
$ pcluster update-compute-fleet --cluster-name testSlurm \  
  --region eu-west-1 --status START_REQUESTED
```

When `update-compute-fleet` is run, you can check the state of the cluster by running the `pcluster describe-compute-fleet` command and checking the `Status`. The following lists possible states:

- **STOP\_REQUESTED:** The stop compute fleet request is sent to the cluster.
- **STOPPING:** The `pcluster` process is currently stopping the compute fleet.
- **STOPPED:** The `pcluster` process finished the stopping process, all partitions are in INACTIVE state, and all compute instances are terminated.
- **START\_REQUESTED:** The start compute fleet request is sent to the cluster.

- **STARTING:** The `pcluster` process is currently starting the cluster.
- **RUNNING:** The `pcluster` process finished the starting process, all partitions are in the UP state, and static nodes are available after a few minutes.
- **PROTECTED:** This status indicates that some partitions have consistent bootstrap failures. Affected partitions are inactive. Please investigate the issue and then run `update-compute-fleet` to re-enable the fleet.

## Manual control of queues

In some cases, you might want to have some manual control over the nodes or queue (known as a partition in Slurm) in a cluster. You can manage nodes in a cluster through the following common procedures using the `scontrol` command.

- **Power up dynamic nodes in `POWER_SAVING` state**

Run the command as an `su root` user:

```
$ scontrol update nodename=nodename state=power_up
```

You can also submit a placeholder `sleep 1` job requesting a certain number of nodes and then rely on Slurm to power up the required number of nodes.

- **Power down dynamic nodes before [ScaledownIdletime](#)**

We recommend that you set dynamic nodes to DOWN as an `su root` user with the command:

```
$ scontrol update nodename=nodename state=down reason="manually draining"
```

AWS ParallelCluster automatically terminates and resets the downed dynamic nodes.

In general, we don't recommend that you set nodes to `POWER_DOWN` directly using the `scontrol update nodename=nodename state=power_down` command. This is because AWS ParallelCluster automatically handles the power down process.

- **Disable a queue (partition) or stop all static nodes in specific partition**

Set a specific queue to INACTIVE as an `su root` user with the command:

```
$ scontrol update partition=queuename state=inactive
```

Doing this terminates all instances backing nodes in the partition.

- **Enable a queue (partition)**

Set a specific queue to UP an su root user with the command:

```
$ scontrol update partition=queuename state=up
```

## Scaling behavior and adjustments

Here is an example of the normal scaling workflow:

- The scheduler receives a job that requires two nodes.
- The scheduler transitions two nodes to a POWER\_UP state, and calls ResumeProgram with the node names (for example queue1-dy-spotcompute1-[1-2]).
- ResumeProgram launches two Amazon EC2 instances and assigns the private IP addresses and hostnames of queue1-dy-spotcompute1-[1-2], waiting for ResumeTimeout (the default period is 30 minutes before resetting the nodes).
- Instances are configured and join the cluster. A job starts running on instances.
- The job completes and stops running.
- After the configured SuspendTime has elapsed (which is set to [ScaledownIdleTime](#)), the scheduler sets the instances to the POWER\_SAVING state. The scheduler then sets queue1-dy-spotcompute1-[1-2] to the POWER\_DOWN state and calls SuspendProgram with the node names.
- SuspendProgram is called for two nodes. Nodes remain in the POWER\_DOWN state, for example, by remaining idle% for a SuspendTimeout (the default period is 120 seconds (2 minutes)). After clustermgtd detects that nodes are powering down, it terminates the backing instances. Then, it transitions queue1-dy-spotcompute1-[1-2] to the idle state and resets the private IP address and hostname so it is ready to power up for future jobs.

**If things go wrong and an instance for a particular node can't be launched for some reason, then the following happens:**

- The scheduler receives a job that requires two nodes.
- The scheduler transitions two cloud bursting nodes to the POWER\_UP state and calls ResumeProgram with the nodenames, (for example queue1-dy-spotcompute1-[1-2]).

- ResumeProgram launches only one (1) Amazon EC2 instance and configures queue1-dy-spotcompute1-1, with one (1) instance, queue1-dy-spotcompute1-2, failing to launch.
- queue1-dy-spotcompute1-1 isn't impacted and comes online after reaching the POWER\_UP state.
- queue1-dy-spotcompute1-2 transitions to the POWER\_DOWN state, and the job is requeued automatically because Slurm detects a node failure.
- queue1-dy-spotcompute1-2 becomes available after SuspendTimeout (the default is 120 seconds (2 minutes)). In the meantime, the job is requeued and can start running on another node.
- The above process repeats until the job can run on an available node without a failure occurring.

**There are two timing parameters that can be adjusted if needed:**

- **ResumeTimeout (the default is 30 minutes):** ResumeTimeout controls the time Slurm waits before transitioning the node to the down state.
  - It might be useful to extend ResumeTimeout if your pre/post installation process takes nearly that long.
  - ResumeTimeout is also the maximum time that AWS ParallelCluster waits before replacing or resetting a node if there is an issue. Compute nodes self-terminate if any error occurs during launch or setup. AWS ParallelCluster processes replace a node upon detection of a terminated instance.
- **SuspendTimeout (the default is 120 seconds (2 minutes)):** SuspendTimeout controls how quickly nodes get placed back into the system and are ready for use again.
  - A shorter SuspendTimeout means that nodes are reset more quickly, and Slurm can try to launch instances more frequently.
  - A longer SuspendTimeout means that failed nodes are reset more slowly. In the meantime, Slurm tries to use other nodes. If SuspendTimeout is more than a few minutes, Slurm tries to cycle through all nodes in the system. A longer SuspendTimeout might be beneficial for large-scale systems (over 1,000 nodes) to reduce stress on Slurm when it tries to frequently re-queue failing jobs.
  - Note that SuspendTimeout doesn't refer to the time AWS ParallelCluster waits to terminate a backing instance for a node. Backing instances for POWER\_DOWN nodes are immediately terminated. The terminate process usually is finished in a few minutes. However, during this time, the node remains in the POWER\_DOWN state and isn't available for the scheduler's use.

## Logs for the architecture

The following list contains the key logs. The log stream name used with Amazon CloudWatch Logs has the format `{hostname}.{instance_id}.{logIdentifier}`, where `logIdentifier` follows the log names.

- ResumeProgram: `/var/log/parallelcluster/slurm_resume.log` (slurm\_resume)
- SuspendProgram: `/var/log/parallelcluster/slurm_suspend.log` (slurm\_suspend)
- clustermgtd: `/var/log/parallelcluster/clustermgtd.log` (clustermgtd)
- computemgtd: `/var/log/parallelcluster/computemgtd.log` (computemgtd)
- slurmctld: `/var/log/slurmctld.log` (slurmctld)
- slurmd: `/var/log/slurmd.log` (slurmd)

## Common issues and how to debug:

### Nodes that failed to launch, power up, or join the cluster

- Dynamic nodes:
  - Check the ResumeProgram log to see if ResumeProgram was called with the node. If not, check the slurmctld log to determine if Slurm tried to call ResumeProgram with the node. Note that incorrect permissions on ResumeProgram might cause it to fail silently.
  - If ResumeProgram is called, check to see if an instance was launched for the node. If the instance didn't launch, there should be clear error message as to why the instance failed to launch.
  - If an instance was launched, there may have been some problem during the bootstrap process. Find the corresponding private IP address and instance ID from the ResumeProgram log and look at corresponding bootstrap logs for the specific instance in CloudWatch Logs.
- Static nodes:
  - Check the clustermgtd log to see if instances were launched for the node. If instances didn't launch, there should be clear errors on why the instances failed to launch.
  - If an instance was launched, there is some problem with the bootstrap process. Find the corresponding private IP and instance ID from the clustermgtd log and look at corresponding bootstrap logs for the specific instance in CloudWatch Logs.

### Nodes replaced or terminated unexpectedly, and node failures

- Nodes replaced/terminated unexpectedly:
  - In most cases, `clustermgtd` handles all node maintenance actions. To check if `clustermgtd` replaced or terminated a node, check the `clustermgtd` log.
  - If `clustermgtd` replaced or terminated the node, there should be a message indicating the reason for the action. If the reason is scheduler related (for example, the node was DOWN), check in the `slurmctld` log for more details. If the reason is Amazon EC2 related, use tools such as Amazon CloudWatch or the Amazon EC2 console, CLI, or SDKs, to check status or logs for that instance. For example, you can check if the instance had scheduled events or failed Amazon EC2 health status checks.
  - If `clustermgtd` didn't terminate the node, check if `computemgtd` terminated the node or if EC2 terminated the instance to reclaim a Spot Instance.
- Node failures:
  - In most cases, jobs are automatically requeued if a node failed. Look in the `slurmctld` log to see why a job or a node failed and assess the situation from there.

### Failure when replacing or terminating instances, failure when powering down nodes

- In general, `clustermgtd` handles all expected instance termination actions. Look in the `clustermgtd` log to see why it failed to replace or terminate a node.
- For dynamic nodes failing [ScaledownIdletime](#), look in the `SuspendProgram` log to see if `slurmctld` processes made calls with the specific node as argument. Note `SuspendProgram` doesn't actually perform any specific action. Rather, it only logs when it's called. All instance termination and `NodeAddr` resets are completed by `clustermgtd`. Slurm transitions nodes to IDLE after `SuspendTimeout`.

### Other issues:

- AWS ParallelCluster doesn't make job allocation or scaling decisions. It only tries to launch, terminate, and maintain resources according to Slurm's instructions.

For issues regarding job allocations, node allocation and scaling decision, look at the `slurmctld` log for errors.

## Slurm cluster protected mode

When a cluster runs with protected mode enabled, AWS ParallelCluster monitors and tracks compute node bootstrap failures as the compute nodes are being launched. It does this to detect whether these failures are occurring continuously.

If the following is detected in a queue (partition), the cluster enters protected status:

1. Consecutive compute node bootstrap failures occur continuously with no successful compute node launches.
2. The failure count reaches a predefined threshold.

After the cluster enters protected status, AWS ParallelCluster disables queues with failures at or above the predefined threshold.

Slurm cluster protected mode was added in AWS ParallelCluster version 3.0.0.

You can use protected mode to reduce the time and resources spent on compute node bootstrap failure cycling.

### Protected mode parameter

#### **protected\_failure\_count**

`protected_failure_count` specifies the number of consecutive failures in a queue (partition) that activate cluster protected status.

The default `protected_failure_count` is 10 and protected mode is enabled.

If `protected_failure_count` is greater than zero, protected mode is enabled.

If `protected_failure_count` is less than or equal to zero, protected mode is disabled.

You can change the `protected_failure_count` value by adding the parameter in the `clustermgtd` config file that's located at `/etc/parallelcluster/slurm_plugin/parallelcluster_clustermgtd.conf` in the HeadNode.

You can update this parameter anytime and you don't need to stop the compute fleet to do so. If a launch succeeds in a queue before the failure count reaches `protected_failure_count`, the failure count is reset to zero.

## Check cluster status in protected status

When a cluster is in protected status, you can check the compute fleet status and node states.

### Compute fleet status

The status of the compute fleet is PROTECTED in a cluster running in protected status.

```
$ pcluster describe-compute-fleet --cluster-name <cluster-name> --region <region-id>
{
  "status": "PROTECTED",
  "lastStatusUpdateTime": "2022-04-22T00:31:24.000Z"
}
```

### Node status

To learn which queues (partitions) have bootstrap failures that have activated protected status, log in to the cluster and run the `sinfo` command. Partitions with bootstrap failures at or above `protected_failure_count` are in the INACTIVE state. Partitions without bootstrap failures at or above `protected_failure_count` are in the UP state and work as expected.

PROTECTED status doesn't impact running jobs. If jobs are running on a partition with bootstrap failures at or above `protected_failure_count`, the partition is set to INACTIVE after the running jobs complete.

Consider the node states shown in the following example.

```
$ sinfo
PARTITION AVAIL TIMELIMIT NODES STATE NODELIST
queue1*  inact infinite  10  down% queue1-dy-c5xlarge-[1-10]
queue1*  inact infinite 3490 idle~ queue1-dy-c5xlarge-[11-3500]
queue2  up  infinite  10  idle~ queue2-dy-c5xlarge-[1-10]
```

Partition `queue1` is INACTIVE because 10 consecutive compute node bootstrap failures were detected.

Instances behind nodes `queue1-dy-c5xlarge-[1-10]` launched but failed to join the cluster because of an unhealthy status.

The cluster is in protected status.



Partition queue2 isn't impacted by the bootstrap failures in queue1. It's in the UP state and can still run jobs.

## How to deactivate protected status

After the bootstrap error has been resolved, you can run the following command to take the cluster out of protected status.

```
$ pcluster update-compute-fleet --cluster-name <cluster-name> \  
--region <region-id> \  
--status START_REQUESTED
```

## Bootstrap failures that activate protected status

Bootstrap errors that activate protected status are subdivided into the following three types. To identify the type and issue, you can check if AWS ParallelCluster generated logs. If logs were generated, you can check them for error details. For more information, see [Retrieving and preserving logs](#).

### 1. Bootstrap error that causes an instance to self-terminate.

An instance fails early in the bootstrap process, such as an instance that self-terminates because of errors in the [SlurmQueues](#) \ [CustomActions](#) \ [OnNodeStart](#) | [OnNodeConfigured](#) script.

For dynamic nodes, look for errors similar to the following:

```
Node bootstrap error: Node ... is in power up state without valid backing instance
```

For static nodes, look in the `clustermgtd` log (`/var/log/parallelcluster/clustermgtd`) for errors similar to the following:

```
Node bootstrap error: Node ... is in power up state without valid backing instance
```

### 2. Nodes `resume_timeout` or `node_replacement_timeout` expires.

An instance can't join the cluster within the `resume_timeout` (for dynamic nodes) or `node_replacement_timeout` (for static nodes). It doesn't self-terminate before the timeout. For example, networking isn't set up correctly for the cluster and the node is set to the DOWN state by Slurm after the timeout expires.

For dynamic nodes, look for errors similar to the following:

```
Node bootstrap error: Resume timeout expires for node
```

For static nodes, look in the `clustermgtd` log (`/var/log/parallelcluster/clustermgtd`) for errors similar to the following:

```
Node bootstrap error: Replacement timeout expires for node ... in replacement.
```

### 3. Nodes fail health check.

An instance behind the node fails an Amazon EC2 health check or scheduled event health check, and the nodes are treated as bootstrap failure nodes. In this case, the instance terminates for a reason outside the control of AWS ParallelCluster.

Look in the `clustermgtd` log (`/var/log/parallelcluster/clustermgtd`) for errors similar to the following:

```
Node bootstrap error: Node %s failed during bootstrap when performing health check.
```

### 4. Compute nodes fail Slurm registration.

The registration of the `slurmd` daemon with the Slurm control daemon (`slurmctld`) fails and causes the compute node state to change to the `INVALID_REG` state. Incorrectly configured Slurm compute nodes can cause this error, such as computed nodes configured with [CustomSlurmSettings](#) compute node specification errors.

Look in the `slurmctld` log file (`/var/log/slurmctld.log`) on the head node, or look in the `slurmd` log file (`/var/log/slurmd.log`) of the failed compute node for errors similar to the following:

```
Setting node %s to INVALID with reason: ...
```

## How to debug protected mode

If your cluster is in protected status, and if AWS ParallelCluster generated `clustermgtd` logs from the `HeadNode` and the `cloud-init-output` logs from problematic compute nodes, then you can check the logs for error details. For more information about how to retrieve logs, see [Retrieving and preserving logs](#).

## clustermgtd log(/var/log/parallelcluster/clustermgtd) on the head node

Log messages show which partitions have bootstrap failures and the corresponding bootstrap failure count.

```
[slurm_plugin.clustermgtd:_handle_protected_mode_process] - INFO - Partitions bootstrap failure count: {'queue1': 2}, cluster will be set into protected mode if protected failure count reach threshold.
```

In the clustermgtd log, search for Found the following bootstrap failure nodes to find which node failed to bootstrap.

```
[slurm_plugin.clustermgtd:_handle_protected_mode_process] - WARNING - Found the following bootstrap failure nodes: (x2) ['queue1-st-c5large-1(192.168.110.155)', 'broken-st-c5large-2(192.168.65.215)']
```

In the clustermgtd log, search for Node bootstrap error to find the reason for the failure.

```
[slurm_plugin.clustermgtd:_is_node_bootstrap_failure] - WARNING - Node bootstrap error: Node broken-st-c5large-2(192.168.65.215) is currently in replacement and no backing instance
```

## cloud-init-output log(/var/log/cloud-init-output.log) on the compute nodes

After obtaining the bootstrap failure node private IP address in the clustermgtd log, you can find the corresponding compute node log by either logging into the compute node or by following the guidance in [Retrieving and preserving logs](#) to retrieve logs. In most cases, the /var/log/cloud-init-output log from the problematic node shows the step that caused the compute node bootstrap failure.

## Slurm cluster fast insufficient capacity fail-over

Starting with AWS ParallelCluster version 3.2.0, clusters run with the fast insufficient capacity fail-over mode enabled by default. This minimizes the time spent retrying to queue a job when Amazon EC2 insufficient capacity errors are detected. This is particularly effective when you configure your cluster with multiple kinds of instance types.

### Amazon EC2 detected insufficient capacity failures:

- InsufficientInstanceCapacity

- `InsufficientHostCapacity`
- `InsufficientReservedInstanceCapacity`
- `MaxSpotInstanceCountExceeded`
- `SpotMaxPriceTooLow`: Activated if the Spot request price is lower than the minimum required Spot request fulfillment price.
- `Unsupported`: Activated with the use of an instance type that isn't supported in a specific AWS Region.

In fast insufficient capacity failure-over mode, if an insufficient capacity error is detected when a job is assigned to a [SlurmQueues](#) / [compute resource](#), AWS ParallelCluster does the following:

1. It sets the compute resource to a disabled (DOWN) state for a predefined period of time.
2. It uses `POWER_DOWN_FORCE` to cancel the compute resource failing node jobs and to suspend the failing node. It sets the failing node to the `IDLE` and `POWER_DOWN (!)` state, and then to `POWERING_DOWN (%)`.
3. It requeues the job to another compute resource.

The static and powered up nodes of the disabled compute resource aren't impacted. Jobs can complete on these nodes.

This cycle repeats until the job is successfully assigned to a compute resource node or nodes. For information about node states, see the [Slurm guide for multiple queue mode](#).

If no compute resources are found to run the job, the job is set to the `PENDING` state until the predefined period of time elapses. In this case, you can modify the predefined period of time as described in the following section.

### Insufficient capacity timeout parameter

#### `insufficient_capacity_timeout`

`insufficient_capacity_timeout` specifies the period of time (in seconds) that the compute resource is kept in the disabled (down) state when an insufficient capacity error is detected.

By default, `insufficient_capacity_timeout` is enabled.

The default `insufficient_capacity_timeout` is 600 seconds (10 minutes).

If the `insufficient_capacity_timeout` value is less than or equal to zero, fast insufficient capacity failure-over mode is disabled.

You can change the `insufficient_capacity_timeout` value by adding the parameter in the `clustermgtd` config file located at `/etc/parallelcluster/slurm_plugin/parallelcluster_clustermgtd.conf` in the HeadNode.

The parameter can be updated at any time without stopping the compute fleet.

For example:

- `insufficient_capacity_timeout=600`:

If an insufficient capacity error is detected, the compute resource is set to a disabled (DOWN). After 10 minutes, its failed node is set to the `idle~` (POWER\_SAVING) state.

- `insufficient_capacity_timeout=60`:

If an insufficient capacity error is detected, the compute resource is in a disabled (DOWN). After 1 minute, its failed node is set to the `idle~` state.

- `insufficient_capacity_timeout=0`:

Fast insufficient capacity failure-over mode is disabled. The compute resource isn't disabled.

### Note

There might be a delay of up to one minute between the time when nodes fail with insufficient capacity errors and the time when the cluster management daemon detects the node failures. This is because the cluster management daemon checks for node insufficient capacity failures and sets the compute resources to the down state at one-minute intervals.

## Fast insufficient capacity fail-over mode status

When a cluster is in fast insufficient capacity fail-over mode, you can check its status and node states.

### Node states

When a job is submitted to a compute resource dynamic node and an insufficient capacity error is detected, the node is placed in the `down#` state with reason.

```
(Code:InsufficientInstanceCapacity)Failure when resuming nodes.
```

Then powered off nodes (nodes in `idle~` state) are set to `down~` with reason.

```
(Code:InsufficientInstanceCapacity)Temporarily disabling node due to insufficient capacity.
```

The job is requeued to other compute resources in the queue.

The compute resource static nodes and nodes that are UP aren't impacted by fast insufficient capacity fail-over mode.

Consider the node states shown in the following example.

```
$ sinfo
PARTITION AVAIL TIMELIMIT NODES STATE NODELIST
queue1*   up    infinite    30  idle~ queue1-dy-c-1-[1-15],queue1-dy-c-2-[1-15]
queue2    up    infinite    30  idle~ queue2-dy-c-1-[1-15],queue2-dy-c-2-[1-15]
```

We submit a job to `queue1` that requires one node.

```
$ sinfo
PARTITION AVAIL TIMELIMIT NODES STATE NODELIST
queue1*   up    infinite    1   down# queue1-dy-c-1-1
queue1*   up    infinite    15  idle~ queue1-dy-c-2-[1-15]
queue1*   up    infinite    14  down~ queue1-dy-c-1-[2-15]
queue2    up    infinite    30  idle~ queue2-dy-c-1-[1-15],queue2-dy-c-2-[1-15]
```

Node `queue1-dy-c-1-1` is launched to run the job. However, the instance failed to launch due to an insufficient capacity error. Node `queue1-dy-c-1-1` is set to `down`. The powered off dynamic node within the compute resource (`queue2-dy-c-1`) is set to `down`.

You can check the node reason with `scontrol show nodes`.

```
$ scontrol show nodes queue1-dy-c-1-1
NodeName=broken-dy-c-2-1 Arch=x86_64 CoresPerSocket=1
CPUAlloc=0 CPUTot=96 CPULoad=0.00
...
ExtSensorsJoules=n/s ExtSensorsWatts=0 ExtSensorsTemp=n/s
```

```
Reason=(Code:InsufficientInstanceCapacity)Failure when resuming nodes
[root@2022-03-10T22:17:50]

$ scontrol show nodes queue1-dy-c-1-2
NodeName=broken-dy-c-2-1 Arch=x86_64 CoresPerSocket=1
CPUAlloc=0 CPUTot=96 CPULoad=0.00
...
ExtSensorsJoules=n/s ExtSensorsWatts=0 ExtSensorsTemp=n/s
Reason=(Code:InsufficientInstanceCapacity)Temporarily disabling node due to
insufficient capacity [root@2022-03-10T22:17:50]
```

The job is queued to another instance type within the queue compute resources.

After the `insufficient_capacity_timeout` elapses, nodes in the compute resource are reset to the `idle~` state.

```
$ sinfo
PARTITION AVAIL TIMELIMIT NODES STATE NODELIST
queue1*   up    infinite    30  idle~ queue1-dy-c-1-[1-15],queue1-dy-c-2-[1-15]
queue2    up    infinite    30  idle~ queue2-dy-c-1-[1-15],queue2-dy-c-2-[1-15]
```

After the `insufficient_capacity_timeout` elapses and nodes in the compute resource are reset to the `idle~` state, the Slurm scheduler gives the nodes lower priority. The scheduler keeps selecting nodes from other queue compute resources with higher weights unless one of the following occurs:

- A job's submission requirements match the recovered compute resource.
- No other compute resources are available because they are at capacity.
- `slurmctld` is restarted.
- The AWS ParallelCluster compute fleet is stopped and started to power down and power up all nodes.

## Related logs

Logs related to insufficient capacity errors and fast insufficient capacity fail-over mode can be found in Slurm's `resume` log and `clustermgtd` log in the head node.

### Slurm resume (`/var/log/parallelcluster/slurm_resume.log`)

Error messages when a node fails to launch because of insufficient capacity.

```
[slurm_plugin.instance_manager:_launch_ec2_instances] - ERROR - Failed RunInstances
request: dcd0c252-90d4-44a7-9c79-ef740f7ecd87
[slurm_plugin.instance_manager:add_instances_for_nodes] - ERROR - Encountered
exception when launching instances for nodes (x1) ['queue1-dy-c-1-1']: An error
occurred
(InsufficientInstanceCapacity) when calling the RunInstances operation (reached max
retries: 1): We currently do not have sufficient p4d.24xlarge capacity in the
Availability Zone you requested (us-west-2b). Our system will be working on
provisioning additional capacity. You can currently get p4d.24xlarge capacity by
not
specifying an Availability Zone in your request or choosing us-west-2a, us-west-2c.
```

## Slurm clustermgtd (/var/log/parallelcluster/clustermgtd)

Compute resource c-1 in queue1 is disabled because of insufficient capacity.

```
[slurm_plugin.clustermgtd:_reset_timeout_expired_compute_resources] - INFO - The
following compute resources are in down state
due to insufficient capacity: {'queue1': {'c-1':
ComputeResourceFailureEvent(timestamp=datetime.datetime(2022, 4, 14, 23, 0, 4,
769380, tzinfo=datetime.timezone.utc),
error_code='InsufficientInstanceCapacity')}}}, compute resources are reset after
insufficient capacity timeout (600 seconds) expired
```

After the insufficient capacity timeout expires, the compute resource is reset, nodes within the compute resources are set to idle~.

```
[root:_reset_insufficient_capacity_timeout_expired_nodes] - INFO - Reset the
following compute resources because insufficient capacity
timeout expired: {'queue1': ['c-1']}
```

## Slurm memory-based scheduling

Starting with version 3.2.0, AWS ParallelCluster supports Slurm memory-based scheduling with the [SlurmSettings](#) / [EnableMemoryBasedScheduling](#) cluster configuration parameter.

### Note

Starting with AWS ParallelCluster version 3.7.0, [EnableMemoryBasedScheduling](#) can be enabled if you configure multiple instance types in [Instances](#).



For AWS ParallelCluster versions 3.2.0 to 3.6.x, `EnableMemoryBasedScheduling` can't be enabled if you configure multiple instance types in [Instances](#).

### Warning

When you specify multiple instances types in a Slurm queue compute resource with `EnableMemoryBasedScheduling` enabled, the `RealMemory` value is the minimum amount of memory made available to all instance types. This might lead to significant amounts of unused memory if you specify instance types with very different memory capacities.

With `EnableMemoryBasedScheduling: true`, the Slurm scheduler tracks the amount of memory that each job requires on each node. Then, the Slurm scheduler uses this information to schedule multiple jobs on the same compute node. The total amount of memory that jobs require on a node can't be larger than the available node memory. The scheduler prevents a job from using more memory than what was requested when the job was submitted.

With `EnableMemoryBasedScheduling: false`, jobs might compete for memory on a shared node and cause job failures and out-of-memory events.

### Warning

Slurm uses a power of 2 notation for its labels, such as MB or GB. Read these labels as MiB and GiB, respectively.

## Slurm configuration and memory-based scheduling

With `EnableMemoryBasedScheduling: true`, Slurm sets the following Slurm configuration parameters:

- [SelectTypeParameters=CR\\_CPU\\_Memory](#) in the `slurm.conf`. This option configures node memory to be a consumable resource in Slurm.
- [ConstrainRAMSpace=yes](#) in the `Slurm cgroup.conf`. With this option, a job's access to memory is limited to the amount of memory that the job requested when submitted.

**Note**

Several other Slurm configuration parameters can impact the behavior of the Slurm scheduler and resource manager when these two options are set. For more information, see the [Slurm Documentation](#).

## Slurm scheduler and memory-based scheduling

### **EnableMemoryBasedScheduling: false (default)**

By default, `EnableMemoryBasedScheduling` is set to `false`. When `false`, Slurm doesn't include memory as a resource in its scheduling algorithm and doesn't track the memory that jobs use. Users can specify the `--mem MEM_PER_NODE` option to set the minimum amount of memory per node that a job requires. This forces the scheduler to choose nodes with a `RealMemory` value of at least `MEM_PER_NODE` when scheduling the job.

For example, suppose that a user submits two jobs with `--mem=5GB`. If requested resources such as CPUs or GPUs are available, the jobs can run at the same time on a node with 8 GiB of memory. The two jobs aren't scheduled on compute nodes with less than 5 GiB of `RealMemory`.

**Warning**

When memory-based scheduling is disabled, Slurm doesn't track the amount of memory that jobs use. Jobs that run on the same node might compete for memory resources and cause the other job to fail.

When memory-based scheduling is disabled, we recommend that users don't specify the [--mem-per-cpu](#) or [--mem-per-gpu](#) options. These options might cause behavior that differs from what's described in the [Slurm Documentation](#).

### **EnableMemoryBasedScheduling: true**

When `EnableMemoryBasedScheduling` is set to `true`, Slurm tracks the memory usage of each job and prevents jobs from using more memory than requested with the `--mem` submission options.

Using the previous example, a user submits two jobs with `--mem=5GB`. The jobs can't run at the same time on a node with 8 GiB of memory. This is because the total amount of memory that's required is greater than the memory that's available on the node.

With memory-based scheduling enabled, `--mem-per-cpu` and `--mem-per-gpu` behave consistently with what's described in the Slurm documentation. For example, a job is submitted with `--ntasks-per-node=2 -c 1 --mem-per-cpu=2GB`. In this case, Slurm assigns the job a total of 4 GiB for each node.

### Warning

When memory-based scheduling is enabled, we recommend that users include a `--mem` specification when submitting a job. With the default Slurm configuration that's included with AWS ParallelCluster, if no memory option is included (`--mem`, `--mem-per-cpu`, or `--mem-per-gpu`), Slurm assigns entire memory of the allocated nodes to the job, even if it requests only a portion of the other resources, such as CPUs or GPUs. This effectively prevents node sharing until the job is finished because no memory is available to other jobs. This happens because Slurm sets the memory per node for the job to [DefMemPerNode](#) when no memory specifications are provided at job submission time. The default value for this parameter is 0 and specifies unlimited access to a node's memory. If multiple types of compute resources with different amounts of memory are available in the same queue, a job submitted without memory options might be assigned different amounts of memory on different nodes. This depends on which nodes the scheduler makes available to the job. Users can define a custom value for options, such as `DefMemPerNode` or [DefMemPerCPU](#), at the cluster or partition level in the Slurm configuration files to prevent this behavior.

## Slurm RealMemory and AWS ParallelCluster SchedulableMemory

With the Slurm configuration that's shipped with AWS ParallelCluster, Slurm interprets [RealMemory](#) to be the amount of memory per node that's available to jobs. Starting with version 3.2.0, by default, AWS ParallelCluster sets `RealMemory` to 95 percent of the memory listed in [Amazon EC2 Instance Types](#) and returned by the Amazon EC2 API [DescribeInstanceTypes](#).

When memory-based scheduling is disabled, the Slurm scheduler uses `RealMemory` to filter nodes when users submit a job with `--mem` specified.

When memory-based scheduling is enabled, the Slurm scheduler interprets `RealMemory` to be the maximum amount of memory that's available to jobs that are running on the compute node.

The default setting might not be optimal for all instance types:

- This setting might be higher than the amount of memory that nodes can actually access. This can happen when compute nodes are small instance types.
- This setting might be lower than the amount of memory that nodes can actually access. This can happen when compute nodes are large instance types and can lead to a significant amount of unused memory.

You can use [SlurmQueues](#) / [ComputeResources](#) / [SchedulableMemory](#) to fine-tune the value of `RealMemory` configured by AWS ParallelCluster for compute nodes. To override the default, define a custom value for `SchedulableMemory` specifically for your cluster configuration.

To check a compute node's actual available memory, run the `/opt/slurm/sbin/slurmd -C` command on the node. This command returns the hardware configuration of the node, including the [RealMemory](#) value. For more information, see [slurmd -C](#).

Make sure that the compute node's operating system processes have sufficient memory. To do this, limit the memory available to jobs by setting the `SchedulableMemory` value to lower than the `RealMemory` value that the `slurmd -C` command returned.

## Multiple instance type allocation with Slurm

Starting with AWS ParallelCluster version 3.3.0, you can configure your cluster to allocate from a compute resource's set of defined instance types. Allocation can be based on Amazon EC2 fleet low cost or optimal capacity strategies.

This set of defined instance types must either all have the same number of vCPUs or, if multithreading is disabled, the same number of cores. Moreover, this set of instance types must have the same number of accelerators of the same manufacturers. If [Efa](#) / [Enabled](#) is set to `true`, the instances must have EFA supported. For more information and requirements, see [Scheduling](#) / [SlurmQueues](#) / [AllocationStrategy](#) and [ComputeResources](#) / [Instances](#).

You can set [AllocationStrategy](#) to lowest-price or capacity-optimized depending on your [CapacityType](#) configuration.

In [Instances](#), you can configure a set of instance types.

**Note**

Starting with AWS ParallelCluster version 3.7.0, `EnableMemoryBasedScheduling` can be enabled if you configure multiple instance types in [Instances](#).  
 For AWS ParallelCluster versions 3.2.0 to 3.6.x, `EnableMemoryBasedScheduling` can't be enabled if you configure multiple instance types in [Instances](#).

The following examples show how you can query instance types for vCPUs, EFA support, and architecture.

Query InstanceTypes with 96 vCPUs and x86\_64 architecture.

```
$ aws ec2 describe-instance-types --region region-id \
  --filters "Name=vcpu-info.default-vcpus,Values=96" "Name=processor-info.supported-
  architecture,Values=x86_64" \
  --query "sort_by(InstanceTypes[*].
  {InstanceType:InstanceType,MemoryMiB:MemoryInfo.SizeInMiB,CurrentGeneration:CurrentGeneration,V
  &InstanceType})" \
  --output table
```

Query InstanceTypes with 64 cores, EFA support, and arm64 architecture.

```
$ aws ec2 describe-instance-types --region region-id \
  --filters "Name=vcpu-info.default-cores,Values=64" "Name=processor-
  info.supported-architecture,Values=arm64" "Name=network-info.efa-
  supported,Values=true" --query "sort_by(InstanceTypes[*].
  {InstanceType:InstanceType,MemoryMiB:MemoryInfo.SizeInMiB,CurrentGeneration:CurrentGeneration,V
  &InstanceType})" \
  --output table
```

The next example cluster configuration snippet shows how you can use these InstanceType and AllocationStrategy properties.

```
...
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue-1
      CapacityType: ONDEMAND
      AllocationStrategy: lowest-price
```

```
...
ComputeResources:
  - Name: computeresource1
    Instances:
      - InstanceType: r6g.2xlarge
      - InstanceType: m6g.2xlarge
      - InstanceType: c6g.2xlarge
    MinCount: 0
    MaxCount: 500
  - Name: computeresource2
    Instances:
      - InstanceType: m6g.12xlarge
      - InstanceType: x2gd.12xlarge
    MinCount: 0
    MaxCount: 500
...
```

## Cluster scaling for dynamic nodes

ParallelCluster supports Slurm's methods to dynamically scale clusters by using Slurm's power saver plugin. For more information, see the [Cloud Scheduling Guide](#) and the [Slurm Power Saving Guide](#) in the Slurm documentation.

Starting with ParallelCluster version 3.8.0, ParallelCluster uses **Job-level resume** or **job-level scaling** as the default dynamic node allocation strategy to scale the cluster: ParallelCluster scales up the cluster based on the requirements of each job, the number of nodes allocated to the job, and which nodes need to be resumed. ParallelCluster gets this information from the `SLURM_RESUME_FILE` environment variable.

The scaling for dynamic nodes is a two steps process, which involves the launch of the EC2 instances and the assignment of the launched Amazon EC2 instances to the Slurm nodes. Each of these two steps can be done using an **all-or-nothing** or **best-effort** logic.

For launch of the Amazon EC2 instances:

- **all-or-nothing** calls the launch Amazon EC2 API with minimum target equals to the total target capacity
- **best-effort** calls the launch Amazon EC2 API with minimum target equals to 1 and the total target capacity equals to the requested capacity

For assignment of the Amazon EC2 instances to Slurm nodes:

- **all-or-nothing** assigns Amazon EC2 instances to Slurm nodes only if it's possible to assign an Amazon EC2 instance to every requested node
- **best-effort** assigns Amazon EC2 instances to Slurm nodes even if all the requested nodes are not covered by Amazon EC2 instance capacity

The possible combinations of the above strategies translates into the ParallelCluster launch strategies.

## Example

<caption>The available **ParallelCluster launch strategies** that can be set into the [ScalingStrategy](#) cluster configuration to be used with **job-level scaling** are:</caption>

### **all-or-nothing** scaling:

This strategy involves AWS ParallelCluster initiating an Amazon EC2 launch instance API call for each job, that requires all instances necessary for the requested compute nodes to be successfully launched. This ensures that the cluster scales only when the required capacity per job is available, avoiding idle instances left at the end of the scaling process.

The strategy uses an **all-or-nothing** logic for the launch of the Amazon EC2 instances for each job plus and **all-or-nothing** logic for the assignment of the Amazon EC2 instances to Slurm nodes.

The strategy groups launch requests into batches, one for each compute resource requested and up to 500 nodes each. For requests spanning multiple compute resources or exceeding 500 nodes, ParallelCluster sequentially processes multiple batches.

The failure of any single resource's batch results in the termination of all associated unused capacity, ensuring that no idle instances will be left at the end of the scaling process.

### Limitations

- The time taken for scaling is directly proportional to the number of jobs submitted per execution of the Slurm resume program.
- The scaling operation is limited by the RunInstances resource account limit, set at 1000 instances by default. This limitation is in accordance with AWS's EC2 API throttling policies, for more details refer to [Amazon EC2 API throttling documentation](#)
- When you submit a job in a compute resource with a single instance type, in a queue that spans multiple Availability Zones, the **all-or-nothing** EC2 launch API call only succeeds if all of the capacity can be provided in a single Availability Zone.

- When you submit a job in a compute resource with multiple instance types, in a queue with a single Availability Zone, the **all-or-nothing** Amazon EC2 launch API call only succeeds if all of the capacity can be provided by a single instance type.
- When you submit a job in a compute resource with multiple instance types, in a queue spanning multiple Availability Zones, the **all-or-nothing** Amazon EC2 launch API call isn't supported and ParallelCluster performs **best-effort** scaling instead.

### **greedy-all-or-nothing** scaling:

This variant of the all-or-nothing strategy still ensures that the cluster scales only when the required capacity per job is available, avoiding idle instances at the end of the scaling process, but it involves ParallelCluster initiating an Amazon EC2 launch instance API call that aims for a minimum target capacity of 1, attempting to maximize the number of nodes launched up to the requested capacity. The strategy uses a best-effort logic for the launch of the EC2 instances for all the jobs plus the **all-or-nothing** logic for the assignment of the Amazon EC2 instances to Slurm nodes for each job.

The strategy groups launch requests into batches, one for each compute resource requested and up to 500 nodes each. For requests spanning multiple compute resources or exceeding 500 nodes, ParallelCluster sequentially processes multiple batches.

It ensure that no idle instances will be left at the end of the scaling process, by maximizing the throughput at the cost of temporary over-scaling during the scaling process.

### Limitations

- Temporary over-scaling is possible, leading to additional costs for instances that transition to a running state before scaling completion.
- The same instance limit as in the all-or-nothing strategy applies, subject to AWS's RunInstances resource account limit.

### **best-effort** scaling:

This strategy calls Amazon EC2 launch instance API call by targeting a minimum capacity of 1 and aiming to achieve the total requested capacity at the cost of leaving idle instances after the scaling process execution if not all the requested capacity is available. The strategy uses a best-effort logic for the launch of the Amazon EC2 instances for all the jobs plus the **best-effort** logic for the assignment of the Amazon EC2 instances to Slurm nodes for each job.



The strategy groups launch requests into batches, one for each compute resource requested and up to 500 nodes each. For requests spanning multiple compute resources or exceeding 500 nodes, ParallelCluster sequentially processes multiple batches.

This strategy allows for scaling far beyond the default 1000 instances limit over multiple scaling process executions, at the cost of having idle instances across the different scaling processes.

### Limitations

- Possible idle running instances at the end of the scaling process, for the case when it's not possible to allocate all the nodes requested by the jobs.

The following is an example that shows how the scaling of dynamic nodes behave using the different **ParallelCluster launch strategies**. Suppose you have submitted two jobs requesting 20 nodes each, for a total of 40 nodes of the same type, but there are only 30 Amazon EC2 instances available to cover the requested capacity on EC2.

#### **all-or-nothing** scaling:

- For the first job, an **all-or-nothing** Amazon EC2 launch instance API is called, requesting 20 instances. A successful call has results in the launch of 20 instances
- **all-or-nothing** assignment of the 20 launched instances to Slurm nodes for the first job is successful
- Another **all-or-nothing** Amazon EC2 launch instance API is called, requesting 20 instances for the second job. The call is not successful, since there is only capacity for another 10 instances. No instances are launched at this time

#### **greedy-all-or-nothing** scaling:

- A **best-effort** Amazon EC2 launch instance API is called, requesting 40 instances, which is the total capacity requested by all the jobs. This results in the launch of 30 instances
- An **all-or-nothing** assignment of 20 of the launched instances to Slurm nodes for the first job is successful
- Another **all-or-nothing** assignment of the remaining launched instances to Slurm nodes for the second job is tried, but since there are only 10 available instances out of the total 20 requested by the job, the assignment is not successful
- The 10 unassigned launched instances are terminated

**best-effort** scaling:

- A **best-effort** Amazon EC2 launch instance API is called, requesting 40 instances, which is the total capacity requested by all the jobs. This results in the launch of 30 instances.
- A **best-effort** assignment of 20 of the launched instances to Slurm nodes for the first job is successful.
- Another **best-effort** assignment of the remaining 10 launched instances to Slurm nodes for the second job is successful, even if the total requested capacity was 20. But since the job was requesting the 20 nodes, and it was possible to assign Amazon EC2 instances to only 10 of them, the job cannot start and the instances are left running idle, until enough capacity is found to start the missing 10 instances at a later call of the scaling process, or the scheduler schedules the job on other, already running, compute nodes.

**Slurm dynamic node allocation strategies in version 3.7.x**

ParallelCluster uses 2 types of dynamic node allocation strategies to scale the cluster:

- **Allocation based on available requested node information:**

- **All-nodes resume** or **node-list** scaling:

ParallelCluster scales up the cluster based only on Slurm's requested node list names when Slurm's `ResumeProgram` runs. It allocates compute resources to nodes only by node name. The list of node names can span multiple jobs.

- **Job-level resume** or **job-level** scaling:

ParallelCluster scales up the cluster based on the requirements of each job, the current number of nodes that are allocated to the job, and which nodes need to be resumed.

ParallelCluster gets this information from the `SLURM_RESUME_FILE` environment variable.

- **Allocation with an Amazon EC2 launch strategy:**

- **Best-effort** scaling:

ParallelCluster scales up the cluster by using an Amazon EC2 launch instance API call with the minimum target capacity equal to 1, to launch some, but not necessarily all of instances needed to support the requested nodes.

- **All-or-nothing** scaling:

ParallelCluster scales up the cluster by using an Amazon EC2 launch instance API call that only succeeds if all of the instances needed to support the requested nodes are launched. In this case, it calls the Amazon EC2 launch instance API with the minimum target capacity equal to the total requested capacity.

By default, ParallelCluster uses **node-list** scaling with a **best-effort** Amazon EC2 launch strategy to launch some, but not necessarily all of instances needed to support the requested nodes. It tries to provision as much capacity as possible to serve the submitted workload.

Starting with ParallelCluster version 3.7.0, ParallelCluster uses **job-level** scaling with an **all-or-nothing** EC2 launch strategy for jobs submitted in **exclusive mode**. When you submit a job in exclusive mode, the job has exclusive access to its allocated nodes. For more information, see [EXCLUSIVE](#) in the Slurm documentation.

To submit a job in exclusive mode:

- Pass the exclusive flag when submitting a Slurm job to the cluster. For example, `sbatch ... --exclusive`.

OR

- Submit a job to a cluster queue that has been configured with [JobExclusiveAllocation](#) set to `true`.

When submitting a job in exclusive mode:

- ParallelCluster currently batches launch requests to include up to 500 nodes. If a job requests more than 500 nodes, ParallelCluster makes an **all-or-nothing** launch request for each set of 500 nodes and an additional launch request for the remainder of nodes.
- If node allocation is in a single compute resource, ParallelCluster makes an **all-or-nothing** launch request for each set of 500 nodes and an additional launch request for the remainder of nodes. If a launch request fails, ParallelCluster terminates the unused capacity created by all of the launch requests.
- If node allocation spans multiple compute resources, ParallelCluster needs to make an **all-or-nothing** launch request for each compute resource. These requests are also batched. If a launch request fails for one of the compute resources, ParallelCluster terminates the unused capacity created by all of the compute resource launch requests.

## job-level scaling with **all-or-nothing** launch strategy known limitations:

- When you submit a job in a compute resource with a single instance type, in a queue that spans multiple Availability Zones, the **all-or-nothing** EC2 launch API call only succeeds if all of the capacity can be provided in a single Availability Zone.
- When you submit a job in a compute resource with multiple instance types, in a queue with a single Availability Zone, the **all-or-nothing** Amazon EC2 launch API call only succeeds if all of the capacity can be provided by a single instance type.
- When you submit a job in a compute resource with multiple instance types, in a queue spanning multiple Availability Zones, the **all-or-nothing** Amazon EC2 launch API call isn't supported and ParallelCluster performs **best-effort** scaling instead.

## Slurm dynamic node allocation strategies in version 3.6.x and previous

AWS ParallelCluster uses only one type of dynamic node allocation strategy to scale the cluster:

- Allocation based on available requested node information:
  - **All-nodes resume** or **node-list** scaling: ParallelCluster scales up the cluster based only on Slurm's requested node list names when Slurm's ResumeProgram runs. It allocates compute resources to nodes only by node name. The list of node names can span multiple jobs.
- Allocation with an Amazon EC2 launch strategy:
  - **Best-effort** scaling: ParallelCluster scales up the cluster by using an Amazon EC2 launch instance API call with the minimum target capacity equal to 1, to launch some, but not necessarily all of instances needed to support the requested nodes.

ParallelCluster uses **node-list** scaling with a **best-effort** Amazon EC2 launch strategy to launch some, but not necessarily all of instances needed to support the requested nodes. It tries to provision as much capacity as possible to serve the submitted workload.

### Limitations

- Possible idle running instances at the end of the scaling process, for the case when it's not possible to allocate all the nodes requested by the jobs.

## Slurm accounting with AWS ParallelCluster

Starting with version 3.3.0, AWS ParallelCluster supports Slurm accounting with the cluster configuration parameter [SlurmSettings](#) / [Database](#).

Starting with version 3.10.0, AWS ParallelCluster supports Slurm accounting with an external Slurmdbd with the cluster configuration parameter [SlurmSettings](#) / [ExternalSlurmdbd](#). Using an external Slurmdbd is recommended if multiple clusters share the same database.

With Slurm accounting, you can integrate an external accounting database to do the following:

- Manage cluster users or groups of users and other entities. With this capability, you can use Slurm's more advanced features, such as resource limit enforcement, fairshare, and QOSs.
- Collect and save job data, such as the user that ran the job, the job's duration, and the resources it uses. You can view the saved data with the `sacct` utility.

### Note

AWS ParallelCluster supports Slurm accounting for [Slurm supported MySQL database servers](#).

### Working with Slurm accounting using external Slurmdbd in AWS ParallelCluster v3.10.0 and later

Before you configure Slurm accounting, you must have an existing external Slurmdbd database server, which connects to an existing external database server.

To configure this, define the following:

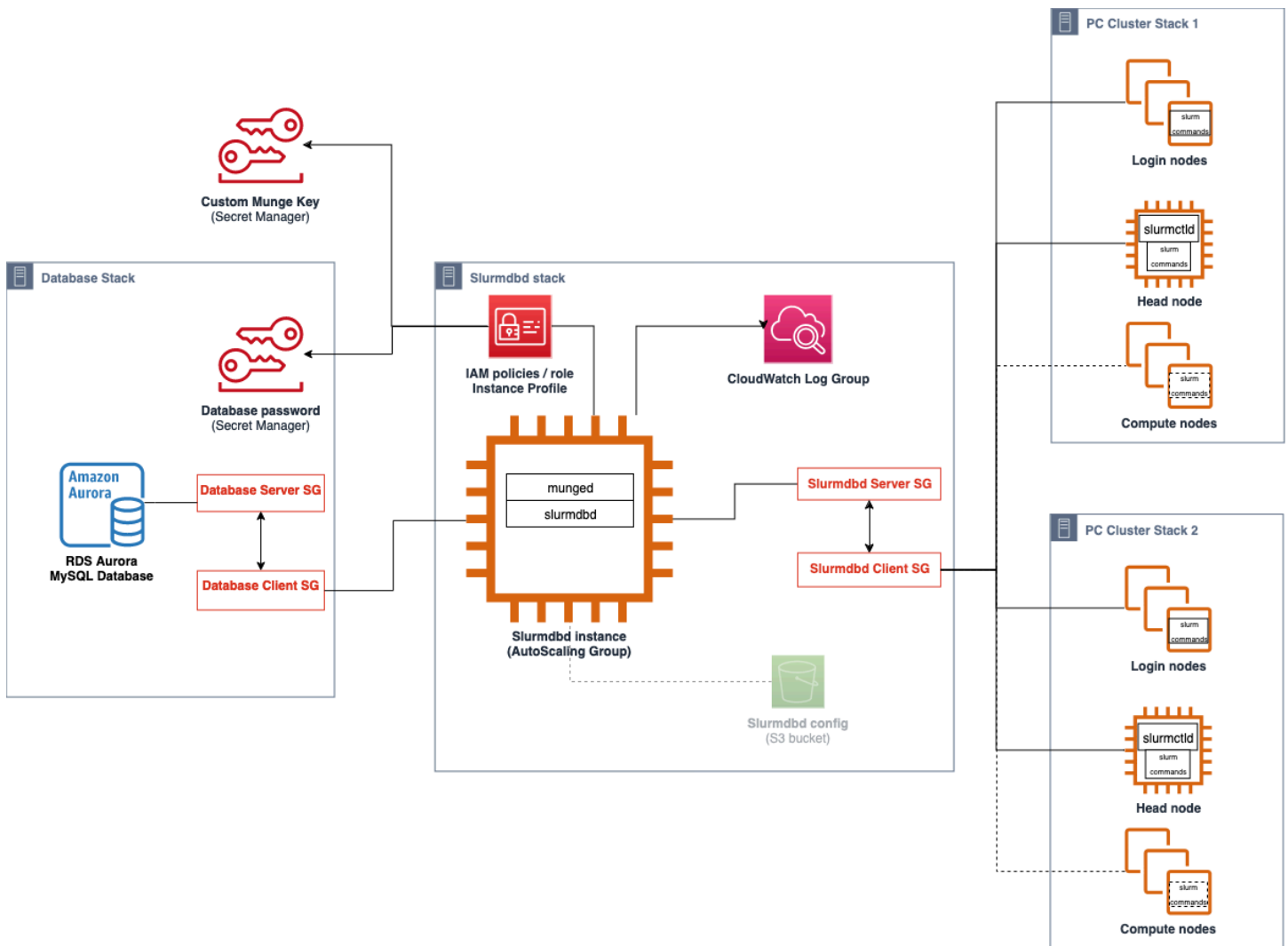
- The address of the external Slurmdbd server in [ExternalSlurmdbd](#) / [Host](#). The server must exist and be reachable from the head node.
- The munge key to communicate with the external Slurmdbd server in [MungeKeySecretArn](#).

To step through a tutorial, see [Creating a cluster with an external SlurmDB accounting](#).

**Note**

You are responsible to manage the Slurm database accounting entities.

The architecture of the AWS ParallelCluster external SlurmDB support feature enables multiple clusters sharing the same SlurmDB and the same database.



**Warning**

Traffic between AWS ParallelCluster and the external SlurmDB is not encrypted. It is recommended to run the cluster and the external SlurmDB in a trusted network.

## Working with Slurm accounting using head node Slurmdbd in AWS ParallelCluster v3.3.0 and later

Before you configure Slurm accounting, you must have an existing external database server and database that uses `mysql` protocol.

To configure Slurm accounting with AWS ParallelCluster, you must define the following:

- The URI for the external database server in [Database](#) / [Uri](#). The server must exist and be reachable from the head node.
- Credentials to access the external database that are defined in [Database](#) / [PasswordSecretArn](#) and [Database](#) / [UserName](#). AWS ParallelCluster uses this information to configure accounting at the Slurm level and the `slurmdbd` service on the head node. `slurmdbd` is the daemon that manages communication between the cluster and the database server.

To step through a tutorial, see [Creating a cluster with Slurm accounting](#).

### Note

AWS ParallelCluster performs a basic bootstrap of the Slurm accounting database by setting the default cluster user as database admin in the Slurm database. AWS ParallelCluster doesn't add any other user to the accounting database. The customer is responsible for managing the accounting entities in the Slurm database.

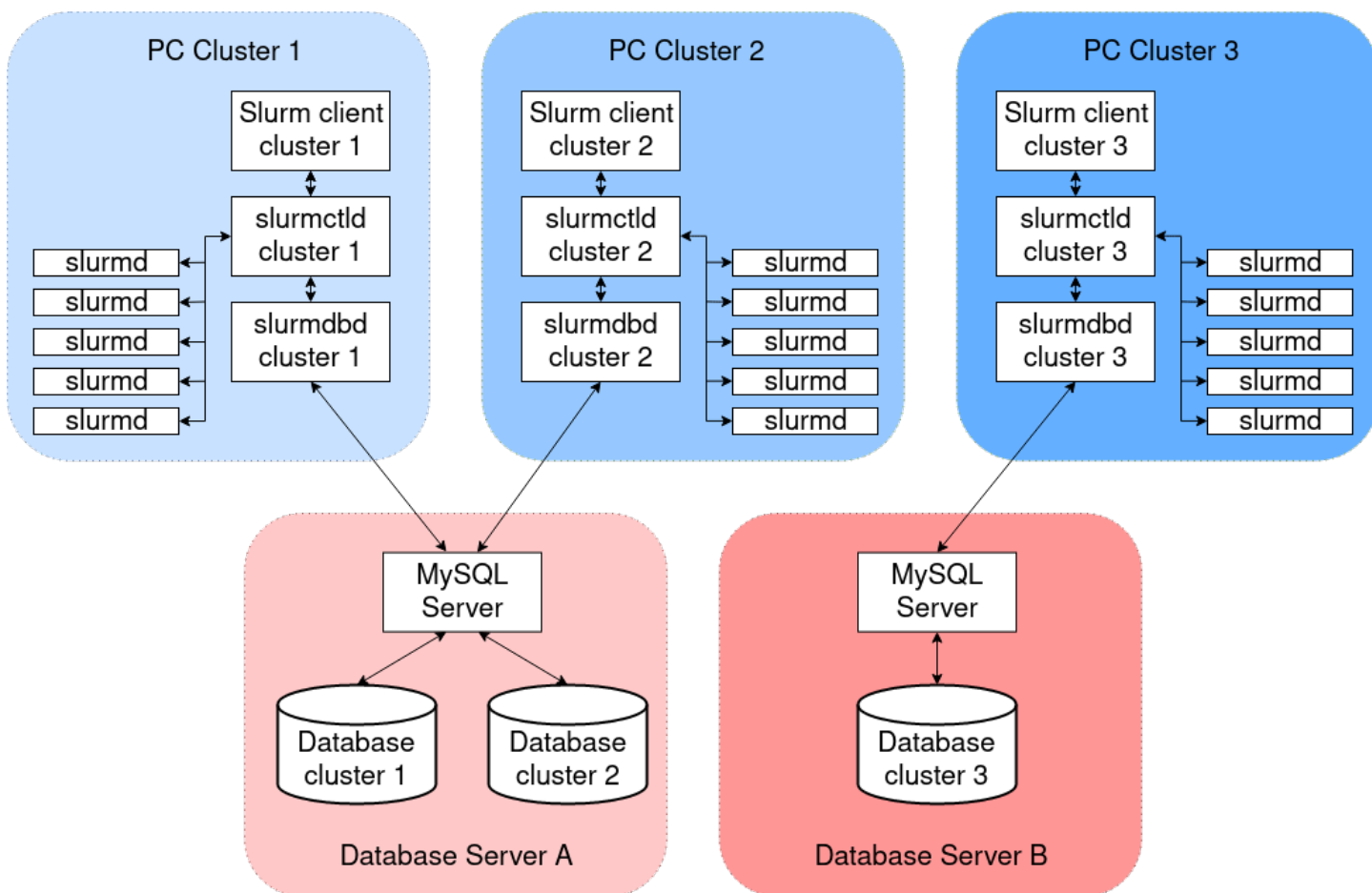
AWS ParallelCluster configures [slurmdbd](#) to ensure that a cluster has its own Slurm database on the database server. The same database server can be used across multiple clusters, but each cluster has its own separate database. AWS ParallelCluster uses the cluster name to define the name for the database in the `slurmdbd` configuration file [StorageLoc](#) parameter. Consider the following situation. A database that's present on the database server includes a cluster name that doesn't map to an active cluster name. In this case, you can create a new cluster with that cluster name to map to that database. Slurm reuses the database for the new cluster.

### Warning

- We don't recommend setting up more than one cluster to use the same database at once. Doing so can lead to performance issues or even database deadlock situations.

- If Slurm accounting is enabled on the head node of a cluster, we recommend using an instance type with a powerful CPU, more memory, and higher network bandwidth. Slurm accounting can add strain on the head node of the cluster.

In the current architecture of the AWS ParallelCluster Slurm accounting feature, each cluster has its own instance of the `slurmdbd` daemon as shown in the following diagram example configurations.



If you're adding custom Slurm multi-cluster or federation functionalities to your cluster environment, all clusters must reference the same `slurmdbd` instance. For this alternative, we recommend that you enable AWS ParallelCluster Slurm accounting on one cluster and manually configure the other clusters to connect to the `slurmdbd` that are hosted on the first cluster.

If you're using AWS ParallelCluster versions prior to version 3.3.0, refer to the alternative method to implement Slurm accounting that's described in this [HPC Blog Post](#).



## Slurm accounting considerations

### Database and cluster on different VPCs

To enable Slurm accounting, a database server is needed to serve as a backend for the read and write operations that the `slurmdbd` daemon performs. Before the cluster is created or updated to enable Slurm accounting, the head node must be able to reach the database server.

If you need to deploy the database server on a VPC other than the one that the cluster uses, consider the following:

- To enable communication between the `slurmdbd` on the cluster side and the database server, you must set up connectivity between the two VPCs. For more information, see [VPC Peering](#) in the *Amazon Virtual Private Cloud User Guide*.
- You must create the security group that you want to attach to the head node on the VPC of the cluster. After the two VPCs have been peered, cross-linking between the database side and the cluster side security groups is available. For more information, see [Security Group Rules](#) in the *Amazon Virtual Private Cloud User Guide*.

### Configuring TLS encryption between `slurmdbd` and the database server

With the default Slurm accounting configuration that AWS ParallelCluster provides, `slurmdbd` establishes a TLS encrypted connection to the database server, if the server supports TLS encryption. AWS database services such as Amazon RDS and Amazon Aurora support TLS encryption by default.

You can require secure connections on the server side by setting the `require_secure_transport` parameter on the database server. This is configured in the provided CloudFormation template.

Following security best practice, we recommend that you also enable server identity verification on the `slurmdbd` client. To do this, configure the [StorageParameters](#) in the `slurmdbd.conf`. Upload the server CA certificate to the head node of the cluster. Next, set the [SSL\\_CA](#) option of `StorageParameters` in `slurmdbd.conf` to the path of the server CA certificate on the head node. Doing this enables server identity verification on the `slurmdbd` side. After you make these changes, restart the `slurmdbd` service to re-establish connectivity to the database server with identity verification enabled.

## Updating the database credentials

To update the values for [Database](#) / [UserName](#) or [PasswordSecretArn](#), you must first stop the compute fleet. Suppose that the secret value that's stored in the AWS Secrets Manager secret is changed and its ARN isn't changed. In this situation, the cluster doesn't automatically update the database password to the new value. To update the cluster for the new secret value, run the following command from the head node.

```
$ sudo /opt/parallelcluster/scripts/slurm/update_slurm_database_password.sh
```

### Warning

To avoid losing accounting data, we recommend that you only change the database password when the compute fleet is stopped.

## Database monitoring

We recommend that you enable the monitoring features of the AWS database services. For more information, see [Amazon RDS monitoring](#) or [Amazon Aurora monitoring](#) documentation.

## Slurm configuration customization

Starting with AWS ParallelCluster version 3.6.0, you can customize the `slurm.conf` Slurm configuration in an AWS ParallelCluster cluster configuration.

In the cluster configuration, you can customize Slurm configuration parameters by using the following cluster configuration settings:

- Customize Slurm parameters for the entire cluster by using either the [SlurmSettings](#) / [CustomSlurmSettings](#) or the [CustomSlurmSettingsIncludeFile](#) parameter. AWS ParallelCluster fails if you specify both.
- Customize Slurm parameters for a queue by using [SlurmQueues](#) / [CustomSlurmSettings](#) (mapped to Slurm partitions).
- Customize Slurm parameters for a compute resource by using [SlurmQueues](#) / [ComputeResources](#) / [CustomSlurmSettings](#) (mapped to Slurm nodes).

## Slurm configuration customization limits and considerations when using AWS ParallelCluster

- For `CustomSlurmSettings` and `CustomSlurmSettingsIncludeFile` settings, you can only specify and update `slurm.conf` parameters that are included in the [Slurm version](#) that's supported by the AWS ParallelCluster version that you are using to configure a cluster.
- If you specify custom Slurm configurations in any of the `CustomSlurmSettings` parameters, AWS ParallelCluster performs validation checks and prevents setting or updating Slurm configuration parameters that conflict with AWS ParallelCluster logic. The Slurm configuration parameters that are known to conflict with AWS ParallelCluster are identified in deny lists. The deny lists can change in future AWS ParallelCluster versions if other Slurm features are added. For more information, see [Deny-listed Slurm configuration parameters for CustomSlurmSettings](#).
- AWS ParallelCluster only checks whether a parameter is in a deny list. AWS ParallelCluster doesn't validate your custom Slurm configuration parameter syntax or semantics. You are responsible for validating your custom Slurm configuration parameters. Invalid custom Slurm configuration parameters can cause Slurm daemon failures that can lead to cluster create and update failures.
- If you specify custom Slurm configurations in `CustomSlurmSettingsIncludeFile`, AWS ParallelCluster doesn't perform any validation.
- You can update `CustomSlurmSettings` and `CustomSlurmSettingsIncludeFile` without stopping and starting the compute fleet. In this case, AWS ParallelCluster restarts the `slurmctld` daemon and runs the `scontrol reconfigure` command.

Some Slurm configuration parameters might require different operations before a change is registered in the entire cluster. For example, they might require a restart of all daemons in the cluster. You are responsible for verifying whether AWS ParallelCluster operations are sufficient for propagating your custom Slurm configuration parameter settings during updates. If you find that AWS ParallelCluster operations aren't sufficient, it's your responsibility to provide the additional actions required to propagate the updated settings as recommended in the [Slurm documentation](#).

## Deny-listed Slurm configuration parameters for CustomSlurmSettings

The following tables list the parameters with the AWS ParallelCluster versions that deny their use, starting with version 3.6.0. `CustomSlurmSettings` isn't supported for AWS ParallelCluster versions earlier than version 3.6.0.

**Deny-listed parameters at cluster level:**

<b>Slurm parameter</b>	<b>Deny-listed in AWS ParallelCluster versions</b>
CommunicationParameters	3.6.0
Epilog	3.6.0
GresTypes	3.6.0
LaunchParameters	3.6.0
Prolog	3.6.0
ReconfigFlags	3.6.0
ResumeFailProgram	3.6.0
ResumeProgram	3.6.0
ResumeTimeout	3.6.0
SlurmctldHost	3.6.0
SlurmctldLogFile	3.6.0
SlurmctldParameters	3.6.0
SlurmdLogFile	3.6.0
SlurmUser	3.6.0
SuspendExcNodes	3.6.0
SuspendProgram	3.6.0
SuspendTime	3.6.0
TaskPlugin	3.6.0
TreeWidth	3.6.0

**Deny-listed parameters at cluster level when the [native Slurm accounting integration](#) is configured in the cluster configuration:**

Slurm parameter	Deny-listed in AWS ParallelCluster versions
AccountingStorageType	3.6.0
AccountingStorageHost	3.6.0
AccountingStoragePort	3.6.0
AccountingStorageUser	3.6.0
JobAcctGatherType	3.6.0

**Deny-listed parameters at the queue (partition) level for queues managed by AWS ParallelCluster:**

Slurm parameter	Deny-listed in AWS ParallelCluster versions
Nodes	3.6.0
PartitionName	3.6.0
ResumeTimeout	3.6.0
State	3.6.0
SuspendTime	3.6.0

**Deny-listed parameters at the compute resource (node) level for compute resource managed by AWS ParallelCluster:**

Slurm parameter	Deny-listed in AWS ParallelCluster version and later versions
CPUs	3.6.0
Features	3.6.0

Slurm parameter	Deny-listed in AWS ParallelCluster version and later versions
Gres	3.6.0
NodeAddr	3.6.0
NodeHostname	3.6.0
NodeName	3.6.0
Weight	3.7.0

## Slurmprolog and epilog

Starting with AWS ParallelCluster version 3.6.0, the Slurm configuration that's deployed with AWS ParallelCluster includes the Prolog and Epilog configuration parameters:

```
# PROLOG AND EPILOG
Prolog=/opt/slurm/etc/scripts/prolog.d/*
Epilog=/opt/slurm/etc/scripts/epilog.d/*
SchedulerParameters=nohold_on_prolog_fail
BatchStartTimeout=180
```

For more information, see the [Prolog and Epilog Guide](#) in the Slurm documentation.

AWS ParallelCluster includes the following prolog and epilog scripts:

- `90_plcluster_health_check_manager` (in the Prolog folder)
- `90_pcluster_noop` (in the Epilog folder)

### Note

Both the Prolog and Epilog folder must contain at least one file.

You can use your own custom prolog or epilog scripts by adding them to the corresponding Prolog and Epilog folders.

**⚠ Warning**

Slurm runs every script in the folders, in reverse alphabetical order.

The run time duration of the prolog and epilog scripts impact the time needed to run a job. Update the `BatchStartTimeout` configuration setting when running multiple or long running prolog scripts. The default is 3 minutes.

If you are using custom prolog and epilog scripts, locate the scripts in the respective `Prolog` and `Epilog` folders. We recommend that you keep the `90_plcluster_health_check_manager` script that runs before every custom script. For more information, see [Slurm configuration customization](#).

## Cluster capacity size and update

The capacity of the cluster is defined by the number of compute nodes the cluster can scale. Compute nodes are backed by Amazon EC2 instances defined within compute resources in the AWS ParallelCluster configuration (`Scheduling/SlurmQueues/ComputeResources`), and are organized into queues (`Scheduling/SlurmQueues`) that map 1:1 to Slurm partitions.

Within a compute resource it's possible to configure the minimum number of compute nodes (instances) that must always be kept running in the cluster (`MinCount`), and the maximum number of instances the compute resource can scale to (`MaxCount3`).

At cluster creation time, or upon a cluster update, AWS ParallelCluster launches as many Amazon EC2 instances as configured in `MinCount` for each compute resource (`Scheduling/SlurmQueues/ComputeResources`) defined in the cluster. The instances launched to cover the minimal amount of nodes for a compute resources in the cluster are called **static nodes**. Once started, static nodes are meant to be persistent in the cluster and they are not terminated by the system, unless a particular event or condition occurs. Such events include, for example, the failure of Slurm or Amazon EC2 health checks and the change of the Slurm node status to DRAIN or DOWN.

The Amazon EC2 instances, in the range of 1 to `'MaxCount - MinCount'` (`MaxCount minus MinCount`), launched on-demand to deal with the increased load of the cluster, are referred to as **dynamic nodes**. Their nature is ephemeral, they are launched to serve pending jobs and are terminated once they stay idle for a period of time defined by `Scheduling/SlurmSettings/ScaledownIdletime` in the cluster configuration (default: 10 minutes).

Static nodes and dynamic node comply to the following naming schema:

- Static nodes `<Queue/Name>-st-<ComputeResource/Name>-<num>` where `<num> = 1..ComputeResource/MinCount`
- Dynamic nodes `<Queue/Name>-dy-<ComputeResource/Name>-<num>` where `<num> = 1..(ComputeResource/MaxCount - ComputeResource/MinCount)`

For example given the following AWS ParallelCluster configuration:

```
Scheduling:
  Scheduler: Slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
        - Name: c5xlarge
          Instances:
            - InstanceType: c5.xlarge
              MinCount: 100
              MaxCount: 150
```

The following nodes will be defined in Slurm

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up      infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up      infinite  100    idle queue1-st-c5xlarge-[1-100]
```

When a compute resource has `MinCount == MaxCount`, all the corresponding compute nodes will be static and all the instances will be launched at cluster creation/update time and kept up and running. For example:

```
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      ComputeResources:
```



```
- Name: c5xlarge
  Instances:
    - InstanceType: c5.xlarge
  MinCount: 100
  MaxCount: 100
```

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up       infinite   100   idle queue1-st-c5xlarge-[1-100]
```

## Cluster capacity update

The update of the cluster capacity includes adding or removing queues, compute resources or changing the MinCount/MaxCount of a compute resource. Starting from AWS ParallelCluster version 3.9.0, reducing the size of a queue requires the compute fleet to be stopped or [QueueUpdateStrategy](#) set to TERMINATE for before a cluster update to take place. It's not required to stop the compute fleet or to set [QueueUpdateStrategy](#) to TERMINATE when:

- Adding new queues to Scheduling/[SlurmQueues](#)
- Adding new compute resources Scheduling/SlurmQueues/[ComputeResources](#) to a queue
- Increasing the [MaxCount](#) of a compute resource
- Increasing MinCount of a compute resource and increasing MaxCount of the same compute resource of at least the same amount

## Considerations and limitations

This section is meant to outline any important factors, constraints, or limitations that should be taken into account when resizing the cluster capacity.

- When removing a queue from Scheduling/<https://docs.aws.amazon.com/parallelcluster/latest/ug/Scheduling-v3.html#Scheduling-v3-SlurmQueues> all the compute nodes with name <Queue/Name>-\* , both static and dynamic, will be removed from the Slurm configuration and the corresponding Amazon EC2 instances will be terminated.

- When removing a compute resource Scheduling/SlurmQueues/<https://docs.aws.amazon.com/parallelcluster/latest/ug/Scheduling-v3.html#Scheduling-v3-SlurmQueues-ComputeResources> ComputeResources from a queue, all the compute nodes with name `<Queue/Name>-*-<ComputeResource/Name>-*`, both static and dynamic, will be removed from the Slurm configuration and the corresponding Amazon EC2 instances will be terminated.

When changing the MinCount parameter of a compute resource we can distinguish two different scenarios, if MaxCount is kept equal to MinCount (static capacity only), and if MaxCount is greater than MinCount (mixed static and dynamic capacity).

### Capacity changes with static nodes only

- If `MinCount == MaxCount`, when increasing MinCount (and MaxCount), the cluster will be configured by extending the number of static nodes to the new value of MinCount `<Queue/Name>-st-<ComputeResource/Name>-<new_MinCount>` and the system will keep trying to launch Amazon EC2 instances to fulfill the new required static capacity.
- If `MinCount == MaxCount`, when decreasing MinCount (and MaxCount) of the amount N, the cluster will be configured by removing the last N static nodes `<Queue/Name>-st-<ComputeResource/Name>-<old_MinCount - N>...<old_MinCount>` and the system will terminate the corresponding Amazon EC2 instances.

- Initial state `MinCount = MaxCount = 100`

- 

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up      infinite   100   idle queue1-st-c5xlarge-[1-100]
```

- Update -30 on MinCount and MaxCount: `MinCount = MaxCount = 70`

- 

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up      infinite    70   idle queue1-st-c5xlarge-[1-70]
```

## Capacity changes with mixed nodes

If  $\text{MinCount} < \text{MaxCount}$ , when increasing  $\text{MinCount}$  by an amount  $N$  (assuming  $\text{MaxCount}$  will be kept unchanged), the cluster will be configured by extending the number static nodes to the new value of  $\text{MinCount}$  ( $\text{old\_MinCount} + N$ ): `<Queue/Name>-st-<ComputeResource/Name>-<old\_MinCount + N>` and the system will keep trying to launch Amazon EC2 instances to fulfill the new required static capacity. Moreover, to honor the  $\text{MaxCount}$  capacity of the compute resource, the cluster configuration is updated by *removing the last  $N$  dynamic nodes*: `<Queue/Name>-dy-<ComputeResource/Name>-[<MaxCount - old\_MinCount - N>...<MaxCount - old\_MinCount>]` and the system will terminate the corresponding Amazon EC2 instances.

- Initial state:  $\text{MinCount} = 100$ ;  $\text{MaxCount} = 150$

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite    50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite   100    idle queue1-st-c5xlarge-[1-100]
```

- Update +30 to  $\text{MinCount}$  :  $\text{MinCount} = 130$  ( $\text{MaxCount} = 150$ )

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite    20    idle~ queue1-dy-c5xlarge-[1-20]
queue1*   up    infinite   130    idle queue1-st-c5xlarge-[1-130]
```

If  $\text{MinCount} < \text{MaxCount}$ , when increasing  $\text{MinCount}$  and  $\text{MaxCount}$  of the same amount  $N$ , the cluster will be configured by extending the number static nodes to the new value of  $\text{MinCount}$  ( $\text{old\_MinCount} + N$ ): `<Queue/Name>-st-<ComputeResource/Name>-<old\_MinCount + N>` and the system will keep trying to launch Amazon EC2 instances to fulfill the new required static capacity. Moreover, no changes will be done on the number of dynamic nodes to honor the new  $\text{MaxCount}$  value.

- Initial state:  $\text{MinCount} = 100$ ;  $\text{MaxCount} = 150$

- ```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*    up    infinite  100    idle queue1-st-c5xlarge-[1-100]

```

- Update +30 to MinCount : MinCount = 130 (MaxCount = 180)

- ```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   20    idle~ queue1-dy-c5xlarge-[1-50]
queue1*    up    infinite  130    idle queue1-st-c5xlarge-[1-130]

```

If  $\text{MinCount} < \text{MaxCount}$ , when decreasing MinCount of the amount  $N$  (assuming MaxCount will be kept unchanged), the cluster will be configured by removing the last  $N$  static nodes `<Queue/Name>-st-<ComputeResource/Name>-[<old_MinCount - N>...<old_MinCount>` and the system will terminate the corresponding Amazon EC2 instances. Moreover, to honor the MaxCount capacity of the compute resource, the cluster configuration is updated by extending the number of the dynamic nodes to fill the gap  $\text{MaxCount} - \text{new\_MinCount}$ : `<Queue/Name>-dy-<ComputeResource/Name>-[1..<MaxCount - new_MinCount>]` In this case, since those are dynamic nodes, no new Amazon EC2 instances will be launched unless the scheduler has jobs in pending on the new nodes.

- Initial state: MinCount = 100; MaxCount = 150

- ```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*    up    infinite  100    idle queue1-st-c5xlarge-[1-100]

```

- Update -30 on MinCount : MinCount = 70 (MaxCount = 120)

-

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   80    idle~ queue1-dy-c5xlarge-[1-80]
queue1*   up    infinite   70    idle queue1-st-c5xlarge-[1-70]
```

If  $\text{MinCount} < \text{MaxCount}$ , when decreasing  $\text{MinCount}$  and  $\text{MaxCount}$  of the same amount  $N$ , the cluster will be configured by removing the last  $N$  static nodes `<Queue/Name>-st-<ComputeResource/Name>-<old_MinCount - N>...<oldMinCount>`] and the system will terminate the corresponding Amazon EC2 instances.

Moreover, no changes will be done on the number of dynamic nodes to honor the new  $\text{MaxCount}$  value.

- Initial state:  $\text{MinCount} = 100$ ;  $\text{MaxCount} = 150$

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite  100    idle queue1-st-c5xlarge-[1-100]
```

- Update -30 on  $\text{MinCount}$  :  $\text{MinCount} = 70$  ( $\text{MaxCount} = 120$ )

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*   up    infinite   80    idle~ queue1-dy-c5xlarge-[1-50]
queue1*   up    infinite   70    idle queue1-st-c5xlarge-[1-70]
```

If  $\text{MinCount} < \text{MaxCount}$ , when decreasing  $\text{MaxCount}$  of the amount  $N$  (assuming  $\text{MinCount}$  will be kept unchanged), the cluster will be configured by removing the last  $N$  dynamic nodes `<Queue/Name>-dy-<ComputeResource/Name>-<old_MaxCount - N...<oldMaxCount>`] and the system will terminate the corresponding Amazon EC2 instances in the case they were running. No impact is expected on the static nodes.

- Initial state: MinCount = 100; MaxCount = 150

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   50    idle~ queue1-dy-c5xlarge-[1-50]
queue1*    up    infinite  100    idle queue1-st-c5xlarge-[1-100]
```

- Update -30 on MaxCount : MinCount = 100 (MaxCount = 120)

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite   20    idle~ queue1-dy-c5xlarge-[1-20]
queue1*    up    infinite  100    idle queue1-st-c5xlarge-[1-100]
```

## Impacts on the Jobs

In all the cases where nodes are removed and Amazon EC2 instances terminated, a sbatch job running on the removed nodes will be re-queued, unless there are no other nodes satisfying the job requirements. In this last case the job will fail with status `NODE_FAIL` and disappears from the queue; if the case, it'll require to be re-submitted manually.

If you are planning to perform a cluster resize update, you can prevent jobs to go running in the nodes that are going to be removed during the planned update. This is possible by setting the nodes to be removed in maintenance. Please be aware that setting a node in maintenance would not impact jobs that are eventually already running in the node.

Suppose that with the planned cluster resize update you are going to remove the node `queue-st-computeresource-[9-10]`. You can create a Slurm reservation with the following command

```
sudo -i scontrol create reservation ReservationName=maint_for_update user=root
starttime=now duration=infinite flags=maint,ignore_jobs nodes=queue-st-
computeresource-[9-10]
```

This will create a Slurm reservation named `maint_for_update` on the nodes `queue-st-computeresource-[9-10]`. From the time when the reservation is created, no more jobs

can go running into the nodes `queue-st-computeresource-[9-10]`. Please be aware that the reservation will not prevent jobs to be eventually allocated on the nodes `queue-st-computeresource-[9-10]`.

After the cluster resize update, if the Slurm reservation was set only on nodes that were removed during the resize update, the maintenance reservation will be automatically deleted. If instead you had created a Slurm reservation on nodes that are still present after the cluster resize update, we may want to remove the maintenance reservation on the nodes after the resize update is performed, by using the following command

```
sudo -i scontrol delete ReservationName=maint_for_update
```

For additional details on Slurm reservation, see the official SchedMD doc [here](#).

## Cluster update process on capacity changes

Upon a scheduler configuration change, the following steps are executed during the cluster update process:

- Stop AWS ParallelCluster `clustermgtd` (`supervisorctl stop clustermgtd`)
- Generate updated Slurm partitions configuration from AWS ParallelCluster configuration
- Restart `slurmctld` (done through Chef service recipe)
- Check `slurmctld` status (`systemctl is-active --quiet slurmctld.service`)
- Reload Slurm configuration (`scontrol reconfigure`)
- Start `clustermgtd` (`supervisorctl start clustermgtd`)

## AWS Batch (`awsbatch`)

For information about AWS Batch, see [AWS Batch](#). For documentation, see the [AWS Batch User Guide](#).

### AWS ParallelCluster CLI commands for AWS Batch

When you use the `awsbatch` scheduler, the AWS ParallelCluster CLI commands for AWS Batch are automatically installed in the AWS ParallelCluster head node. The CLI uses AWS Batch API operations and permits the following operations:

- Submit and manage jobs.
- Monitor jobs, queues, and hosts.
- Mirror traditional scheduler commands.

### Important

AWS ParallelCluster doesn't support GPU jobs for AWS Batch. For more information, see [GPU jobs](#).

This CLI is distributed as a separate package. For more information, see [Scheduler Support](#).

## Topics

- [awsbsub](#)
- [awsbstat](#)
- [awsbout](#)
- [awsbkill](#)
- [awsbqueues](#)
- [awsbhosts](#)

## awsbsub

Submits jobs to the job queue of the cluster.

```
awsbsub [-h] [-jn JOB_NAME] [-c CLUSTER] [-cf] [-w WORKING_DIR]  
        [-pw PARENT_WORKING_DIR] [-if INPUT_FILE] [-p VCPUS] [-m MEMORY]  
        [-e ENV] [-eb ENV_DENYLIST] [-r RETRY_ATTEMPTS] [-t TIMEOUT]  
        [-n NODES] [-a ARRAY_SIZE] [-d DEPENDS_ON]  
        [command] [arguments [arguments ...]]
```

### Important

AWS ParallelCluster doesn't support GPU jobs for AWS Batch. For more information, see [GPU jobs](#).



## Positional Arguments

### ***command***

Submits the job (the command specified must be available on the compute instances) or the file name to be transferred. See also `--command-file`.

### **arguments**

(Optional) Specifies arguments for the command or the command-file.

## Named Arguments

### **-jn *JOB\_NAME*, --job-name *JOB\_NAME***

Names the job. The first character must be either a letter or number. The job name can contain letters (both uppercase and lowercase), numbers, hyphens, and underscores, and be up to 128 characters in length.

### **-c *CLUSTER*, --cluster *CLUSTER***

Specifies the cluster to use.

### **-cf, --command-file**

Indicates that the command is a file to be transferred to the compute instances.

Default: False

### **-w *WORKING\_DIR*, --working-dir *WORKING\_DIR***

Specifies the folder to use as the job's working directory. If a working directory isn't specified, the job is run in the `job-<AWS_BATCH_JOB_ID>` subfolder of the user's home directory. You can use either this parameter or the `--parent-working-dir` parameter.

### **-pw *PARENT\_WORKING\_DIR*, --parent-working-dir *PARENT\_WORKING\_DIR***

Specifies the parent folder of the job's working directory. If a parent working directory isn't specified, it defaults to the user's home directory. A subfolder named `job-<AWS_BATCH_JOB_ID>` is created in the parent working directory. You can use either this parameter or the `--working-dir` parameter.

### **-if *INPUT\_FILE*, --input-file *INPUT\_FILE***

Specifies the file to be transferred to the compute instances, in the job's working directory. You can specify multiple input file parameters.

**-p *VCPUS*, --vcpus *VCPUS***

Specifies the number of vCPUs to reserve for the container. When used together with `-nodes`, it identifies the number of vCPUs for each node.

Default: 1

**-m *MEMORY*, --memory *MEMORY***

Specifies the hard limit of memory (in MiB) to provide for the job. If your job attempts to exceed the memory limit specified here, the job is ended.

Default: 128

**-e *ENV*, --env *ENV***

Specifies a comma-separated list of environment variable names to export to the job environment. To export all environment variables, specify 'all'. Note that a list of 'all' environment variables doesn't include those listed in the `-env-blacklist` parameter, or variables starting with the `PCLUSTER_*` or `AWS_*` prefix.

**-eb *ENV\_DENYLIST*, --env-blacklist *ENV\_DENYLIST***

Specifies a comma-separated list of environment variable names to **not** export to the job environment. By default, `HOME`, `PWD`, `USER`, `PATH`, `LD_LIBRARY_PATH`, `TERM`, and `TERMCAP` are not exported.

**-r *RETRY\_ATTEMPTS*, --retry-attempts *RETRY\_ATTEMPTS***

Specifies the number of times to move a job to the `RUNNABLE` status. You can specify between 1 and 10 attempts. If the value of attempts is greater than 1, the job is retried if it fails, until it has moved to a `RUNNABLE` status for the specified number of times.

Default: 1

**-t *TIMEOUT*, --timeout *TIMEOUT***

Specifies the time duration in seconds (measured from the job attempt's `startedAt` timestamp) after which AWS Batch terminates your job if it hasn't finished. The timeout value must be at least 60 seconds.

**-n *NODES*, --nodes *NODES***

Specifies the number of nodes to reserve for the job. Specify a value for this parameter to enable multi-node parallel submission.

**Note**

When the [Scheduler](#) / [AwsBatchQueues](#) / [CapacityType](#) parameter is set to SPOT, multi-node parallel jobs *aren't* supported. Additionally, there must be an `AWSServiceRoleForEC2Spot` service-linked role in your account. You can create this role with the following AWS CLI command:

```
$ aws iam create-service-linked-role --aws-service-name spot.amazonaws.com
```

For more information, see [Service-linked role for Spot Instance requests](#) in the *Amazon Elastic Compute Cloud User Guide for Linux Instances*.

**-a *ARRAY\_SIZE*, --array-size *ARRAY\_SIZE***

Indicates the size of the array. You can specify a value between 2 and 10,000. If you specify array properties for a job, it becomes an array job.

**-d *DEPENDS\_ON*, --depends-on *DEPENDS\_ON***

Specifies a semicolon-separated list of dependencies for a job. A job can depend upon a maximum of 20 jobs. You can specify a SEQUENTIAL type dependency without specifying a job ID for array jobs. A sequential dependency allows each child array job to complete sequentially, starting at index 0. You can also specify an N\_TO\_N type dependency with a job ID for array jobs. An N\_TO\_N dependency means that each index child of this job must wait for the corresponding index child of each dependency to complete before it can begin. The syntax for this parameter is "jobId=<*string*>,type=<*string*>;...".

**awsbstat**

Shows the jobs that are submitted in the cluster's job queue.

```
awsbstat [-h] [-c CLUSTER] [-s STATUS] [-e] [-d] [job_ids [job_ids ...]]
```

## Positional Arguments

### *job\_ids*

Specifies the space-separated list of job IDs to show in the output. If the job is a job array, all of the child jobs are displayed. If a single job is requested, it is shown in a detailed version.

## Named Arguments

### **-c *CLUSTER*, --cluster *CLUSTER***

Indicates the cluster to use.

### **-s *STATUS*, --status *STATUS***

Specifies a comma-separated list of job statuses to include. The default job status is "active.". Accepted values are: SUBMITTED, PENDING, RUNNABLE, STARTING, RUNNING, SUCCEEDED, FAILED, and ALL.

Default: "SUBMITTED,PENDING,RUNNABLE,STARTING,RUNNING"

### **-e, --expand-children**

Expands jobs with children (both array and multi-node parallel).

Default: False

### **-d, --details**

Shows jobs details.

Default: False

## awsbout

Shows the output of a given job.

```
awsbout [-h] [-c CLUSTER] [-hd HEAD] [-t TAIL] [-s] [-sp STREAM_PERIOD] job_id
```

## Positional Arguments

### *job\_id*

Specifies the job ID.

## Named Arguments

**-c *CLUSTER*, --cluster *CLUSTER***

Indicates the cluster to use.

**-hd *HEAD*, --head *HEAD***

Gets the first *HEAD* lines of the job output.

**-t *TAIL*, --tail *TAIL***

Gets the last <tail> lines of the job output.

**-s, --stream**

Gets the job output, and then waits for additional output to be produced. This argument can be used together with `-tail` to start from the latest <tail> lines of the job output.

Default: False

**-sp *STREAM\_PERIOD*, --stream-period *STREAM\_PERIOD***

Sets the streaming period.

Default: 5

## awsbkill

Cancels or terminates jobs submitted in the cluster.

```
awsbkill [-h] [-c CLUSTER] [-r REASON] job_ids [job_ids ... ]
```

## Positional Arguments

***job\_ids***

Specifies the space-separated list of job IDs to cancel or terminate.

## Named Arguments

**-c *CLUSTER*, --cluster *CLUSTER***

Indicates the name of the cluster to use.

**-r *REASON*, --reason *REASON***

Indicates the message to attach to a job, explaining the reason for canceling it.

Default: "Terminated by the user"

## awsbqueues

Shows the job queue that is associated with the cluster.

```
awsbqueues [-h] [-c CLUSTER] [-d] [job_queues [job_queues ... ]]
```

### Positional arguments

#### *job\_queues*

Specifies the space-separated list of queue names to show. If a single queue is requested, it is shown in a detailed version.

### Named arguments

**-c *CLUSTER*, --cluster *CLUSTER***

Specifies the name of the cluster to use.

**-d, --details**

Indicates whether to show the details of the queues.

Default: False

## awsbhosts

Shows the hosts that belong to the cluster's compute environment.

```
awsbhosts [-h] [-c CLUSTER] [-d] [instance_ids [instance_ids ... ]]
```

## Positional Arguments

### *instance\_ids*

Specifies a space-separated list of instances IDs. If a single instance is requested, it is shown in a detailed version.

## Named Arguments

### **-c** *CLUSTER*, **--cluster** *CLUSTER*

Specifies the name of the cluster to use.

### **-d**, **--details**

Indicates whether to show the details of the hosts.

Default: False

## Shared storage

AWS ParallelCluster supports either using [Amazon EBS](#), [FSx for ONTAP](#), and [FSx for OpenZFS](#) shared storage volumes, [Amazon EFS](#) and [FSx for Lustre](#) shared storage file systems, or [File Caches](#). We recommend that you follow the [AWS well-architected framework reliability pillar](#) guidance and back up your volumes and file systems.

Select a storage system that meets your HPC application I/O requirements. You can optimize each file system based on your specific use case. For more information, see [storage options overview](#).

**Amazon EBS volumes** are attached to the head node and shared with compute nodes through NFS. This option can be cost effective, but performance depends on the head node resources as storage needs scale. This can become a bottleneck as more compute nodes are added to the cluster and the throughput demand increases.

**Amazon EFS files systems** scale as storage needs change. You can configure these file systems for a variety of use cases. Use Amazon EFS file systems to run parallelized and latency sensitive applications on your cluster.

**FSx for Lustre file systems** can process massive data sets at up to hundreds of gigabytes per second throughput, millions of IOPS, and sub-millisecond latencies. Use FSx for Lustre file systems for demanding high performance compute environments.

In the [SharedStorage section](#), you can define either external or AWS ParallelCluster managed storage:

- **External storage** refers to an existing volume or file system that you manage. AWS ParallelCluster doesn't create or delete this storage.
- **Managed storage** refers to a volume or file system that AWS ParallelCluster created and can delete.

## External storage

You can configure AWS ParallelCluster to attach external storage to the cluster when the cluster is created or updated. Similarly you can configure it to detach external storage from the cluster when the cluster is deleted or updated. Your data is preserved and you can use it for long-term permanent shared storage outside of the cluster lifecycle.

### Note

Versions of AWS ParallelCluster prior to 3.8 do not allow for externally managed filesystems to be mounted at `/home`. Starting from version 3.8, AWS ParallelCluster allows you to use `/home` as a mount point for an external managed filesystem. You can mount an externally managed file system to `/home` by specifying `/home` as the value to the [MountDir](#) parameter under the [SharedStorage section](#).

Amazon File Cache is not suitable for use as the system `/home` directory and therefore is not supported at this time for mounting `/home`.

When specifying a `/home` directory under the [SharedStorage section](#) the [SharedStorageType](#) configuration option will be overridden, meaning the settings under [SharedStorage section](#) will be used instead.

When mounting an external filesystem to the `/home` directory AWS ParallelCluster copies the head node's `/home` contents to the external filesystem, without overwriting existing files on the external storage. This includes transferring the cluster's SSH key for the default user, if it is absent on the external filesystem. For more information refer to [AWS ParallelCluster shared storage considerations](#).

## AWS ParallelCluster managed storage



AWS ParallelCluster managed storage is dependent on the lifecycle of the cluster by default in the configuration. The `SharedStorage DeletionPolicy` configuration parameter is set to `Delete` by default.

By default, an AWS ParallelCluster managed file system or volume and its data are deleted if one of the following is true.

- You delete the cluster.
- You change the managed shared storage configuration Name.
- You remove the managed shared storage from the configuration.

Set `DeletionPolicy` to `Retain` to persist your managed shared file system or volume and data. We recommend that you backup your data regularly to avoid the loss of data. You can use [AWS Backup](#) to centrally manage backups for all of your storage options.

You can remove the life cycle dependency with configuration settings. For more information, see [Convert AWS ParallelCluster managed storage to external storage](#).

For information on shared storage quotas, see [Quotas for shared storage](#).

For more information about shared storage and switching to new AWS ParallelCluster versions, see [Best practices: moving a cluster to a new AWS ParallelCluster minor or patch version](#).

You can configure AWS ParallelCluster to attach external storage to the cluster when the cluster is created or updated. Similarly, you can configure it to detach external storage from the cluster when the cluster is deleted or updated. Your data is preserved and you can use it for long term permanent shared storage solutions that are independent of the cluster lifecycle.

By default, managed storage is dependent on the lifecycle of the cluster. You can remove the dependency with configuration settings that are described in [Convert AWS ParallelCluster managed storage to external storage](#).

With specific settings, you can optimize each of the supported storage solutions for your use cases.

For shared storage quotas, see [Quotas for shared storage](#).

For more information about shared storage and switching to new AWS ParallelCluster versions, see [Best practices: moving a cluster to a new AWS ParallelCluster minor or patch version](#).

## Topics

- [Configure shared storage](#)
- [Working with shared storage in AWS ParallelCluster](#)
- [Quotas for shared storage](#)

## Configure shared storage

Learn about the configuration settings that you can use to define shared storage for your cluster.

### Topics

- [Amazon Elastic Block Store](#)
- [Amazon Elastic File System](#)
- [Amazon FSx for Lustre](#)
- [Configure FSx for ONTAP, FSx for OpenZFS, and File Cache shared storage](#)

### Amazon Elastic Block Store

To use an existing external Amazon EBS volume for long term permanent storage that's independent of the cluster life cycle, specify [EbsSettings](#) / [VolumeId](#).

If you don't specify [VolumeId](#), by default, AWS ParallelCluster creates a managed EBS volume from [EbsSettings](#) when your cluster is created. AWS ParallelCluster also deletes the volume and data when the cluster is deleted or the volume is removed from the cluster configuration.

For an AWS ParallelCluster managed EBS volume, you can use [EbsSettings](#) / [DeletionPolicy](#) to instruct AWS ParallelCluster to Delete, Retain, or Snapshot the volume when either the cluster is deleted or when the volume is removed from the cluster configuration. By default, [DeletionPolicy](#) is set to Delete.

#### Warning

For AWS ParallelCluster managed shared storage, [DeletionPolicy](#) is set to Delete by default.

This means that, if one of the following is true, a managed volume and its data are deleted:

- You delete the cluster.
- You change the managed shared storage configuration [SharedStorage](#) / [Name](#).

- You remove the managed shared storage from the configuration.

We recommend that you back up your shared storage with snapshots regularly to avoid the loss of data. For more information about Amazon EBS snapshots, see [Amazon EBS snapshots](#) in the *Amazon Elastic Compute Cloud User Guide for Linux Instances*. To learn how to manage data backups across AWS services, see [AWS Backup](#) in the *AWS Backup Developer Guide*.

## Amazon Elastic File System

To use an existing external Amazon EFS file system for long-term permanent storage outside of the cluster life cycle, specify [EfsSettings](#) / [FileSystemId](#), by default, AWS ParallelCluster creates a managed Amazon EFS file system from [EfsSettings](#) when it creates the cluster. AWS ParallelCluster also deletes the file system and data when the cluster is deleted or when the file system is removed from the cluster configuration.

For an AWS ParallelCluster managed Amazon EFS file system, you can use the [EfsSettings](#) / [DeletionPolicy](#) to instruct AWS ParallelCluster to Delete or Retain either when the cluster is deleted or when the file system removed from the cluster configuration. By default, [DeletionPolicy](#) is set to Delete.

### Warning

For AWS ParallelCluster managed shared storage, [DeletionPolicy](#) is set to Delete by default.

This means that, if one of the following is true, a managed file system and its data are deleted:

- You delete the cluster.
- You change the managed shared storage configuration [SharedStorage](#) / [Name](#).
- You remove the managed shared storage from the configuration.

We recommend that you back up your shared storage regularly to avoid the loss of data. For more information about how to back up individual Amazon EFS volumes, see [Backing up your Amazon EFS file systems](#) in the *Amazon Elastic File System User Guide*. To learn

how to manage data backups across AWS services, see [AWS Backup](#) in the *AWS Backup Developer Guide*.

## Amazon FSx for Lustre

To use an existing external FSx for Lustre file system for long-term permanent storage outside of the cluster life cycle, specify [FsxLustreSettings](#) / [FileSystemId](#).

If you don't specify [FsxLustreSettings](#) / [FileSystemId](#), by default, AWS ParallelCluster creates a managed FSx for Lustre file system from [FsxLustreSettings](#) when it creates the cluster. AWS ParallelCluster also deletes the file system and data when the cluster is deleted or when the file system is removed from the cluster configuration.

For an AWS ParallelCluster managed FSx for Lustre file system, you can use the [FsxLustreSettings](#) / [DeletionPolicy](#) to instruct AWS ParallelCluster to Delete or Retain the file system when either the cluster is deleted or when the file system is removed from the cluster configuration. By default, [DeletionPolicy](#) is set to Delete.

### Warning

For AWS ParallelCluster managed shared storage, [DeletionPolicy](#) is set to Delete by default.

This means that, if one of the following is true, a managed file system and its data are deleted:

- You delete the cluster.
- You change the managed shared storage configuration [SharedStorage](#) / [Name](#).
- You remove the managed shared storage from the configuration.

We recommend that you back up your shared storage regularly to avoid the loss of data. You can define backups in your cluster with [SharedStorage](#) / [FsxLustreSettings](#) / [AutomaticBackupRetentionDays](#) and [DailyAutomaticBackupStartTime](#). To learn how to manage data backups across AWS services, see [AWS Backup](#) in the *AWS Backup Developer Guide*.

## Configure FSx for ONTAP, FSx for OpenZFS, and File Cache shared storage

For FSx for ONTAP, FSx for OpenZFS, and File Cache, you can use [FsxOntapSettings / VolumeId](#), [FsxOpenZfsSettings / VolumeId](#), and [FileCacheSettings / FileCacheId](#) to specify mounting an external existing volume or File Cache for your cluster.

AWS ParallelCluster managed shared storage isn't supported for FSx for ONTAP, FSx for OpenZFS, and File Cache.

## Working with shared storage in AWS ParallelCluster

Learn about working with AWS ParallelCluster and shared storage.

### Topics

- [AWS ParallelCluster shared storage considerations](#)
- [Convert AWS ParallelCluster managed storage to external storage](#)

## AWS ParallelCluster shared storage considerations

Consider the following when working with shared storage in AWS ParallelCluster.

- Back up your file system data with [AWS Backup](#) or another method to manage backups for all of your storage systems.
- To add shared storage, you add a shared storage section to your configuration file and create or update the cluster.
- To remove shared storage, you remove the shared storage section from your configuration file and update the cluster.
- To replace existing AWS ParallelCluster managed shared storage with new managed storage, change the value for [SharedStorage / Name](#) and update the cluster.

### Warning

By default, the existing AWS ParallelCluster managed storage and data is deleted when you perform the cluster update with a new Name parameter. If you need to change Name and retain the existing managed shared storage data, make sure you either set the DeletionPolicy to Retain or back up the data before you update the cluster.

- If you don't back up AWS ParallelCluster managed storage data and `DeletionPolicy` is `Delete`, your data is deleted when either your cluster is deleted or when your managed storage is removed from the cluster configuration and the cluster is updated.
- If you don't back up AWS ParallelCluster managed storage data and `DeletionPolicy` is `Retain`, your file system is detached before the cluster is deleted and can be re-attached to another cluster as an external file system. Your data is preserved.
- If AWS ParallelCluster managed storage is removed from the cluster configuration and `DeletionPolicy` is `Retain`, it can be re-attached to the cluster as an external file system with your cluster data preserved.
- Starting with AWS ParallelCluster version 3.4.0, you can enhance security for Amazon EFS file system mounts by configuring [SharedStorage](#) / [EfsSettings](#) / [EncryptionInTransit](#) and [IamAuthorization](#) settings.
- When mounting an external filesystem to the `/home` directory, AWS ParallelCluster copies the contents of the head node's `/home` directory to the external filesystem. It copies existing data in the `/home` directory without overwriting existing files or directories on the external storage. This includes the cluster's SSH key for the default user in case it does not already exist on the external filesystem. Consequently all other clusters that mount the same external filesystem to their respective `/home` directory will also have the same SSH key for their default user of the cluster.
- In a multi-cluster environment that mounts the same external filesystem to the `/home` directories of clusters, SSH keys that grant access to the compute nodes, created on the head node by AWS ParallelCluster, are generated only once when the first cluster mounts the external filesystem to `/home`. All other clusters use the same SSH key. As a result, anyone possessing the SSH key for the default user of these shared clusters can access any cluster. All compute nodes allow connections using the initially generated key.

## Convert AWS ParallelCluster managed storage to external storage

Learn how to convert AWS ParallelCluster managed storage to external storage.

The procedures are based on the following example configuration file snippet.

```
...  
- MountDir: /fsx  
  Name: fsx  
  StorageType: FsxLustre
```

```
FsxLustreSettings:
  StorageCapacity: 1200
  DeletionPolicy: Delete
...
```

## Convert AWS ParallelCluster managed storage to external storage

1. Set the DeletionPolicy to Retain in the cluster configuration file.

```
...
- MountDir: /fsx
  Name: fsx
  StorageType: FsxLustre
  FsxLustreSettings:
    StorageCapacity: 1200
    DeletionPolicy: Retain
...
```

2. To set the DeletionPolicy change, run the following command.

```
pcluster update-cluster -n cluster-name -c cluster-config.yaml
```

3. Remove the SharedStorage section from the cluster configuration file.

```
...
...
```

4. To change the managed SharedStorage to external SharedStorage and detach it from the cluster, run the following command.

```
pcluster update-cluster -n cluster-name -c cluster-config.yaml
```

5. Your shared storage is now external and detached from the cluster.
6. To attach your external file system to the original cluster or another cluster, follow these steps.
  - a. Get the FSx for Lustre file system ID.

- i. To use the AWS CLI run the following command and find the file system with a name that includes the name of your original cluster and note the file system ID.

```
aws fsx describe-file-systems
```

- ii. To use the AWS Management Console, log in and navigate to the <https://console.aws.amazon.com/fsx/>. In the list of file systems, find the file system with a name that includes the name of your original cluster and note the file system ID.
- b. Update the file system security group rules to provide access to and from the file system and cluster subnets. You can find the file system security group name and ID in the Amazon FSx console.

Add rules to the file system security group that allow inbound and outbound TCP traffic from and to the head node and the compute node IP CIDR ranges or prefixes. Specify TCP ports 988, 1021, 1022, and 1023 for the inbound and outbound TCP traffic.

For more information, see [SharedStorage](#) / [FsxLustreSettings](#) / [FileSystemId](#) and [Creating, configuring, and deleting security groups for Amazon EC2](#) in the *AWS Command Line Interface User Guide for Version 2*.

- c. Add the SharedStorage section to the cluster configuration.

```
...
- MountDir: /fsx
  Name: fsx-external
  StorageType: FsxLustre
  FsxLustreSettings:
    FileSystemId: fs-02e5b4b4abd62d51c
...
```

- d. To add the external shared storage to the cluster, run the following command.

```
pcluster update-cluster -n cluster-name -c cluster-config.yaml
```

## Quotas for shared storage

Configure cluster SharedStorage to mount existing shared file storage and create new shared file storage based on the quotas that are listed in the following table.



## The mounted file storage quotas for each cluster

| File shared storage type | AWS ParallelCluster managed storage | External storage | Quota net total |
|--------------------------|-------------------------------------|------------------|-----------------|
| Amazon EBS               | 5                                   | 5                | 5               |
| RAID                     | 1                                   | 0                | 1               |
| Amazon EFS               | 1                                   | 20               | 21              |
| Amazon FSx †             | 1 FSx for Lustre                    | 20               | 21              |

### Note

This table of quotas is added in AWS ParallelCluster version 3.2.0.

† AWS ParallelCluster only supports mounting existing Amazon FSx for NetApp ONTAP, Amazon FSx for OpenZFS, and File Cache systems. It doesn't support the creation of new FSx for ONTAP, FSx for OpenZFS, and File Cache systems.

### Note

If you use AWS Batch as a scheduler, FSx for Lustre is only available on the cluster head node.  
File Caches don't support AWS Batch schedulers.

## AWS ParallelCluster resources and tagging

With AWS ParallelCluster you can create tags to track and manage your AWS ParallelCluster resources. You define the tags that you want AWS CloudFormation to create and propagate to all cluster resources in the [Tags section](#) of the cluster configuration file. You can also use tags that AWS ParallelCluster automatically generates to track and manage your resources.

When you create a cluster, the cluster and its resources are tagged with the AWS ParallelCluster and AWS systems tags defined in this section.

AWS ParallelCluster applies tags to the cluster instances, volumes, and resources. To identify the cluster stack, AWS CloudFormation applies AWS system tags to the cluster instances. To identify the cluster Amazon EC2 launch templates, Amazon EC2 applies system tags to the instances. You can use these tags to view and manage your AWS ParallelCluster resources.

You can't modify AWS system tags. In order to avoid impacts to AWS ParallelCluster functionality, don't modify AWS ParallelCluster tags.

The following is an example of an AWS system tag for an AWS ParallelCluster resource. You can't modify them.

```
"aws:cloudformation:stack-name"="clustername"
```

The following is an example of an AWS ParallelCluster tag applied to a resource. Don't modify them.

```
"parallelcluster:cluster-name"="clustername"
```

You can view these tags in the Amazon EC2 section of the AWS Management Console.

## View tags

1. Navigate the Amazon EC2 console at <https://console.aws.amazon.com/ec2/>.
2. To view all cluster tags, choose **Tags** in the navigation pane.
3. To view cluster tags by instance, choose **Instances** in the navigation pane.
4. Select a cluster instance.
5. Choose the **Manage tags** tab in the instance details and view the tags.
6. Choose the **Storage** tab in the instance details.
7. Select the **Volume ID**.
8. In **Volumes**, choose the volume.
9. Choose the **Tags** tab in the volume details and view the tags.

## AWS ParallelCluster head node instance tags

| Key                          | Tag value          |
|------------------------------|--------------------|
| parallelcluster:cluster-name | <i>clustername</i> |

| Key                           | Tag value                                                                                                                                 |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Name                          | HeadNode                                                                                                                                  |
| aws:ec2launchtemplate:id      | <i>lt-1234567890abcdef0</i>                                                                                                               |
| aws:ec2launchtemplate:version | <i>1</i>                                                                                                                                  |
| parallelcluster:node-type     | HeadNode                                                                                                                                  |
| aws:cloudformation:stack-name | <i>clustername</i>                                                                                                                        |
| aws:cloudformation:logical-id | HeadNode                                                                                                                                  |
| aws:cloudformation:stack-id   | arn:aws:cloudformation: <i>region-id</i> : <i>ACCOUNTID</i> :stack/ <i>clustername</i> / <i>1234abcd-12ab-12ab-12ab-1234567890abcdef0</i> |
| parallelcluster:version       | <i>3.7.0</i>                                                                                                                              |

### AWS ParallelCluster head node root volume tags

| Tag key                      | Tag value          |
|------------------------------|--------------------|
| parallelcluster:cluster-name | <i>clustername</i> |
| parallelcluster:node-type    | HeadNode           |
| parallelcluster:version      | <i>3.7.0</i>       |

### AWS ParallelCluster compute node instance tags

| Key                                   | Tag value                    |
|---------------------------------------|------------------------------|
| parallelcluster:cluster-name          | <i>clustername</i>           |
| parallelcluster:compute-resource-name | <i>compute-resource-name</i> |

| Key                           | Tag value                   |
|-------------------------------|-----------------------------|
| aws:ec2launchtemplate:id      | <i>lt-1234567890abcdef0</i> |
| aws:ec2launchtemplate:version | <i>1</i>                    |
| parallelcluster:node-type     | Compute                     |
| parallelcluster:queue-name    | <i>queue-name</i>           |
| parallelcluster:version       | <i>3.7.0</i>                |

### AWS ParallelCluster compute node root volume tags

| Tag key                               | Tag value                    |
|---------------------------------------|------------------------------|
| parallelcluster:cluster-name          | <i>clustername</i>           |
| parallelcluster:compute-resource-name | <i>compute-resource-name</i> |
| parallelcluster:node-type             | Compute                      |
| parallelcluster:queue-name            | <i>queue-name</i>            |
| parallelcluster:version               | <i>3.7.0</i>                 |

### AWS ParallelCluster UI tags

| Tag key            | Tag value |
|--------------------|-----------|
| parallelcluster-ui | true      |

## Monitoring AWS ParallelCluster and logs

Monitoring is an important part of maintaining the reliability, availability, and performance of AWS ParallelCluster and your other AWS solutions. AWS provides the following monitoring tools

to watch AWS ParallelCluster, report when something is wrong, and take automatic actions when appropriate:

- *Amazon CloudWatch* monitors your AWS resources and the applications you run on AWS in real time. You can collect and track metrics, create customized dashboards, and set alarms that notify you or take actions when a specified metric reaches a threshold that you specify. For example, you can have CloudWatch track CPU usage or other metrics of your Amazon EC2 instances and automatically launch new instances when needed. For more information, see the [Amazon CloudWatch User Guide](#).
- *Amazon CloudWatch Logs* enables you to monitor, store, and access your log files from Amazon EC2 instances, CloudTrail, and other sources. CloudWatch Logs can monitor information in the log files and notify you when certain thresholds are met. You can also archive your log data in highly durable storage. For more information, see the [Amazon CloudWatch Logs User Guide](#).
- *AWS CloudTrail* captures API calls and related events made by or on behalf of your AWS account and delivers the log files to an Amazon S3 bucket that you specify. You can identify which users and accounts called AWS, the source IP address from which the calls were made, and when the calls occurred. For more information, see the [AWS CloudTrail User Guide](#).
- *Amazon EventBridge* is a serverless event bus service that makes it easy to connect your applications with data from a variety of sources. EventBridge delivers a stream of real-time data from your own applications, Software-as-a-Service (SaaS) applications, and AWS services and routes that data to targets such as Lambda. This enables you to monitor events that happen in services, and build event-driven architectures. For more information, see the [Amazon EventBridge User Guide](#).

## Topics

- [Integration with Amazon CloudWatch Logs](#)
- [Amazon CloudWatch dashboard](#)
- [Amazon CloudWatch alarms for cluster metrics](#)
- [AWS ParallelCluster configured log rotation](#)
- [pcluster CLI logs](#)
- [Amazon EC2 console output logs](#)
- [Retrieve AWS ParallelCluster UI and AWS ParallelCluster runtime logs](#)
- [Retrieving and preserving logs](#)

## Integration with Amazon CloudWatch Logs

For more information about CloudWatch Logs, see [Amazon CloudWatch Logs User Guide](#). To configure CloudWatch Logs integration, see the [Monitoring](#) section. To learn how to append custom logs to the CloudWatch configuration using `append-config`, see [Multiple CloudWatch agent configuration files](#) in the *Amazon CloudWatch User Guide*.

### Amazon CloudWatch Logs cluster logs

A log group is created for each cluster with a name, `/aws/parallelcluster/cluster-name-<timestamp>` (for example, `/aws/parallelcluster/testCluster-202202050215`). Each log (or set of logs if the path contains a `*`) on each node has a log stream named `{hostname}.{instance_id}.{logIdentifier}`. (For example `ip-172-31-10-46.i-02587cf29cc3048f3.nodewatcher`.) Log data is sent to CloudWatch by the [CloudWatch agent](#), which runs as `root` on all cluster instances.

An Amazon CloudWatch dashboard is created when the cluster is created. This dashboard gives you the ability to review the logs stored in CloudWatch Logs. For more information, see [Amazon CloudWatch dashboard](#).

This list contains the *logIdentifier* and path for the log streams available for platforms, schedulers, and nodes.

### Log streams available for platforms, schedulers, and nodes

| Platform | Schedulers | Nodes    | Log streams                                                                                    |
|----------|------------|----------|------------------------------------------------------------------------------------------------|
| amazon   | awsbatch   | HeadNode | dcv-authenticator: <code>/var/log/parallelcluster/parallelcluster_dcv_authenticator.log</code> |
| centos   | slurm      |          | dcv-ext-authenticator: <code>/var/log/parallelcluster/parallelcluster_dcv_connect.log</code>   |
| redhat   |            |          | dcv-agent: <code>/var/log/dcv/agent.*.log</code>                                               |
| ubuntu   |            |          | dcv-xsession: <code>/var/log/dcv/dcv-xsession.*.log</code>                                     |
|          |            |          | dcv-server: <code>/var/log/dcv/server.log</code>                                               |
|          |            |          | dcv-session-launcher: <code>/var/log/dcv/sessionlauncher.log</code>                            |

| Platform                             | Schedulers        | Nodes                      | Log streams                                                                                                                                                                                                    |
|--------------------------------------|-------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      |                   |                            | Xdcv: /var/log/dcv/Xdcv.*.log<br>cfn-init: /var/log/cfn-init.log<br>chef-client: /var/log/chef-client.log                                                                                                      |
| amazon<br>centos<br>redhat<br>ubuntu | awsbatch<br>slurm | Compute<br>eet<br>HeadNode | cloud-init: /var/log/cloud-init.log<br>supervisord: /var/log/supervisord.log                                                                                                                                   |
| amazon<br>centos<br>redhat<br>ubuntu | slurm             | Compute<br>eet             | cloud-init-output: /var/log/cloud-init-output.log<br>computemgtd: /var/log/parallelcluster/computemgtd<br>slurmd: /var/log/slurmd.log<br>slurm_prolog_epilog: /var/log/parallelcluster/slurm_prolog_epilog.log |

| Platform                             | Schedulers        | Nodes                   | Log streams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------|-------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| amazon<br>centos<br>redhat<br>ubuntu | slurm             | HeadNode                | sssd: /var/log/sssds/sssds.log<br><br>sssd_domain_default: /var/log/sssds/sssds_default.log<br><br>pam_ssh_key_generator: /var/log/parallelcluster/pam_ssh_key_generator.log<br><br>clusterstatusmgtd: /var/log/parallelcluster/clusterstatusmgtd<br><br>clustermgtd: /var/log/parallelcluster/clustermgtd<br><br>compute_console_output: /var/log/parallelcluster/compute_console_output<br><br>slurm_resume: /var/log/parallelcluster/slurm_resume.log<br><br>slurm_suspend: /var/log/parallelcluster/slurm_suspend.log<br><br>slurmctld: /var/log/slurmctld.log<br><br>slurm_fleet_status_manager: /var/log/parallelcluster/slurm_fleet_status_manager.log |
| amazon<br>centos<br>redhat           | awsbatch<br>slurm | ComputeNode<br>HeadNode | system-messages: /var/log/messages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| ubuntu                               | awsbatch<br>slurm | ComputeNode<br>HeadNode | syslog: /var/log/syslog                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



Jobs in clusters that use AWS Batch store the output of jobs that reached a state of RUNNING, SUCCEEDED, or FAILED in CloudWatch Logs. The log group is `/aws/batch/job`, and the log stream name format is `jobDefinitionName/default/ecs_task_id`. By default, these logs are set not to expire, but you can modify the retention period. For more information, see [Change log data retention in CloudWatch Logs](#) in the *Amazon CloudWatch Logs User Guide*.

## Amazon CloudWatch Logs build image logs

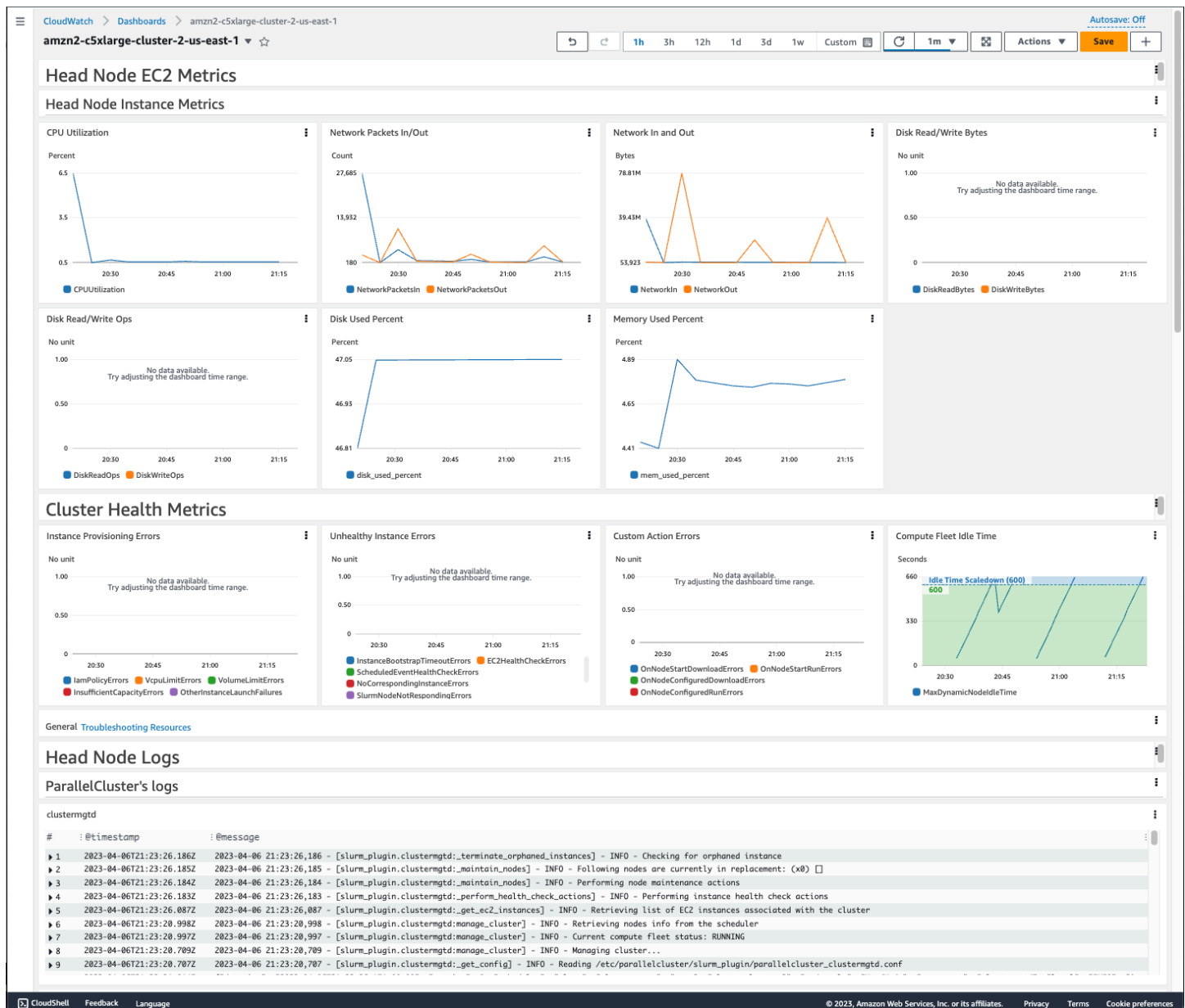
A log group is created for each custom build image with a name, `/aws/imagebuilder/ParallelClusterImage-<image-id>`. A unique log stream with name, `{pcluster-version}/1` contains the output of the build image process.

You can access the logs by using the [pcluster](#) image commands. For more information, see [AWS ParallelCluster AMI customization](#).

## Amazon CloudWatch dashboard

An Amazon CloudWatch dashboard is created when a cluster is created. This makes it easier to monitor the nodes in your cluster, and to view the logs stored in Amazon CloudWatch Logs. The name of the dashboard is `ClusterName-Region`. `ClusterName` is the name of your cluster and `Region` is the AWS Region the cluster is in. You can access the dashboard in the console, or by opening `https://console.aws.amazon.com/cloudwatch/home?region=Region#dashboards:name=ClusterName-Region`.

The following image shows an example CloudWatch dashboard for a cluster.



## Head Node Instance Metrics

The first section of the dashboard displays graphs of the head node Amazon EC2 metrics.

If your cluster has shared storage, the next section shows shared storage metrics.

## Cluster Health Metrics

If your cluster uses Slurm for scheduling, the cluster health metric graphs show real-time cluster compute node errors. For more information, see [Troubleshooting cluster health metrics](#). Cluster health metrics are added to the dashboard starting with AWS ParallelCluster version 3.6.0.

## Head Node Logs

The final section lists head node logs grouped by AWS ParallelCluster's logs, Scheduler's logs, NICE DCV integration logs, and System's logs.

For more information about Amazon CloudWatch dashboards, see [Using Amazon CloudWatch dashboards](#) in the *Amazon CloudWatch User Guide*.

If you don't want to create the Amazon CloudWatch dashboard, you can turn it off by setting [Monitoring / Dashboards / CloudWatch / Enabled](#) to false.

### Note

If you disable the creation of the Amazon CloudWatch dashboard, you also disable the Amazon CloudWatch `disk_used_percent` and `memory_used_percent` alarms for your cluster. For more information, see [Amazon CloudWatch alarms for cluster metrics](#). The `disk_used_percent` and `memory_used_percent` alarms are added starting with AWS ParallelCluster version 3.6.

## Amazon CloudWatch alarms for cluster metrics

Starting with AWS ParallelCluster version 3.6, you can configure your cluster with Amazon CloudWatch alarms for monitoring the head node. One alarm monitors the root volume `disk_used_percent`. The other alarm monitors the `mem_used_percent` metric. For more information, see [Metrics collected by the CloudWatch agent](#) in the *Amazon CloudWatch User Guide*.

The alarms are named as follows:

- `cluster-name_DiskAlarm_HeadNode`
- `cluster-name_MemAlarm_HeadNode`

`cluster-name` is the name of your cluster.

Access the alarms in the CloudWatch console by choosing **Alarms** in the navigation pane. The following images show the disk usage alarm and memory usage alarm for a cluster.

CloudWatch > Alarms > test-disk-alarm-1\_DiskAlarm\_HeadNode

**Alarms (11)**

Any state

Any type

Any actions status

Hide Auto Scaling alarms

< 1 >

test-disk-alarm-1\_DiskAlarm\_HeadNode

Metric alarm  OK

test-disk-alarm-1\_MemAlarm\_HeadNode

Metric alarm  OK

mytest

Metric alarm  Insufficient data

### Graph

**disk\_used\_percent**  OK

disk\_used\_percent > 90 for 1 datapoints within 1 minute

Percent

90.00

67.67

45.35

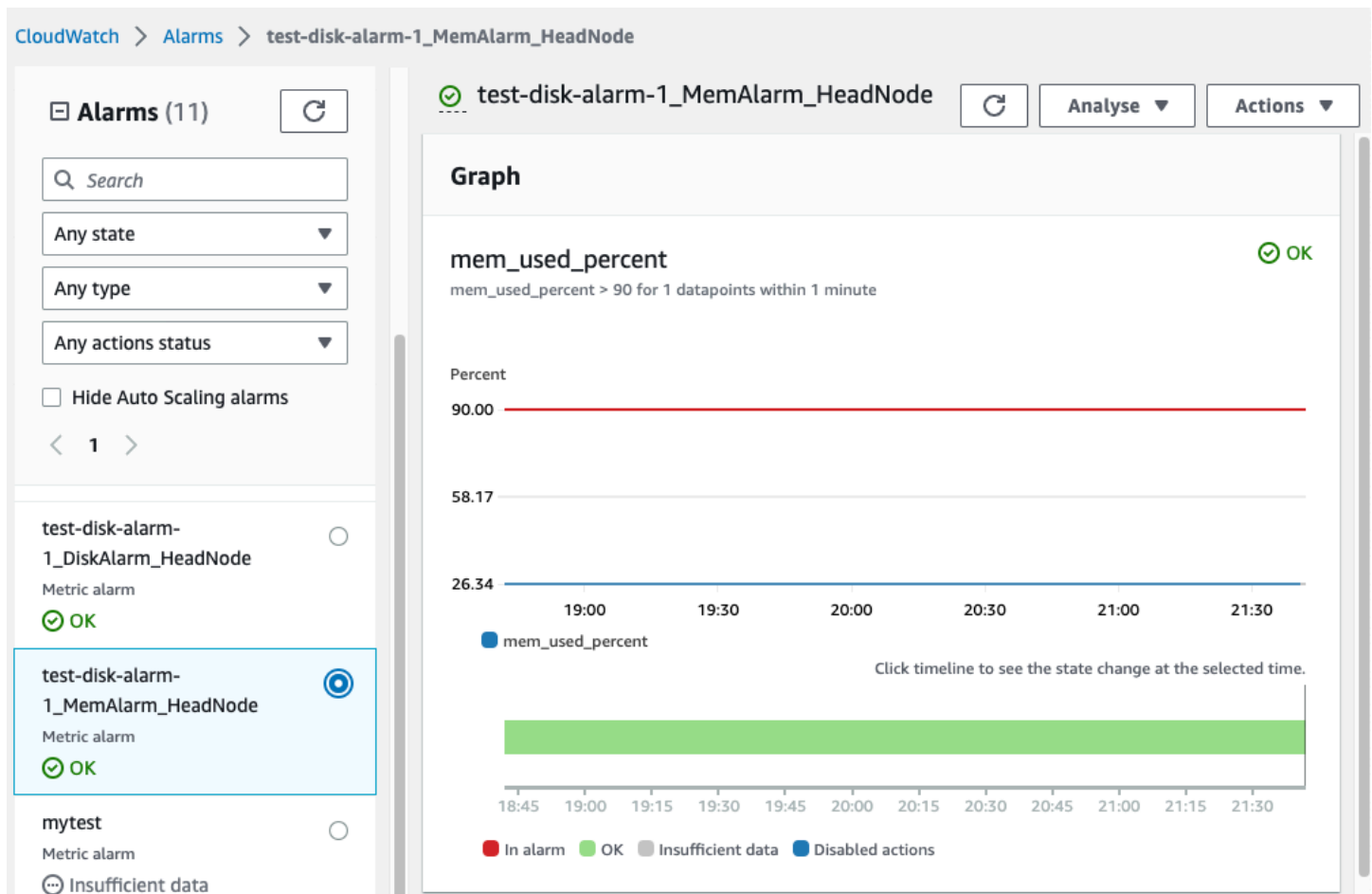
19:00 19:30 20:00 20:30 21:00 21:30

disk\_used\_percent

Click timeline to see the state change at the selected time.

18:45 19:00 19:15 19:30 19:45 20:00 20:15 20:30 20:45 21:00 21:15 21:30

In alarm  OK  Insufficient data  Disabled actions



The disk usage alarm is in the ALARM state when the disk usage percentage is greater than 90% for 1 data point, within a 1 minute time period.

The memory usage alarm is in the ALARM state when the memory usage percentage is greater than 90% for 1 data point, within a 1 minute time period.

### Note

AWS ParallelCluster doesn't configure alarm actions by default. For information about how to set up alarm actions, such as sending notifications, see [Alarm actions](#). For more information about Amazon CloudWatch alarms, see [Using Amazon CloudWatch alarms](#) in the *Amazon CloudWatch User Guide*.

If you don't want to create these Amazon CloudWatch alarms, deactivate them by setting [Monitoring](#) / [Dashboards](#) / [CloudWatch](#) / [Enabled](#) to false in the cluster configuration.

This also disables the creation of the Amazon CloudWatch dashboard. For more information, see [Amazon CloudWatch dashboard](#).

### Note

If you deactivate the creation of the Amazon CloudWatch dashboard, you also deactivate the Amazon CloudWatch `disk_used_percent` and `memory_used_percent` alarms for your cluster.

## AWS ParallelCluster configured log rotation

The AWS ParallelCluster log rotation configurations are located in `/etc/logrotate.d/parallelcluster_*_log_rotation` files. When a configured log rotates, the current log content is preserved in a single backup and the emptied log resumes logging.

Only 1 backup is maintained for each configured log.

AWS ParallelCluster configures a fast-growing log to rotate when it reaches 50 MB in size. Fast-growing logs are related to scaling and Slurm, including `/var/log/parallelcluster/clustermgtd`, `/var/log/parallelcluster/slurm_resume.log`, and `/var/log/slurmctld.log`.

AWS ParallelCluster configures a slow-growing log to rotate when it reaches 10 MB in size.

You can view earlier logs that are retained for the number of days defined in the cluster configuration [Logs](#) / [CloudWatch](#) / [RetentionInDays](#) setting with CloudFormation logging enabled. Check the `RetentionInDays` settings to see if the number of days needs to be increased for your use case.

AWS ParallelCluster configures and rotates the following logs:

### Head node logs

```
/var/log/cloud-init.log
/var/log/supervisord.log
/var/log/cfn-init.log
/var/log/chef-client.log
/var/log/dcv/server.log
/var/log/dcv/sessionlauncher.log
```

```
/var/log/dcv/agent.*.log
/var/log/dcv/dcv-xsession.*.log
/var/log/dcv/Xdcv.*.log
/var/log/parallelcluster/pam_ssh_key_generator.log
/var/log/parallelcluster/clustermgtd
/var/log/parallelcluster/clusterstatusmgtd
/var/log/parallelcluster/slurm_fleet_status_manager.log
/var/log/parallelcluster/slurm_resume.log
/var/log/parallelcluster/slurm_suspend.log
/var/log/slurmctld.log
/var/log/slurmdbd.log
/var/log/parallelcluster/compute_console_output.log
```

## Compute node logs

```
/var/log/cloud-init.log
/var/log/supervisord.log
/var/log/cloud-init-output.log
/var/log/parallelcluster/computemgtd
/var/log/slurmd.log
```

## Login node logs

```
/var/log/cloud-init.log
/var/log/cloud-init.log
/var/log/cloud-init-output.log
/var/log/supervisord.log
/var/log/parallelcluster/pam_ssh_key_generator.log
```

## pcluster CLI logs

The `pcluster` CLI writes logs of your commands to `pcluster.log.#` files in `/home/user/.parallelcluster/`.

For each command, the logs generally include the command with inputs, a copy of the CLI API version used to make the command, the response, and both info and error messages. For a `create` and `build` command, the logs also include the configuration file, configuration file validation operations, the CloudFormation template, and stack commands.

You can use these logs to verify errors, inputs, versions and `pcluster` CLI commands. They can also serve as a record of when commands were made.

## Amazon EC2 console output logs

When AWS ParallelCluster detects that a static compute node instance terminates unexpectedly, it attempts to retrieve the Amazon EC2 console output from the terminated node instance after a period of time elapses. This way, if the compute node was unable to communicate with Amazon CloudWatch, useful troubleshooting information on why the node terminated might still be retrieved from the console output. This console output is recorded in the `/var/log/parallelcluster/compute_console_output` log on the head node. For more information about the Amazon EC2 console output, see [Instance console output](#) in the *Amazon EC2 User Guide for Linux Instances*.

By default, AWS ParallelCluster only retrieves the console output from a sample subset of terminated nodes. This prevents the cluster head node from being overwhelmed with multiple console output requests caused by large numbers of terminations. By default, AWS ParallelCluster waits 5 minutes between termination detection and console output retrieval to give Amazon EC2 time to retrieve the final console output from the nodes.

You can edit the sample size and wait time parameter values in the `/etc/parallelcluster/slurm_plugin/parallelcluster_clustermgtd.conf` file on the head node.

This feature is added in AWS ParallelCluster version 3.5.0.

### Amazon EC2 console output parameters

You can edit the values of the following Amazon EC2 console output parameters in the `/etc/parallelcluster/slurm_plugin/parallelcluster_clustermgtd.conf` file on the head node.

#### **compute\_console\_logging\_enabled**

To disable console output log collection, set `compute_console_logging_enabled` to `false`. The default is `true`.

You can update this parameter at any time, without stopping the compute fleet.

#### **compute\_console\_logging\_max\_sample\_size**

`compute_console_logging_max_sample_size` sets the maximum number of compute nodes from which AWS ParallelCluster collects console outputs each time it detects an unexpected



termination. If this value is less than 1, AWS ParallelCluster retrieves the console output from all terminated nodes. The default value is 1.

You can update this parameter at any time, without stopping the compute fleet.

### **compute\_console\_wait\_time**

`compute_console_wait_time` sets the time, in seconds, that AWS ParallelCluster waits between detecting a node failure and collecting the console output from that node. You can increase the wait time if you determine that Amazon EC2 needs more time to collect the final output from the terminated node. The default value is 300 seconds (5 minutes).

You can update this parameter at any time, without stopping the compute fleet.

## **Retrieve AWS ParallelCluster UI and AWS ParallelCluster runtime logs**

Learn how to retrieve the AWS ParallelCluster UI and AWS ParallelCluster runtime logs for troubleshooting. To start, find the relevant AWS ParallelCluster UI and AWS ParallelCluster stack names. Use the stack name to locate the installation log groups. To finish, export the logs. These logs are specific to the AWS ParallelCluster runtime. For cluster logs, see [Retrieving and preserving logs](#).

### **Prerequisites**

- The AWS CLI is installed.
- You have credentials to run AWS CLI commands on the AWS account that the AWS ParallelCluster UI is on.
- You can access the Amazon CloudWatch console on the AWS account that the AWS ParallelCluster UI is on.

### **Step 1: Locate the stack names for the relevant stacks**

In the following example, replace the red highlighted text with your actual values.

List the stacks, using the AWS Region where you installed the AWS ParallelCluster UI:

```
$ aws cloudformation list-stacks --region aws-region-id
```

Note the stack names for the following stacks:

- The name of the stack that deployed the AWS ParallelCluster UI on your account. You entered this name when you installed the AWS ParallelCluster UI; for example, `pcluster-ui`.
- The AWS ParallelCluster stack that is prefixed with the stack name you entered; for example, `pcluster-ui-ParallelClusterApi-ABCD1234EFGH`.

## Step 2: Locate the log groups

List the log groups of the AWS ParallelCluster UI stack, as shown in the following example:

```
$ aws cloudformation describe-stack-resources \  
  --region aws-region-id \  
  --stack-name pcluster-ui \  
  --query "StackResources[?ResourceType == 'AWS::Logs::LogGroup' &&  
(LogicalResourceId == 'ApiGatewayAccessLog' || LogicalResourceId ==  
'ParallelClusterUILambdaLogGroup')].PhysicalResourceId" \  
  --output text
```

List the log groups of the AWS ParallelCluster API stack, as shown in the following example:

```
$ aws cloudformation describe-stack-resources \  
  --region aws-region-id \  
  --stack-name pcluster-ui-ParallelCluster-Api-ABCD1234EFGH \  
  --query "StackResources[?ResourceType == 'AWS::Logs::LogGroup' && LogicalResourceId  
== 'ParallelClusterFunctionLogGroup'].PhysicalResourceId" \  
  --output text
```

Note the lists of log groups for use in the next step.

## Step 3: Export the logs

Use the following steps to gather and export the logs:

1. Log in to the AWS Management Console, and then navigate to the [Amazon CloudWatch](#) console on the AWS account that the AWS ParallelCluster UI is on.
2. Choose **Logs, Logs Insights** in the navigation pane.
3. Select all of the log groups listed in the previous step.
4. Choose a time range, such as 12 hours.
5. Run the following query:

```
$ fields @timestamp, @message
| sort @timestamp desc
| limit 10000
```

6. Choose **Export results, Download table (JSON)**.

## Retrieving and preserving logs

AWS ParallelCluster creates Amazon EC2 metrics for HeadNode and Compute instances and storage. You can view the metrics in the CloudWatch console **Custom Dashboards**. AWS ParallelCluster also creates cluster CloudWatch log streams in log groups. You can view these logs in the CloudWatch console **Custom Dashboards** or **Log groups**. The [Monitoring](#) cluster configuration section describes how you can modify the cluster CloudWatch logs and dashboard. For more information, see [Integration with Amazon CloudWatch Logs](#) and [Amazon CloudWatch dashboard](#).

Logs are a useful resource for troubleshooting issues. For example, if you want to delete a failing cluster, it might be useful to first create an archive of the cluster logs. Follow the steps in [Archive logs](#) to create an archive.

### Topics

- [Cluster logs unavailable in CloudWatch](#)
- [Archive logs](#)
- [Preserved logs](#)
- [Terminated node logs](#)

## Cluster logs unavailable in CloudWatch

If cluster logs aren't available in CloudWatch, check to make sure you haven't overwritten the AWS ParallelCluster CloudWatch log configuration when adding custom logs to the configuration.

To add custom logs to the CloudWatch configuration, make sure you append to the configuration rather than fetch and overwrite it. For more information on `fetch-config` and `append-config`, see [Multiple CloudWatch agent configuration files](#) in the *CloudWatch User Guide*.

To restore the AWS ParallelCluster CloudWatch log configuration, you can run the following commands inside an AWS ParallelCluster node:

```
$ PLATFORM="$(ohai platform | jq -r ".[]")"
LOG_GROUP_NAME="$(cat /etc/chef/dna.json | jq -r ".cluster.log_group_name")"
SCHEDULER="$(cat /etc/chef/dna.json | jq -r ".cluster.scheduler")"
NODE_ROLE="$(cat /etc/chef/dna.json | jq -r ".cluster.node_type")"
CONFIG_DATA_PATH="/usr/local/etc/cloudwatch_agent_config.json"
/opt/parallelcluster/pyenv/versions/cookbook_virtualenv/bin/python /usr/local/bin/
write_cloudwatch_agent_json.py --platform $PLATFORM --config $CONFIG_DATA_PATH --log-
group $LOG_GROUP_NAME --scheduler $SCHEDULER --node-role $NODE_ROLE
/opt/aws/amazon-cloudwatch-agent/bin/amazon-cloudwatch-agent-ctl -a fetch-config -m ec2
-c file:/opt/aws/amazon-cloudwatch-agent/etc/amazon-cloudwatch-agent.json -s
```

## Archive logs

You can archive the logs in Amazon S3 or in a local file (depending on the `--output-file` parameter).

### Note

Add permissions to the Amazon S3 bucket policy to grant CloudWatch access. For more information, see [Set permissions on an Amazon S3 bucket](#) in the *CloudWatch Logs User Guide*.

```
$ pcluster export-cluster-logs --cluster-name mycluster --region eu-west-1 \
  --bucket bucketname --bucket-prefix logs
{
  "url": "https://bucketname.s3.eu-west-1.amazonaws.com/export-log/mycluster-
logs-202109071136.tar.gz?..."
}

# use the --output-file parameter to save the logs locally
$ pcluster export-cluster-logs --cluster-name mycluster --region eu-west-1 \
  --bucket bucketname --bucket-prefix logs --output-file /tmp/archive.tar.gz
{
  "path": "/tmp/archive.tar.gz"
}
```

The archive contains the Amazon CloudWatch Logs streams and AWS CloudFormation stack events from the head node and compute nodes for the last 14 days, unless specified explicitly in the configuration or in the parameters for the `export-cluster-logs` command. The time it takes

for the command to finish depends on the number of nodes in the cluster and the number of log streams available in CloudWatch Logs. For more information about the available log streams, see [Integration with Amazon CloudWatch Logs](#).

## Preserved logs

Starting from version 3.0.0, AWS ParallelCluster preserves CloudWatch Logs by default when a cluster is deleted. If you want to delete a cluster and preserve its logs, make sure that [Monitoring / Logs / CloudWatch / DeletionPolicy](#) isn't set to Delete in the cluster configuration. Otherwise, change the value for this field to Retain, and run the `pcluster update-cluster` command. Then, run `pcluster delete-cluster --cluster-name <cluster_name>` to delete the cluster, but retain the log group that's stored in Amazon CloudWatch.

## Terminated node logs

If a static compute node unexpectedly terminates and CloudWatch has no logs for it, check if AWS ParallelCluster has recorded the console output for that compute node on the head node in the `/var/log/parallelcluster/compute_console_output` log. For more information, see [Key logs for debugging](#).

If the `/var/log/parallelcluster/compute_console_output` log isn't available or doesn't contain the output for the node, use the AWS CLI to retrieve the console output from the failed node. Log in to the cluster head node and get the failed node `instance-id` from the `/var/log/parallelcluster/slurm_resume.log` file.

Retrieve the console output by using the following command with the `instance-id`:

```
$ aws ec2 get-console-output --instance-id i-abcdef01234567890
```

If a dynamic compute node self-terminates after launching and CloudWatch has no logs for it, submit a job that activates a cluster scaling action. Wait for the instance to fail and retrieve the instance console log.

Log in to the cluster head node and get the compute node `instance-id` from the `/var/log/parallelcluster/slurm_resume.log` file.

Retrieve the instance console log by using the following command:

```
$ aws ec2 get-console-output --instance-id i-abcdef01234567890
```

The console output log can help you debug the root cause of a compute node failure when the compute node log isn't available.

## AWS CloudFormation custom resource

Starting with AWS ParallelCluster version 3.6.0, you can use an AWS ParallelCluster CloudFormation custom resource in an AWS CloudFormation stack. The custom resource is an AWS ParallelCluster hosted stack. This way, you can use CloudFormation to configure and manage your clusters. For example, you can configure cluster external resources such as network, shared storage, and security group infrastructure in a CloudFormation stack. Furthermore, you can manage your cluster with a CloudFormation infrastructure as code pipeline.

Add an AWS ParallelCluster custom resource to your CloudFormation template by doing the following:

1. Add a custom resource provider stack that is owned and hosted by AWS ParallelCluster.
2. Reference the provider stack in your CloudFormation template as a custom resource.

The custom resource provider stack handles and responds to CloudFormation requests. For example, when you deploy your CloudFormation stack, you also configure and create a cluster. To update a cluster, you update your CloudFormation stack. You delete a cluster when you delete your stack. For more information about CloudFormation custom resources, see [Custom resources](#) in the *AWS CloudFormation User Guide*.

### Warning

CloudFormation doesn't detect custom resource drift. Only use CloudFormation to update the cluster configuration and to delete a cluster.

You can use the [pcluster](#) CLI or the [AWS ParallelCluster UI](#) to monitor the state of the cluster or to update the compute fleet, but you must not use them to update the cluster configuration or to delete the cluster.

### Note

We recommend that you add [termination protection](#) to your stack to avoid accidental removal.

## Provider stack hosted by AWS ParallelCluster

The custom resource provider stack is formatted as shown in the following CloudFormation template snippet:

```
PclusterClusterProvider:
  Type: AWS::CloudFormation::Stack
  Properties:
    Parameters:
      CustomLambdaRole: # (Optional) RoleARN to override default
      AdditionalIamPolicies: # (Optional) comma-separated list of IAM policies to add
    TemplateURL: !Sub
      - https://${AWS::Region}-aws-parallelcluster.s3.${AWS::Region}.${AWS::URLSuffix}/
parallelcluster/${Version}/templates/custom_resource/cluster.yaml
      - { Version: 3.7.0 }
```

### Properties:

#### Parameters:

##### **CustomLambdaRole (optional):**

A custom role with permissions to run the AWS Lambda that creates and manages the cluster. By default, the role uses the same policies defined by default in the [AWS ParallelCluster documentation](#).

##### **AdditionalIamPolicies (optional):**

A comma-separated list of additional IAM Policy Amazon Resource Names (ARNs) to add to the role that the Lambda uses. This is only used if a CustomLambdaRole isn't specified and can be kept blank.

If you need additional policies for the head node, compute nodes, or for access to an Amazon S3 bucket, add them to the CustomLambdaRole or AdditionalIamPolicy property.

For more information about the default policies, see [AWS Identity and Access Management permissions in AWS ParallelCluster](#).

##### **TemplateURL (required):**

The AWS ParallelCluster custom resource file URL.

## Outputs:

### ServiceToken:

A value that can be used as a custom resource `ServiceToken` property. A custom resource `ServiceToken` specifies where AWS CloudFormation sends requests. This is a required input for a cluster resource that you include in your AWS CloudFormation template.

### LogGroupArn:

The ARN of the CloudWatch LogGroup that the underlying resource logs to.

### LambdaLayerArn:

The ARN of the Lambda layer that's used for running AWS ParallelCluster operations.

## Cluster resource

The CloudFormation cluster resource is formatted as shown in the following CloudFormation template snippet:

```
PclusterCluster:
  Type: Custom::PclusterCluster
  Properties:
    ServiceToken: !GetAtt [ PclusterClusterProvider , Outputs.ServiceToken ]
    ClusterName: !Sub 'c-${AWS::StackName}' # Must be different from StackName
    ClusterConfiguration:
      # Your Cluster Configuration
```

## Properties:

### ServiceToken:

The AWS ParallelCluster provider stack `ServiceToken` output.

### ClusterName:

The name of the cluster to be created and managed. The name must not match the CloudFormation stack's name. The name can't be changed after the cluster has been created.

### ClusterConfiguration:

The cluster configuration YAML file, as described in [Cluster configuration file](#). However, you can use the usual CloudFormation constructs, such as [Intrinsic functions](#).



**DeletionPolicy:**

Defines whether to delete the cluster when the root stack is deleted. The default is `Delete`.

**Retain:**

Retain the cluster if the custom resource is deleted.

**Note**

To keep the retained cluster functioning, cluster-dependent resources, such as storage and networking, must have a deletion policy set to retain.

**Delete:**

Delete the cluster if the custom resource is deleted.

**Fn::GetAtt return values:**

The `Fn::GetAtt` intrinsic function returns a value for a specified attribute of a type. For more information about using the `Fn::GetAtt` intrinsic function, see [Fn::GetAtt](#).

**ClusterProperties:**

The values from the [pcluster describe-cluster](#) operation.

**validationMessages:**

A string containing all the validation messages that occurred during the last create or update operation.

**logGroupName:**

The name of the log group that's used for logging Lambda cluster operations. The log events are retained for 90 days and the log group is retained after cluster deletion.

**Example: Fn::GetAtt:**

```
# Provide the public IP address of the head node as an output of a stack
Outputs:
  HeadNodeIp:
    Description: The public IP address of the head node
```

```
Value: !GetAtt [ PclusterCluster, headNode.publicIpAddress ]
```

**Example:** Simple, complete CloudFormation template with an AWS ParallelCluster custom resource:

```
AWSTemplateFormatVersion: '2010-09-09'
Description: >
  AWS ParallelCluster CloudFormation Template

Parameters:
  HeadNodeSubnet:
    Description: Subnet where the HeadNode will run
    Type: AWS::EC2::Subnet::Id

  ComputeSubnet:
    Description: Subnet where the Compute Nodes will run
    Type: AWS::EC2::Subnet::Id

  KeyName:
    Description: KeyPair to login to the head node
    Type: AWS::EC2::KeyPair::KeyName

Resources:
  PclusterClusterProvider:
    Type: AWS::CloudFormation::Stack
    Properties:
      TemplateURL: !Sub
        - https://${AWS::Region}-aws-parallelcluster.s3.${AWS::Region}.
          ${AWS::URLSuffix}/parallelcluster/${Version}/templates/custom_resource/cluster.yaml
        - { Version: 3.7.0 }

  PclusterCluster:
    Type: Custom::PclusterCluster
    Properties:
      ServiceToken: !GetAtt [ PclusterClusterProvider , Outputs.ServiceToken ]
      ClusterName: !Sub 'c-${AWS::StackName}'
      ClusterConfiguration:
        Image:
          Os: alinux2
        HeadNode:
          InstanceType: t2.medium
          Networking:
            SubnetId: !Ref HeadNodeSubnet
```

```
Ssh:
  KeyName: !Ref KeyName
Scheduling:
  Scheduler: slurm
  SlurmQueues:
  - Name: queue0
    ComputeResources:
    - Name: queue0-cr0
      InstanceType: t2.micro
  Networking:
    SubnetIds:
    - !Ref ComputeSubnet

Outputs:
  HeadNodeIp:
    Description: The Public IP address of the HeadNode
    Value: !GetAtt [ PclusterCluster, headNode.publicIpAddress ]
  ValidationMessages:
    Description: Any warnings from cluster create or update operations.
    Value: !GetAtt PclusterCluster.validationMessages
```

To learn more about how to use the CloudFormation AWS ParallelCluster custom resource, see [Creating a cluster with AWS CloudFormation](#).

## Cluster operations

When a cluster custom resource is added to a CloudFormation stack, CloudFormation can perform the following cluster operations:

- CloudFormation creates a cluster in a new separate stack when it deploys a stack that includes the AWS ParallelCluster custom resource.
- If you update the cluster configuration defined in the stack, according to configuration update policies, CloudFormation updates the cluster. The AWS ParallelCluster custom resource provider doesn't stop the compute fleet before updating the cluster. We recommend that you use the [QueueUpdateStrategy](#) setting for cluster updates. This way, you can avoid making explicit `pcluster update-compute-fleet` calls before and after updates when using the AWS ParallelCluster custom resource.
- If you delete the stack, the cluster is deleted.

## Troubleshooting stacks that include the AWS ParallelCluster custom resource

With an AWS ParallelCluster custom resource, CloudFormation deploys a cluster from a new, separate stack. You can monitor cluster creation by taking the following steps:

1. Navigate to CloudFormation in the AWS Management Console and choose **Stacks** in the navigation pane.
2. Choose the stack with the name that you defined for the cluster name.
3. If the stack state is ROLLBACK\_COMPLETE, an error occurred during cluster creation.
4. Choose **Stack details**, and choose the **Events** tab.
5. Search **Events** on **Logical ID** for the name that you defined for the cluster name. It has a Status reason that gives a reason for an issue.
6. You can also choose the **Stacks** drop down menu, and then **Deleted** to see the list of deleted stacks. Select the stack with the cluster name and view **Events** for more details.
7. To view the output from the custom resource provider that manages the cluster, select the stack with the **Description** "AWS ParallelCluster Cluster Custom Resource." Choose the **Resources** tab, find the resource with **Logical ID** PclusterCfnFunctionLogGroup, and follow the given link. View the log streams that show the Lambda debug output.
8. To troubleshoot the cluster, see [AWS ParallelCluster troubleshooting](#).

## Elastic Fabric Adapter

Elastic Fabric Adapter (EFA) is a network device that has OS-bypass capabilities for low-latency network communications with other instances on the same subnet. EFA is exposed by using Libfabric, and can be used by applications using the Messaging Passing Interface (MPI).

To use EFA with AWS ParallelCluster and a Slurm scheduler, set [SlurmQueues](#) / [ComputeResources](#) / [Efa](#) / [Enabled](#) to true.

To view the list of Amazon EC2 instances that support EFA, see [Supported instance types](#) in the *Amazon EC2 User Guide for Linux Instances*.

We recommend that you run your EFA-enabled instances in a placement group. This way the instances are launched into a low-latency group in a single Availability Zone. For more information

on how to configure placement groups with AWS ParallelCluster, see [SlurmQueues](#) / [Networking](#) / [PlacementGroup](#).

For more information, see [Elastic Fabric Adapter](#) in the *Amazon EC2 User Guide* and [Scale HPC workloads with elastic fabric adapter and AWS ParallelCluster](#) in the *AWS Open Source Blog*.

### Note

Elastic Fabric Adapter (EFA) isn't supported over different availability zones. For more information, see [Scheduling](#) / [SlurmQueues](#) / [Networking](#) / [SubnetIds](#).

### Note

By default, Ubuntu distributions enable ptrace (process trace) protection. ptrace protection is disabled so that Libfabric works properly. For more information, see [Disable ptrace protection](#) in the *Amazon EC2 User Guide*.

## Enable Intel MPI

Intel MPI is available on the AWS ParallelCluster AMIs for `alinux2`, `centos7`, `rhel8`, `ubuntu2204`, and `ubuntu2004` values for the [Image](#) / [Os](#) setting.

### Note

To use Intel MPI, you must acknowledge and accept the terms of the [Intel simplified software license](#).

By default, Open MPI is placed on the path. To enable Intel MPI instead of Open MPI, you must first load the Intel MPI module. Then, you need to install the latest version by using `module load intelmpi`. The exact name of the module changes with every update. To see which modules are available, run `module avail`. The output is as follows.

```
$ module avail
-----/usr/share/Modules/modulefiles
-----
```

```
dot                modules
libfabric-aws/1.16.0~amzn3.0  null
module-git         openmpi/4.1.4
module-info        use.own

-----/opt/intel/mpi/2021.6.0/modulefiles
-----
intelmpi
```

To load a module, run `module load modulename`. You can add this to the script used to run `mpirun`.

```
$ module load intelmpi
```

To see which modules are loaded, run `module list`.

```
$ module list
Currently Loaded Modulefiles:
 1) intelmpi
```

To verify that Intel MPI is enabled, run `mpirun --version`.

```
$ mpirun --version
Intel(R) MPI Library for Linux* OS, Version 2021.6 Build 20220227 (id: 28877f3f32)
Copyright 2003-2022, Intel Corporation.
```

After the Intel MPI module has been loaded, multiple paths are changed to use the Intel MPI tools. To run code that was compiled by the Intel MPI tools, load the Intel MPI module first.

#### Note

Intel MPI isn't compatible with AWS Graviton-based instances.

#### Note

Before AWS ParallelCluster version 2.5.0, Intel MPI wasn't available on the AWS ParallelCluster AMIs in the China (Beijing) and China (Ningxia) Regions.

# AWS ParallelCluster API

## What is AWS ParallelCluster API?

AWS ParallelCluster API is a serverless application that, once deployed to your AWS account, provides programmatic access to AWS ParallelCluster features through an API.

AWS ParallelCluster API is distributed as a self-contained [AWS CloudFormation](#) template that includes an [Amazon API Gateway](#) endpoint, that exposes AWS ParallelCluster features, and an [AWS Lambda](#) function, that takes care of processing the invoked features.

The following image shows a high-level architecture diagram of the AWS ParallelCluster API infrastructure.

## AWS ParallelCluster API Documentation

The OpenAPI specification file describing the AWS ParallelCluster API can be downloaded from:

```
https://<REGION>-aws-parallelcluster.s3.<REGION>.amazonaws.com/  
parallelcluster/<VERSION>/api/ParallelCluster.openapi.yaml
```

Starting from the OpenAPI specification file, you can generate documentation for the AWS ParallelCluster API by using one of the many available tools such as [Swagger UI](#) or [Redoc](#).

## How to deploy AWS ParallelCluster API

To deploy AWS ParallelCluster API you need to be an Administrator of the AWS account.

The template used to deploy the API is available at the following URL:

```
https://<REGION>-aws-parallelcluster.s3.<REGION>.amazonaws.com/  
parallelcluster/<VERSION>/api/parallelcluster-api.yaml
```

where **<REGION>** is the AWS Region where the API needs to be deployed to and **<VERSION>** is the AWS ParallelCluster version (e.g. 3.7.0).

AWS Lambda processes the API invoked features by using a Lambda layer interface with the [AWS ParallelCluster Python library API](#).

**⚠ Warning**

Any user in the AWS account, that has privileged access to AWS Lambda or Amazon API Gateway services, automatically inherits permissions to administer AWS ParallelCluster API resources.

## Deploy with AWS CLI

Configure AWS Credentials to be used with the CLI if you haven't already done so.

```
$ aws configure
```

Run the following commands to deploy the API:

```
$ REGION=<region>
$ API_STACK_NAME=<stack-name> # This can be any name
$ VERSION=3.7.0
$ aws cloudformation create-stack \
  --region ${REGION} \
  --stack-name ${API_STACK_NAME} \
  --template-url https://${REGION}-aws-parallelcluster.s3.${REGION}.amazonaws.com/
parallelcluster/${VERSION}/api/parallelcluster-api.yaml \
  --capabilities CAPABILITY_NAMED_IAM CAPABILITY_AUTO_EXPAND
$ aws cloudformation wait stack-create-complete --stack-name ${API_STACK_NAME} --region
${REGION}
```

## Customize your deployment

You can customize the API deployment by using the AWS CloudFormation parameters exposed by the template. To configure the value of a parameter when deploying through the CLI, the following option can be used: `--parameters ParameterKey=KeyName,ParameterValue=Value`.

The following parameters optional:

- **Region** - Use the Region parameter to specify whether the API is able to control resources in all AWS Regions (default) or in a single AWS Region. Set this value to the AWS Region the API is being deployed to in order to restrict access.



- **ParallelClusterFunctionRole** - This overrides the IAM role that gets assigned to the AWS Lambda function implementing AWS ParallelCluster features. The parameter accepts the ARN of an IAM role. Such role needs to be configured to have AWS Lambda as the IAM principal.
- **CustomDomainName, CustomDomainCertificate, CustomDomainHostedZoneId**
  - Use these parameters to set a custom domain for the Amazon API Gateway endpoint. CustomDomainName is the name of the domain to use, CustomDomainCertificate is the ARN of an AWS managed certificate for this domain name and CustomDomainHostedZoneId is the ID of the [Amazon Route 53](#) hosted zone that you want to create records in.

 **Warning**

You can configure custom domain settings to enforce a minimum version of Transport Layer Security (TLS) for the API. For more information, see [Choosing a minimum TLS version for a custom domain in API Gateway](#).

- **EnableIamAdminAccess** - By default the AWS Lambda function processing AWS ParallelCluster API operations is configured with an IAM role that prevents any privileged IAM access (EnableIamAdminAccess=false). This makes the API unable to process operations that require the creation of IAM roles or policies. Because of this, the creation of clusters or custom images is successful only when IAM roles are provided as input as part of the resource configuration.

When EnableIamAdminAccess is set to true the AWS ParallelCluster API is granted permissions to manage the creation of IAM roles required to deploy clusters or generating custom AMIs.

 **Warning**

Setting this to true grants IAM admin privileges to the AWS Lambda function processing AWS ParallelCluster operations.

Refer to [AWS ParallelCluster user example policies for managing IAM resources](#) for additional details on the features that can be unlocked when enabling this mode.

- **PermissionsBoundaryPolicy** - This optional parameter accepts an existing IAM policy ARN that will be set as permissions boundary for all the IAM roles created by the PC API infrastructure and

as a condition on the administrative IAM permissions so that only roles with this policy can be created by the PC API.

Refer to [PermissionsBoundary mode](#) for additional details on the restrictions imposed by this mode.

- **CreateApiUserRole** - By default, the deployment of the AWS ParallelCluster API includes the creation of an IAM role which is set as the only role authorized to invoke the API. The Amazon API Gateway endpoint is configured with a resource based policy to grant invoke permission to the created user only. To change this, set `CreateApiUserRole=false` and then grant API access to selected IAM users. For more information, see [Control access for invoking an API](#) in the *Amazon API Gateway Developer Guide*.

### Warning

When `CreateApiUserRole=true` access to the API endpoint is not restricted by Amazon API Gateway resource policies, all IAM roles having unconstrained `execute-api:Invoke` permission can access AWS ParallelCluster features. For more information, see [Controlling access to an API with API Gateway resource policies](#) in the *API Gateway Developer Guide*.

### Warning

The `ParallelClusterApiUserRole` has permission to invoke all AWS ParallelCluster API operations. To restrict access to a subset of API resources, see the [Control who can call an API Gateway API method with IAM policies](#) in the *API Gateway Developer Guide*.

- **IAMRoleAndPolicyPrefix** - This optional parameter accepts a max 10 characters string that will be used as prefix for both IAM roles and policies created as part of the PC API infrastructure.

## Updating the API

### Upgrading to a newer AWS ParallelCluster version

Option 1: Remove the existing API by deleting the corresponding AWS CloudFormation stack and deploying the new API as shown above.

Option 2: Update the existing API by running the following commands:

```
$ REGION=<region>
$ API_STACK_NAME=<stack-name> # This needs to correspond to the existing API stack
name
$ VERSION=3.7.0
$ aws cloudformation update-stack \
  --region ${REGION} \
  --stack-name ${API_STACK_NAME} \
  --template-url https://${REGION}-aws-parallelcluster.s3.${REGION}.amazonaws.com/
parallelcluster/${VERSION}/api/parallelcluster-api.yaml \
  --capabilities CAPABILITY_NAMED_IAM CAPABILITY_AUTO_EXPAND
$ aws cloudformation wait stack-update-complete --stack-name ${API_STACK_NAME} --region
${REGION}
```

## Invoking AWS ParallelCluster API

The AWS ParallelCluster Amazon API Gateway endpoint is configured with [AWS\\_IAM authorization type](#), and requires all requests to be SigV4 signed with valid IAM credentials ([API reference: making http requests](#)).

When deployed with default settings, API invoke permissions are only granted to the default IAM user created with the API.

To retrieve the ARN of the default IAM user, run:

```
$ REGION=<region>
$ API_STACK_NAME=<stack-name>
$ aws cloudformation describe-stacks --region ${REGION} --stack-name ${API_STACK_NAME}
--query "Stacks[0].Outputs[?OutputKey=='ParallelClusterApiUserRole'].OutputValue" --
output text
```

To obtain temporary credentials for the default IAM user, run the [STS AssumeRole](#) command.

You can retrieve the AWS ParallelCluster API endpoint by running the following command:

```
$ REGION=<region>
$ API_STACK_NAME=<stack-name>
$ aws cloudformation describe-stacks --region ${REGION} --stack-name ${API_STACK_NAME}
--query "Stacks[0].Outputs[?OutputKey=='ParallelClusterApiInvokeUrl'].OutputValue" --
output text
```

The AWS ParallelCluster API can be invoked by any HTTP client that complies with the OpenAPI specifications that can be found here:

```
https://<REGION>-aws-parallelcluster.s3.<REGION>.amazonaws.com/  
parallelcluster/<VERSION>/api/ParallelCluster.openapi.yaml
```

Requests need to be SigV4 signed as documented [here](#).

At this time, we do not offer any official API client implementation. However, API clients can be easily generated from the OpenAPI model by using [OpenAPI Generator](#). Once the client is generated SigV4 signing needs to be added if not provided out of the box.

A reference implementation for a Python API client can be found in the [AWS ParallelCluster repository](#). To learn more about how you can use the Python API client, see the [Using the AWS ParallelCluster API](#) tutorial.

To implement more advanced access control mechanisms, such as Amazon Cognito or Lambda Authorizers, or to further protect the API with AWS WAF or API keys, follow the [Amazon API Gateway documentation](#).

### Warning

An IAM user that is authorized to invoke the AWS ParallelCluster API, can indirectly control all AWS resources managed by AWS ParallelCluster in the AWS account. This includes the creation of AWS resources that the user can't control directly due to restrictions on the user IAM policy. For example, the creation of a AWS ParallelCluster cluster, depending on its configuration, might include the deployment of Amazon EC2 instances, Amazon Route 53, Amazon Elastic File System file systems, Amazon FSx file systems, IAM roles, and resources from other AWS services used by AWS ParallelCluster that the user might not have direct control over.

### Warning

When creating a cluster with `AdditionalIamPolicies` specified in the configuration, the additional policies must match one of the following patterns:

```
- !Sub arn:${AWS::Partition}:iam::${AWS::AccountId}:policy/parallelcluster*
```

```

- !Sub arn:${AWS::Partition}:iam::${AWS::AccountId}:policy/parallelcluster/*
- !Sub arn:${AWS::Partition}:iam::aws:policy/CloudWatchAgentServerPolicy
- !Sub arn:${AWS::Partition}:iam::aws:policy/AmazonSSMManagedInstanceCore
- !Sub arn:${AWS::Partition}:iam::aws:policy/AWSBatchFullAccess
- !Sub arn:${AWS::Partition}:iam::aws:policy/AmazonS3ReadOnlyAccess
- !Sub arn:${AWS::Partition}:iam::aws:policy/service-role/AWSBatchServiceRole
- !Sub arn:${AWS::Partition}:iam::aws:policy/service-role/
AmazonEC2ContainerServiceforEC2Role
- !Sub arn:${AWS::Partition}:iam::aws:policy/service-role/
AmazonECSTaskExecutionRolePolicy
- !Sub arn:${AWS::Partition}:iam::aws:policy/service-role/
AmazonEC2SpotFleetTaggingRole
- !Sub arn:${AWS::Partition}:iam::aws:policy/EC2InstanceProfileForImageBuilder
- !Sub arn:${AWS::Partition}:iam::aws:policy/service-role/
AWSLambdaBasicExecutionRole

```

If you need other additional policies, you can do one of the following:

- Edit the `DefaultParallelClusterIamAdminPolicy` in:

```

https://<REGION>-aws-parallelcluster.s3.<REGION>.amazonaws.com/
parallelcluster/<VERSION>/api/parallelcluster-api.yaml

```

Add the policy in the `ArnLike/iam:PolicyARN` section.

- Omit specifying policies for `AdditionalIamPolicies` in the configuration file and manually add policies to the AWS ParallelCluster Instance Role created within the cluster.

## Accessing the API logs and metrics

API logs are published to Amazon CloudWatch with a retention of 30 days. To retrieve the LogGroup name associated with an API deployment, run the following command:

```

$ REGION=<region>
$ API_STACK_NAME=<stack-name>
$ aws cloudformation describe-stacks --region ${REGION} --
stack-name ${API_STACK_NAME} --query "Stacks[0].Outputs[?
OutputKey=='ParallelClusterLambdaLogGroup'].OutputValue" --output text

```

Lambda metrics, logs and [AWS X-Ray](#) trace logs can be also accessed through the Lambda console. To retrieve the ARN of the Lambda function associated with an API deployment run the following command:

```
$ REGION=<region>
$ API_STACK_NAME=<stack-name>
$ aws cloudformation describe-stacks --region ${REGION} --stack-name ${API_STACK_NAME}
  --query "Stacks[0].Outputs[?OutputKey=='ParallelClusterLambdaArn'].OutputValue" --
output text
```

## AWS ParallelCluster for Terraform

Beginning with AWS ParallelCluster 3.8.0, you can deploy clusters and custom images using [Terraform](#). To begin using this feature, see [Terraform Provider for AWS ParallelCluster](#) from the Terraform Registry.

### Note

You must have [ParallelCluster API](#) deployed in your account to use the provider.

Use the following chart to determine the compatibility between the provider and the AWS ParallelCluster versions:

| Provider version | AWS ParallelCluster version |
|------------------|-----------------------------|
| 1.0.0            | 3.8.0+                      |

See [examples](#) of how to use the provider.

For an even smoother experience, use the official [Terraform Module for AWS ParallelCluster](#) from Terraform Registry. The module allows you to deploy:

1. ParallelCluster API
2. ParallelCluster clusters defined with YAML configuration file and HCL
3. Networking infrastructure required by a ParallelCluster cluster

See [examples](#) of how to use the module.

## Connect to the head node through NICE DCV

NICE DCV is a remote visualization technology that enables users to securely connect to graphic-intensive 3D applications that are hosted on a remote high-performance server. For more information, see [NICE DCV](#).

The NICE DCV software is automatically installed on the head node and can be enabled by using the [Dcv](#) section from the [HeadNode](#) configuration.

```
HeadNode:
  Dcv:
    Enabled: true
```

This way, AWS ParallelCluster sets `/home/<DEFAULT_AMI_USER>` in the head node to the [DCV server storage folder](#). For more information about NICE DCV configuration parameters, see [HeadNode / Dcv](#). To connect to the NICE DCV session, use the [pcluster dcv-connect](#) command.

## NICE DCV HTTPS certificate

NICE DCV automatically generates a self-signed certificate to secure traffic between the NICE DCV client and NICE DCV server.

To replace the default self-signed NICE DCV certificate with another certificate, first connect to the head node. Then, copy both the certificate and key to the `/etc/dcv` folder before running the [pcluster dcv-connect](#) command.

For more information, see [Changing the TLS certificate](#) in the *NICE DCV Administrator Guide*.

## Licensing NICE DCV

The NICE DCV server doesn't require a license server when running on Amazon EC2 instances. However, the NICE DCV server must periodically connect to an Amazon S3 bucket to determine if a valid license is available.

AWS ParallelCluster automatically adds the required permissions to the head node IAM policy. When using a custom IAM Instance Policy, use the permissions described in [NICE DCV on Amazon EC2](#) in the *NICE DCV Administrator Guide*.

For troubleshooting tips, see [Troubleshooting issues in NICE DCV](#).

## Using `pcluster update-cluster`

In AWS ParallelCluster 3.x, [pcluster update-cluster](#) analyzes the settings used to create the current cluster and the settings in the configuration file for issues. If any issues are discovered, they are reported, and the steps to take to fix the issues are displayed. For example, if the compute [InstanceType](#) is changed, the compute fleet must be stopped before an update can proceed. This issue is reported when it is discovered. If no blocking issues are discovered, update process is started and the changes are reported.

You can use the [pcluster update-cluster --dryrun](#) option to see the changes before their run. For more information, see [pcluster update-cluster examples](#).

For troubleshooting guidance, see [AWS ParallelCluster troubleshooting](#).

### Update Policy: definitions

**Update policy: This setting can be changed during an update.**

After changing this setting, the cluster can be updated using [pcluster update-cluster](#).

**Update policy: If this setting is changed, the update is not allowed.**

After changing this setting, the cluster can't be updated. You must revert the settings for the original cluster and create a new cluster with the updated settings. You can delete the original cluster at a later date. To create the new cluster, use [pcluster create-cluster](#). To delete the original cluster, use [pcluster delete-cluster](#).

**Update policy: This setting is not analyzed during an update.**

These settings can be changed, and the cluster updated using [pcluster update-cluster](#).

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

These settings cannot be changed while the compute fleet exists. Either the change must be reverted or the compute fleet must be stopped (using [pcluster update-compute-fleet](#)). After the compute fleet is stopped you can update the cluster ([pcluster update-cluster](#)) to activate the changes. For example, if you are using a Slurm scheduler with [SlurmQueues](#) / [ComputeResources](#) / - [Name](#) / [MinCount](#) > 0, a compute fleet is started.



**Update policy: The compute fleet and login nodes must be stopped for this setting to be changed for an update.**

These settings cannot be changed while the compute fleet exists or if the login nodes are in use. Either the change must be reverted or the compute fleet and login nodes must be stopped (The compute fleet can be stopped using [pcluster update-compute-fleet](#)). After the compute fleet and login nodes have been stopped, you can update the cluster ([pcluster update-cluster](#)) to activate the changes.

**Update policy: This setting can't be decreased during an update.**


These settings can be changed, but they cannot be decreased. If these settings must be decreased, you must revert the settings for the original cluster and create a new cluster with the updated settings. You can delete the original cluster at a later date. To create the new cluster, use [pcluster create-cluster](#). To delete the original cluster, use [pcluster delete-cluster](#).

**Update policy: If this setting is changed, the update is not allowed. If you force the update, the new value will be ignored and the old value will be used.**

After changing this setting, the cluster can't be updated. You must revert the settings for the original cluster and create a new cluster with the updated settings. You can delete the original cluster at a later date. To create the new cluster, use [pcluster create-cluster](#). To delete the original cluster, use [pcluster delete-cluster](#).

**Update policy: The compute fleet must be stopped or [QueueUpdateStrategy](#) must be set for this setting to be changed for an update.**

These settings can be changed. Either the compute fleet must be stopped (using [pcluster update-compute-fleet](#)) or [QueueUpdateStrategy](#) must be set. After the compute fleet is stopped or [QueueUpdateStrategy](#) is set, you can update the cluster ([pcluster update-cluster](#)) to activate the changes.

 **Note**

This update policy is supported starting with AWS ParallelCluster version 3.2.0.

**Update policy:** For this list values setting, a new value can be added during an update or the compute fleet must be stopped when removing an existing value.

A new value for these settings can be added during an update. After adding a new value to the list, the cluster can be updated using ([pcluster update-cluster](#)).

To remove an existing value from the list, the compute fleet must be stopped (using [pcluster update-compute-fleet](#)).

For example, if you are using a Slurm scheduler and adding a new instance type to [Instances/InstanceType](#), you can update the cluster without stopping the compute fleet. To remove an existing instance type from [Instances/InstanceType](#), the compute fleet must be stopped first (using [pcluster update-compute-fleet](#)).

**Note**

This update policy is supported starting with AWS ParallelCluster version 3.2.0.

**Update policy:** Reducing the size of a queue requires the compute fleet to be stopped or [QueueUpdateStrategy](#) must be set to TERMINATE for this setting to be changed for an update.

These settings can be changed, but if the change would reduce the size of the queue, the compute fleet must be stopped (using [pcluster update-compute-fleet](#)) or [QueueUpdateStrategy](#) must be set to TERMINATE. After the compute fleet is stopped or [QueueUpdateStrategy](#) is set to TERMINATE, you can update the cluster ([pcluster update-cluster](#)) to activate the changes.

The TERMINATE set when resizing the capacity of the cluster, will only terminate the nodes from the back of the node list, and will leave untouched all the other nodes of the same partition.

For example, if cluster initial capacity is `MinCount = 5` and `MaxCount = 10`, the nodes are `st-[1-5]`; `dy-[1-5]`. When resizing the cluster to `MinCount = 3` and `MaxCount = 5`, the new cluster capacity will be composed by the nodes `st-[1-3]`; `dy-[1-2]`, which will not be touched during the update. Only the nodes `st-[4-5]`; `dy-[3-5]` are going to be terminated during the update.

The following changes are supported and don't require the compute fleet to be stopped nor the [QueueUpdateStrategy](#) set to TERMINATE:


- A new [SlurmQueue](#) is added
- A new [ComputeResource](#) is added
- [MaxCount](#) is increased
- [MinCount](#) is increased and [MaxCount](#) is increased of at least the same amount

**Note:** This update policy is supported starting with AWSParallelCluster version 3.9.0.

**Update policy:** For this list values setting, the compute fleet must be stopped or [QueueUpdateStrategy](#) must be set to add a new value; the compute fleet must be stopped when removing an existing value.

A new value for these settings can be added during an update. Either the compute fleet must be stopped (using [pcluster update-compute-fleet](#)) or [QueueUpdateStrategy](#) must be set. After the compute fleet is stopped or [QueueUpdateStrategy](#) is set, you can update the cluster ([pcluster update-cluster](#)) to activate the changes.

To remove an existing value from the list, the compute fleet must be stopped (using [pcluster update-compute-fleet](#)).

 **Note**

This update policy is supported starting with AWS ParallelCluster version 3.3.0.

**Update policy:** All compute nodes must be stopped for a managed placement group deletion. The compute fleet must be stopped or [QueueUpdateStrategy](#) must be set for this setting to be changed for an update.

The compute fleet must be stopped (using [pcluster update-compute-fleet](#)) in order to remove a managed placement group. If you run a cluster update to remove a managed placement group before stopping the compute fleet, an invalid configuration message is returned and the update doesn't proceed. Stopping the compute fleet guarantees no instances are running.

## pcluster update-cluster examples

These settings can be changed, but if the change would reduce the size of the queue, the compute fleet must be stopped (using [pcluster update-compute-fleet](#)) or [QueueUpdateStrategy](#) must be set

to TERMINATE. After the compute fleet is stopped or [QueueUpdateStrategy](#) is set to TERMINATE, you can update the cluster ([pcluster update-cluster](#) to activate the changes.

- This example demonstrates an update with some allowed changes and the update is started directly.

```
$ pcluster update-cluster --cluster-name cluster_name --cluster-config
~/.parallelcluster/test_cluster --region us-east-1
{
  "cluster": {
    "clusterName": cluster_name,
    "cloudformationStackStatus": "UPDATE_IN_PROGRESS",
    "cloudformationStackArn": stack_arn,
    "region": "us-east-1",
    "version": "3.7.0",
    "clusterStatus": "UPDATE_IN_PROGRESS"
  },
  "changeSet": [
    {
      "parameter": "HeadNode.Networking.AdditionalSecurityGroups",
      "requestedValue": [
        "sg-0cd61884c4ad11234"
      ],
      "currentValue": [
        "sg-0cd61884c4ad16341"
      ]
    }
  ]
}
```

- This example demonstrates a dryrun update with some allowed changes. Dryrun is useful to report the change set without starting the update.

```
$ pcluster update-cluster --cluster-name cluster_name --cluster-config
~/.parallelcluster/test_cluster --region us-east-1 --dryrun true
{
  "message": "Request would have succeeded, but DryRun flag is set.",
  "changeSet": [
    {
      "parameter": "HeadNode.Networking.AdditionalSecurityGroups",
      "requestedValue": [
        "sg-0cd61884c4ad11234"
      ],
    }
  ]
}
```

```

    "currentValue": [
      "sg-0cd61884c4ad16341"
    ]
  }
]
}

```

- This example demonstrates an update with some changes that block the update.

```

$ pcluster update-cluster --cluster-name cluster_name --cluster-config
~/.parallelcluster/test_cluster --region us-east-1
{
  "message": "Update failure",
  "updateValidationErrors": [
    {
      "parameter": "HeadNode.Ssh.KeyName",
      "requestedValue": "mykey_2",
      "message": "Update actions are not currently supported for the 'KeyName'
parameter. Restore 'KeyName' value to 'jenkinsjun'. If you need this change, please
consider creating a new cluster instead of updating the existing one.",
      "currentValue": "mykey_1"
    },
    {
      "parameter": "Scheduling.SlurmQueues[queue1].ComputeResources[queue1-
t2micro].InstanceType",
      "requestedValue": "c4.xlarge",
      "message": "All compute nodes must be stopped. Stop the compute fleet with the
pcluster update-compute-fleet command",
      "currentValue": "t2.micro"
    },
    {
      "parameter": "SharedStorage[ebs1].MountDir",
      "requestedValue": "/my/very/very/long/shared_dir",
      "message": "Update actions are not currently supported for the 'MountDir'
parameter. Restore 'MountDir' value to '/shared'. If you need this change, please
consider creating a new cluster instead of updating the existing one.",
      "currentValue": "/shared"
    }
  ],
  "changeSet": [
    {
      "parameter": "HeadNode.Networking.AdditionalSecurityGroups",
      "requestedValue": [
        "sg-0cd61884c4ad11234"

```

```
    ],
    "currentValue": [
      "sg-0cd61884c4ad16341"
    ]
  },
  {
    "parameter": "HeadNode.Ssh.KeyName",
    "requestedValue": "mykey_2",
    "currentValue": "mykey_1"
  },
  {
    "parameter": "Scheduling.SlurmQueues[queue1].ComputeResources[queue1-
t2micro].InstanceType",
    "requestedValue": "c4.xlarge",
    "currentValue": "t2.micro"
  },
  {
    "parameter": "SharedStorage[ebs1].MountDir",
    "requestedValue": "/my/very/very/long/shared_dir",
    "currentValue": "/shared"
  }
]
}
```

## AWS ParallelCluster AMI customization

There are scenarios where building a custom AMI for AWS ParallelCluster is necessary. This section covers what to consider when building a custom AWS ParallelCluster AMI.

You can build a custom AWS ParallelCluster AMI using one of the following methods:

1. Create a [build image configuration file](#), and then use the `pcluster` CLI to build the image with EC2 Image Builder. This process is automated, repeatable, and supports monitoring. For more information, see the [pcluster](#) image commands.
2. Create an instance from an AWS ParallelCluster AMI, then log in to it and make manual modifications. Last, use Amazon EC2 to create a new AMI from the modified instance. This process takes less time. However, it isn't automated or repeatable, and it doesn't support use of the `pcluster` CLI image monitoring commands.

For more information about these methods, see [Building a custom AWS ParallelCluster AMI](#).

## AWS ParallelCluster AMI customization considerations

No matter how you create your custom image, we recommend that you perform preliminary validation tests and include provisions to monitor the status of the image being created.

To build a custom AMI using `pcluster`, you create a [build image configuration file](#) with a [Build](#) and [Image](#) section that [EC2 Image Builder](#) uses to build your custom image. The [Build](#) section specifies what Image Builder needs to build the image. This includes the [ParentImage](#) (base image), and [Components](#). An [Image Builder component](#) defines a sequence of steps that are required to customize an instance before an image is created or to test an instance that was launched by the created image. For AWS ParallelCluster component examples, see [Custom AMIs](#). The [Image](#) section specifies the image properties.

When called from `pcluster` [build-image](#) to create a custom image, Image Builder uses the build image configuration with the AWS ParallelCluster cookbook to bootstrap AWS ParallelCluster on your [ParentImage](#). Image Builder downloads components, runs build and validate phases, creates the AMI, launches an instance from the AMI, and runs tests. When the process completes, Image Builder then produces a new image or a stop message.

### Perform custom component validation tests

Before you include an Image Builder component in a configuration, test and validate it using one of the following methods. Because the Image Builder process can take up to 1 hour, we recommend that you test the components beforehand. This can save you a considerable amount of time.

#### Script case

Test the script in a running instance, outside the build image process, and verify that the script exits with exit code 0.

#### Amazon Resource Name (ARN) case

Test the component document in a running instance, outside the build image process. For a list of requirements, see [Component manager](#) in the *Image Builder User Guide*.

#### After successful validation, add the component to your build image configuration

After you verified that the custom component is working, add it to the [Build image configuration file](#).

## Monitor the Image Builder process with `pcluster` commands to aid in debugging

### [describe-image](#)

Use this command to monitor the build image status.

### [list-image-log-streams](#)

Use this command to get the IDs of log streams that you can use to retrieve log events with [get-image-log-events](#).

### [get-image-log-events](#)

Use this command to get the log stream of build image process events.

For example, you can tail build image events using the following command.

```
$ watch -n 1 'pcluster get-image-log-events -i <image-id> \
  --log-stream-name/1 <pcluster-version> \
  --query "events[*].message" | tail -n 50'
```

### [get-image-stack-events](#)

Use this command to retrieve image stack events for the stack that Image Builder creates.

### [export-image-logs](#)

Use this command save image logs.

For more information about AWS ParallelCluster logs and Amazon CloudWatch, see [Amazon CloudWatch Logs build image logs](#) and [Amazon CloudWatch dashboard](#).

## Other considerations

### New AWS ParallelCluster releases and custom AMIs

If you build and use a custom AMI, you must repeat the steps that you used to create your custom AMI with each new AWS ParallelCluster release.

### Custom bootstrap actions

Review the [Custom bootstrap actions](#) section to determine if the modifications you want to make can be scripted and supported with future AWS ParallelCluster releases.



## Using custom AMIs

You can specify custom AMIs in the cluster configuration in the [Image / CustomAmi](#) and [Scheduling / SlurmQueues / - Name / Image / CustomAmi](#) sections.

To troubleshoot custom AMI validation warnings, see [Troubleshooting custom AMI issues](#).

## Launch instances with On-Demand Capacity Reservations (ODCR)

With [On-Demand Capacity Reservations \(ODCR\)](#), you can reserve capacity for your cluster Amazon EC2 instances in a specific Availability Zone. This way, you can create and manage Capacity Reservations independently from the billing accounts that [Savings Plans](#) or [regional Reserved Instances](#) offer.

You can configure open or targeted ODCR. *Open* ODCR cover any instances that match the ODCR attributes. These attributes are instance type, platform, and Availability Zone. You must explicitly define *Targeted* ODCR in the cluster configuration. To determine whether an ODCR is open or targeted, run the AWS CLI Amazon EC2 [describe-capacity-reservation](#) command.

You can also create an ODCR in a cluster placement group that's called a [cluster placement group on-demand capacity reservation \(CPG ODCR\)](#).

Multiple ODCRs can be grouped in a resource group. This can be defined in the cluster configuration file. For more information about resource groups, see [What are resource groups?](#) in the *Resource Groups and Tags User Guide*.

## Using ODCR with AWS ParallelCluster

AWS ParallelCluster supports open ODCR. When using an open ODCR, you don't need to specify anything in AWS ParallelCluster. Instances are automatically selected for the cluster. You can specify an existing placement group or have AWS ParallelCluster create a new one for you.

### ODCR in the cluster configuration

Starting with AWS ParallelCluster version 3.3.0, you can define ODCRs in the cluster configuration file, with no need to specify Amazon EC2 run-instances overrides.

You start by creating [capacity reservations](#) and [resource groups](#) using the methods described in the linked documentation for each. You must use the AWS CLI methods to create capacity

reservation groups. If you use the AWS Management Console, you can only create Tag based or Stack based resource groups. Tag based and Stack based resource groups aren't supported by AWS ParallelCluster or the AWS CLI when launching instances with capacity reservations.

After the capacity reservations and resource groups are created, specify them in [SlurmQueues / CapacityReservationTarget](#) or [SlurmQueues / ComputeResources / CapacityReservationTarget](#) as shown in the following example cluster configuration. Replace *values* high-lighted in red with your valid values.

```
Image:
  Os: os
HeadNode:
  InstanceType: head_node_instance
  Networking:
    SubnetId: public_subnet_id
  Ssh:
    KeyName: key_name
Scheduling:
  Scheduler: scheduler
SlurmQueues:
  - Name: queue1
    Networking:
      SubnetIds:
        - private_subnet_id
ComputeResources:
  - Name: cr1
    Instances:
      - InstanceType: instance
    MaxCount: max_queue_size
    MinCount: max_queue_size
    Efa:
      Enabled: true
    CapacityReservationTarget:
      CapacityReservationResourceGroupArn: capacity_reservation_arn
```

## OBSOLETE / NOT RECOMMENDED - Targeted ODCR with Amazon EC2 instance overrides

### Warning

- Starting with AWS ParallelCluster version 3.3.0, we don't recommend this method. This section remains as a reference for implementations using prior versions.

- This method is not compatible with Multiple instance type allocation with Slurm.

Support for targeted ODCRs is added in AWS ParallelCluster 3.1.1. In this release, a mechanism was introduced that overrides EC2 RunInstances parameters and passes information about the reservation to use for each configured compute resource in AWS ParallelCluster. This mechanism is compatible with targeted ODCR. However, when you use targeted ODCR, you must specify the `run-instances` override configuration. *Targeted* ODCRs must be explicitly defined in the AWS CLI Amazon EC2 [run-instances](#) command. To determine whether an ODCR is open or targeted run the AWS CLI Amazon EC2 command [describe-capacity-reservation](#).

Multiple ODCRs can be grouped in a resource group. This can be used in the `run-instances` override to target multiple ODCRs at the same time.

If you're using a targeted ODCR, you can specify a placement group. However, you also need to specify a `run-instances` override configuration.

Suppose that AWS created a targeted ODCR for you or you have a specific set of Reserved Instances. Then, you can't specify a placement group. The rules that are configured by AWS might conflict with the placement group setting. So, if a placement group is required for your application, use a [CPG ODCR](#). In either case, you must also specify the `run-instances` override configuration.

If you're using a CPG ODCR, you must specify the `run-instances` override configuration and you must specify the same placement group in the cluster configuration.

## Using Reserved Instances with AWS ParallelCluster

Reserved instances [are different](#) than Capacity Reservations (ODCR). There are [2 types](#) of reserved instances. A *Regional* Reserved Instance doesn't reserve capacity. A *zonal* Reserved Instance reserves capacity in the specified Availability Zone.

If you have Regional Reserved Instances, there's no capacity reservation and you can get Insufficient Capacity Errors. If you have zonal Reserved Instances, you have capacity reservation, but there are no `run-instances` API parameters that you can use to specify them.

Reserved instances are supported by any AWS ParallelCluster version. You don't have to specify anything in AWS ParallelCluster and the instances are automatically selected.

When using zonal Reserved Instances, you can avoid potential Insufficient Capacity Errors by omitting the placement group specification in the cluster configuration.

## OBSOLETE / NOT RECOMMENDED - Using RunInstances customization in AWS ParallelCluster 3 for targeted On-Demand Capacity Reservations (ODCR)

### Warning

- Starting with AWS ParallelCluster version 3.3.0, we don't recommend this method. This section remains as a reference for implementations using prior versions.
- This method is not compatible with Multiple instance type allocation with Slurm.

You can override Amazon EC2 RunInstances parameters for each compute resource that's configured in a cluster queue. To do so, create the `/opt/slurm/etc/pcluster/run_instances_overrides.json` file on the head node of the cluster with the following code snippet content:

- `${queue_name}` is the name of the queue that you want to apply overrides to.
- `${compute_resource_name}` is the compute resource that you want to apply overrides to.
- `${overrides}` is an arbitrary JSON object that contains a list of RunInstances overrides to use for the specific combination of queue and instance-type. The overrides syntax needs to follow the same specifications that are documented in a [run\\_instances](#) boto3 call.

```
{
  "${queue_name}": {
    "${compute_resource_name}": {
      ${overrides}
    },
    ...
  },
  ...
}
```

For example, the following JSON configures the ODCR group `group_arn` to be used for `p4d.24xlarge` instances that are configured in `my-queue` and `my-compute-resource`.

```
{
  "my-queue": {
    "my-compute-resource": {
      "CapacityReservationSpecification": {
```

```

        "CapacityReservationTarget": {
            "CapacityReservationResourceGroupArn": "group_arn"
        }
    }
}

```

After this JSON file is generated, the AWS ParallelCluster daemons that are responsible for cluster scaling automatically use the override configuration for instance launches. To confirm that the specified parameters are being used for instance provisioning, look at the following log files:

- `/var/log/parallelcluster/clustermgtd` (for static capacity)
- `/var/log/parallelcluster/slurm_resume.log` (for dynamic capacity)

If the parameters are correct, you'll find a log entry that contains the following:

```
Found RunInstances parameters override. Launching instances with: <parameters_list>
```

## OBSOLETE / NOT RECOMMENDED - Create a cluster with targeted On-Demand Capacity Reservations (ODCR)

### Warning

- Starting with AWS ParallelCluster version 3.3.0, we don't recommend this method. This section remains as a reference for implementations using prior versions.
- This method is not compatible with [Multiple instance type allocation with Slurm](#).

### 1. Create a resource group, to group capacity.

```

$ aws resource-groups create-group --name EC2CRGroup \
  --configuration '{"Type":"AWS::EC2::CapacityReservationPool"}'
  '{"Type":"AWS::ResourceGroups::Generic", "Parameters": [{"Name": "allowed-
resource-types", "Values": ["AWS::EC2::CapacityReservation"]}]}'
```

### Note

A resource group doesn't support resources that are shared by other accounts. If the target ODCR is shared by another account, you don't need to create a resource group. Use `CapacityReservationId` instead of a resource group in step 3.

```
#!/bin/bash
set -e

# Override run_instance attributes
cat > /opt/slurm/etc/pcluster/run_instances_overrides.json << EOF
{
  "my-queue": {
    "my-compute-resource": {
      "CapacityReservationSpecification": {
        "CapacityReservationTarget": {
          "CapacityReservationId": "cr-abcdef01234567890"
        }
      }
    }
  }
}
EOF
```

Add capacity reservations to the resource group. Every time that you create a new ODCR, add it to the Group Reservation. Replace `ACCOUNT_ID` with your account ID, `PLACEHOLDER_CAPACITY_RESERVATION` with your capacity reservation ID, and `REGION_ID` with your AWS Region ID (for example, us-east-1).

```
$ aws resource-groups group-resources --region REGION_ID --group EC2CRGroup \
  --resource-arns arn:aws:ec2:REGION_ID:ACCOUNT_ID:capacity-
  reservation/PLACEHOLDER_CAPACITY_RESERVATION
```

Create a policy document on your local computer. Replace `ACCOUNT_ID` with your account ID and `REGION_ID` with your AWS Region ID (for example, us-east-1).

```
cat > policy.json << EOF
{
```

```

"Version": "2012-10-17",
"Statement": [
  {
    "Sid": "RunInstancesInCapacityReservation",
    "Effect": "Allow",
    "Action": "ec2:RunInstances",
    "Resource": [
      "arn:aws:ec2:REGION_ID:ACCOUNT_ID:capacity-reservation/*",
      "arn:aws:resource-groups:REGION_ID:ACCOUNT_ID:group/*"
    ]
  }
]
}
EOF

```

2. **Create the IAM policy on your AWS account using the json file that you created.**

```

$ aws iam create-policy --policy-name RunInstancesCapacityReservation --policy-
document file://policy.json

```

3. **Create the following post install script locally on the instance and name it `postinstall.sh`.**

Replace *ACCOUNT\_ID* with your AWS account ID, and *REGION\_ID* with your AWS Region ID (for example, us-east-1).

```

#!/bin/bash
set -e

# Override run_instance attributes
cat > /opt/slurm/etc/pcluster/run_instances_overrides.json << EOF
{
  "my-queue": {
    "my-compute-resource": {
      "CapacityReservationSpecification": {
        "CapacityReservationTarget": {
          "CapacityReservationResourceGroupArn": "arn:aws:resource-
groups:REGION_ID:ACCOUNT_ID:group/EC2CRGroup"
        }
      }
    }
  }
}
EOF

```

```
EOF
```

Upload the file to an Amazon S3 bucket. Replace *S3\_NAME\_BUCKET* with your specific S3 bucket name.

```
$ aws s3 mb s3://S3_NAME_BUCKET
aws s3 cp postinstall.sh s3://S3_NAME_BUCKET/postinstall.sh
```

#### 4. Create the local cluster configuration, replacing the placeholders with your own values.

```
Region: REGION_ID
Image:
  Os: alinux2
HeadNode:
  InstanceType: c5.2xlarge
  Ssh:
    KeyName: YOUR_SSH_KEY
  Iam:
    S3Access:
      - BucketName: S3_NAME_BUCKET
    AdditionalIamPolicies:
      - Policy: arn:aws:iam::ACCOUNT_ID:policy/RunInstancesCapacityReservation
## This post-install script is executed after the node is configured.
## It is used to install scripts at boot time and specific configurations
## In the script below we are overriding the calls to RunInstance to force
## the provisioning of our my-queue partition to go through
## the On-Demand Capacity Reservation
CustomActions:
  OnNodeConfigured:
    Script: s3://S3_NAME_BUCKET/postinstall.sh
Networking:
  SubnetId: YOUR_PUBLIC_SUBNET_IN_TARGET_AZ

Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: my-queue
      ComputeResources:
        - MinCount: 0
          MaxCount: 100
          InstanceType: p4d.24xlarge
          Name: my-compute-resource
          Efa:
```



```
    Enabled: true
Networking:
  ## PlacementGroup:
  ##   Enabled: true ## Keep PG disabled if using targeted ODCR
  SubnetIds:
    - YOUR_PRIVATE_SUBNET_IN_TARGET_AZ
```

## 5. Create the cluster.

Use the following command to create the cluster. Replace *cluster-config.yaml* with your configuration file name, *cluster-dl* with your cluster name, and *REGION\_ID* with your Region ID (for example, us-east-1).

```
$ pcluster create-cluster --cluster-configuration cluster-config.yaml --cluster-name cluster-dl --region REGION_ID
```

After the cluster is created, the post-install script runs in the head node. The script creates the `run_instances_overrides.json` file and overrides the calls to `RunInstances` to force the provisioning of the partition to go through the On-Demand Capacity Reservation.

The AWS ParallelCluster daemons that are responsible for cluster scaling automatically use this configuration for new instances that are launched. To confirm that the specified parameters are being used to provision instances, you can look at the following log files:

- `/var/log/parallelcluster/clustermgtd` (for static capacity - [MinCount](#) > 0)
- `/var/log/parallelcluster/slurm_resume.log` (for dynamic capacity)

If the parameters are correct, you'll find a log entry contains the following.

```
Found RunInstances parameters override. Launching instances with: <parameters_list>
```

## Updating RunInstances overrides

You can update the generated JSON configuration at any time without stopping the compute fleet. After the changes are applied, all new instances launch with the updated configuration. If you need to apply the updated configuration to running nodes, recycle the nodes by forcing an instance termination and wait for AWS ParallelCluster to replace those nodes. You can do this by

terminating the instance from the Amazon EC2 console or AWS CLI, or by setting the Slurm nodes in a DOWN or DRAIN state.

Use the following command to set the Slurm node to DOWN or DRAIN.

```
$ scontrol update nodename=my-queue-dy-my-compute-resource-1 state=down  
reason=your_reason  
scontrol update nodename=my-queue-dy-my-compute-resource-1 state=drain  
reason=your_reason
```

## Launch instances with Capacity Blocks (CB)

AWS ParallelCluster supports [On-Demand Capacity Reservations \(ODCR\)](#) and [Capacity Blocks \(CB\) for Machine Learning](#). Unlike ODCR, CB can have a future start time and is time-bound. For more information about launching with ODCR, see [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#).

### Using CB with AWS ParallelCluster

To configure your new or existing clusters to use a CB, you first need to have a valid CB in your AWS account. You can use the AWS Management Console, AWS Command Line Interface, or SDK to find and purchase an available CB by following official documentation. Once you have a valid CB, you can set CB Amazon Resource Name (ARN) and related parameters in your AWS ParallelCluster configuration file. For more information, see [Find and purchase Capacity Blocks \(CB\)](#)

### CB in the cluster configuration

To use a CB for a specific queue you need to use the `CapacityReservationId` parameter. Configure it to an existing CB ID. You can obtain the CB ARN from the AWS Management Console, AWS CLI, or SDK that you used to create the CB.

You have to set `CapacityType = CAPACITY_BLOCK` for the queue where you want to use the CB. Set it to the `InstanceType` of the compute resource (the same Amazon Elastic Compute Cloud instance type of the CB).

When `CapacityReservationId` is specified at compute resource level, `InstanceType` is optional because it will be automatically retrieved from the reservation.

When using `CapacityType = CAPACITY_BLOCK`, `MaxCount` must be equal to `MinCount` and greater than 0, because all the instances that are part of the CB reservation are managed as static nodes.

At the cluster creation time, the head node waits for all the static nodes to be ready before signaling the success of cluster creation. However, when using `CapacityType = CAPACITY_BLOCK`, the nodes that are part of the compute resources associated to won't be considered for this check. The cluster will be created even if not all the configured are active.

The following configuration file snippet shows the required parameters to enable in the AWS ParallelCluster configuration file.

```
SlurmQueues:  
- Name: string  
  CapacityType: CAPACITY_BLOCK  
  InstanceType: String (EC2 Instance type of the CB)  
  MinCount: integer (<= total capacity of the CB)  
  MaxCount: integer (equal to MinCount)  
  ComputeResources:  
  - Name: string  
    CapacityReservationTarget:  
      CapacityReservationId: String (CB id)
```

## How AWS ParallelCluster uses Capacity Blocks (CB)

AWS ParallelCluster manages static nodes associated with in a peculiar way. AWS ParallelCluster creates a cluster even if the CB is not yet active, and instances are launched automatically once the CB is active.

The Slurm nodes that correspond to compute resources, associated with , and are not yet active, are kept in maintenance until they reach the CB start time. Slurm nodes remain in a reservation/maintenance state and are associated with the slurm admin user. This means they can accept jobs, but the jobs remain in pending until the reservation is removed.

AWS ParallelCluster automatically updates Slurm reservations and puts the related CB nodes in maintenance (corresponding to the CB state). When the CB is active, the Slurm reservation is removed, nodes start, and become available for the pending jobs or for new job submissions.

When the CB end time is reached, nodes will be moved back to a reservation/maintenance state. It's up to users to resubmit/requeue the jobs to a new queue/compute-resource when CB is no longer active and instances are terminated.

## AMI patching and Amazon EC2 instance replacement

To ensure that all dynamically launched cluster compute nodes behave in a consistent manner, AWS ParallelCluster disables cluster instance automatic OS updates. Additionally, a specific set of AWS ParallelCluster AMIs are built for each version of AWS ParallelCluster and its associated CLI. This specific set of AMIs remain unchanged and they are only supported by the AWS ParallelCluster version they were built for. AWS ParallelCluster AMIs for released versions aren't updated.

However, due to emergent security issues, customers might want to add patches to these AMIs and then update their clusters with the patched AMI. This aligns with the [AWS ParallelCluster Shared Responsibility Model](#).

To view the specific set of AWS ParallelCluster AMIs supported by the AWS ParallelCluster CLI version you are currently using, run:

```
$ pcluster version
$ pcluster list-official-images
```

The AWS ParallelCluster head node is a static instance and you can manually update it. Restart and reboot of the head node is fully supported starting with AWS ParallelCluster version 3.0.0.

If your instances have ephemeral instance stores, you must remember to save instance store data before manual updates. For more information, see the [HeadNode / LocalStorage / EphemeralVolume](#) cluster configuration and [Instance types with instance store volumes](#) in the *Amazon EC2 User Guide for Linux Instances*.

The compute nodes are ephemeral instances. By default you can only access them from the head node. Starting with AWS ParallelCluster version 3.0.0, you can update the AMI associated with compute instances by modifying the [Scheduling / SlurmQueues / Image / CustomAmi](#) parameter and running the [pcluster update-cluster](#) command, after stopping the compute fleet with [pcluster update-compute-fleet](#):

```
$ pcluster update-compute-fleet-status --status STOP_REQUESTED
```

It's possible to automate the creation of an updated custom AMI for the compute nodes by using one of the following methods:

- Use the [pcluster build-image](#) command with an updated [Build / ParentImage](#).
- Run the build with [Build / UpdateOsPackages / Enabled:true](#).

## Head node instance update or replacement

In some circumstances, you might be required to restart or reboot the head node. For example, this is required when you manually update the OS, or when there's an [AWS instance scheduled retirement](#) that imposes a head node instance restart.

If your instance doesn't have ephemeral drives, you can stop and start it again at any time. In the case of a scheduled retirement, starting the stopped instance migrates it to use the new hardware.

Similarly, you can manually stop and start an instance that doesn't have instance stores. For this case and for other cases of instances without ephemeral volumes, continue to [Stop and start a cluster's head node](#).

If your instance has ephemeral drives and its been stopped, the data in the instance store is lost. You can determine if the instance type used for the head node has instance stores from the table found in [Instance store volumes](#).

## Save data from ephemeral drives

Starting with AWS ParallelCluster version 3.0.0, the head node restart and reboot is fully supported for every instance type. However, if instances have an ephemeral drive, its data is lost. Follow the next steps to preserve your data before a head node restart or reboot.

To check if you have data that needs to be preserved, view the content in the [EphemeralVolume / MountDir](#) folder (/scratch by default).

You can transfer the data to the root volume or the shared storage systems attached to the cluster, such as Amazon FSx, Amazon EFS, or Amazon EBS. Note that the data transfer to remote storage can incur additional costs.

After saving the data, continue to [Stop and start a cluster's head node](#).

## Stop and start a cluster's head node

1. Verify there aren't any running jobs in the cluster.

When using a Slurm scheduler:

- If the `sbatch --no-requeue` option isn't specified, running jobs are requeued.
- If the `--no-requeue` option is specified, running jobs fail.

## 2. Request a cluster compute fleet stop:

```
$ pcluster update-compute-fleet --cluster-name cluster-name --status STOP_REQUESTED
{
  "status": "STOP_REQUESTED",
  ...
}
```

## 3. Wait until the compute fleet status is STOPPED:

```
$ pcluster update-compute-fleet --cluster-name cluster-name --status STOP_REQUESTED
{
  "status": "STOPPED",
  ...
}
```

## 4. For manual updates with an OS reboot or instance restart, you can use the AWS Management Console or AWS CLI. The following is an example of using the AWS CLI.

```
# Retrieve head node instance id
$ pcluster describe-cluster --cluster-name cluster-name --status STOP_REQUESTED
{
  "headNode": {
    "instanceId": "i-1234567890abcdef0",
    ...
  },
  ...
}
# stop and start the instance
$ aws ec2 stop-instances --instance-ids 1234567890abcdef0
{
  "StoppingInstances": [
    {
      "CurrentState": {
        "Name": "stopping"
        ...
      },
      "InstanceId": "i-1234567890abcdef0",
      "PreviousState": {
        "Name": "running"
        ...
      }
    }
  ]
}
```

```
]
}
$ aws ec2 start-instances --instance-ids 1234567890abcdef0
{
  "StartingInstances": [
    {
      "CurrentState": {
        "Name": "pending"
        ...
      },
      "InstanceId": "i-1234567890abcdef0",
      "PreviousState": {
        "Name": "stopped"
        ...
      }
    }
  ]
}
```

## 5. Start the cluster compute fleet:

```
$ pcluster update-compute-fleet --cluster-name cluster-name --status
START_REQUESTED
{
  "status": "START_REQUESTED",
  ...
}
```

# Operating Systems

AWS ParallelCluster supports Amazon Linux 2, Amazon Linux 2023, CentOS 7, Ubuntu 22.04, Ubuntu 2004, Red Hat Enterprise Linux 8 (RHEL8), Rocky 8, Red Hat Enterprise Linux 9 (RHEL9), and Rocky 9. AWS ParallelCluster offers pre-built AMIs for select operating systems, for more details on AMI's provided by AWS ParallelCluster refer to [Image section](#).

## Operating System Considerations

### Ubuntu 22.04

Ubuntu 2204 requires more secure keys for ssh and does not support RSA keys by default. Please generate an ed25519 key and use that for cluster creation.

Ubuntu 2204 cannot be updated to the latest kernel because there is no Fsx client for that kernel.

## RHEL 8

RedHat Enterprise Linux 8.7 (rhel8) is added starting in AWS ParallelCluster version 3.6.0. If you configure your cluster to use rhel8, the on-demand cost for any instance type is higher than when you configure your cluster to use other supported operation systems.

For more information about pricing, see [On-Demand Pricing](#) and [How is Red Hat Enterprise Linux on Amazon Elastic Compute Cloud offered and priced?](#).

## Rocky 8

AWS ParallelCluster 3.8.0 supports Rocky Linux 8, but pre-built Rocky Linux 8 AMIs (for x86 and ARM architectures) are not available. AWS ParallelCluster 3.8.0 supports creating clusters with Rocky Linux 8 using custom AMIs using the [CustomAmi](#) property. For more information about building custom AMIs, refer to [AWS ParallelCluster AMI customization](#).

To build your custom AMI from a base Rocky Linux 8 AMI, you can consider subscribing to the [Rocky Linux 8 AMIs](#) available on the AWS [Marketplace](#). Make sure to review the pricing and subscription costs for Rocky Linux 8 AMIs on the AWS Marketplace. Alternatively you can also use the [official Rocky Linux 8 AMIs](#) as your base AMI.

## Centos7

[Gdrcopy](#) has removed Centos7 from their OS support matrix. This means that gdrcopy 2.3.1 is the latest version that supports this OS. You must pin the NVIDIA and gdrcopy versions for Centos7, because the latest NVIDIA open source driver versions ( OpenRM ie. 535.129.03+) are incompatible with this version of gdrcopy. From ParallelCluster 3.8.0 onward, our official Centos7 AMI's will be released with gdrcopy 2.3.1 and NVIDIA driver 535.129.03.

## Rocky9

AWS ParallelCluster 3.9.0 supports Rocky Linux 9, but pre-built Rocky Linux 9 AMIs (for x86 and ARM architectures) are not available. AWS ParallelCluster 3.9.0 supports creating clusters with Rocky Linux 9 using custom AMIs using the [CustomAmi](#) property. For more information about building custom AMIs, refer to [AWS ParallelCluster AMI customization](#). To build your custom AMI from a base Rocky Linux 9 AMI, you can also use the [official Rocky Linux 9 AMIs](#) as your base AMI. Custom Rocky Linux 9 AMI build may fail if the base AMI does not have the latest kernel. To upgrade the kernel before building the AMI:



- Launch an instance using a rocky9 AMI id from here: <https://rockylinux.org/cloud-images/>
- ssh into the instance and run the following command:`sudo yum -y update`
- Create an image from the instance to use as ParentImage

# Reference for AWS ParallelCluster

## Topics

- [AWS ParallelCluster CLI commands](#)
- [Configuration files](#)
- [AWS ParallelCluster API reference](#)
- [AWS ParallelCluster Python library API](#)

## AWS ParallelCluster CLI commands

`pcluster` is the primary AWS ParallelCluster CLI command. You use `pcluster` to launch and manage HPC clusters in the AWS Cloud and to create and manage custom AMI images.

`pcluster3-config-converter` is used to convert cluster configurations in AWS ParallelCluster version 2 format into AWS ParallelCluster version 3 format.

```
pcluster [-h] ( build-image | configure |
               create-cluster | dcv-connect |
               delete-cluster | delete-cluster-instances | delete-image |
               describe-cluster | describe-cluster-instances |
               describe-compute-fleet | describe-image |
               export-cluster-logs | export-image-logs |
               get-cluster-log-events | get-cluster-stack-events |
               get-image-log-events | get-image-stack-events |
               list-cluster-log-streams | list-clusters |
               list-images | list-image-log-streams | list-official-images |
               ssh | update-cluster |
               update-compute-fleet | version ) ...
pcluster3-config-converter [-h] [-t CLUSTER_TEMPLATE]
                           [-c CONFIG_FILE]
                           [--force-convert]
                           [-o OUTPUT_FILE]
```

## Topics

- [pcluster](#)
- [pcluster3-config-converter](#)

# pcluster

`pcluster` is the primary AWS ParallelCluster CLI command. You use `pcluster` to launch and manage HPC clusters in the AWS Cloud.

`pcluster` writes logs of your commands to `pcluster.log.#` files in `/home/user/.parallelcluster/`. For more information, see [pcluster CLI logs](#).

To use `pcluster`, you must have an IAM role with the [permissions](#) required to run it.

```
pcluster [-h]
```

## Arguments

`pcluster` *command*

Possible choices: [build-image](#) [configure](#) [create-cluster](#) [dcv-connect](#) [delete-cluster](#) [delete-cluster-instances](#) [delete-image](#) [describe-cluster](#) [describe-cluster-instances](#) [describe-compute-fleet](#) [describe-image](#) [export-cluster-logs](#) [export-image-logs](#) [get-cluster-log-events](#) [get-cluster-stack-events](#) [get-image-log-events](#) [get-image-stack-events](#) [list-clusters](#) [list-cluster-log-streams](#) [list-images](#) [list-image-log-streams](#) [list-official-images](#) [ssh](#) [update-cluster](#) [update-compute-fleet](#) [version](#)

## Sub-commands:

### Topics

- [pcluster build-image](#)
- [pcluster configure](#)
- [pcluster create-cluster](#)
- [pcluster dcv-connect](#)
- [pcluster delete-cluster](#)
- [pcluster delete-cluster-instances](#)
- [pcluster delete-image](#)
- [pcluster describe-cluster](#)

- [pcluster describe-cluster-instances](#)
- [pcluster describe-compute-fleet](#)
- [pcluster describe-image](#)
- [pcluster export-cluster-logs](#)
- [pcluster export-image-logs](#)
- [pcluster get-cluster-log-events](#)
- [pcluster get-cluster-stack-events](#)
- [pcluster get-image-log-events](#)
- [pcluster get-image-stack-events](#)
- [pcluster list-clusters](#)
- [pcluster list-cluster-log-streams](#)
- [pcluster list-images](#)
- [pcluster list-image-log-streams](#)
- [pcluster list-official-images](#)
- [pcluster ssh](#)
- [pcluster update-cluster](#)
- [pcluster update-compute-fleet](#)
- [pcluster version](#)

## pcluster build-image

Create a custom AWS ParallelCluster image in the specified Region.

```
pcluster build-image [-h]
    --image-configuration IMAGE_CONFIGURATION
    --image-id IMAGE_ID
    [--debug]
    [--dryrun DRYRUN]
    [--query QUERY]
    [--region REGION]
    [--rollback-on-failure ROLLBACK_ON_FAILURE]
    [--suppress-validators SUPPRESS_VALIDATORS [SUPPRESS_VALIDATORS ...]]
    [--validation-failure-level {INFO,WARNING,ERROR}]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster build-image`.

### **--image-configuration, -c *IMAGE\_CONFIGURATION***

Specifies the image configuration file as a YAML document.

### **--image-id, -i *IMAGE\_ID***

Specifies the id of the image that will be built.

### **--debug**

Turn on debug logging.

### **--dryrun *DRYRUN***

When `true`, the command performs validation without creating any resources. You can use this to validate the image configuration. (Defaults to `false`.)

### **--query *QUERY***

JMESPath query to perform on output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the [Region](#) setting in the image configuration file, the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

### **--rollback-on-failure *ROLLBACK\_ON\_FAILURE***

When `true`, automatically initiates an image stack rollback on failure. (Defaults to `false`.)

### **--suppress-validators *SUPPRESS\_VALIDATORS* [*SUPPRESS\_VALIDATORS ...*]**

Identifies one or more config validators to suppress.

Format: `(ALL|type:[A-Za-z0-9]+)`

### **--validation-failure-level {INFO,WARNING,ERROR}**

Specifies the minimum validation level that will cause the creation to fail. (Defaults to `ERROR`.)

## Example using AWS ParallelCluster version 3.1.2:

```
$ pcluster build-image --image-configuration image-config.yaml --image-id custom-  
alinux2-image  
{  
  "image": {  
    "imageId": "custom-alinux2-image",  
    "imageBuildStatus": "BUILD_IN_PROGRESS",  
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",  
    "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/  
custom-alinux2-image/1234abcd-56ef-78gh-90ij-abcd1234efgh",  
    "region": "us-east-1",  
    "version": "3.1.2"  
  }  
}
```

### Warning

`pcluster build-image` uses the default VPC. If the default VPC has been deleted, perhaps by using AWS Control Tower or AWS Landing Zone, then the subnet ID must be specified in the image configuration file. For more information, see [SubnetId](#).

## pcluster configure

Begins an interactive configuration wizard for AWS ParallelCluster version 3. For more information, see [Configure and create a cluster with the AWS ParallelCluster command line interface](#).

```
pcluster configure [-h]  
    --config CONFIG  
    [--debug]  
    [--region REGION]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster configure`.

#### **--config *CONFIG***

Path to output the generated config file.

**--debug**

Turn on debug logging.

**--region, -r *REGION***

Specifies the AWS Region to use. The Region must be specified, using the [Region](#) setting in the image configuration file, the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**pcluster create-cluster**

Creates an AWS ParallelCluster cluster.

```
pcluster create-cluster [-h]
                        --cluster-configuration CLUSTER_CONFIGURATION
                        --cluster-name CLUSTER_NAME
                        [--debug]
                        [--dryrun DRYRUN]
                        [--query QUERY]
                        [--region REGION]
                        [--rollback-on-failure ROLLBACK_ON_FAILURE]
                        [--suppress-validators SUPPRESS_VALIDATORS [SUPPRESS_VALIDATORS ...]]

                        [--validation-failure-level {INFO,WARNING,ERROR}]
```

**Named arguments****-h, --help**

Shows the help text for `pcluster create-cluster`.

**--cluster-configuration, -c *CLUSTER\_CONFIGURATION***

Specifies the YAML cluster configuration file.

**--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster to be created.

The name must start with an alphabetical character. The name can have up to 60 characters. If Slurm accounting is enabled, the name can have up to 40 characters.

Valid characters: a-z, A-Z, 0-9, and - (hyphen).

**--debug**

Enables debug logging.

**--dryrun *DRYRUN***

When true, the command performs validation without creating any resources. You can use this to validate the cluster configuration. (Defaults to false.)

**--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the [Region](#) setting in the cluster configuration file, the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**--rollback-on-failure *ROLLBACK\_ON\_FAILURE***

When true, automatically initiates a cluster stack rollback on failures. (Defaults to true.)

**--suppress-validators *SUPPRESS\_VALIDATORS* [*SUPPRESS\_VALIDATORS ...*]**

Identifies one or more config validators to suppress.

Format: (ALL|type:[A-Za-z0-9]+)

**--validation-failure-level {INFO,WARNING,ERROR}**

Specifies the minimum validation level that will cause the creation to fail. (Defaults to ERROR.)

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster create-cluster -c cluster-config.yaml -n cluster-v3
{
  "cluster": {
    "clusterName": "cluster-v3",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster-v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
    "region": "us-east-1",
    "version": "3.1.4",
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}
```



```
}
```

## pcluster dcv-connect

Permits to connect to the head node through an interactive session by using NICE DCV.

```
pcluster dcv-connect [-h]
                    --cluster-name CLUSTER_NAME
                    [--debug]
                    [--key-path KEY_PATH]
                    [--region REGION]
                    [--show-url]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster dcv-connect`.

#### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

#### **--debug**

Enables debug logging.

#### **--key-path *KEY\_PATH***

Specifies the path of the SSH key to use for the connection.

#### **--region, -r *REGION***

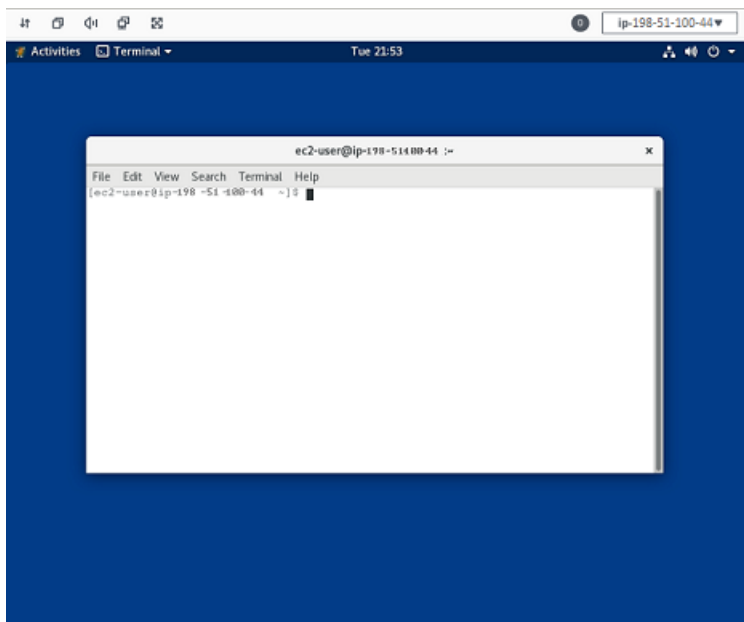
Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

#### **--show-url**

Prints the URL that would be used for the DCV connection and exits.

### Example using AWS ParallelCluster version 3.1.4:

```
$ pcluster dcv-connect -n cluster-3Dcv -r us-east-1 --key-path /home/user/.ssh/key.pem
```



## **pcluster delete-cluster**

Starts the deletion of a cluster.

```
pcluster delete-cluster [-h]
                        --cluster-name CLUSTER_NAME
                        [--debug]
                        [--query QUERY]
                        [--region REGION]
```

### **Named arguments**

#### **-h, --help**

Shows the help text for `pcluster delete-cluster`.

#### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

#### **--debug**

Enables debug logging.

#### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster delete-cluster -n cluster-v3
{
  "cluster": {
    "clusterName": "cluster-v3",
    "cloudformationStackStatus": "DELETE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster-v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
    "region": "us-east-1",
    "version": "3.1.4",
    "clusterStatus": "DELETE_IN_PROGRESS"
  }
}
```

**pcluster delete-cluster-instances**

Initiate the forced termination of all cluster compute nodes. This does not work with AWS Batch clusters.

```
pcluster delete-cluster-instances [-h]
    --cluster-name CLUSTER_NAME
    [--debug]
    [--force FORCE]
    [--query QUERY]
    [--region REGION]
```

**Named arguments****-h, --help**

Shows the help text for `pcluster delete-cluster-instances`.

**--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

**--debug**

Enables debug logging.

**--force *FORCE***

When true, forces the deletion by ignoring validation errors. (Defaults to false.)

**--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

```
$ pcluster delete-cluster-instances -n cluster-v3
```

## pcluster delete-image

Starts the deletion of the custom AWS ParallelCluster image.

```
pcluster delete-image [-h]
                      --image-id IMAGE_ID
                      [--debug]
                      [--force FORCE]
                      [--query QUERY]
                      [--region REGION]
```

### Named arguments

**-h, --help**

Shows the help text for `pcluster delete-image`.

**--image-id, -i *IMAGE\_ID***

Specifies the id of the image that will be deleted.

**--debug**

Enables debug logging.

**--force *FORCE***

When true, forces the deletion in case there are instances using the AMI or if the AMI is shared. (Defaults to false.)

**--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster delete-image --image-id custom-alinux2-image
{
  "image": {
    "imageId": "custom-alinux2-image",
    "imageBuildStatus": "DELETE_IN_PROGRESS",
    "region": "us-east-1",
    "version": "3.1.4"
  }
}
```

**pcluster describe-cluster**

Get detailed information about a cluster.

```
pcluster describe-cluster [-h]
                        --cluster-name CLUSTER_NAME
                        [--debug]
                        [--query QUERY]
                        [--region REGION]
```

**Named arguments****-h, --help**

Shows the help text for `pcluster describe-cluster`.

**--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

**--debug**

Enables debug logging.

**--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Examples using AWS ParallelCluster version 3.1.4:**

Describe cluster details:

```
$ pcluster describe-cluster -n cluster-v3
{
  "creationTime": "2022-07-12T17:19:16.101Z",
  "headNode": {
    "launchTime": "2022-07-12T17:22:21.000Z",
    "instanceId": "i-1234567890abcdef0",
    "publicIpAddress": "198.51.100.44",
    "instanceType": "t2.micro",
    "state": "running",
    "privateIpAddress": "192.0.2.0.196"
  },
  "loginNodes": {
    "status": "active",
    "address": "8af2145440569xyz.us-east-1.amazonaws.com",
    "scheme": "internet-facing|internal",
    "healthyNodes": 3,
    "unhealthyNodes": 0
  },
  "version": "3.1.4",
  "clusterConfiguration": {
    "url": "https://parallelcluster-e5ca74255d6c3886-v1-do-not-delete..."
  },
}
```

```
"tags": [
  {
    "value": "3.1.4",
    "key": "parallelcluster:version"
  }
],
"cloudFormationStackStatus": "CREATE_COMPLETE",
"clusterName": "cluster-v3",
"computeFleetStatus": "RUNNING",
"cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster-v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
"lastUpdatedTime": "2022-07-12T17:19:16.101Z",
"region": "us-east-1",
"clusterStatus": "CREATE_COMPLETE"
}
```

Use `describe-cluster` to retrieve the cluster configuration:

```
$ curl -o - - $(pcluster describe-cluster -n cluster-v3 --query clusterConfiguration.url
| xargs echo)
Region: us-east-1
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-abcdef01234567890
  Ssh:
    KeyName: adpc
  Iam:
    S3Access:
      - BucketName: cluster-v3-bucket
        KeyName: logs
        EnableWriteAccess: true
  Scheduling:
    Scheduler: slurm
    SlurmQueues:
      - Name: queue1
        ComputeResources:
          - Name: t2micro
            InstanceType: t2.micro
            MinCount: 0
            MaxCount: 10
```

```
Networking:
  SubnetIds:
    - subnet-021345abcdef6789
```

## **pcluster describe-cluster-instances**

Describe the instances in a cluster.

```
pcluster describe-cluster-instances [-h]
  --cluster-name CLUSTER_NAME
  [--debug]
  [--next-token NEXT_TOKEN]
  [--node-type {HeadNode,ComputeNode,LoginNode}]
  [--query QUERY]
  [--queue-name QUEUE_NAME]
  [--region REGION]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster describe-cluster-instances`.

#### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

#### **--debug**

Enables debug logging.

#### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

#### **--node-type {HeadNode,ComputeNode,LoginNode}**

Specifies the node types to list. Supported values are `HeadNode`, `ComputeNode` and `LoginNode`. If this parameter is not specified, the `HeadNode`, `ComputeNode` and `LoginNode` instances are described.

#### **--query *QUERY***

Specifies the JMESPath query to perform on the output.



**--queue-name** *QUEUE\_NAME*

Specifies the name of the queue to list. If this parameter is not specified, instances in all queues are described.

**--region, -r** *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster describe-cluster-instances -n cluster-v3
{
  "instances": [
    {
      "launchTime": "2022-07-12T17:22:21.000Z",
      "instanceId": "i-1234567890abcdef0",
      "publicIpAddress": "198.51.100.44",
      "instanceType": "t2.micro",
      "state": "running",
      "nodeType": "HeadNode",
      "privateIpAddress": "192.0.2.0.196"
    },
    {
      "launchTime": "2022-07-12T17:37:42.000Z",
      "instanceId": "i-021345abcdef6789",
      "queueName": "queue1",
      "publicIpAddress": "198.51.100.44",
      "instanceType": "t2.micro",
      "state": "pending",
      "nodeType": "ComputeNode",
      "privateIpAddress": "192.0.2.0.196"
    }
  ]
}
```

**pcluster describe-compute-fleet**

Describe the status of the compute fleet.

```
pcluster describe-compute-fleet [-h]
    --cluster-name CLUSTER_NAME
    [--debug]
    [--query QUERY]
    [--region REGION]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster describe-compute-fleet`.

### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

### **--debug**

Enables debug logging.

### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

## Example using AWS ParallelCluster version 3.1.4:

```
$ pcluster describe-compute-fleet -n pcluster-v3
{
  "status": "RUNNING",
  "lastStatusUpdatedTime": "2022-07-12T17:24:26.000Z"
}
```

## **pcluster describe-image**

Get detailed information about an image.

```
pcluster describe-image [-h]
```

```
--image-id IMAGE_ID
[--debug]
[--query QUERY]
[--region REGION]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster describe-image`.

### **--image-id, -i *IMAGE\_ID***

Specifies the ID of the image.

### **--debug**

Enables debug logging.

### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

## Example using AWS ParallelCluster version 3.1.2:

```
$ pcluster describe-image --image-id custom-alinux2-image
{
  "imageConfiguration": {
    "url": "https://parallelcluster-1234abcd5678-v1-do-not-delete.../configs/image-
config.yaml"
  },
  "imageId": "custom-alinux2-image",
  "creationTime": "2022-04-05T20:23:07.000Z"
  "imageBuildStatus": "BUILD_COMPLETE",
  "region": "us-east-1",
  "ec2AmiInfo": {
    "amiName": "custom-alinux2-image 2022-04-05T19-55-22.518Z",
    "amiId": "ami-1234abcd5678efgh",
```

```
"description": "AWS ParallelCluster AMI for alinux2,
kernel-4.14.268-205.500.amzn2.x86_64, lustre-2.10.8-5.amzn2.x86_64,
efa-1.14.2-1.amzn2.x86_64, dcv-2021.3.11591-1.el7.x86_64, slurm-21-08-6-1",
"state": "AVAILABLE",
"tags": [
  {
    "value": "arn:aws:imagebuilder:us-east-1:123456789012:image/
parallelclusterimage-custom-alinux2-image/3.1.2/1",
    "key": "Ec2ImageBuilderArn"
  },
  {
    "value": "parallelcluster-1234abcd5678efgh-v1-do-not-delete",
    "key": "parallelcluster:s3_bucket"
  },
  {
    "value": "custom-alinux2-image",
    "key": "parallelcluster:image_name"
  },
  {
    "value": "available",
    "key": "parallelcluster:build_status"
  },
  {
    "value": "s3://parallelcluster-1234abcd5678efgh-v1-do-not-delete/
parallelcluster/3.1.2/images/custom-alinux2-image-1234abcd5678efgh/configs/image-
config.yaml",
    "key": "parallelcluster:build_config"
  },
  {
    "value": "Amazon EC2 Image Builder",
    "key": "CreatedBy"
  },
  {
    "value": "arn:aws:logs:us-east-1:123456789012:log-group:/aws/imagebuilder/
ParallelClusterImage-custom-alinux2-image",
    "key": "parallelcluster:build_log"
  },
  {
    "value": "4.14.268-205.500.amzn2.x86_64",
    "key": "parallelcluster:kernel_version"
  },
  {
    "value": "arn:aws:imagebuilder:us-east-1:444455556666:image/amazon-linux-2-
x86/2022.3.16/1",
```

```
    "key": "parallelcluster:parent_image"
  },
  {
    "value": "3.1.2",
    "key": "parallelcluster:version"
  },
  {
    "value": "0.5.14",
    "key": "parallelcluster:munge_version"
  },
  {
    "value": "21-08-6-1",
    "key": "parallelcluster:slurm_version"
  },
  {
    "value": "2021.3.11591-1.el7.x86_64",
    "key": "parallelcluster:dcv_version"
  },
  {
    "value": "alinux2-image",
    "key": "parallelcluster:image_id"
  },
  {
    "value": "3.2.3",
    "key": "parallelcluster:pmix_version"
  },
  {
    "value": "parallelcluster/3.7.0/images/alinux2-image-abcd1234efgh56781234",
    "key": "parallelcluster:s3_image_dir"
  },
  {
    "value": "1.14.2-1.amzn2.x86_64",
    "key": "parallelcluster:efa_version"
  },
  {
    "value": "alinux2",
    "key": "parallelcluster:os"
  },
  {
    "value": "aws-parallelcluster-cookbook-3.1.2",
    "key": "parallelcluster:bootstrap_file"
  },
  {
    "value": "1.8.23-10.amzn2.1.x86_64",
```

```
    "key": "parallelcluster:sudo_version"
  },
  {
    "value": "2.10.8-5.amzn2.x86_64",
    "key": "parallelcluster:lustre_version"
  }
],
"architecture": "x86_64"
},
"version": "3.1.2"
}
```

## pcluster export-cluster-logs

Export the logs of the cluster to a local tar.gz archive by passing through an Amazon S3 Bucket.

```
pcluster export-cluster-logs [-h]
    --bucket BUCKET_NAME
    --cluster-name CLUSTER_NAME
    [--bucket-prefix BUCKET_PREFIX]
    [--debug]
    [--end-time END_TIME]
    [--filters FILTER [FILTER ...]]
    [--keep-s3-objects KEEP_S3_OBJECTS]
    [--output-file OUTPUT_FILE]
    [--region REGION]
    [--start-time START_TIME]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster export-cluster-logs`.

#### **--bucket *BUCKET\_NAME***

Specifies the name of the Amazon S3 bucket to export cluster logs data to. It must be in the same Region as the cluster.

**Note**

You must add permissions to the Amazon S3 bucket policy to grant CloudWatch access. For more information, see [Set permissions on an Amazon S3 bucket](#) in the *CloudWatch Logs User Guide*.

**--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

**--bucket-prefix *BUCKET\_PREFIX***

Specifies the path in the Amazon S3 bucket where exported logs data is to be stored.

By default, the bucket-prefix is:

```
cluster-name-logs-202209061743.tar.gz
```

*202209061743* is the current time in %Y%m%d%H%M format.

**--debug**

Enables debug logging.

**--end-time *END\_TIME***

Specifies the end of the time range to collect log events, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example 2021-01-01T20:00:00Z). Events with a timestamp equal to or later than this time are not included. Time elements (e.g. minutes and seconds) may be omitted. The default value is the current time.

**--filters *FILTER* [*FILTER* ...]**

Specifies filters for the log. Format: Name=a,Values=1 Name=b,Values=2,3. Supported filters are:

private-dns-name

Specifies the short form of the private DNS name of the instance (e.g. ip-10-0-0-101).

node-type

Specifies the node type, the only accepted value for this filter is HeadNode.

**--keep-s3-objects** *KEEP\_S3\_OBJECTS*

If true, the exported objects exports to Amazon S3 are kept. (Defaults to false.)

**--output-file** *OUTPUT\_FILE*

Specifies the file path to save the log archive to. If this is provided, then the logs are saved locally. Otherwise they are uploaded to Amazon S3 with the URL returned in the output. Default is to upload to Amazon S3.

**--region, -r** *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**--start-time** *START\_TIME*

Specifies the start of the time range, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example `2021-01-01T20:00:00Z`). Log events with a timestamp equal to this time or later than this time are included. If not specified, the default is the time the cluster was created.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster export-cluster-logs --bucket cluster-v3-bucket -n cluster-v3
{
  "url": "https://cluster-v3-bucket..."
}
```

**pcluster export-image-logs**

Export the logs of the image builder stack to a local `tar.gz` archive by passing through an Amazon S3 Bucket.

```
pcluster export-image-logs [-h]
    --bucket BUCKET
    --image-id IMAGE_ID
    [--bucket-prefix BUCKET_PREFIX]
    [--debug]
    [--end-time END_TIME]
    [--keep-s3-objects KEEP_S3_OBJECTS]
    [--output-file OUTPUT_FILE]
    [--region REGION]
```



```
[--start-time START_TIME]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster export-image-logs`.

### **--bucket *BUCKET\_NAME***

Specifies the Amazon S3 bucket name to export image build logs to. It must be in the same Region as the image.

#### **Note**

You must add permissions to the Amazon S3 bucket policy to grant CloudWatch access. For more information, see [Set permissions on an Amazon S3 bucket](#) in the *CloudWatch Logs User Guide*.

### **--image-id, -i *IMAGE\_ID***

The image ID whose logs will be exported.

### **--bucket-prefix *BUCKET\_PREFIX***

Specifies the path in the Amazon S3 bucket where exported logs data is to be stored.

By default, the bucket-prefix is:

```
ami-id-logs-202209061743.tar.gz
```

*202209061743* is the current time in `%Y%m%d%H%M` format.

### **--debug**

Enables debug logging.

### **--end-time *END\_TIME***

Specifies the end of the time range to collect log events, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example `2021-01-01T20:00:00Z`). Events with a timestamp equal to or later than this time are not included. Time elements (e.g. minutes and seconds) may be omitted. The default value is the current time.

**--keep-s3-objects** *KEEP\_S3\_OBJECTS*

If true, the exported objects exports to Amazon S3 are kept. (Defaults to false.)

**--output-file** *OUTPUT\_FILE*

Specifies the file path to save the log archive to. If this is provided, then the logs are saved locally. Otherwise they are uploaded to Amazon S3 with the URL returned in the output. Default is to upload to Amazon S3.

**--region, -r** *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**--start-time** *START\_TIME*

Specifies the start of the time range, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example `2021-01-01T20:00:00Z`). Log events with a timestamp equal to this time or later than this time are included. If not specified, the default is the time the cluster was created.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster export-image-logs --bucket image-v3-bucket --image-id ami-1234abcd5678efgh
{
  "url": "https://image-v3-bucket..."
}
```

**pcluster get-cluster-log-events**

Retrieve the events associated with a log stream.

```
pcluster get-cluster-log-events [-h]
    --cluster-name CLUSTER_NAME
    --log-stream-name LOG_STREAM_NAME
    [--debug]
    [--end-time END_TIME]
    [--limit LIMIT]
    [--next-token NEXT_TOKEN]
    [--query QUERY]
    [--region REGION]
```

```
[--start-from-head START_FROM_HEAD]  
[--start-time START_TIME]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster get-cluster-log-events`.

### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

### **--log-stream-name *LOG\_STREAM\_NAME***

Specifies the name of the log stream. You can use the `list-cluster-log-streams` command to retrieve a log stream associated with an event or events.

### **--debug**

Enables debug logging.

### **--end-time *END\_TIME***

Specifies the end of the time range, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example 2021-01-01T20:00:00Z). Events with a timestamp equal to or later than this time are not included.

### **--limit *LIMIT***

Specifies the maximum number of log events returned. If a value is not specified, the maximum is as many log events as can fit in a response size of 1 MB, up to 10,000 log events.

### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**--start-from-head *START\_FROM\_HEAD***

If the value is `true`, the earliest log events are returned first. If the value is `false`, the most recent log events are returned first. (Defaults to `false`.)

**--start-time *START\_TIME***

Specifies the start of the time range, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example `2021-01-01T20:00:00Z`). Events with a timestamp equal to this time or later than this time are included.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster get-cluster-log-events \
  -c cluster-v3 \
  -r us-east-1 \
  --log-stream-name ip-198-51-100-44.i-1234567890abcdef0.clustermgtd \
  --limit 3
{
  "nextToken": "f/36966906399261933213029082268132291405859205452101451780/s",
  "prevToken": "b/36966906399239632467830551644990755687586557090595471362/s",
  "events": [
    {
      "message": "2022-07-12 19:16:53,379 - [slurm_plugin.clustermgtd:_maintain_nodes]
- INFO - Performing node maintenance actions",
      "timestamp": "2022-07-12T19:16:53.379Z"
    },
    {
      "message": "2022-07-12 19:16:53,380 - [slurm_plugin.clustermgtd:_maintain_nodes]
- INFO - Following nodes are currently in replacement: (x0) []",
      "timestamp": "2022-07-12T19:16:53.380Z"
    },
    {
      "message": "2022-07-12 19:16:53,380 -
[slurm_plugin.clustermgtd:_terminate_orphaned_instances] - INFO - Checking for
orphaned instance",
      "timestamp": "2022-07-12T19:16:53.380Z"
    }
  ]
}
```

## pcluster get-cluster-stack-events

Retrieve the events associated with the stack for the specified cluster.

### Note

Starting in version 3.6.0, AWS ParallelCluster uses nested stacks to create the resources associated with queues and compute resources. The `GetClusterStackEvents` API and the `pcluster get-cluster-stack-events` command only return the cluster main stack events. You can view the cluster stack events, including those related to queues and compute resources, in the CloudFormation console.

```
pcluster get-cluster-stack-events [-h]
    --cluster-name CLUSTER_NAME
    [--debug]
    [--next-token NEXT_TOKEN]
    [--query QUERY]
    [--region REGION]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster get-cluster-stack-events`.

#### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

#### **--debug**

Enables debug logging.

#### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

#### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster get-cluster-stack-events \
  -n cluster-v3 \
  -r us-east-1 \
  --query "events[0]"
{
  "eventId": "1234abcd-56ef-78gh-90ij-abcd1234efgh",
  "physicalResourceId": "arn:aws:cloudformation:us-east-1:123456789012:stack/cluster-
v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
  "resourceStatus": "CREATE_COMPLETE",
  "stackId": "arn:aws:cloudformation:us-east-1:123456789012:stack/cluster-
v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
  "stackName": "cluster-v3",
  "logicalResourceId": "cluster-v3",
  "resourceType": "AWS::CloudFormation::Stack",
  "timestamp": "2022-07-12T18:29:12.140Z"
}
```

**pcluster get-image-log-events**

Retrieve the events associated with an image build.

```
pcluster get-image-log-events [-h]
  --image-id IMAGE_ID
  --log-stream-name LOG_STREAM_NAME
  [--debug]
  [--end-time END_TIME]
  [--limit LIMIT]
  [--next-token NEXT_TOKEN]
  [--query QUERY]
  [--region REGION]
  [--start-from-head START_FROM_HEAD]
  [--start-time START_TIME]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster get-image-log-events`.

### **--image-id, -i *IMAGE\_ID***

Specifies the Id of the image.

### **--log-stream-name *LOG\_STREAM\_NAME***

Specifies the name of the log stream. You can use the `list-image-log-streams` command to retrieve a log stream associated with an event or events.

### **--debug**

Enables debug logging.

### **--end-time *END\_TIME***

Specifies the end of the time range, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example 2021-01-01T20:00:00Z). Events with a timestamp equal to or later than this time are not included.

### **--limit *LIMIT***

Specifies the maximum number of log events returned. If a value is not specified, the maximum is as many log events as can fit in a response size of 1 MB, up to 10,000 log events.

### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

### **--start-from-head *START\_FROM\_HEAD***

If the value is `true`, the earliest log events are returned first. If the value is `false`, the most recent log events are returned first. (Defaults to `false`.)

**--start-time** *START\_TIME*

Specifies the start of the time range, expressed in ISO 8601 format (YYYY-MM-DDThh:mm:ssZ, for example 2021-01-01T20:00:00Z). Events with a timestamp equal to or later than this time are included.

**Example using AWS ParallelCluster version 3.1.2:**

```
$ pcluster get-image-log-events --image-id custom-linux2-image --region us-east-1 --
log-stream-name 3.1.2/1 --limit 3
{
  "nextToken": "f/36778317771100849897800729464621464113270312017760944178/s",
  "prevToken": "b/36778317766952911290874033560295820514557716777648586800/s",
  "events": [
    {
      "message": "ExecuteBash: FINISHED EXECUTION",
      "timestamp": "2022-04-05T22:13:26.633Z"
    },
    {
      "message": "Document arn:aws:imagebuilder:us-east-1:123456789012:component/
parallelclusterimage-test-1234abcd-56ef-78gh-90ij-abcd1234efgh/3.1.2/1",
      "timestamp": "2022-04-05T22:13:26.741Z"
    },
    {
      "message": "TOE has completed execution successfully",
      "timestamp": "2022-04-05T22:13:26.819Z"
    }
  ]
}
```

**pcluster get-image-stack-events**

Retrieve the events associated with the stack for the specified image build.

```
pcluster get-image-stack-events [-h]
    --image-id IMAGE_ID
    [--debug]
    [--next-token NEXT_TOKEN]
    [--query QUERY]
    [--region REGION]
```



## Named arguments

### **-h, --help**

Shows the help text for `pcluster get-image-stack-events`.

### **--image-id, -i *IMAGE\_ID***

Specifies the ID of the image.

### **--debug**

Enables debug logging.

### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

## Example using AWS ParallelCluster version 3.1.2:

```
$ pcluster get-image-stack-events --image-id custom-alinux2-image --region us-east-1 --  
query "events[0]"  
{  
  "eventId": "ParallelClusterImage-CREATE_IN_PROGRESS-2022-04-05T21:39:24.725Z",  
  "physicalResourceId": "arn:aws:imagebuilder:us-east-1:123456789012:image/  
parallelclusterimage-custom-alinux2-image/3.1.2/1",  
  "resourceStatus": "CREATE_IN_PROGRESS",  
  "resourceStatusReason": "Resource creation Initiated",  
  "resourceProperties": "{\"InfrastructureConfigurationArn\":  
\"arn:aws:imagebuilder:us-east-1:123456789012:infrastructure-configuration/  
parallelclusterimage-1234abcd-56ef-78gh-90ij-abcd1234efgh\", \"ImageRecipeArn  
\": \"arn:aws:imagebuilder:us-east-1:123456789012:image-recipe/  
parallelclusterimage-custom-alinux2-image/3.1.2\", \"DistributionConfigurationArn  
\": \"arn:aws:imagebuilder:us-east-1:123456789012:distribution-  
configuration/parallelclusterimage-1234abcd-56ef-78gh-90ij-abcd1234efgh\",
```

```

{"EnhancedImageMetadataEnabled": "false", "Tags": {"parallelcluster:image_name":
"custom-alinux2-image", "parallelcluster:image_id": "custom-alinux2-image"}},
  "stackId": "arn:aws:cloudformation:us-east-1:123456789012:stack/custom-alinux2-
image/1234abcd-56ef-78gh-90ij-abcd1234efgh",
  "stackName": "custom-alinux2-image",
  "logicalResourceId": "ParallelClusterImage",
  "resourceType": "AWS::ImageBuilder::Image",
  "timestamp": "2022-04-05T21:39:24.725Z"
}

```

## pcluster list-clusters

Retrieve the list of existing clusters.

```

pcluster list-clusters [-h]
    [--cluster-status {CREATE_IN_PROGRESS,CREATE_FAILED,CREATE_COMPLETE,
    DELETE_IN_PROGRESS,DELETE_FAILED,UPDATE_IN_PROGRESS,
    UPDATE_COMPLETE,UPDATE_FAILED}]
    [{CREATE_IN_PROGRESS,CREATE_FAILED,CREATE_COMPLETE,
    DELETE_IN_PROGRESS,DELETE_FAILED,UPDATE_IN_PROGRESS,
    UPDATE_COMPLETE,UPDATE_FAILED} ...]
    [--debug]
    [--next-token NEXT_TOKEN]
    [--query QUERY]
    [--region REGION]

```

### Named arguments

#### -h, --help

Shows the help text for `pcluster list-clusters`.

**--cluster-status** {CREATE\_IN\_PROGRESS, CREATE\_FAILED, CREATE\_COMPLETE, DELETE\_IN\_PROGRESS, DELETE\_FAILED, UPDATE\_IN\_PROGRESS, UPDATE\_COMPLETE, UPDATE\_FAILED} [{CREATE\_IN\_PROGRESS, CREATE\_FAILED, CREATE\_COMPLETE, DELETE\_IN\_PROGRESS, DELETE\_FAILED, UPDATE\_IN\_PROGRESS, UPDATE\_COMPLETE, UPDATE\_FAILED} ...]

Specifies the list of cluster statuses to filter for. (Defaults to all.)

#### --debug

Enables debug logging.

**--next-token** *NEXT\_TOKEN*

Specifies the token to use for paginated requests.

**--query** *QUERY*

Specifies the JMESPath query to perform on the output.

**--region, -r** *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster list-clusters
{
  "clusters": [
    {
      "clusterName": "cluster-v3",
      "cloudformationStackStatus": "CREATE_COMPLETE",
      "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster-v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
      "region": "us-east-1",
      "version": "3.1.4",
      "clusterStatus": "CREATE_COMPLETE"
    }
  ]
}
```

**pcluster list-cluster-log-streams**

Retrieve the list of log streams associated with a cluster.

```
pcluster list-cluster-log-streams [-h]
    --cluster-name CLUSTER_NAME
    [--filters FILTERS [FILTERS ...]]
    [--next-token NEXT_TOKEN] [--debug]
    [--query QUERY]
    [--region REGION]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster list-cluster-log-streams`.

### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

### **--debug**

Enables debug logging.

### **--filters *FILTERS* [*FILTERS* ...]**

Specifies filters for the log streams. Format: `Name=a,Values=1 Name=b,Values=2,3`.

Supported filters are:

`private-dns-name`

Specifies the short form of the private DNS name of the instance (e.g. `ip-10-0-0-101`).

`node-type`

Specifies the node type, the only accepted value for this filter is `HeadNode`.

### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

## Example using AWS ParallelCluster version 3.1.4:

```
$ pcluster list-cluster-log-streams \  
-n cluster-v3 \  
-r us-east-1
```

```
-r us-east-1 \  
--query 'LogStreams[*].LogStreamName'  
[  
  "ip-172-31-58-205.i-1234567890abcdef0.cfn-init",  
  "ip-172-31-58-205.i-1234567890abcdef0.chef-client",  
  "ip-172-31-58-205.i-1234567890abcdef0.cloud-init",  
  "ip-172-31-58-205.i-1234567890abcdef0.clustermgtd",  
  "ip-172-31-58-205.i-1234567890abcdef0.slurmctld",  
  "ip-172-31-58-205.i-1234567890abcdef0.supervisord",  
  "ip-172-31-58-205.i-1234567890abcdef0.system-messages"  
]
```

## pcluster list-images

Retrieve the list of existing custom images.

```
pcluster list-images [-h]  
    --image-status {AVAILABLE,PENDING,FAILED}  
    [--debug]  
    [--next-token NEXT_TOKEN]  
    [--query QUERY]  
    [--region REGION]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster list-images`.

#### **--image-status {AVAILABLE,PENDING,FAILED}**

Filter returned images by the status provided.

#### **--debug**

Enables debug logging.

#### **--next-token *NEXT\_TOKEN***

Specifies the token to use for paginated requests.

#### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.2:**

```
$ pcluster list-images --image-status AVAILABLE
{
  "images": [
    {
      "imageId": "custom-alinux2-image",
      "imageBuildStatus": "BUILD_COMPLETE",
      "ec2AmiInfo": {
        "amiId": "ami-1234abcd5678efgh"
      },
      "region": "us-east-1",
      "version": "3.1.2"
    }
  ]
}
```

**pcluster list-image-log-streams**

Retrieve the list of log streams associated with an image.

```
pcluster list-image-log-streams [-h]
    --image-id IMAGE_ID
    [--next-token NEXT_TOKEN] [--debug]
    [--query QUERY]
    [--region REGION]
```

**Named arguments****-h, --help**

Shows the help text for `pcluster list-image-log-streams`.

**--image-id, -i *IMAGE\_ID***

Specifies the ID of the image.

**--debug**

Enables debug logging.

**--next-token** *NEXT\_TOKEN*

Specifies the token to use for paginated requests.

**--query** *QUERY*

Specifies the JMESPath query to perform on the output.

**--region, -r** *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.2:**

```
$ pcluster list-image-log-streams --image-id custom-linux2-image --region us-east-1 --  
query 'LogStreams[*].LogStreamName'  
[  
  "3.0.0/1",  
  "3.1.2/1"  
]
```

**pcluster list-official-images**

Describe official AWS ParallelCluster AMIs.

```
pcluster list-official-images [-h]  
    [--architecture ARCHITECTURE]  
    [--debug]  
    [--os OS]  
    [--query QUERY]  
    [--region REGION]
```

**Named arguments****-h, --help**

Shows the help text for `pcluster list-official-images`.

**--architecture** *ARCHITECTURE*

Specifies the architecture to use to filter the results. If this parameter is not specified, all architectures are returned.

**--debug**

Enables debug logging.

**--os** *OS*

Specifies the operating system to use to filter the results. If this parameter is not specified, all operating systems are returned.

**--query** *QUERY*

Specifies the JMESPath query to perform on the output.

**--region, -r** *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the [Region](#) setting in the image configuration file, the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**Example using AWS ParallelCluster version 3.1.2:**

```
$ pcluster list-official-images
{
  "images": [
    {
      "amiId": "ami-015cfef4e0d6306b2",
      "os": "ubuntu2004",
      "name": "aws-parallelcluster-3.1.2-ubuntu-2004-lts-hvm-x86_64-202202261505
2022-02-26T15-08-34.759Z",
      "version": "3.1.2",
      "architecture": "x86_64"
    },
    {
      "amiId": "ami-036f23237ce49d25b",
      "os": "ubuntu2204",
      "name": "aws-parallelcluster-3.1.2-ubuntu-1804-lts-hvm-x86_64-202202261505
2022-02-26T15-08-17.558Z",
      "version": "3.1.2",
      "architecture": "x86_64"
    },
  ],
}
```



```
{
  "amiId": "ami-09e5327e694d89ef4",
  "os": "ubuntu2004",
  "name": "aws-parallelcluster-3.1.2-ubuntu-2004-lts-hvm-arm64-202202261505
2022-02-26T15-08-45.736Z",
  "version": "3.1.2",
  "architecture": "arm64"
},
{
  "amiId": "ami-0b9b0874c35f626ae",
  "os": "alinux2",
  "name": "aws-parallelcluster-3.1.2-amzn2-hvm-x86_64-202202261505
2022-02-26T15-08-31.311Z",
  "version": "3.1.2",
  "architecture": "x86_64"
},
{
  "amiId": "ami-0bf6d01f398f3737e",
  "os": "centos7",
  "name": "aws-parallelcluster-3.1.2-centos7-hvm-x86_64-202202261505
2022-02-26T15-08-25.001Z",
  "version": "3.1.2",
  "architecture": "x86_64"
},
{
  "amiId": "ami-0d0de4f95f56374bc",
  "os": "alinux2",
  "name": "aws-parallelcluster-3.1.2-amzn2-hvm-arm64-202202261505
2022-02-26T15-08-46.088Z",
  "version": "3.1.2",
  "architecture": "arm64"
},
{
  "amiId": "ami-0ebf7bc54b8740dc6",
  "os": "ubuntu2204",
  "name": "aws-parallelcluster-3.1.2-ubuntu-1804-lts-hvm-arm64-202202261505
2022-02-26T15-08-45.293Z",
  "version": "3.1.2",
  "architecture": "arm64"
}
]
```

## pcluster ssh

Runs a ssh command with the cluster user name and IP address pre-populated. Arbitrary arguments are appended to the end of the ssh command line.

```
pcluster ssh [-h]
              --cluster-name CLUSTER_NAME
              [--debug]
              [--dryrun DRYRUN]
              [--region REGION]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster ssh`.

#### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster to connect to.

#### **--debug**

Enables debug logging.

#### **--dryrun *DRYRUN***

When true, prints the command line that would be run and exits. (Defaults to false.)

#### **--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

Example:

```
$ pcluster ssh --cluster-name mycluster -i ~/.ssh/id_rsa
```

Runs an ssh command with the user name and IP address of the cluster pre-populated:

```
ssh ec2-user@1.1.1.1 -i ~/.ssh/id_rsa
```

## pcluster update-cluster

Updates an existing cluster to match the settings of a specified configuration file.

```
pcluster update-cluster [-h]
                        --cluster-configuration CLUSTER_CONFIGURATION
                        --cluster-name CLUSTER_NAME
                        [--debug]
                        [--dryrun DRYRUN]
                        [--force-update FORCE_UPDATE]
                        [--query QUERY]
                        [--region REGION]
                        [--suppress-validators SUPPRESS_VALIDATORS [SUPPRESS_VALIDATORS ...]]
                        [--validation-failure-level {INFO,WARNING,ERROR}]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster update-cluster`.

#### **--cluster-configuration, -c *CLUSTER\_CONFIGURATION***

Specifies the YAML cluster configuration file.

#### **--cluster-name, -n *CLUSTER\_NAME***

Specifies the name of the cluster.

#### **--debug**

Enables debug logging.

#### **--dryrun *DRYRUN***

When `true`, performs the validation without updating the cluster and creating any resources. It can be used to validate the image configuration and update requirements. (Defaults to `false`.)

#### **--force-update *FORCE\_UPDATE***

When `true`, forces the update by ignoring the update validation errors. (Defaults to `false`.)

#### **--query *QUERY***

Specifies the JMESPath query to perform on the output.

**--region, -r *REGION***

Specifies the AWS Region to use. The AWS Region must be specified, using the [Region](#) setting in the cluster configuration file, the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

**--suppress-validators *SUPPRESS\_VALIDATORS* [*SUPPRESS\_VALIDATORS ...*]**

Identifies one or more config validators to suppress.

Format: (ALL|type:[A-Za-z0-9]+)

**--validation-failure-level *{INFO,WARNING,ERROR}***

Specifies the level of validation failures reported for update.

**Example using AWS ParallelCluster version 3.1.4:**

```
$ pcluster update-cluster -c cluster-config.yaml -n cluster-v3 -r us-east-1
{
  "cluster": {
    "clusterName": "cluster-v3",
    "cloudformationStackStatus": "UPDATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster-v3/1234abcd-56ef-78gh-90ij-abcd1234efgh",
    "region": "us-east-1",
    "version": "3.1.4",
    "clusterStatus": "UPDATE_IN_PROGRESS"
  },
  "changeSet": [
    {
      "parameter": "HeadNode.Iam.S3Access",
      "requestedValue": {
        "BucketName": "pc-beta-test",
        "KeyName": "output",
        "EnableWriteAccess": false
      }
    },
    {
      "parameter": "HeadNode.Iam.S3Access",
      "currentValue": {
        "BucketName": "pcluster-east-test-bucket",
        "KeyName": "logs",
        "EnableWriteAccess": true
      }
    }
  ]
}
```

```
    }  
  }  
]  
}
```

## pcluster update-compute-fleet

Updates the status of the cluster compute fleet.

```
pcluster update-compute-fleet [-h]  
    --cluster-name CLUSTER_NAME  
    --status {START_REQUESTED,STOP_REQUESTED,ENABLED,DISABLED}  
  
    [--debug]  
    [--query QUERY]  
    [--region REGION]
```

### Named arguments

#### -h, --help

Shows the help text for `pcluster update-compute-fleet`.

#### --cluster-name, -n *CLUSTER\_NAME*

Specifies the name of the cluster.

#### --status {START\_REQUESTED,STOP\_REQUESTED,ENABLED,DISABLED}

Specifies the status applied to the cluster compute fleet. The statuses `START_REQUESTED` and `STOP_REQUESTED` correspond to the Slurm scheduler while the statuses `ENABLED` and `DISABLED` correspond to the AWS Batch scheduler.

#### --debug

Enables debug logging.

#### --query *QUERY*

Specifies the JMESPath query to perform on the output.

#### --region, -r *REGION*

Specifies the AWS Region to use. The AWS Region must be specified, using the `AWS_DEFAULT_REGION` environment variable, the `region` setting in the `[default]` section of the `~/.aws/config` file, or the `--region` parameter.

## Example using AWS ParallelCluster version 3.1.4:

```
$ pcluster update-compute-fleet -n cluster-v3 --status STOP_REQUESTED
{
  "status": "STOP_REQUESTED",
  "lastStatusUpdateTime": "2022-07-12T20:19:47.653Z"
}
```

## pcluster version

Displays the version of AWS ParallelCluster.

```
pcluster version [-h] [--debug]
```

### Named arguments

#### **-h, --help**

Shows the help text for `pcluster version`.

#### **--debug**

Enables debug logging.

## Example using AWS ParallelCluster version 3.1.4:

```
$ pcluster version
{
  "version": "3.1.4"
}
```

## pcluster3-config-converter

Reads a AWS ParallelCluster version 2 configuration file and writes a AWS ParallelCluster version 3 configuration file.

```
pcluster3-config-converter [-h]
                          [-t CLUSTER_TEMPLATE]
                          [-c CONFIG_FILE]
```

```
[--force-convert]
[-o OUTPUT_FILE]
```

## Named arguments

### **-h, --help**

Shows the help text for `pcluster3-config-converter`.

### **-t *CLUSTER\_TEMPLATE*, --cluster-template *CLUSTER\_TEMPLATE***

Specifies the [\[cluster\] section](#) of the configuration file to convert. If not specified the script will look for the [cluster-template](#) parameter in the [\[global\] section](#) or will search for `[cluster default]`.

### **-c *CONFIG\_FILE*, --config-file *CONFIG\_FILE***

Specifies the AWS ParallelCluster version 2 configuration file to be read.

### **--force-convert**

Enables a conversion even if one or more settings is not supported and not recommended.

### **-o *OUTPUT\_FILE*, --output-file *OUTPUT\_FILE***

Specifies the AWS ParallelCluster version 3 configuration file to be written. If this parameter is not specified, the configuration is written to stdout.

#### **Note**

The `pcluster3-config-converter` command was added in AWS ParallelCluster version 3.0.1.

## Configuration files

AWS ParallelCluster uses YAML 1.1 files for configuration parameters.

### Topics

- [Cluster configuration file](#)

- [Build image configuration files](#)

## Cluster configuration file

AWS ParallelCluster version 3 uses separate configuration files to control the definition of cluster infrastructure and the definition of custom AMIs. All configuration files use YAML 1.1 files. Detailed information for each of these configuration files is linked below. For some example configurations, see [https://github.com/aws/aws-parallelcluster/tree/release-3.0/cli/tests/pcluster/example\\_configs](https://github.com/aws/aws-parallelcluster/tree/release-3.0/cli/tests/pcluster/example_configs).

These objects are used for the AWS ParallelCluster version 3 cluster configuration.

### Topics

- [Cluster configuration file properties](#)
- [Imds section](#)
- [Image section](#)
- [HeadNode section](#)
- [Scheduling section](#)
- [SharedStorage section](#)
- [lam section](#)
- [LoginNodes section](#)
- [Monitoring section](#)
- [Tags section](#)
- [AdditionalPackages section](#)
- [DirectoryService section](#)
- [DeploymentSettings section](#)

## Cluster configuration file properties

Region (**Optional**, String)

Specifies the AWS Region for the cluster. For example, us-east-2.

**Update policy: If this setting is changed, the update is not allowed.**



### CustomS3Bucket (Optional, String)

Specifies the name of an Amazon S3 bucket that's created in your AWS account to store resources that are used by your clusters, such as the cluster configuration file. AWS ParallelCluster maintains one Amazon S3 bucket in each AWS Region that you create clusters in. By default, these Amazon S3 buckets are named `parallelcluster-hash-v1-DO-NOT-DELETE`.

**Update policy: If this setting is changed, the update is not allowed. If you force the update, the new value will be ignored and the old value will be used.**

### AdditionalResources (Optional, String)

Defines an additional AWS CloudFormation template to launch along with the cluster. This additional template is used for creating resources that are outside of the cluster but are part of the cluster's lifecycle.

The value must be an HTTPS URL to a public template, with all parameters provided.

There is no default value.

**Update policy: This setting can be changed during an update.**

## Imds section

**(Optional)** Specifies the global instance metadata service (IMDS) configuration.

```
Imds:  
  ImdsSupport: string
```

## Imds properties

### ImdsSupport (Optional, String)

Specifies which IMDS versions are supported in the cluster nodes. Supported values are `v1.0` and `v2.0`. The default value is `v2.0`.

If `ImdsSupport` is set to `v1.0`, both IMDSv1 and IMDSv2 are supported.

If `ImdsSupport` is set to `v2.0`, only IMDSv2 is supported.

For more information, see [Use IMDSv2](#) in the *Amazon EC2 User Guide for Linux instances*.

## Update policy: If this setting is changed, the update is not allowed.

### Note

Starting with AWS ParallelCluster 3.7.0, the `ImdsSupport` default value is `v2.0`. We recommend that you set `ImdsSupport` to `v2.0` and replace `IMDSv1` with `IMDSv2` in your custom actions calls.

Support for [Imds](#) / [ImdsSupport](#) is added with AWS ParallelCluster version 3.3.0.

## Image section

**(Required)** Defines the operating system for the cluster.

Image:

Os: *string*

CustomAmi: *string*

## Image properties

**Os** (**Required**, String)

Specifies the operating system to use for the cluster. The supported values are `alinux2`, `alinux2023`, `centos7`, `ubuntu2204`, `ubuntu2004`, `rhel8`, `rocky8`, `rhel9`, `rocky9`.

### Note

RedHat Enterprise Linux 8.7 (`rhel8`) is added starting in AWS ParallelCluster version 3.6.0.

If you configure your cluster to use `rhel`, the on-demand cost for any instance type is higher than when you configure your cluster to use other supported operation systems. For more information about pricing, see [On-Demand Pricing](#) and [How is Red Hat Enterprise Linux on Amazon EC2 offered and priced?](#).

RedHat Enterprise Linux 9 (`rhel9`) is added starting in AWS ParallelCluster version 3.9.0.

Other than the specific AWS Regions mentioned in the following table that don't support `centos7`. All other AWS commercial Regions support all of the following operating systems.

| Partition (AWS Regions)                                 | alinux2 | centos7 | ubuntu224 and ubuntu204 | rhel8 | rhel9 | alinux2023 |
|---------------------------------------------------------|---------|---------|-------------------------|-------|-------|------------|
| Commercial (All AWS Regions not specifically mentioned) | True    | True    | True                    | True  | True  | True       |
| AWS GovCloud (US-East) (us-gov-east-1 )                 | True    | False   | True                    | True  | True  | True       |
| AWS GovCloud (US-West) (us-gov-west-1 )                 | True    | False   | True                    | True  | True  | True       |
| China (Beijing) (cn-north-1 )                           | True    | False   | True                    | True  | True  | True       |
| China (Ningxia) (cn-northwest-1 )                       | True    | False   | True                    | True  | True  | True       |

**Update policy: If this setting is changed, the update is not allowed.**

**Note**

AWS ParallelCluster 3.8.0 supports Rocky Linux 8, but pre-built Rocky Linux 8 AMIs (for x86 and ARM architectures) are not available. AWS ParallelCluster 3.8.0 supports creating clusters with Rocky Linux 8 using custom AMIs. For more information refer to [Operating System Considerations](#). AWS ParallelCluster 3.9.0 supports Rocky Linux 9, but pre-built Rocky Linux 9 AMIs (for x86 and ARM architectures) are not available. AWS ParallelCluster 3.9.0 supports creating clusters with Rocky Linux 9 using custom AMIs. For more information refer to [Operating System Considerations](#).

## CustomAmi (Optional, String)

Specifies the ID of a custom AMI to use for the head and compute nodes instead of the default AMI. For more information, see [AWS ParallelCluster AMI customization](#).

If the custom AMI requires additional permissions for its launch, these permissions must be added to both the user and head node policies.

For example, if a custom AMI has an encrypted snapshot associated with it, the following additional policies are required in both the user and head node policies:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "kms:DescribeKey",
        "kms:ReEncrypt*",
        "kms:CreateGrant",
        "kms:Decrypt"
      ],
      "Resource": [
        "arn:aws:kms:<AWS_REGION>:<AWS_ACCOUNT_ID>:key/<AWS_KMS_KEY_ID>"
      ]
    }
  ]
}
```

To build a RedHat Enterprise Linux custom AMI, you must configure the OS for installing the packages that are provided by the RHUI (AWS) repositories: `rhel-<version>-baseos-rhui-rpms`, `rhel-<version>-appstream-rhui-rpms`, and `codeready-builder-for-rhel-<version>-rhui-rpms`. Moreover, the repositories on the custom AMI must contain `kernel-devel` packages on the same version as the running kernel version. `kernel`.

### Known limitations:

- Only RHEL 8.2 and later versions support FSx for Lustre.
- RHEL 8.7 kernel version 4.18.0-425.3.1.el8 doesn't support FSx for Lustre.
- Only RHEL 8.4 and later versions support EFA.

- AL23 doesn't support NICE DCV, as it doesn't include a graphical desktop environment, which is required to run NICE DCV. For more information, see the official [NICE DCV documentation](#).

To troubleshoot custom AMI validation warnings, see [Troubleshooting custom AMI issues](#).

**Update policy: If this setting is changed, the update is not allowed.**

## HeadNode section

**(Required)** Specifies the configuration for the head node.

```
HeadNode:
  InstanceType: string
  Networking:
    SubnetId: string
    ElasticIp: string/boolean
    SecurityGroups:
      - string
    AdditionalSecurityGroups:
      - string
  Proxy:
    HttpProxyAddress: string
  DisableSimultaneousMultithreading: boolean
  Ssh:
    KeyName: string
    AllowedIps: string
  LocalStorage:
    RootVolume:
      Size: integer
      Encrypted: boolean
      VolumeType: string
      Iops: integer
      Throughput: integer
      DeleteOnTermination: boolean
    EphemeralVolume:
      MountDir: string
  SharedStorageType: string
  Dcv:
    Enabled: boolean
    Port: integer
    AllowedIps: string
  CustomActions:
    OnNodeStart:
```

```
Sequence:  
  - Script: string  
    Args:  
      - string  
Script: string  
Args:  
  - string  
OnNodeConfigured:  
  Sequence:  
    - Script: string  
      Args:  
        - string  
  Script: string  
  Args:  
    - string  
OnNodeUpdated:  
  Sequence:  
    - Script: string  
      Args:  
        - string  
  Script: string  
  Args:  
    - string  
Iam:  
  InstanceRole: string  
  InstanceProfile: string  
  S3Access:  
    - BucketName: string  
      EnableWriteAccess: boolean  
      KeyName: string  
  AdditionalIamPolicies:  
    - Policy: string  
Imsds:  
  Secured: boolean  
Image:  
  CustomAmi: string
```

## HeadNode properties

InstanceType (**Required**, String)

Specifies the instance type for the head node.

Specifies the Amazon EC2 instance type that's used for the head node. The architecture of the instance type must be the same as the architecture used for the AWS Batch [InstanceType](#) or Slurm [InstanceType](#) setting.

**Note**

AWS ParallelCluster doesn't support the following instance types for the HeadNode setting.

- hpc6id

If you define a p4d instance type or another instance type that has multiple network interfaces or a network interface card, you must set [ElasticIp](#) to true to provide public access. AWS public IPs can only be assigned to instances launched with a single network interface. For this case, we recommend that you use a [NAT gateway](#) to provide public access to the cluster compute nodes. For more information, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.

**Update policy: If this setting is changed, the update is not allowed.**

DisableSimultaneousMultithreading (**Optional**, Boolean)

If true, disables hyperthreading on the head node. The default value is false.

Not all instance types can disable hyperthreading. For a list of instance types that support disabling hyperthreading, see [CPU cores and threads for each CPU core per instance type](#) in the *Amazon EC2 User Guide*.

**Update policy: If this setting is changed, the update is not allowed.**

SharedStorageType (**Optional**, String)

Specifies the type of storage used for internally shared data. Internally shared data includes data that AWS ParallelCluster uses to manage the cluster and the default shared /home if not specified in the [SharedStorage section](#) as a Mount directory to mount a shared filesystem volume. For more details on internal shared data refer [AWS ParallelCluster Internal directories](#).

If Ebs, which is the default storage type, the head node will export portions of its root volume as shared directories for compute nodes and login nodes using NFS.

If Efs, Parallelcluster will create an EFS filesystem to use for shared internal data and /home.

**Update policy: If this setting is changed, the update is not allowed.**

**Note**

When the cluster scales out, the EBS storage type may present performance bottlenecks as the head node shares data from the root volume with the compute nodes using NFS exports. Using EFS, you can avoid NFS exports as your cluster scales out and avoid performance bottlenecks associated with them. It is recommended to choose EBS for max read/write potential for small files and installation process. Choose EFS for scale.

## Networking

**(Required)** Defines the networking configuration for the head node.

Networking:

SubnetId: *string*

ElasticIp: *string/boolean*

SecurityGroups:

- *string*

AdditionalSecurityGroups:

- *string*

Proxy:

HttpProxyAddress: *string*

**Update policy: If this setting is changed, the update is not allowed.**

## Networking properties

SubnetId (**Required**, String)

Specifies the ID of an existing subnet in which to provision the head node.

**Update policy: If this setting is changed, the update is not allowed.**

ElasticIp (**Optional**, String)

Creates or assigns an Elastic IP address to the head node. Supported values are true, false, or the ID of an existing Elastic IP address. The default is false.

**Update policy: If this setting is changed, the update is not allowed.**



## SecurityGroups (Optional, [String])

List of Amazon VPC security group ids to use for the head node. These replace the security groups that AWS ParallelCluster creates if this property is not included.

Verify that the security groups are configured correctly for your [SharedStorage](#) systems.

**Update policy: This setting can be changed during an update.**

## AdditionalSecurityGroups (Optional, [String])

List of additional Amazon VPC security group ids to use for the head node.

**Update policy: This setting can be changed during an update.**

## Proxy (Optional)

Specifies the proxy settings for the head node.

```
Proxy:  
  HttpProxyAddress: string
```

## HttpProxyAddress (Optional, String)

Defines an HTTP or HTTPS proxy server, typically `https://x.x.x.x:8080`.

There is no default value.

**Update policy: If this setting is changed, the update is not allowed.**

## Ssh

(Optional) Defines the configuration for SSH access to the head node.

```
Ssh:  
  KeyName: string  
  AllowedIps: string
```

**Update policy: This setting can be changed during an update.**

## Ssh properties

### KeyName (Optional, String)

Names an existing Amazon EC2 key pair to enable SSH access to the head node.

**Update policy: If this setting is changed, the update is not allowed.**

AllowedIps (**Optional**, String)

Specifies the CIDR-formatted IP range or a prefix list id for SSH connections to the head node. The default is 0.0.0.0/0.

**Update policy: This setting can be changed during an update.**

## LocalStorage

**(Optional)** Defines the local storage configuration for the head node.

```
LocalStorage:  
  RootVolume:  
    Size: integer  
    Encrypted: boolean  
    VolumeType: string  
    Iops: integer  
    Throughput: integer  
    DeleteOnTermination: boolean  
  EphemeralVolume:  
    MountDir: string
```

**Update policy: This setting can be changed during an update.**

## LocalStorage properties

RootVolume (**Required**)

Specifies the root volume storage for the head node.

```
RootVolume:  
  Size: integer  
  Encrypted: boolean  
  VolumeType: string  
  Iops: integer  
  Throughput: integer  
  DeleteOnTermination: boolean
```

**Update policy: This setting can be changed during an update.**

### Size (**Optional**, Integer)

Specifies the head node root volume size in gibibytes (GiB). The default size comes from the AMI. Using a different size requires that the AMI supports `growroot`.

**Update policy: If this setting is changed, the update is not allowed.**

### Encrypted (**Optional**, Boolean)

Specifies if the root volume is encrypted. The default value is `true`.

**Update policy: If this setting is changed, the update is not allowed.**

### VolumeType (**Optional**, String)

Specifies the [Amazon EBS volume type](#). Supported values are `gp2`, `gp3`, `io1`, `io2`, `sc1`, `st1`, and `standard`. The default value is `gp3`.

For more information, see [Amazon EBS volume types](#) in the *Amazon EC2 User Guide*.

**Update policy: If this setting is changed, the update is not allowed.**

### Iops (**Optional**, Integer)

Defines the number of IOPS for `io1`, `io2`, and `gp3` type volumes.

The default value, supported values, and `volume_iops` to `volume_size` ratio varies by `VolumeType` and `Size`.

**Update policy: If this setting is changed, the update is not allowed.**

`VolumeType = io1`

Default Iops = 100

Supported values Iops = 100–64000 †

Maximum Iops to Size ratio = 50 IOPS per GiB. 5000 IOPS requires a Size of at least 100 GiB.

`VolumeType = io2`

Default Iops = 100

Supported values Iops = 100–64000 (256000 for io2 Block Express volumes) †

Maximum Iops to Size ratio = 500 IOPS per GiB. 5000 IOPS requires a Size of at least 10 GiB.

VolumeType = gp3

Default Iops = 3000

Supported values Iops = 3000–16000

Maximum Iops to Size ratio = 500 IOPS per GiB. 5000 IOPS requires a Size of at least 10 GiB.

† Maximum IOPS is guaranteed only on [Instances built on the Nitro System](#) provisioned with more than 32,000 IOPS. Other instances guarantee up to 32,000 IOPS. Older io1 volumes might not reach full performance unless you [modify the volume](#). io2 Block Express volumes support Iops values up to 256000 on R5b instance types. For more information, see [io2 Block Express volumes](#) in the *Amazon EC2 User Guide*.

**Update policy: This setting can be changed during an update.**

Throughput (**Optional**, Integer)

Defines the throughput for gp3 volume types, in MiB/s. This setting is valid only when VolumeType is gp3. The default value is 125. Supported values: 125–1000 MiB/s

The ratio of Throughput to Iops can be no more than 0.25. The maximum throughput of 1000 MiB/s requires that the Iops setting is at least 4000.

**Update policy: If this setting is changed, the update is not allowed.**

DeleteOnTermination (**Optional**, Boolean)

Specifies whether the root volume should be deleted when the head node is terminated. The default value is true.

**Update policy: If this setting is changed, the update is not allowed.**

EphemeralVolume (**Optional**)

Specifies details for any instance store volume. For more information, see [Instance store volumes](#) in the *Amazon EC2 User Guide*.

EphemeralVolume:  
MountDir: *string*

**Update policy: If this setting is changed, the update is not allowed.**

MountDir (**Optional**, String)

Specifies the mount directory for the instance store volume. The default is `/scratch`.

**Update policy: If this setting is changed, the update is not allowed.**

## Dcv

**(Optional)** Defines configuration settings for the NICE DCV server running on the head node.

For more information, see [Connect to the head node through NICE DCV](#).

Dcv:  
Enabled: *boolean*  
Port: *integer*  
AllowedIps: *string*

### Important

By default, the NICE DCV port setup by AWS ParallelCluster is open to all IPv4 addresses. However, you can connect to a NICE DCV port only if you have the URL for the NICE DCV session and connect to the NICE DCV session within 30 seconds of when the URL is returned from `pcluster dcv-connect`. Use the `AllowedIps` setting to further restrict access to the NICE DCV port with a CIDR-formatted IP range, and use the `Port` setting to set a nonstandard port.

**Update policy: If this setting is changed, the update is not allowed.**

## Dcv properties

Enabled (**Required**, Boolean)

Specifies whether NICE DCV is enabled on the head node. The default value is `false`.

**Update policy: If this setting is changed, the update is not allowed.**

**Note**

NICE DCV automatically generates a self-signed certificate that's used to secure traffic between the NICE DCV client and NICE DCV server running on the head node. To configure your own certificate, see [NICE DCV HTTPS certificate](#).

Port (**Optional**, Integer)

Specifies the port for NICE DCV. The default value is 8443.

**Update policy: If this setting is changed, the update is not allowed.**

AllowedIps (**Optional, Recommended**, String)

Specifies the CIDR-formatted IP range for connections to NICE DCV. This setting is used only when AWS ParallelCluster creates the security group. The default value is `0.0.0.0/0`, which allows access from any internet address.

**Update policy: This setting can be changed during an update.**

## CustomActions

**(Optional)** Specifies custom scripts to run on the head node.

```
CustomActions:
  OnNodeStart:
    Sequence:
      - Script: string
        Args:
          - string
    Script: string
    Args:
      - string
  OnNodeConfigured:
    Sequence:
      - Script: string
        Args:
          - string
```

```
Script: string
Args:
  - string
OnNodeUpdated:
  Sequence:
    - Script: string
      Args:
        - string
    Script: string
    Args:
      - string
```

## CustomActions properties

### OnNodeStart (Optional)

Specifies single script or a sequence of scripts to run on the head node before any node deployment bootstrap action is started. For more information, see [Custom bootstrap actions](#).

### Sequence (Optional)

List of scripts to run. AWS ParallelCluster runs the scripts in the same order as they are listed in the configuration file, starting with the first.

#### Script (Required, String)

Specifies the file to use. The file path can start with `https://` or `s3://`.

#### Args (Optional, [String])

List of arguments to pass to the script.

#### Script (Required, String)

Specifies the file to use for a single script. The file path can start with `https://` or `s3://`.

#### Args (Optional, [String])

List of arguments to pass to the single script.

### Update policy: If this setting is changed, the update is not allowed.

### OnNodeConfigured (Optional)

Specifies a single script or a sequence of scripts to run on the head node after the node bootstrap actions are complete. For more information, see [Custom bootstrap actions](#).

### Sequence (**Optional**)

Specifies the list of scripts to run.

Script (**Required**, String)

Specifies the file to use. The file path can start with `https://` or `s3://`.

Args (**Optional**, [String])

List of arguments to pass to the script.

Script (**Required**, String)

Specifies the file to use for a single script. The file path can start with `https://` or `s3://`.

Args (**Optional**, [String])

List of arguments to pass to the single script.

**Update policy: If this setting is changed, the update is not allowed.**

### OnNodeUpdated (**Optional**)

Specifies a single script or a sequence of scripts to run on the head node after node update actions are complete. For more information, see [Custom bootstrap actions](#).

#### Sequence (**Optional**)

Specifies the list of scripts to run.

Script (**Required**, String)

Specifies the file to use. The file path can start with `https://` or `s3://`.

Args (**Optional**, [String])

List of arguments to pass to the script.

Script (**Required**, String)

Specifies the file to use for the single script. The file path can start with `https://` or `s3://`.

Args (**Optional**, [String])

List of arguments to pass to the single script.

**Update policy: This setting can be changed during an update.**



**Note**

OnNodeUpdated is added starting with AWS ParallelCluster 3.4.0.  
Sequence is added starting with AWS ParallelCluster version 3.6.0. When you specify Sequence, you can list multiple scripts for a custom action. AWS ParallelCluster continues to support configuring a custom action with a single script, without including Sequence.  
AWS ParallelCluster doesn't support including both a single script and Sequence for the same custom action.

**Iam**

**(Optional)** Specifies either an instance role or an instance profile to use on the head node to override the default instance role or instance profile for the cluster.

Iam:

```
InstanceRole: string
InstanceProfile: string
S3Access:
- BucketName: string
  EnableWriteAccess: boolean
  KeyName: string
AdditionalIamPolicies:
- Policy: string
```

**Update policy: This setting can be changed during an update.**

**Iam properties**

InstanceProfile (**Optional**, String)

Specifies an instance profile to override the default head node instance profile. You can't specify both InstanceProfile and InstanceRole. The format is `arn:Partition:iam::Account:instance-profile/InstanceProfileName`.

If this is specified, the S3Access and AdditionalIamPolicies settings can't be specified.

We recommend that you specify one or both of the S3Access and AdditionalIamPolicies settings because features added to AWS ParallelCluster often require new permissions.

**Update policy: If this setting is changed, the update is not allowed.**

### InstanceRole (Optional, String)

Specifies an instance role to override the default head node instance role. You can't specify both InstanceProfile and InstanceRole. The format is `arn:Partition:iam::Account:role/RoleName`.

If this is specified, the S3Access and AdditionalIamPolicies settings can't be specified.

We recommend that you specify one or both of the S3Access and AdditionalIamPolicies settings because features added to AWS ParallelCluster often require new permissions.

**Update policy: This setting can be changed during an update.**

## S3Access

### S3Access (Optional)

Specifies a bucket. This is used to generate policies to grant the specified access to the bucket.

If this is specified, the InstanceProfile and InstanceRole settings can't be specified.

We recommend that you specify one or both of the S3Access and AdditionalIamPolicies settings because features added to AWS ParallelCluster often require new permissions.

S3Access:

- BucketName: *string*
- EnableWriteAccess: *boolean*
- KeyName: *string*

**Update policy: This setting can be changed during an update.**

### BucketName (Required, String)

The name of the bucket.

**Update policy: This setting can be changed during an update.**

### KeyName (Optional, String)

The key for the bucket. The default value is "\*".

**Update policy: This setting can be changed during an update.**

## EnableWriteAccess (Optional, Boolean)

Indicates whether write access is enabled for the bucket. The default value is false.

**Update policy: This setting can be changed during an update.**

## AdditionalIamPolicies

### AdditionalIamPolicies (Optional)

Specifies a list of Amazon Resource Names (ARNs) of IAM policies for Amazon EC2 . This list is attached to the root role used for the head node in addition to the permissions required by AWS ParallelCluster.

An IAM policy name and its ARN are different. Names can't be used.

If this is specified, the InstanceProfile and InstanceRole settings can't be specified.

We recommend that you use AdditionalIamPolicies because AdditionalIamPolicies are added to the permissions that AWS ParallelCluster requires, and the InstanceRole must include all permissions required. The permissions required often change from release to release as features are added.

There is no default value.

AdditionalIamPolicies:

- Policy: *string*

**Update policy: This setting can be changed during an update.**

Policy (Optional, [String])

List of IAM policies.

**Update policy: This setting can be changed during an update.**

## Ims

**(Optional)** Specifies the properties for instance metadata service (IMDS). For more information, see [How instance metadata service version 2 works](#) in the *Amazon EC2 User Guide*.

Ims:

`Secured`: *boolean*

### Update policy: If this setting is changed, the update is not allowed.

## Imds properties

### Secured (Optional, Boolean)

If `true`, restricts access to the head node's IMDS (and the instance profile credentials) to a subset of superusers.

If `false`, every user in the head node has access to the head node's IMDS.

The following users are permitted access to the head node's IMDS:

- root user
- cluster administrative user (`pc-cluster-admin` by default)
- operating system specific default user (`ec2-user` on Amazon Linux 2 and RedHat, `ubuntu` on Ubuntu 18.04, `centos` on CentOS 7)

The default is `true`.

The default users are responsible for ensuring a cluster has the permissions it needs to interact with AWS resources. If you disable default user IMDS access, AWS ParallelCluster can't manage the compute nodes and stops working. Don't disable default user IMDS access.

When a user is granted access to the head node's IMDS, they can use the permissions included in the [head node's instance profile](#). For example, they can use these permissions to launch Amazon EC2 instances or to read the password for an AD domain that the cluster is configured to use for authentication.

To restrict IMDS access, AWS ParallelCluster manages a chain of `iptables`.

Cluster users with `sudo` access can selectively enable or disable access to the head node's IMDS for other individual users, including default users, by running the command:

```
$ sudo /opt/parallelcluster/scripts/imds/imds-access.sh --allow <USERNAME>
```

You can disable user IMDS access with the `--deny` option for this command.

If you unknowingly disable default user IMDS access, you can restore the permission by using the `--allow` option.

**Note**

Any customization of iptables or ip6tables rules can interfere with the mechanism used to restrict IMDS access on the head node.

**Update policy: If this setting is changed, the update is not allowed.**

**Image**

**(Optional)** Defines a custom image for the head node.

Image:

CustomAmi: *string*

**Update policy: If this setting is changed, the update is not allowed.**

**Image properties**

CustomAmi (**Optional**, String)

Specifies the ID of a custom AMI to use for the head node instead of the default AMI. For more information, see [AWS ParallelCluster AMI customization](#).

If the custom AMI requires additional permissions for its launch, these permissions must be added to both the user and head node policies.

For example, if a custom AMI has an encrypted snapshot associated with it, the following additional policies are required in both the user and head node policies:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "kms:DescribeKey",
        "kms:ReEncrypt*",
        "kms:CreateGrant",
        "kms:Decrypt"
      ]
    }
  ],
}
```

```

    "Resource": [
      "arn:aws:kms:<AWS_REGION>:<AWS_ACCOUNT_ID>:key/<AWS_KMS_KEY_ID>"
    ]
  }
]
}

```

To troubleshoot custom AMI validation warnings, see [Troubleshooting custom AMI issues](#).

**Update policy: If this setting is changed, the update is not allowed.**

## Scheduling section

**(Required)** Defines the job scheduler that's used in the cluster and the compute instances that the job scheduler manages. You can either use the Slurm or AWS Batch scheduler. Each supports a different set of settings and properties.

### Topics

- [Scheduling properties](#)
- [AwsBatchQueues](#)
- [SlurmQueues](#)
- [SlurmSettings](#)

#### Scheduling:

Scheduler: slurm

ScalingStrategy: *string*

SlurmSettings:

MungeKeySecretArn: *string*

ScaledownIdleTime: *integer*

QueueUpdateStrategy: *string*

EnableMemoryBasedScheduling: *boolean*

CustomSlurmSettings: *[dict]*

CustomSlurmSettingsIncludeFile: *string*

Database:

Uri: *string*

UserName: *string*

PasswordSecretArn: *string*

DatabaseName: *string*

ExternalSlurmdbd: *boolean*

Host: *string*

Port: *integer*

Dns:

DisableManagedDns: *boolean*

HostedZoneId: *string*

UseEc2Hostnames: *boolean*

SlurmQueues:

- Name: *string*

ComputeSettings:

LocalStorage:

RootVolume:

Size: *integer*

Encrypted: *boolean*

VolumeType: *string*

Iops: *integer*

Throughput: *integer*

EphemeralVolume:

MountDir: *string*

CapacityReservationTarget:

CapacityReservationId: *string*

CapacityReservationResourceGroupArn: *string*

CapacityType: *string*

AllocationStrategy: *string*

JobExclusiveAllocation: *boolean*

CustomSlurmSettings: *dict*

Tags:

- Key: *string*

Value: *string*

HealthChecks:

Gpu:

Enabled: *boolean*

Networking:

SubnetIds:

- *string*

AssignPublicIp: *boolean*

SecurityGroups:

- *string*

AdditionalSecurityGroups:

- *string*

PlacementGroup:

Enabled: *boolean*

Id: *string*

Name: *string*

Proxy:

```
    HttpProxyAddress: string
  ComputeResources:
    - Name: string
      InstanceType: string
      Instances:
        - InstanceType: string
      MinCount: integer
      MaxCount: integer
      DynamicNodePriority: integer
      StaticNodePriority: integer
      SpotPrice: float
      DisableSimultaneousMultithreading: boolean
      SchedulableMemory: integer
      HealthChecks:
        Gpu:
          Enabled: boolean
        Efa:
          Enabled: boolean
          GdrSupport: boolean
      CapacityReservationTarget:
        CapacityReservationId: string
        CapacityReservationResourceGroupArn: string
      Networking:
        PlacementGroup:
          Enabled: boolean
          Name: string
      CustomSlurmSettings: dict
      Tags:
        - Key: string
          Value: string
  CustomActions:
    OnNodeStart:
      Sequence:
        - Script: string
          Args:
            - string
      Script: string
      Args:
        - string
    OnNodeConfigured:
      Sequence:
        - Script: string
          Args:
            - string
```



```

    Script: string
    Args:
      - string
  Iam:
    InstanceProfile: string
    InstanceRole: string
    S3Access:
      - BucketName: string
        EnableWriteAccess: boolean
        KeyName: string
    AdditionalIamPolicies:
      - Policy: string
  Image:
    CustomAmi: string

```

### Scheduling:

```

Scheduler: awsbatch
AwsBatchQueues:
  - Name: string
    CapacityType: string
  Networking:
    SubnetIds:
      - string
    AssignPublicIp: boolean
    SecurityGroups:
      - string
    AdditionalSecurityGroups:
      - string
  ComputeResources: # this maps to a Batch compute environment (initially we
support only 1)
  - Name: string
    InstanceTypes:
      - string
    MinvCpus: integer
    DesiredvCpus: integer
    MaxvCpus: integer
    SpotBidPercentage: float

```

## Scheduling properties

### Scheduler (Required, String)

Specifies the type of scheduler that's used. Supported values are `slurm` and `awsbatch`.

### Update policy: If this setting is changed, the update is not allowed.

#### Note

awsbatch only supports the `alinux2` operating system and `x86_64` platform.

### ScalingStrategy (Optional, String)

Allows you to choose how dynamic Slurm nodes scale up. Supported values are `all-or-nothing`, `greedy-all-or-nothing` and `best-effort`. The default value is `all-or-nothing`.

### Update policy: This setting can be changed during an update.

#### Note

The scaling strategy applies only to nodes to be resumed by Slurm, not to nodes that are eventually already running.

- `all-or-nothing` This strategy strictly follows an all-or-nothing-approach, aimed at avoiding idle instances at the end of the scaling process. It operates on an all-or-nothing basis, meaning it either scales up completely or not at all. Be aware that there may be additional costs due to temporarily launched instances, when jobs require over 500 nodes or span multiple compute resources. This strategy has the lowest throughput among the three possible Scaling Strategies. The scaling time depends on the number of jobs submitted per Slurm resume program execution. Also, you can't scale far beyond the default `RunInstances` resource account limit per execution, which is 1000 instances by default. More details can be found at the [Amazon EC2 API throttling documentation](#)
- `greedy-all-or-nothing` Similar to the all-or-nothing strategy, it aims to avoid idle instances post-scaling. This strategy allows for temporary over-scaling during the scaling process in order to achieve higher throughput than the all-or-nothing approach but also comes with the same scaling limit of 1000 instances as per the `RunInstances` resource account limit.
- `best-effort` This strategy prioritizes high throughput, even if it means that some instances might be idle at the end of the scaling process. It attempts to allocate as many nodes as requested by the jobs, but there's a possibility of not fulfilling the entire request. Unlike the

other strategies, the best-effort approach can accumulate more instances than the standard RunInstances limit, at the cost of having idle resources along the multiple scaling process executions.

Each strategy is designed to cater to different scaling needs, allowing you to select one that meets your specific requirements and constraints.

## AwsBatchQueues

**(Optional)** The AWS Batch queue settings. Only one queue is supported. If [Scheduler](#) is set to `awsbatch`, this section is required. For more information about the `awsbatch` scheduler, see [networking setup](#) and [AWS Batch \(awsbatch\)](#).

```
AwsBatchQueues:
- Name: string
  CapacityType: string
  Networking:
    SubnetIds:
      - string
    AssignPublicIp: boolean
    SecurityGroups:
      - string
    AdditionalSecurityGroups:
      - string
  ComputeResources: # this maps to a Batch compute environment (initially we support
only 1)
    - Name: string
      InstanceTypes:
        - string
      MinvCpus: integer
      DesiredvCpus: integer
      MaxvCpus: integer
      SpotBidPercentage: float
```

**Update policy: This setting can be changed during an update.**

## AwsBatchQueues properties

### Name (Required, String)

The name of the AWS Batch queue.

**Update policy: If this setting is changed, the update is not allowed.**

## CapacityType (Optional, String)

The type of the compute resources that the AWS Batch queue uses. Supported values are ONDEMAND , SPOT or CAPACITY\_BLOCK. The default value is ONDEMAND.

### Note

If you set CapacityType to SPOT, your account must contain an AWSServiceRoleForEC2Spot service-linked role. You can create this role using the following AWS CLI command.

```
$ aws iam create-service-linked-role --aws-service-name spot.amazonaws.com
```

For more information, see [Service-linked role for Spot Instance requests](#) in the *Amazon Amazon EC2 User Guide for Linux Instances*.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

## Networking

**(Required)** Defines the networking configuration for the AWS Batch queue.

Networking:

SubnetIds:

- *string*

AssignPublicIp: *boolean*

SecurityGroups:

- *string*

AdditionalSecurityGroups:

- *string*

## Networking properties

### SubnetIds (Required, [String])

Specifies the ID of an existing subnet to provision the AWS Batch queue in. Currently only one subnet is supported.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### **AssignPublicIp (Optional, String)**

Creates or assigns a public IP address to the nodes in the AWS Batch queue. Supported values are `true` and `false`. The default depends on the subnet that you specified.

**Update policy: If this setting is changed, the update is not allowed.**

### **SecurityGroups (Optional, [String])**

List of security groups that the AWS Batch queue uses. If you don't specify security groups, AWS ParallelCluster creates new security groups.

**Update policy: This setting can be changed during an update.**

### **AdditionalSecurityGroups (Optional, [String])**

List of security groups that the AWS Batch queue uses.

**Update policy: This setting can be changed during an update.**

## **ComputeResources**

**(Required)** Defines the ComputeResources configuration for the AWS Batch queue.

```
ComputeResources: # this maps to a Batch compute environment (initially we support only 1)
- Name: string
  InstanceTypes:
  - string
  MinvCpus: integer
  DesiredvCpus: integer
  MaxvCpus: integer
  SpotBidPercentage: float
```

## **ComputeResources properties**

### **Name (Required, String)**

The name of the AWS Batch queue compute environment.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

## InstanceTypes (Required, [String])

The AWS Batch compute environment array of instance types. All of the instance types must use the x86\_64 architecture.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

## MinvCpus (Optional, Integer)

The minimum number of VCPUs that an AWS Batch compute environment can use.

**Update policy: This setting can be changed during an update.**

## DesiredVcpus (Optional, Integer)

The desired number of VCPUs in the AWS Batch compute environment. AWS Batch adjusts this value between MinvCpus and MaxvCpus based on the demand in the job queue.

**Update policy: This setting is not analyzed during an update.**

## MaxvCpus (Optional, Integer)

The maximum number of VCPUs for the AWS Batch compute environment. You can't set this to a value that's lower than DesiredVcpus.

**Update policy: This setting can't be decreased during an update.**

## SpotBidPercentage (Optional, Float)

The maximum percentage of the On-Demand price for the instance type that an Amazon EC2 Spot Instance price can reach before instances are launched. The default value is 100 (100%). The supported range is 1-100.

**Update policy: This setting can be changed during an update.**

## SlurmQueues

**(Optional)** Settings for the Slurm queue. If [Scheduler](#) is set to slurm, this section is required.

```
SlurmQueues:  
- Name: string  
  ComputeSettings:  
    LocalStorage:  
    RootVolume:
```

```
    Size: integer
    Encrypted: boolean
    VolumeType: string
    Iops: integer
    Throughput: integer
    EphemeralVolume:
      MountDir: string
CapacityReservationTarget:
  CapacityReservationId: string
  CapacityReservationResourceGroupArn: string
CapacityType: string
AllocationStrategy: string
JobExclusiveAllocation: boolean
CustomSlurmSettings: dict
Tags:
  - Key: string
    Value: string
HealthChecks:
  Gpu:
    Enabled: boolean
Networking:
  SubnetIds:
    - string
  AssignPublicIp: boolean
  SecurityGroups:
    - string
  AdditionalSecurityGroups:
    - string
  PlacementGroup:
    Enabled: boolean
    Id: string
    Name: string
  Proxy:
    HttpProxyAddress: string
ComputeResources:
  - Name: string
    InstanceType: string
    Instances:
      - InstanceType: string
    MinCount: integer
    MaxCount: integer
    DynamicNodePriority: integer
    StaticNodePriority: integer
    SpotPrice: float
```

```
DisableSimultaneousMultithreading: boolean
SchedulableMemory: integer
HealthChecks:
  Gpu:
    Enabled: boolean
  Efa:
    Enabled: boolean
    GdrSupport: boolean
CapacityReservationTarget:
  CapacityReservationId: string
  CapacityReservationResourceGroupArn: string
Networking:
  PlacementGroup:
    Enabled: boolean
    Name: string
  CustomSlurmSettings: dict
Tags:
  - Key: string
    Value: string
CustomActions:
  OnNodeStart:
    Sequence:
      - Script: string
        Args:
          - string
    Script: string
    Args:
      - string
  OnNodeConfigured:
    Sequence:
      - Script: string
        Args:
          - string
    Script: string
    Args:
      - string
Iam:
  InstanceProfile: string
  InstanceRole: string
  S3Access:
    - BucketName: string
      EnableWriteAccess: boolean
      KeyName: string
  AdditionalIamPolicies:
```



```
- Policy: string
Image:
  CustomAmi: string
```

**Update policy: For this list values setting, a new value can be added during an update or the compute fleet must be stopped when removing an existing value.**

## SlurmQueues properties

### Name (Required, String)

The name of the Slurm queue.

#### Note

Cluster size may change during an update. For more information, see [Cluster capacity size and update](#)

**Update policy: If this setting is changed, the update is not allowed.**

### CapacityReservationTarget

#### Note

CapacityReservationTarget is added with AWS ParallelCluster version 3.3.0.

```
CapacityReservationTarget:
  CapacityReservationId: string
  CapacityReservationResourceGroupArn: string
```


Specifies the On-Demand capacity reservation for the queue's compute resources.

### CapacityReservationId (Optional, String)

The ID of the existing capacity reservation to target for the queue's compute resources. The id can refer to an [ODCR](#) or a [Capacity Block for ML](#).

The reservation must use the same platform that the instance uses. For example, if your instances run on `rhel8`, your capacity reservation must run on the Red Hat Enterprise Linux

platform. For more information, see [Supported platforms](#) in the *Amazon EC2 User Guide for Linux Instances*.

 **Note**

If you include [Instances](#) in the cluster configuration, you must exclude this queue level `CapacityReservationId` setting from the configuration.

### **CapacityReservationResourceGroupArn (Optional, String)**

The Amazon Resource Name (ARN) of the resource group that serves as the service-linked group of capacity reservations for the queue's compute resources. AWS ParallelCluster identifies and uses the most appropriate capacity reservation from the resource group based on the following conditions:

- If `PlacementGroup` is enabled in [SlurmQueues / Networking](#) or [SlurmQueues / ComputeResources / Networking](#), AWS ParallelCluster selects a resource group that targets the instance type and `PlacementGroup` for a compute resource, if the compute resource exists.

The `PlacementGroup` must target one of the instance types that's defined in [ComputeResources](#).

- If `PlacementGroup` isn't enabled in [SlurmQueues / Networking](#) or [SlurmQueues / ComputeResources / Networking](#), AWS ParallelCluster selects a resource group that targets only the instance type of a compute resource, if the compute resource exists.

The resource group must have at least one ODCR for each instance type reserved in an Availability Zone across all of the queue's compute resources and Availability Zones. For more information, see [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#).

For more information on multiple subnet configuration requirements, see [Networking / SubnetIds](#).

 **Note**

Multiple Availability Zones is added in AWS ParallelCluster version 3.4.0.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### CapacityType (Optional, String)

The type of the compute resources that the Slurm queue uses. Supported values are ONDEMAND or SPOT. The default value is ONDEMAND.

#### Note

If you set the CapacityType to SPOT, your account must have an AWSServiceRoleForEC2Spot service-linked role. You can create this role by using the following AWS CLI command.

```
$ aws iam create-service-linked-role --aws-service-name spot.amazonaws.com
```

For more information, see [Service-linked role for Spot Instance requests](#) in the *Amazon Amazon EC2 User Guide for Linux Instances*.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### AllocationStrategy (Optional, String)

Specify the allocation strategy for all the compute resources defined in [Instances](#).

Valid values: lowest-price | capacity-optimized | price-capacity-optimized

Default: lowest-price

#### **lowest-price**

- If you use CapacityType = ONDEMAND, Amazon EC2 Fleet uses price to determine the order and launches the lowest price instances first.
- If you use CapacityType = SPOT, Amazon EC2 Fleet launches instances from the lowest price Spot Instance pool that has available capacity. If a pool runs out of capacity before fulfilling your required capacity, Amazon EC2 Fleet fulfills your request by launching instances for you. In particular, Amazon EC2 Fleet launches instances from the lowest price Spot Instance pool that has available capacity. Amazon EC2 Fleet might launch Spot Instances from several different pools.

- If you set `CapacityType = CAPACITY_BLOCK`, there are no allocation strategies, thus `AllocationStrategy` parameter cannot be configured.

### **capacity-optimized**

- If you set `CapacityType = ONDEMAND`, `capacity-optimized` isn't available.
- If you set `CapacityType = SPOT`, Amazon EC2 Fleet launches instances from Spot Instance pools with optimal capacity for the number of instances to be launched.

### **price-capacity-optimized**

- If you set `CapacityType = ONDEMAND`, `capacity-optimized` isn't available.
- If you set `CapacityType = SPOT`, Amazon EC2 Fleet identifies the pools with the highest capacity availability for the number of instances that are launching. This means that we will request Spot Instances from the pools that we believe have the lowest chance of interruption in the near term. Amazon EC2 Fleet then requests Spot Instances from the lowest priced of these pools.

[Update policy: The compute fleet must be stopped or `QueueUpdateStrategy` must be set for this setting to be changed for an update.](#)

#### **Note**

`AllocationStrategy` is supported starting in AWS ParallelCluster version 3.3.0.

## **JobExclusiveAllocation (Optional, String)**

If set to `true`, the Slurm partition `OverSubscribe` flag is set to `EXCLUSIVE`. When `OverSubscribe=EXCLUSIVE`, jobs in the partition have exclusive access to all allocated nodes. For more information, see [EXCLUSIVE](#) in the Slurm documentation.

Valid values: `true` | `false`

Default: `false`

[Update policy: This setting can be changed during an update.](#)

#### **Note**

`JobExclusiveAllocation` is supported starting in AWS ParallelCluster version 3.7.0.

## CustomSlurmSettings (Optional, Dict)

Defines the custom Slurm partition (queue) configuration settings.

Specifies a dictionary of custom Slurm configuration parameter key-value pairs that apply to queues (partitions).

Each separate key-value pair, such as `Param1: Value1`, is added separately to the end of the Slurm partition configuration line in the format `Param1=Value1`.

You can only specify Slurm configuration parameters that aren't deny-listed in `CustomSlurmSettings`. For information about deny-listed Slurm configuration parameters, see [Deny-listed Slurm configuration parameters for CustomSlurmSettings](#).

AWS ParallelCluster only checks whether a parameter is in a deny list. AWS ParallelCluster doesn't validate your custom Slurm configuration parameter syntax or semantics. You are responsible for validating your custom Slurm configuration parameters. Invalid custom Slurm configuration parameters can cause Slurm daemon failures that can lead to cluster create and update failures.

For more information about how to specify custom Slurm configuration parameters with AWS ParallelCluster, see [Slurm configuration customization](#).

For more information about Slurm configuration parameters, see [slurm.conf](#) in the Slurm documentation.

**Update policy: This setting can be changed during an update.**

### Note

`CustomSlurmSettings` is supported starting with AWS ParallelCluster version 3.6.0.

## Tags (Optional, [String])

A list of tag key-value pairs. [ComputeResource](#) tags override duplicate tags specified in the [Tags section](#) or in `SlurmQueues / Tags`.

### Key (Optional, String)

The tag key.

## Value (Optional, String)

The tag value.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

## HealthChecks (Optional)

Specify compute node health checks on all compute resources in the queue.

## Gpu (Optional)

Specify GPU health checks on all compute resources in a queue.

### Note

AWS ParallelCluster doesn't support HealthChecks / Gpu in nodes that use `alinux2` ARM operating systems. These platforms don't support the [NVIDIA Data Center GPU Manager \(DCGM\)](#).

## Enabled (Optional, Boolean)

Whether AWS ParallelCluster performs GPU health checks on compute nodes. The default is `false`.

## Gpu health check behavior

- If `Gpu` / `Enabled` is set to `true`, AWS ParallelCluster performs GPU health checks on compute resources in the queue.
- The `Gpu` health check performs GPU health checks on compute resources to prevent the submission of jobs on nodes with a degraded GPU.
- If a compute node fails a `Gpu` health check, the compute node state changes to `DRAIN`. New jobs don't start on this node. Existing jobs run to completion. After all running jobs complete, the compute node terminates if it's a dynamic node, and it's replaced if it's a static node.
- The duration of the `Gpu` health check depends on the selected instance type, the number of GPUs in the instance, and the number of `Gpu` health check targets (equivalent to the number of job GPU targets). For an instance with 8 GPUs, the typical duration is less than 3 minutes.

- If the Gpu health check runs on an instance that's not supported, it exits and the job runs on the compute node. For example, if an instance doesn't have a GPU, or, if an instance has a GPU, but it isn't an NVIDIA GPU, the health check exits and the job runs on the compute node. Only NVIDIA GPUs are supported.
- The Gpu health check uses the `dcgmi` tool to perform health checks on a node and takes the following steps:

When the Gpu health check begins in a node:

1. It detects whether the `nvidia-dcgm` and `nvidia-fabricmanager` services are running.
2. If these services aren't running, the Gpu health check starts them.
3. It detects whether the persistence mode is enabled.
4. If the persistence mode isn't enabled, the Gpu health check enables it.

At the end of the health check, the Gpu health check restores these services and resources to their initial state.

- If the job is assigned to a specific set of node GPUs, the Gpu health check runs only on that specific set. Otherwise, the Gpu health check runs on all GPUs in the node.
- If a compute node receives 2 or more Gpu health check requests at the same time, only the first health check runs and the others are skipped. This is also the case for health checks targeting node GPUs. You can check the log files for additional information regarding this situation.
- The health check log for a specific compute node is available in the `/var/log/parallelcluster/slurm_health_check.log` file. The file is available in Amazon CloudWatch, in the cluster CloudWatch log group, where you can find:
  - Details on the action run by the Gpu health check, including enabling and disabling services and persistence mode.
  - The GPU identifier, serial ID, and the UUID.
  - The health check output.

**Update policy: This setting can be changed during an update.**

**Note**

HealthChecks is supported starting in AWS ParallelCluster version 3.6.0.

## Networking

**(Required)** Defines the networking configuration for the Slurm queue.

```
Networking:
  SubnetIds:
    - string
  AssignPublicIp: boolean
  SecurityGroups:
    - string
  AdditionalSecurityGroups:
    - string
  PlacementGroup:
    Enabled: boolean
    Id: string
    Name: string
  Proxy:
    HttpProxyAddress: string
```

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### Networking properties

#### SubnetIds (Required, [String])

The IDs of existing subnets that you provision the Slurm queue in.

If you configure instance types in [SlurmQueues](#) / [ComputeResources](#) / [InstanceType](#), you can only define one subnet.

If you configure instance types in [SlurmQueues](#) / [ComputeResources](#) / [Instances](#), you can define a single subnet or multiple subnets.

If you use multiple subnets, all subnets defined for a queue must be in the same VPC, with each subnet in a separate Availability Zone (AZ).

For example, suppose you define subnet-1 and subnet-2 for your queue.

subnet-1 and subnet-2 can't both be in AZ-1.

subnet-1 can be in AZ-1 and subnet-2 can be in AZ-2.



If you configure only one instance type and want to use multiple subnets, define your instance type in `Instances` rather than `InstanceType`.

For example, define `ComputeResources / Instances / InstanceType=instance.type` instead of `ComputeResources / InstanceType=instance.type`.

**Note**

Elastic Fabric Adapter (EFA) isn't supported over different availability zones.

The use of multiple Availability Zones might cause increases in storage networking latency and added inter-AZ data transfer costs. For example, this could occur when an instance accesses file storage that's located in a different AZ. For more information, see [Data Transfer within the same AWS Region](#).

**Cluster updates to change from the use of a single subnet to multiple subnets:**

- Suppose the subnet definition of a cluster is defined with a single subnet and an AWS ParallelCluster managed FSx for Lustre file system. Then, you can't update this cluster with an updated subnet ID definition directly. To make the cluster update, you must first change the managed file system to an external file system. For more information, see [Convert AWS ParallelCluster managed storage to external storage](#).
- Suppose the subnet definition of a cluster is defined with a single subnet and an external Amazon EFS file system if EFS mount targets don't exist for all of the AZs for the multiple subnets defined to be added. Then, you can't update this cluster with an updated subnet ID definition directly. To make the cluster update or to create a cluster, you must first create all of the mount targets for all of the AZs for the defined multiple subnets.

**Availability Zones and cluster capacity reservations defined in [CapacityReservationResourceGroupArn](#):**

- You can't create a cluster if there is no overlap between the set of instance types and availability zones covered by the defined capacity reservation resource group and the set of instance types and availability zones defined for the queue.
- You can create a cluster if there is a partial overlap between the set of instance types and availability zones covered by the defined capacity reservation resource group and the set of instance types and availability zones defined for the queue. AWS ParallelCluster sends a warning message about the partial overlap for this case.

- For more information, see [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#).

**Note**

Multiple Availability Zones is added in AWS ParallelCluster version 3.4.0.

**Warning**

This warning applies to all 3.x.y AWS ParallelCluster versions prior to version 3.3.1. AWS ParallelCluster version 3.3.1 isn't impacted if this parameter is changed.

For AWS ParallelCluster 3 versions prior to version 3.3.1:

Changing this parameter and updating a cluster creates a new managed FSx for Lustre file system and deletes the existing managed FSx for Lustre file system without preserving the existing data. This results in data loss. Before you proceed, make sure you back up the data from the existing FSx for Lustre file system if you want to preserve data. For more information, see [Working with backups](#) in the *FSx for Lustre User Guide*.

If a new subnet value is added, [Update policy: This setting can be changed during an update.](#)

If a subnet value is removed, [Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**AssignPublicIp (Optional, String)**

Creates or assigns a public IP address to the nodes in the Slurm queue. Supported values are `true` and `false`. The subnet that you specify determines the default value. A subnet with public IPs default to assigning public IP addresses.

If you define a `p4d` or `hpc6id` instance type, or another instance type that has multiple network interfaces or a network interface card, you must set [HeadNode](#) / [Networking](#) / [ElasticIp](#) to `true` to provide public access. AWS public IPs can only be assigned to instances launched with a single network interface. For this case, we recommend that you use a [NAT gateway](#) to provide public access to the cluster compute nodes. In this case, set `AssignPublicIp` to `false`. For more information on IP addresses, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.

[Update policy: If this setting is changed, the update is not allowed.](#)

## SecurityGroups (Optional, [String])

A list of security groups to use for the Slurm queue. If no security groups are specified, AWS ParallelCluster creates security groups for you.

Verify that the security groups are configured correctly for your [SharedStorage](#) systems.

### Warning

This warning applies to all 3.x.y AWS ParallelCluster versions prior to version 3.3.0. AWS ParallelCluster version 3.3.0 isn't impacted if this parameter is changed.

For AWS ParallelCluster 3 versions prior to version 3.3.0:

Changing this parameter and updating a cluster creates a new managed FSx for Lustre file system and deletes the existing managed FSx for Lustre file system without preserving the existing data. This results in data loss. Make sure to back up the data from the existing FSx for Lustre file system if you want to preserve data. For more information, see [Working with backups](#) in the *FSx for Lustre User Guide*.

### Warning

If you enable [Efa](#) for your compute instances, make sure that your EFA-enabled instances are members of a security group that allows all inbound and outbound traffic to itself.

**Update policy: This setting can be changed during an update.**

## AdditionalSecurityGroups (Optional, [String])

A list of additional security groups to use for the Slurm queue.

**Update policy: This setting can be changed during an update.**

## PlacementGroup (Optional)

Specifies the placement group settings for the Slurm queue.

PlacementGroup:

Enabled: *boolean*

Id: *string*

**Name:** *string*

Update policy: All compute nodes must be stopped for a managed placement group deletion. The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### Enabled (Optional, Boolean)

Indicates whether a placement group is used for the Slurm queue. The default is `false`.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### Id (Optional, String)

The placement group name for an existing cluster placement group that the Slurm queue uses. Make sure to provide the placement group *name* and *not the ID*.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### Name (Optional, String)

The placement group name for an existing cluster placement group that the Slurm queue uses. Make sure to provide the placement group *name* and *not the ID*.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

#### Note

- If `PlacementGroup / Enabled` is set to `true`, without a `Name` or `Id` defined, each compute resource is assigned its own managed placement group, unless `ComputeResources / Networking / PlacementGroup` is defined to override this setting.
- Starting with AWS ParallelCluster version 3.3.0, `SlurmQueues / Networking / PlacementGroup / Name` was added as a preferred alternative to `SlurmQueues / Networking / PlacementGroup / Id`.

`PlacementGroup / Id` and `PlacementGroup / Name` are equivalent. You can use either one.

If you include both [PlacementGroup / Id](#) and [PlacementGroup / Name](#), AWS ParallelCluster fails. You can only choose one or the other.

You don't need to update your cluster to use [PlacementGroup / Name](#).

## Proxy (Optional)

Specifies the proxy settings for the Slurm queue.

```
Proxy:  
HttpProxyAddress: string
```

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### **HttpProxyAddress (Optional, String)**

Defines an HTTP or HTTPS proxy server for the Slurm queue. Typically, it's `https://x.x.x.x:8080`.

There's no default value.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

## Image

**(Optional)** Specifies the image to use for the Slurm queue. To use the same AMI for all nodes, use the [CustomAmi](#) setting in the [Image section](#).

```
Image:  
CustomAmi: string
```

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

## Image Properties

### CustomAmi (Optional, String)

The AMI to use for the Slurm queue instead of the default AMIs. You can use the pcluster CLI command to view a list of the default AMIs.

#### Note

The AMI must be based on the same operating system that's used by the head node.

```
pcluster list-official-images
```

If the custom AMI requires additional permissions for its launch, you must add these permissions to the head node policy.

For example, if a custom AMI has an encrypted snapshot associated with it, the following additional policies are required in the head node policies.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "kms:DescribeKey",
        "kms:ReEncrypt*",
        "kms:CreateGrant",
        "kms:Decrypt"
      ],
      "Resource": [
        "arn:aws:kms:<AWS_REGION>:<AWS_ACCOUNT_ID>;key/<AWS_KMS_KEY_ID>"
      ]
    }
  ]
}
```

To troubleshoot custom AMI validation warnings, see [Troubleshooting custom AMI issues](#).

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

## ComputeResources

**(Required)** Defines the ComputeResources configuration for the Slurm queue.

### Note

Cluster size may change during an update. For more information, see [Cluster capacity size and update](#)

```

ComputeResources:
- Name: string
  InstanceType: string
  Instances:
    - InstanceType: string
  MinCount: integer
  MaxCount: integer
  DynamicNodePriority: integer
  StaticNodePriority: integer
  SpotPrice: float
  DisableSimultaneousMultithreading: boolean
  SchedulableMemory: integer
  HealthChecks:
    Gpu:
      Enabled: boolean
  Efa:
    Enabled: boolean
    GdrSupport: boolean
  CapacityReservationTarget:
    CapacityReservationId: string
    CapacityReservationResourceGroupArn: string
  Networking:
    PlacementGroup:
      Enabled: boolean
      Name: string
  CustomSlurmSettings: dict
  Tags:
    - Key: string

```

Value: *string*

**Update policy: For this list values setting, a new value can be added during an update or the compute fleet must be stopped when removing an existing value.**

## ComputeResources properties

### Name (Required, String)

The name of the Slurm queue compute environment. The name can have up to 25 characters.

**Update policy: If this setting is changed, the update is not allowed.**

### InstanceType (Required, String)

The instance type that's used in this Slurm compute resource. All of the instance types in a cluster must use the same processor architecture. Instances can use either the x86\_64 or arm64 architecture.

The cluster configuration must define either [InstanceType](#) or [Instances](#). If both are defined, AWS ParallelCluster fails.

When you define InstanceType, you can't define multiple subnets. If you configure only one instance type and want to use multiple subnets, define your instance type in Instances rather than in InstanceType. For more information, see [Networking / SubnetIds](#).

If you define a p4d or hpc6id instance type, or another instance type that has multiple network interfaces or a network interface card, you must launch the compute instances in private subnet as described in [AWS ParallelCluster using two subnets](#). AWS public IPs can only be assigned to instances that are launched with a single network interface. For more information, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### Instances (Required)

Specifies the list of instance types for a compute resource. To specify the allocation strategy for the list of instance types, see [AllocationStrategy](#).

The cluster configuration must define either [InstanceType](#) or [Instances](#). If both are defined, AWS ParallelCluster fails.

For more information, see [Multiple instance type allocation with Slurm](#).



**Instances:**

- `InstanceType`: *string*

**Note**

Starting with AWS ParallelCluster version 3.7.0, `EnableMemoryBasedScheduling` can be enabled if you configure multiple instance types in [Instances](#).  
For AWS ParallelCluster versions 3.2.0 to 3.6.x, `EnableMemoryBasedScheduling` can't be enabled if you configure multiple instance types in [Instances](#).

**Update policy: For this list values setting, a new value can be added during an update or the compute fleet must be stopped when removing an existing value.**

**InstanceType (Required, String)**

The instance type to use in this Slurm compute resource. All of the instance types in a cluster must use the same processor architecture, either x86\_64 or arm64.

The instance types listed in [Instances](#) must have:

- The same number of vCPUs, or, if [DisableSimultaneousMultithreading](#) is set to `true`, the same number of cores.
- The same number of accelerators of the same manufacturers.
- EFA supported, if [Efa](#) / [Enabled](#) set to `true`.

The instance types that are listed in [Instances](#) can have:

- Different amount of memory.

In this case, the minimum memory is to be set as a consumable Slurm resource.

**Note**

Starting with AWS ParallelCluster version 3.7.0, `EnableMemoryBasedScheduling` can be enabled if you configure multiple instance types in [Instances](#).  
For AWS ParallelCluster versions 3.2.0 to 3.6.x, `EnableMemoryBasedScheduling` can't be enabled if you configure multiple instance types in [Instances](#).

- Different network cards.

In this case, the number of network interfaces configured for the compute resource is defined by the instance type with the smallest number of network cards.

- Different network bandwidth.
- Different instance store size.

If you define a p4d or hpc6id instance type, or another instance type that has multiple network interfaces or a network interface card, you must launch the compute instances in private subnet as described in [AWS ParallelCluster using two subnets](#). AWS public IPs can only be assigned to instances launched with a single network interface. For more information, see [Assign a public IPv4 address during instance launch](#) in the *Amazon EC2 User Guide for Linux Instances*.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

**Note**

Instances is supported starting with AWS ParallelCluster version 3.3.0.

### MinCount (Optional, Integer)

The minimum number of instances that the Slurm compute resource uses. The default is 0.

**Note**

Cluster size may change during an update. For more information, see [Cluster capacity size and update](#)

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### MaxCount (Optional, Integer)

The maximum number of instances that the Slurm compute resource uses. The default is 10.

When using `CapacityType = CAPACITY_BLOCK`, `MaxCount` must be equal to `MinCount` and greater than 0, because all the instances part of the Capacity Block reservation are managed as static nodes.

At cluster creation time, the head node waits for all the static nodes to be ready before signaling the success of cluster creation. However, when using `CapacityType = CAPACITY_BLOCK`, the nodes part of the compute resources associated to Capacity Blocks won't be considered for this check. The cluster will be created even if not all the configured Capacity Blocks are active.

**Note**

Cluster size may change during an update. For more information, see [Cluster capacity size and update](#)

### **DynamicNodePriority (Optional, Integer)**

The priority of dynamic nodes in a queue compute resource. The priority maps to the Slurm node [Weight](#) configuration parameter for the compute resource dynamic nodes. The default value is 1000.

Slurm prioritizes nodes with the lowest `Weight` values first.

**Warning**

The use of many different `Weight` values in a Slurm partition (queue) might slow down the rate of job scheduling in the queue.

In AWS ParallelCluster versions earlier than version 3.7.0, both static and dynamic nodes were assigned the same default weight of 1. In this case, Slurm might prioritize idle dynamic nodes over idle static nodes due to the naming schema for static and dynamic nodes. When all else is equal, Slurm schedules nodes alphabetically by name.

**Note**

`DynamicNodePriority` is added in AWS ParallelCluster version 3.7.0.

**Update policy: This setting can be changed during an update.**

### StaticNodePriority (Optional, Integer)

The priority of static nodes in a queue compute resource. The priority maps to the Slurm node [Weight](#) configuration parameter for the compute resource static nodes. The default value is 1.

Slurm prioritizes nodes with the lowest Weight values first.

#### **Warning**

The use of many different Weight values in a Slurm partition (queue) might slow down the rate of job scheduling in the queue.

#### **Note**

StaticNodePriority is added in AWS ParallelCluster version 3.7.0.

**Update policy: This setting can be changed during an update.**

### SpotPrice (Optional, Float)

The maximum price that paid for an Amazon EC2 Spot Instance before any instances are launched. The default value is the On-Demand price.

**Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.**

### DisableSimultaneousMultithreading (Optional, Boolean)

If true, multithreading on the nodes in the Slurm queue is disabled. The default value is false.

Not all instance types can disable multithreading. For a list of instance types that support disabling multithreading, see [CPU cores and threads for each CPU core per instance type](#) in the *Amazon EC2 User Guide*.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

## SchedulableMemory (Optional, Integer)

The amount of memory in MiB that's configured in the Slurm parameter `RealMemory` for the compute nodes of a compute resource. This value is the upper limit for the node memory available to jobs when [SlurmSettings](#) / [EnableMemoryBasedScheduling](#) is enabled. The default value is 95 percent of the memory that's listed in [Amazon EC2 Instance Types](#) and returned by the Amazon EC2 API [DescribeInstanceTypes](#). Make sure to convert values that are given in GiB to MiB.

Supported values: 1-EC2Memory

`EC2Memory` is the memory (in MiB) that's listed in [Amazon EC2 Instance Types](#) and returned by the Amazon EC2 API [DescribeInstanceTypes](#). Make sure to convert values that are given in GiB to MiB.

This option is most relevant when [SlurmSettings](#) / [EnableMemoryBasedScheduling](#) is enabled. For more information, see [Slurm memory-based scheduling](#).

### Note

`SchedulableMemory` is supported starting with AWS ParallelCluster version 3.2.0. Starting with version 3.2.0, by default, AWS ParallelCluster configures `RealMemory` for Slurm compute nodes to 95 percent of the memory that's returned by the Amazon EC2 API `DescribeInstanceTypes`. This configuration is independent of the value of `EnableMemoryBasedScheduling`.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

## HealthChecks (Optional)

Specify health checks on a compute resource.

### Gpu (Optional)

Specify GPU health checks on a compute resource.

### Enabled (Optional, Boolean)

Whether AWS ParallelCluster performs GPU health checks on compute a resource in a queue. The default is `false`.

**Note**

AWS ParallelCluster doesn't support HealthChecks / Gpu in nodes that use `alinux2` ARM operating systems. These platforms don't support the [NVIDIA Data Center GPU Manager \(DCGM\)](#).

**Gpu health check behavior**

- If `Gpu / Enabled` is set to `true`, AWS ParallelCluster performs health GPU health checks on a compute resource.
- The Gpu health check performs health checks on a compute resource to prevent the submission of jobs on nodes with a degraded GPU.
- If a compute node fails a Gpu health check, the compute node state changes to DRAIN. New jobs don't start on this node. Existing jobs run to completion. After all running jobs complete, the compute node terminates if it's a dynamic node, and it's replaced if it's a static node.
- The duration of the Gpu health check depends on the selected instance type, the number of GPUs in the instance, and the number of Gpu health check targets (equivalent to the number of job GPU targets). For an instance with 8 GPUs, the typical duration is less than 3 minutes.
- If the Gpu health check runs on an instance that's not supported, it exits and the job runs on the compute node. For example, if an instance doesn't have a GPU, or, if an instance has a GPU, but it isn't an NVIDIA GPU, the health check exits and the job runs on the compute node. Only NVIDIA GPUs are supported.
- The Gpu health check uses the `dcgmi` tool to perform health checks on a node and takes the following steps:

When the Gpu health check begins in a node:

1. It detects whether the `nvidia-dcgm` and `nvidia-fabricmanager` services are running.
2. If these services aren't running, the Gpu health check starts them.
3. It detects whether the persistence mode is enabled.
4. If the persistence mode isn't enabled, the Gpu health check enables it.

At the end of the health check, the Gpu health check restores these services and resources to their initial state.

- If the job is assigned to a specific set of node GPUs, the Gpu health check runs only on that specific set. Otherwise, the Gpu health check runs on all GPUs in the node.
- If a compute node receives 2 or more Gpu health check requests at the same time, only the first health check runs and the others are skipped. This is also the case for health checks targeting node GPUs. You can check the log files for additional information regarding this situation.
- The health check log for a specific compute node is available in the `/var/log/parallelcluster/slurm_health_check.log` file. This file is available in Amazon CloudWatch, in the cluster CloudWatch log group, where you can find:
  - Details on the action run by the Gpu health check, including enabling and disabling services and persistence mode.
  - The GPU identifier, serial ID, and the UUID.
  - The health check output.

**Update policy: This setting can be changed during an update.**

**Note**

HealthChecks is supported starting in AWS ParallelCluster version 3.6.0.

## Efa (Optional)

Specifies the Elastic Fabric Adapter (EFA) settings for the nodes in the Slurm queue.

Efa:

Enabled: *boolean*

GdrSupport: *boolean*

**Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.**

### Enabled (Optional, Boolean)

Specifies that Elastic Fabric Adapter (EFA) is enabled. To view the list of Amazon EC2 instances that support EFA, see [Supported instance types](#) in the *Amazon EC2 User Guide*

for Linux Instances. For more information, see [Elastic Fabric Adapter](#). We recommend that you use a cluster [SlurmQueues](#) / [Networking](#) / [PlacementGroup](#) to minimize latencies between instances.

The default value is false.

**Note**

Elastic Fabric Adapter (EFA) isn't supported over different availability zones. For more information, see [SubnetIds](#).

**Warning**

If you're defining a custom security group in [SecurityGroups](#), make sure that your EFA-enabled instances are members of a security group that allows all inbound and outbound traffic to itself.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### **GdrSupport (Optional, Boolean)**

**(Optional)** Starting with AWS ParallelCluster version 3.0.2, this setting has no effect. Elastic Fabric Adapter (EFA) support for GPUDirect RDMA (remote direct memory access) is always enabled if it's supported by the instance type for the Slurm compute resource and the operating system.

**Note**

AWS ParallelCluster version 3.0.0 through 3.0.1: Support for GPUDirect RDMA is enabled for Slurm compute resources. Support for GPUDirect RDMA is supported by specific instance types (p4d.24xlarge) on specific operating systems ([Os](#) is `alinux2`, `centos7`, `ubuntu1804`, or `ubuntu2004`). The default value is false.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)



## CapacityReservationTarget

CapacityReservationTarget:

CapacityReservationId: *string*

CapacityReservationResourceGroupArn: *string*

Specifies the on-demand capacity reservation to use for the compute resource.

### CapacityReservationId (Optional, String)

The ID of the existing capacity reservation to target for the queue's compute resources. The id can refer to an [ODCR](#) or a [Capacity Block for ML](#).

When this parameter is specified at compute resource level, InstanceType is optional, it will be automatically retrieved from the reservation.

### CapacityReservationResourceGroupArn (Optional, String)

Indicates the Amazon Resource Name (ARN) of the resource group that serves as the service linked group of capacity reservations for the compute resource. AWS ParallelCluster identifies and uses the most appropriate capacity reservation from the group. The resource group must have at least one ODCR for each instance type that's listed for the compute resource. For more information, see [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#).

- If PlacementGroup is enabled in [SlurmQueues / Networking](#) or [SlurmQueues / ComputeResources / Networking](#), AWS ParallelCluster selects a resource group that targets the instance type and PlacementGroup for a compute resource if it exists.

The PlacementGroup must target one of the instances types defined in [ComputeResources](#).

- If PlacementGroup isn't enabled in [SlurmQueues / Networking](#) or [SlurmQueues / ComputeResources / Networking](#), AWS ParallelCluster selects a resource group that targets only the instance type of a compute resource, if it exists.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

#### Note

CapacityReservationTarget is added with AWS ParallelCluster version 3.3.0.

## Networking

### Networking:

#### PlacementGroup:

Enabled: *boolean*

Name: *string*

Update policy: All compute nodes must be stopped for a managed placement group deletion. The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### **PlacementGroup (Optional)**

Specifies the placement group settings for the compute resource.

#### **Enabled (Optional, Boolean)**

Indicates whether a placement group is used for the compute resource.

- If set to `true`, without a `Name` defined, that compute resource is assigned its own managed placement group, regardless of the [SlurmQueues](#) / [Networking](#) / [PlacementGroup](#) setting.
- If set to `true`, with a `Name` defined, that compute resource is assigned the named placement group, regardless of `SlurmQueues` / `Networking` / `PlacementGroup` settings.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

#### **Name (Optional, String)**

The placement group name for an existing cluster placement group that's used for the compute resource.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

#### **Note**

- If both `PlacementGroup` / `Enabled` and `Name` aren't set, their respective values default to the [SlurmQueues](#) / [Networking](#) / [PlacementGroup](#) settings.

- `ComputeResources / Networking / PlacementGroup` is added with AWS ParallelCluster version 3.3.0.

## CustomSlurmSettings (Optional, Dict)

**(Optional)** Defines the custom Slurm node (compute resource) configuration settings.

Specifies a dictionary of custom Slurm configuration parameter key-value pairs that apply to Slurm nodes (compute resources).

Each separate key-value pair, such as `Param1: Value1`, is added separately to the end of the Slurm node configuration line in the format `Param1=Value1`.

You can only specify Slurm configuration parameters that aren't deny-listed in `CustomSlurmSettings`. For information about deny-listed Slurm configuration parameters, see [Deny-listed Slurm configuration parameters for CustomSlurmSettings](#).

AWS ParallelCluster only checks whether a parameter is in a deny list. AWS ParallelCluster doesn't validate your custom Slurm configuration parameter syntax or semantics. You are responsible for validating your custom Slurm configuration parameters. Invalid custom Slurm configuration parameters can cause Slurm daemon failures that can lead to cluster create and update failures.

For more information about how to specify custom Slurm configuration parameters with AWS ParallelCluster, see [Slurm configuration customization](#).

For more information about Slurm configuration parameters, see [slurm.conf](#) in the Slurm documentation.

**Update policy: This setting can be changed during an update.**

### Note

`CustomSlurmSettings` is supported starting with AWS ParallelCluster version 3.6.0.

## Tags (Optional, [String])

A list of tag key-value pairs. `ComputeResource` tags override duplicate tags specified in the [Tags section](#) or [SlurmQueues / Tags](#).

**Key (Optional, String)**

The tag key.

**Value (Optional, String)**

The tag value.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**ComputeSettings**

**(Required)** Defines the ComputeSettings configuration for the Slurm queue.

**ComputeSettings properties**

Specifies the properties of ComputeSettings of the nodes in the Slurm queue.

```
ComputeSettings:  
  LocalStorage:  
    RootVolume:  
      Size: integer  
      Encrypted: boolean  
      VolumeType: string  
      Iops: integer  
      Throughput: integer  
    EphemeralVolume:  
      MountDir: string
```

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**LocalStorage (Optional)**

Specifies the properties of LocalStorage of the nodes in the Slurm queue.

```
LocalStorage:  
  RootVolume:  
    Size: integer  
    Encrypted: boolean  
    VolumeType: string
```

```
Iops: integer  
Throughput: integer  
EphemeralVolume:  
MountDir: string
```

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### RootVolume (Optional)

Specifies the details of the root volume of the nodes in the Slurm queue.

```
RootVolume:  
Size: integer  
Encrypted: boolean  
VolumeType: string  
Iops: integer  
Throughput: integer
```

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### Size (Optional, Integer)

Specifies the root volume size in gibibytes (GiB) for the nodes in the Slurm queue. The default size comes from the AMI. Using a different size requires that the AMI supports `growroot`.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### Encrypted (Optional, Boolean)

If `true`, the root volume of the nodes in the Slurm queue are encrypted. The default value is `false`.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

### VolumeType (Optional, String)

Specifies the [Amazon EBS volume type](#) of the nodes in the Slurm queue. Supported values are `gp2`, `gp3`, `io1`, `io2`, `sc1`, `st1`, and `standard`. The default value is `gp3`.

For more information, see [Amazon EBS volume types](#) in the *Amazon EC2 User Guide*.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### Iops (Optional, Boolean)

Defines the number of IOPS for io1, io2, and gp3 type volumes.

The default value, supported values, and volume\_iops to volume\_size ratio varies by VolumeType and Size.

#### VolumeType = io1

Default Iops = 100

Supported values Iops = 100–64000 †

Maximum volume\_iops to volume\_size ratio = 50 IOPS per GiB. 5000 IOPS requires a volume\_size of at least 100 GiB.

#### VolumeType = io2

Default Iops = 100

Supported values Iops = 100–64000 (256000 for io2 Block Express volumes) †

Maximum Iops to Size ratio = 500 IOPS per GiB. 5000 IOPS requires a Size of at least 10 GiB.

#### VolumeType = gp3

Default Iops = 3000

Supported values Iops = 3000–16000 †

Maximum Iops to Size ratio = 500 IOPS per GiB for volumes with IOPS greater than 3000.

† Maximum IOPS is guaranteed only on [Instances built on the Nitro System](#) that are also provisioned with more than 32,000 IOPS. Other instances can have up to 32,000 IOPS. Earlier io1 volumes might not reach full performance unless you [modify the volume](#). io2 Block Express volumes support volume\_iops values up to 256000 on R5b instance

types. For more information, see [io2 Block Express volumes](#) in the *Amazon EC2 User Guide*.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### Throughput (Optional, Integer)

Defines the throughput for gp3 volume types, in MiB/s. This setting is valid only when `VolumeType` is gp3. The default value is 125. Supported values: 125–1000 MiB/s

The ratio of Throughput to Iops can be no more than 0.25. The maximum throughput of 1000 MiB/s requires that the Iops setting is at least 4000.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### EphemeralVolume (Optional, Boolean)

Specifies the settings for the ephemeral volume. The ephemeral volume is created by combining all instance store volumes into a single logical volume formatted with the ext4 file system. The default is `/scratch`. If the instance type doesn't have any instance store volumes, no ephemeral volume is created. For more information, see [Instance store volumes](#) in the *Amazon EC2 User Guide*.

```
EphemeralVolume:  
  MountDir: string
```

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### MountDir (Optional, String)

The mount directory for the ephemeral volume for each node in the Slurm queue.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

## CustomActions

**(Optional)** Specifies custom scripts to run on the nodes in the Slurm queue.

```
CustomActions:
  OnNodeStart:
    Sequence:
      - Script: string
      Args:
        - string
    Script: string
    Args:
      - string
  OnNodeConfigured:
    Sequence:
      - Script: string
      Args:
        - string
    Script: string
    Args:
      - string
```

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

## CustomActions Properties

### OnNodeStart (Optional, String)

Specifies a sequence of scripts or single script to run on the nodes in the Slurm queue before any node deployment bootstrap action is started. AWS ParallelCluster doesn't support including both a single script and Sequence for the same custom action. For more information, see [Custom bootstrap actions](#).

#### Sequence (Optional)

List of scripts to run.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.

#### Script (Required, String)

The file to use. The file path can start with `https://` or `s3://`.

Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.



**Args (Optional, [String])**

The list of arguments to pass to the script.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**Script (Required, String)**

The file to use for a single script. The file path can start with `https://` or `s3://`.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**Args (Optional, [String])**

The list of arguments to pass to the single script.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**OnNodeConfigured (Optional, String)**

Specifies a sequence of scripts or a single script to run on the nodes in the Slurm queue after all of the node bootstrap actions are complete. AWS ParallelCluster doesn't support including both a single script and Sequence for the same custom action. For more information, see [Custom bootstrap actions](#).

**Sequence (Optional)**

List of scripts to run.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

**Script (Required, String)**

The file to use. The file path can start with `https://` or `s3://`.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### Args (Optional, [String])

The list of arguments to pass to the script.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### Script (Required, String)

The file to use for a single script. The file path can start with `https://` or `s3://`.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

### Args (Optional, [String])

A list of arguments to pass to the single script.

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

#### Note

Sequence is added starting with AWS ParallelCluster version 3.6.0. When you specify Sequence, you can list multiple scripts for a custom action. AWS ParallelCluster continues to support configuring a custom action with a single script, without including Sequence.

AWS ParallelCluster doesn't support including both a single script and Sequence for the same custom action.

## Iam

**(Optional)** Defines optional IAM settings for the Slurm queue.

Iam:

S3Access:

- BucketName: *string*

```
EnableWriteAccess: boolean  
KeyName: string  
AdditionalIamPolicies:  
- Policy: string  
InstanceProfile: string  
InstanceRole: string
```

**Update policy: This setting can be changed during an update.**

## Iam Properties

### InstanceProfile (Optional, String)

Specifies an instance profile to override the default instance role or instance profile for the Slurm queue. You cannot specify both InstanceProfile and InstanceRole. The format is `arn:${Partition}:iam:${Account}:instance-profile/${InstanceProfileName}`.

If this is specified, the S3Access and AdditionalIamPolicies settings can't be specified.

We recommend that you specify one or both of the S3Access and AdditionalIamPolicies settings because features added to AWS ParallelCluster often require new permissions.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### InstanceRole (Optional, String)

Specifies an instance role to override the default instance role or instance profile for the Slurm queue. You cannot specify both InstanceProfile and InstanceRole. The format is `arn:${Partition}:iam:${Account}:role/${RoleName}`.

If this is specified, the S3Access and AdditionalIamPolicies settings can't be specified.

We recommend that you specify one or both of the S3Access and AdditionalIamPolicies settings because features added to AWS ParallelCluster often require new permissions.

**Update policy: This setting can be changed during an update.**

### S3Access (Optional)

Specifies a bucket for the Slurm queue. This is used to generate policies to grant the specified access to the bucket in the Slurm queue.

If this is specified, the `InstanceProfile` and `InstanceRole` settings can't be specified.

We recommend that you specify one or both of the `S3Access` and `AdditionalIamPolicies` settings because features added to AWS ParallelCluster often require new permissions.

#### `S3Access`:

- `BucketName`: *string*
- `EnableWriteAccess`: *boolean*
- `KeyName`: *string*

**Update policy: This setting can be changed during an update.**

#### **BucketName (Required, String)**

The name of the bucket.

**Update policy: This setting can be changed during an update.**

#### **KeyName (Optional, String)**

The key for the bucket. The default value is `*`.

**Update policy: This setting can be changed during an update.**

#### **EnableWriteAccess (Optional, Boolean)**

Indicates whether write access is enabled for the bucket.

**Update policy: This setting can be changed during an update.**

#### **AdditionalIamPolicies (Optional)**

Specifies a list of Amazon Resource Names (ARNs) of IAM policies for Amazon EC2. This list is attached to the root role used for the Slurm queue in addition to the permissions that are required by AWS ParallelCluster.

An IAM policy name and its ARN are different. Names can't be used.

If this is specified, the `InstanceProfile` and `InstanceRole` settings can't be specified.

We recommend that you use `AdditionalIamPolicies` because `AdditionalIamPolicies` are added to the permissions that AWS ParallelCluster requires, and the `InstanceRole` must

include all permissions required. The permissions required often change from release to release as features are added.

There's no default value.

AdditionalIamPolicies:

- Policy: *string*

**Update policy: This setting can be changed during an update.**

**Policy (Required, [String])**

List of IAM policies.

**Update policy: This setting can be changed during an update.**

## SlurmSettings

**(Optional)** Defines the settings for Slurm that apply to the entire cluster.

SlurmSettings:

ScaledownIdleTime: *integer*

QueueUpdateStrategy: *string*

EnableMemoryBasedScheduling: *boolean*

CustomSlurmSettings: *[dict]*

CustomSlurmSettingsIncludeFile: *string*

Database:

Uri: *string*

UserName: *string*

PasswordSecretArn: *string*

ExternalSlurmdbd:

Host: *string*

Port: *integer*

Dns:

DisableManagedDns: *boolean*

HostedZoneId: *string*

UseEc2Hostnames: *boolean*

## SlurmSettings Properties

### ScaledownIdleTime (Optional, Integer)

Defines the amount of time (in minutes) that there's no job and the Slurm node terminates.

The default value is 10.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### **MungeKeySecretArn (Optional, String)**

The Amazon Resource Name (ARN) of the plaintext AWS Secrets Manager secret that contains the base64-encoded munge key to be used in the Slurm cluster. This munge key will be used to authenticate RPC calls between Slurm client commands and Slurm daemons acting as remote servers. If MungeKeySecretArn is not provided, AWS ParallelCluster will generate a random munge key for the cluster.

#### **Note**

MungeKeySecretArn is supported starting with AWS ParallelCluster version 3.8.0.

#### **Warning**

If the MungeKeySecretArn is newly added to an existing cluster, ParallelCluster will not restore the previous munge Key in the event of a Rollback or when later removing the MungeKeySecretArn. Instead, a new random munge key will be generated.

If the AWS ParallelCluster user has the permission to [DescribeSecret](#) on that specific secret resource, MungeKeySecretArn is validated. MungeKeySecretArn is valid if:

- The specified secret exists, and
- The secret is plaintext and contains a valid base64-encoded string, and
- The decoded binary munge key has a size between 256 and 8192 bits.

If the pcluster user IAM policy doesn't include DescribeSecret, MungeKeySecretArn is not validated and a warning message is displayed. For more information, see [Base AWS ParallelCluster pcluster user policy](#).

When you update MungeKeySecretArn, the compute fleet and all login nodes must be stopped.

If the secret value in the secret ARN is modified while the ARN remains the same, the cluster won't automatically be updated with the new munge key. In order to use the secret ARN's new

munge key, you must stop the compute fleet and login nodes then run the following command from the head node.

```
sudo /opt/parallelcluster/scripts/slurm/update_munge_key.sh
```

After running the command, you can resume both the compute fleet and login nodes: the newly provisioned compute and login nodes will automatically start using the new munge key.

To generate a base64-encoded custom munge key, you can use the [mungekey utility](#) distributed with the munge software and then encode it using the base64 utility generally available in your OS. Alternatively, you either use bash (please set the bs parameter between 32 and 1024)

```
dd if=/dev/random bs=128 count=1 2>/dev/null | base64 -w 0
```

or Python as follows:

```
import random
import os
import base64

# key length in bytes
key_length=128

base64.b64encode(os.urandom(key_length)).decode("utf-8")
```

Update Policy: NEW UPDATE POLICY WITH COMPUTE FLEET AND LOGIN NODES STOPPED (erroneously not added in 3.7.0).

### **QueueUpdateStrategy (Optional, String)**

Specifies the replacement strategy for the [SlurmQueues](#) section parameters that have the following update policy:

[Update policy: The compute fleet must be stopped or QueueUpdateStrategy must be set for this setting to be changed for an update.](#)

The QueueUpdateStrategy value is used only when a cluster update process starts.

Valid values: COMPUTE\_FLEET\_STOP | DRAIN | TERMINATE

Default value: COMPUTE\_FLEET\_STOP

## DRAIN

Nodes in queues with changed parameter values are set to DRAINING. Nodes in this state don't accept new jobs and running jobs continue to completion.

After a node becomes idle (DRAINED), a node is replaced if the node is static, and the node is terminated if the node is dynamic. Other nodes in other queues without changed parameter values aren't impacted.

The time this strategy needs to replace all of the queue nodes with changed parameter values depends on the running workload.

## COMPUTE\_FLEET\_STOP

The default value of the `QueueUpdateStrategy` parameter. With this setting, updating parameters under the [SlurmQueues](#) section requires you to [stop the compute fleet](#) before performing a cluster update:

```
$ pcluster update-compute-fleet --status STOP_REQUESTED
```

## TERMINATE

In queues with changed parameter values, running jobs are terminated and the nodes are powered down immediately.

Static nodes are replaced and dynamic nodes are terminated.

Other nodes in other queues without changed parameter values aren't impacted.

**Update policy: This setting is not analyzed during an update.**

### Note

`QueueUpdateStrategy` is supported starting with AWS ParallelCluster version 3.2.0.

## EnableMemoryBasedScheduling (Optional, Boolean)

If `true`, memory-based scheduling is enabled in Slurm. For more information, see [SlurmQueues](#) / [ComputeResources](#) / [SchedulableMemory](#).



The default value is `false`.

**Warning**

Enabling memory-based scheduling impacts the way that the Slurm scheduler handles jobs and node allocation.

For more information, see [Slurm memory-based scheduling](#).

**Note**

`EnableMemoryBasedScheduling` is supported starting with AWS ParallelCluster version 3.2.0.

**Note**

Starting with AWS ParallelCluster version 3.7.0, `EnableMemoryBasedScheduling` can be enabled if you configure multiple instance types in [Instances](#).

For AWS ParallelCluster versions 3.2.0 to 3.6.x, `EnableMemoryBasedScheduling` can't be enabled if you configure multiple instance types in [Instances](#).

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### **CustomSlurmSettings (Optional, [Dict])**

Defines the custom Slurm settings that apply to the entire cluster.

Specifies a list of Slurm configuration dictionaries of key-value pairs to be appended to the end of the `slurm.conf` file that AWS ParallelCluster generates.

Each dictionary in the list appears as a separate line added to the Slurm configuration file. You can specify either simple or complex parameters.

Simple parameters consist of a single key pair, as shown in the following examples:

```
- Param1: 100
- Param2: "SubParam1,SubParam2=SubValue2"
```

**Example rendered in Slurm configuration:**

```
Param1=100
Param2=SubParam1,SubParam2=SubValue2
```

Complex Slurm configuration parameters consist of multiple space-separated key-value, pairs as shown in the next examples:

```
- NodeName: test-nodes[1-10]
  CPUs: 4
  RealMemory: 4196
  ... # other node settings
- NodeSet: test-nodeset
  Nodes: test-nodes[1-10]
  ... # other nodeset settings
- PartitionName: test-partition
  Nodes: test-nodeset
  ... # other partition settings
```

**Example, rendered in Slurm configuration:**

```
NodeName=test-nodes[1-10] CPUs=4 RealMemory=4196 ... # other node settings
NodeSet=test-nodeset Nodes=test-nodes[1-10] ... # other nodeset settings
PartitionName=test-partition Nodes=test-nodeset ... # other partition settings
```

**Note**

Custom Slurm nodes must not contain the `-st-` or `-dy-` patterns in their names. These patterns are reserved for nodes managed by AWS ParallelCluster.

If you specify custom Slurm configuration parameters in `CustomSlurmSettings`, you must not specify custom Slurm configuration parameters for `CustomSlurmSettingsIncludeFile`.

You can only specify Slurm configuration parameters that aren't deny-listed in `CustomSlurmSettings`. For information about deny-listed Slurm configuration parameters, see [Deny-listed Slurm configuration parameters for CustomSlurmSettings](#).


AWS ParallelCluster only checks whether a parameter is in a deny list. AWS ParallelCluster doesn't validate your custom Slurm configuration parameter syntax or semantics. You are

responsible for validating your custom Slurm configuration parameters. Invalid custom Slurm configuration parameters can cause Slurm daemon failures that can lead to cluster create and update failures.

For more information about how to specify custom Slurm configuration parameters with AWS ParallelCluster, see [Slurm configuration customization](#).

For more information about Slurm configuration parameters, see [slurm.conf](#) in the Slurm documentation.

**Update policy: This setting can be changed during an update.**

 **Note**

CustomSlurmSettings is supported starting with AWS ParallelCluster version 3.6.0.


### **CustomSlurmSettingsIncludeFile (Optional, String)**

Defines the custom Slurm settings that apply to the entire cluster.

Specifies the custom Slurm file consisting of custom Slurm configuration parameters to be appended at the end of the `slurm.conf` file that AWS ParallelCluster generates.

You must include the path to the file. The path can start with `https://` or `s3://`.

If you specify custom Slurm configuration parameters for `CustomSlurmSettingsIncludeFile`, you must not specify custom Slurm configuration parameters for `CustomSlurmSettings`.

 **Note**

Custom Slurm nodes must not contain the `-st-` or `-dy-` patterns in their names. These patterns are reserved for nodes managed by AWS ParallelCluster.

You can only specify Slurm configuration parameters that aren't deny-listed in `CustomSlurmSettingsIncludeFile`. For information about deny-listed Slurm configuration parameters, see [Deny-listed Slurm configuration parameters for CustomSlurmSettings](#).

AWS ParallelCluster only checks whether a parameter is in a deny list. AWS ParallelCluster doesn't validate your custom Slurm configuration parameter syntax or semantics. You are responsible for validating your custom Slurm configuration parameters. Invalid custom Slurm configuration parameters can cause Slurm daemon failures that can lead to cluster create and update failures.

For more information about how to specify custom Slurm configuration parameters with AWS ParallelCluster, see [Slurm configuration customization](#).

For more information about Slurm configuration parameters, see [slurm.conf](#) in the Slurm documentation.

**Update policy: This setting can be changed during an update.**

**Note**

CustomSlurmSettings is supported starting with AWS ParallelCluster version 3.6.0.

## Database

**(Optional)** Defines the settings to enable Slurm Accounting on the cluster. For more information, see [Slurm accounting with AWS ParallelCluster](#).

Database:

Uri: *string*

UserName: *string*

PasswordSecretArn: *string*

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

## Database properties

### Uri (Required, String)

The address to the database server that's used as the backend for Slurm accounting. This URI must be formatted as `host:port` and must not contain a scheme, such as `mysql://`. The host can either be an IP address or a DNS name that's resolvable by the head node. If a port isn't provided, AWS ParallelCluster uses the MySQL default port 3306.

AWS ParallelCluster bootstraps the Slurm accounting database to the cluster and must access the database.

The database must be reachable before the following occurs:

- A cluster is created.
- Slurm accounting is enabled with a cluster update.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### **UserName (Required, String)**

The identity that Slurm uses to connect to the database, write accounting logs, and perform queries. The user must have both read and write permissions on the database.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

### **PasswordSecretArn (Required, String)**

The Amazon Resource Name (ARN) of the AWS Secrets Manager secret that contains the UserName plaintext password. This password is used together with UserName and Slurm accounting to authenticate on the database server.

#### **Note**

When creating a secret using the AWS Secrets Manager console be sure to select "Other type of secret", select plaintext, and only include the password text in the secret. For more information on how to use AWS Secrets Manager to create a secret refer to [Create an AWS Secrets Manager Secret](#)

If the user has the permission to [DescribeSecret](#), PasswordSecretArn is validated. PasswordSecretArn is valid if the specified secret exists. If the user IAM policy doesn't include DescribeSecret, PasswordSecretArn isn't validated and a warning message is displayed. For more information, see [Base AWS ParallelCluster pcluster user policy](#).

When you update PasswordSecretArn, the compute fleet must be stopped. If the secret value changes, and the secret ARN doesn't change, the cluster isn't automatically updated with the new database password. To update the cluster for the new secret value, you must run the following command from within the head node after the compute fleet is stopped.

```
$ sudo /opt/parallelcluster/scripts/slurm/update_slurm_database_password.sh
```

**⚠ Warning**

We recommend that you only change the database password when the compute fleet is stopped to avoid loss of accounting data.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

**DatabaseName (Optional, String)**

Name of the database on the database server (defined by the Uri parameter) to be used for Slurm Accounting.

The name of the database may contain lowercase letters, numbers and underscores. The name may not be longer than 64 characters.

This parameter maps to the StorageLoc parameter of [slurmdbd.conf](#).

If DatabaseName is not provided, ParallelCluster will use the name of the cluster to define a value for StorageLoc.

Updating the DatabaseName is allowed, with the following considerations:

- If a database with a name DatabaseName does not yet exist on the database server, slurmdbd will create it. It will be your responsibility to reconfigure the new database as needed (e.g. adding the accounting entities — clusters, accounts, users, associations, QOSs, etc.).
- If a database with a name DatabaseName already exists on the database server, slurmdbd will use it for the Slurm Accounting functionality.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

**📘 Note**

Database is added starting with release 3.3.0.

## ExternalSlurmdbd

**(Optional)** Defines the settings to enable Slurm Accounting with an external slurmdbd server. For more information, see [Slurm accounting with AWS ParallelCluster](#).

ExternalSlurmdbd:

Host: *string*

Port: *integer*

## ExternalSlurmdbd properties

### Host (Required, String)

The address to the external slurmdbd server for Slurm accounting. The host can either be an IP address or a DNS name that's resolvable by the head node.

**Update policy: This setting can be changed during an update.**

### Port (Optional, Integer)

The port the slurmdbd service listens to. The default value is 6819.

**Update policy: This setting can be changed during an update.**

## Dns

**(Optional)** Defines the settings for Slurm that apply to the entire cluster.

Dns:

DisableManagedDns: *boolean*

HostedZoneId: *string*

UseEc2Hostnames: *boolean*

## Dns properties

### DisableManagedDns (Optional, Boolean)

If `true`, the DNS entries for the cluster aren't created and Slurm node names aren't resolvable.

By default, AWS ParallelCluster creates a Route 53 hosted zone where nodes are registered when launched. The default value is `false`. If `DisableManagedDns` is set to `true`, the hosted zone isn't created by AWS ParallelCluster.

To learn how to use this setting to deploy clusters in subnets with no internet access, see [AWS ParallelCluster in a single subnet with no internet access](#).

### **Warning**

A name resolution system is required for the cluster to operate properly. If `DisableManagedDns` is set to `true`, you must provide a name resolution system. To use the Amazon EC2 default DNS, set `UseEc2Hostnames` to `true`. Alternatively, configure your own DNS resolver and make sure that node names are registered when instances are launched. For example, you can do this by configuring [CustomActions / OnNodeStart](#).

**Update policy: If this setting is changed, the update is not allowed.**

### **HostedZoneId (Optional, String)**

Defines a custom Route 53 hosted zone ID to use for DNS name resolution for the cluster. When provided, AWS ParallelCluster registers cluster nodes in the specified hosted zone and doesn't create a managed hosted zone.

**Update policy: If this setting is changed, the update is not allowed.**

### **UseEc2Hostnames (Optional, Boolean)**

If `true`, cluster compute nodes are configured with the default EC2 hostname. The `Slurm NodeHostName` is also updated with this information. The default is `false`.

To learn how to use this setting to deploy clusters in subnets with no internet access, see [AWS ParallelCluster in a single subnet with no internet access](#).

### **Note**

**This note isn't relevant starting with AWS ParallelCluster version 3.3.0.**

For AWS ParallelCluster supported versions prior to 3.3.0:

When `UseEc2Hostnames` is set to `true`, the Slurm configuration file is set with the AWS ParallelCluster prolog and epilog scripts:

- `prolog` runs to add nodes info to `/etc/hosts` on compute nodes when each job is allocated.
- `epilog` runs to clean contents written by `prolog`.



To add custom prolog or epilog scripts, add them to the `/opt/slurm/etc/pcluster/prolog.d/` or `/opt/slurm/etc/pcluster/epilog.d/` folders respectively.

**Update policy: If this setting is changed, the update is not allowed.**

## SharedStorage section

**(Optional)** The shared storage settings for the cluster.

AWS ParallelCluster supports either using [Amazon EBS](#), [FSx for ONTAP](#), and [FSx for OpenZFS](#) shared storage volumes, [Amazon EFS](#) and [FSx for Lustre](#) shared storage file systems, or [File Caches](#).

In the SharedStorage section, you can define either external or managed storage:

- **External storage** refers to an existing volume or file system that you manage. AWS ParallelCluster doesn't create or delete it.
- **AWS ParallelCluster managed storage** refers to a volume or file system that AWS ParallelCluster created and can delete.

For [shared storage quotas](#) and more information about configuring your shared storage, see [Shared storage](#) in *Using AWS ParallelCluster*.

### Note

If AWS Batch is used as a scheduler, FSx for Lustre is only available on the cluster head node.

#### SharedStorage:

```
- MountDir: string
  Name: string
  StorageType: Ebs
  EbsSettings:
    VolumeType: string
    Iops: integer
    Size: integer
    Encrypted: boolean
```

```
KmsKeyId: string
SnapshotId: string
Throughput: integer
VolumeId: string
DeletionPolicy: string
Raid:
  Type: string
  NumberOfVolumes: integer
- MountDir: string
Name: string
StorageType: Efs
EfsSettings:
  Encrypted: boolean
  KmsKeyId: string
  EncryptionInTransit: boolean
  IamAuthorization: boolean
  PerformanceMode: string
  ThroughputMode: string
  ProvisionedThroughput: integer
  FileSystemId: string
  DeletionPolicy: string
- MountDir: string
Name: string
StorageType: FsxLustre
FsxLustreSettings:
  StorageCapacity: integer
  DeploymentType: string
  ImportedFileChunkSize: integer
  DataCompressionType: string
  ExportPath: string
  ImportPath: string
  WeeklyMaintenanceStartTime: string
  AutomaticBackupRetentionDays: integer
  CopyTagsToBackups: boolean
  DailyAutomaticBackupStartTime: string
  PerUnitStorageThroughput: integer
  BackupId: string
  KmsKeyId: string
  FileSystemId: string
  AutoImportPolicy: string
  DriveCacheType: string
  StorageType: string
  DeletionPolicy: string
  DataRepositoryAssociations:
```

- Name: *string*
- BatchImportMetaDataOnCreate: *boolean*
- DataRepositoryPath: *string*
- FileSystemPath: *string*
- ImportedFileChunkSize: *integer*
- AutoExportPolicy: *string*
- AutoImportPolicy: *string*
- MountDir: *string*
- Name: *string*
- StorageType: FsxOntap
- FsxOntapSettings:
  - VolumeId: *string*
- MountDir: *string*
- Name: *string*
- StorageType: FsxOpenZfs
- FsxOpenZfsSettings:
  - VolumeId: *string*
- MountDir: *string*
- Name: *string*
- StorageType: FileCache
- FileCacheSettings:
  - FileCacheId: *string*

## SharedStorage update policies

- For managed/external EBS, managed EFS and managed FSx Lustre, the update policy is [Update policy: For this list values setting, the compute fleet must be stopped or QueueUpdateStrategy must be set to add a new value; the compute fleet must be stopped when removing an existing value.](#)
- For external EFS, FSx Lustre, FSx ONTAP, FSx OpenZfs and File Cache, the update policy is, [Update policy: This setting can be changed during an update.](#)

## SharedStorage properties

MountDir (**Required**, String)

The path where the shared storage is mounted.

[Update policy: If this setting is changed, the update is not allowed.](#)

**Name (Required, String)**

The name of the shared storage. You use this name when you update the settings.

**⚠ Warning**

If you specify AWS ParallelCluster managed shared storage, and you change the value for Name, the existing managed shared storage and data is deleted and new managed shared storage is created. Changing the value for Name with a cluster update is equivalent to replacing the existing managed shared storage with a new one. Make sure you back up your data before changing Name if you need to retain the data from the existing shared storage.

Update policy: For this list values setting, the compute fleet must be stopped or QueueUpdateStrategy must be set to add a new value; the compute fleet must be stopped when removing an existing value.

**StorageType (Required, String)**

The type of the shared storage. Supported values are Ebs, Efs, FsxLustre, FsxOntap, and FsxOpenZfs.

For more information, see [FsxLustreSettings](#), [FsxOntapSettings](#), and [FsxOpenZfsSettings](#).

**i Note**

If you use AWS Batch as a scheduler, FSx for Lustre is only available on the cluster head node.

Update policy: If this setting is changed, the update is not allowed.

**EbsSettings**

**(Optional)** The settings for an Amazon EBS volume.

[EbsSettings](#):

```

VolumeType: string
Iops: integer
Size: integer
Encrypted: boolean
KmsKeyId: string
SnapshotId: string
VolumeId: string
Throughput: integer
DeletionPolicy: string
Raid:
  Type: string
  NumberOfVolumes: integer

```

**Update policy: If this setting is changed, the update is not allowed.**

### EbsSettings properties

When the [DeletionPolicy](#) is set to Delete, a managed volume, with its data, is deleted if the cluster is deleted or if the volume is removed with a cluster update.

For more information, see [Shared storage](#) in *Using AWS ParallelCluster*.

VolumeType (**Optional**, String)

Specifies the [Amazon EBS volume type](#). Supported values are gp2, gp3, io1, io2, sc1, st1, and standard. The default value is gp3.

For more information, see [Amazon EBS volume types](#) in the *Amazon EC2 User Guide*.

**Update policy: If this setting is changed, the update is not allowed.**

Iops (**Optional**, Integer)

Defines the number of IOPS for io1, io2, and gp3 type volumes.

The default value, supported values, and volume\_iops to volume\_size ratio varies by VolumeType and Size.

VolumeType = io1

Default Iops = 100

Supported values Iops = 100–64000 †

Maximum `volume_iops` to `volume_size` ratio = 50 IOPS for each GiB. 5000 IOPS requires a `volume_size` of at least 100 GiB.

`VolumeType = io2`

Default Iops = 100

Supported values Iops = 100–64000 (256000 for io2 Block Express volumes) †

Maximum Iops to Size ratio = 500 IOPS for each GiB. 5000 IOPS requires a Size of at least 10 GiB.

`VolumeType = gp3`

Default Iops = 3000

Supported values Iops = 3000–16000

Maximum Iops to Size ratio = 500 IOPS for each GiB. 5000 IOPS requires a Size of at least 10 GiB.

† Maximum IOPS is guaranteed only on [Instances built on the Nitro System](#) provisioned with more than 32,000 IOPS. Other instances guarantee up to 32,000 IOPS. Unless you [modify the volume](#), earlier io1 volumes might not reach full performance. io2 Block Express volumes support `volume_iops` values up to 256000 on R5b instance types. For more information, see [io2 Block Express volumes](#) in the *Amazon EC2 User Guide*.

**Update policy: This setting can be changed during an update.**

Size (**Optional**, Integer)

Specifies the volume size in gibibytes (GiB). The default value is 35.

**Update policy: If this setting is changed, the update is not allowed.**

Encrypted (**Optional**, Boolean)

Specifies if the volume is encrypted. The default value is true.

**Update policy: If this setting is changed, the update is not allowed.**

KmsKeyId (**Optional**, String)

Specifies a custom AWS KMS key to use for encryption. This setting requires that the Encrypted setting is set to true.

**Update policy: If this setting is changed, the update is not allowed.**

SnapshotId (**Optional**, String)

Specifies the Amazon EBS snapshot ID if you use a snapshot as the source for the volume.

**Update policy: If this setting is changed, the update is not allowed.**

VolumeId (**Optional**, String)

Specifies the Amazon EBS volume ID. When this is specified for an EbsSettings instance, only the MountDir parameter can also be specified.

The volume must be created in the same Availability Zone as the HeadNode.

**Note**

Multiple Availability Zones is added in AWS ParallelCluster version 3.4.0.

**Update policy: If this setting is changed, the update is not allowed.**

Throughput (**Optional**, Integer)

The throughput, in MiB/s to provision for a volume, with a maximum of 1,000 MiB/s.

This setting is valid only when VolumeType is gp3. The supported range is 125 to 1000, with a default value of 125.

**Update policy: This setting can be changed during an update.**

DeletionPolicy (**Optional**, String)

Specifies whether the volume should be retained, deleted, or snapshotted when the cluster is deleted or the volume is removed. The supported values are Delete, Retain, and Snapshot. The default value is Delete.

When the [DeletionPolicy](#) set to Delete, a managed volume, with its data, is deleted if the cluster is deleted or if the volume is removed with a cluster update.

For more information, see [Shared storage](#).

**Update policy: This setting can be changed during an update.**

**Note**

DeletionPolicy is supported starting with AWS ParallelCluster version 3.2.0.

**Raid**

**(Optional)** Defines the configuration of a RAID volume.

Raid:

Type: *string*

NumberOfVolumes: *integer*

**Update policy: If this setting is changed, the update is not allowed.**

**Raid properties**

Type (**Required**, String)

Defines the type of RAID array. Supported values are "0" (striped) and "1" (mirrored).

**Update policy: If this setting is changed, the update is not allowed.**

NumberOfVolumes (**Optional**, Integer)

Defines the number of Amazon EBS volumes to use to create the RAID array. The supported range of values is 2-5. The default value (when the Raid setting is defined) is 2.

**Update policy: If this setting is changed, the update is not allowed.**

**EfsSettings**

**(Optional)** The settings for an Amazon EFS file system.

EfsSettings:

Encrypted: *boolean*

KmsKeyId: *string*

EncryptionInTransit: *boolean*

IamAuthorization: *boolean*

PerformanceMode: *string*

ThroughputMode: *string*



```
ProvisionedThroughput: integer  
FileSystemId: string  
DeletionPolicy: string
```

**Update policy: If this setting is changed, the update is not allowed.**

## EfsSettings properties

When the [DeletionPolicy](#) set to Delete, a managed file system, with its data, is deleted if the cluster is deleted, or if the file system is removed with a cluster update.

For more information, see [Shared storage](#) in *Using AWS ParallelCluster*.

Encrypted (**Optional**, Boolean)

Specifies if the Amazon EFS file system is encrypted. The default value is false.

**Update policy: If this setting is changed, the update is not allowed.**

KmsKeyId (**Optional**, String)

Specifies a custom AWS KMS key to use for encryption. This setting requires that the Encrypted setting is set to true.

**Update policy: If this setting is changed, the update is not allowed.**

EncryptionInTransit (**Optional**, Boolean)

If set to true, Amazon EFS file systems are mounted using Transport Layer Security (TLS). By default, this is set to false.

### Note

If AWS Batch is used as scheduler, EncryptionInTransit isn't supported.

### Note

EncryptionInTransit is added starting with AWS ParallelCluster version 3.4.0.

**Update policy: If this setting is changed, the update is not allowed.**

## IamAuthorization (**Optional**, Boolean)

If set to `true`, Amazon EFS is authenticated by using the system's IAM identity. By default, this is set to `false`.

### **Note**

If `IamAuthorization` is set to `true`, `EncryptionInTransit` must also be set to `true`.

### **Note**

If AWS Batch is used as scheduler, `IamAuthorization` isn't supported.

### **Note**

`IamAuthorization` is added starting with AWS ParallelCluster version 3.4.0.

### **Update policy: If this setting is changed, the update is not allowed.**

## PerformanceMode (**Optional**, String)

Specifies the performance mode of the Amazon EFS file system. Supported values are `generalPurpose` and `maxIO`. The default value is `generalPurpose`. For more information, see [Performance modes](#) in the *Amazon Elastic File System User Guide*.

We recommend the `generalPurpose` performance mode for most file systems.

File systems that use the `maxIO` performance mode can scale to higher levels of aggregate throughput and operations per second. However, there's a trade-off of slightly higher latencies for most file operations.

### **Update policy: If this setting is changed, the update is not allowed.**

## ThroughputMode (**Optional**, String)

Specifies the throughput mode of the Amazon EFS file system. Supported values are `bursting` and `provisioned`. The default value is `bursting`. When `provisioned` is used, `ProvisionedThroughput` must be specified.

**Update policy: This setting can be changed during an update.**

ProvisionedThroughput (**Required** when ThroughputMode is provisioned, Integer)

Defines the provisioned throughput (in MiB/s) of the Amazon EFS file system, measured in MiB/s. This corresponds to the [ProvisionedThroughputInMibps](#) parameter in the *Amazon EFS API Reference*.

If you use this parameter, you must set ThroughputMode to provisioned.

The supported range is 1-1024. To request a limit increase, contact AWS Support.

**Update policy: This setting can be changed during an update.**

FileSystemId (**Optional**, String)

Defines the Amazon EFS file system ID for an existing file system.

If the cluster is configured to span multiple Availability Zones, you must define a file system mount target in each Availability Zone that's used by the cluster.

When this is specified, only MountDir can be specified. No other EfsSettings can be specified.

**If you set this option, the following must be true for the file systems that you define:**

- The file systems have an existing mount target in each of the cluster's Availability Zones, with inbound and outbound NFS traffic allowed from the HeadNode and ComputeNodes. Multiple availability zones are configured in [Scheduling](#) / [SlurmQueues](#) / [Networking](#) / [SubnetIds](#).

**To make sure traffic is allowed between the cluster and file system, you can do one of the following:**

- Configure the security groups of the mount target to allow the traffic to and from the CIDR or prefix list of cluster subnets.

**Note**

AWS ParallelCluster validates that ports are open and that the CIDR or prefix list is configured. AWS ParallelCluster doesn't validate the content of CIDR block or prefix list.

- Set custom security groups for cluster nodes by using [SlurmQueues](#) / [Networking](#) / [SecurityGroups](#) and [HeadNode](#) / [Networking](#) / [SecurityGroups](#). The custom security groups must be configured to allow traffic between the cluster and the file system.

**Note**

If all cluster nodes use custom security groups, AWS ParallelCluster only validates that the ports are open. AWS ParallelCluster doesn't validate that the source and destination are properly configured.

**Warning**

EFS OneZone is only supported if all compute nodes and the head node are in the same Availability Zone. EFS OneZone can have only one mount target.

**Note**

Multiple Availability Zones is added in AWS ParallelCluster version 3.4.0.

**Update policy: If this setting is changed, the update is not allowed.**

DeletionPolicy (**Optional**, String)

Specifies whether the file system should be retained or deleted when the file system is removed from the cluster or the cluster is deleted. The supported values are Delete and Retain. The default value is Delete.

When the [DeletionPolicy](#) is set to Delete, a managed file system, with its data, is deleted if the cluster is deleted, or if the file system is removed with a cluster update.

For more information, see [Shared storage](#).

**Update policy: This setting can be changed during an update.****Note**

DeletionPolicy is supported starting with AWS ParallelCluster version 3.3.0.

## FsxLustreSettings

### Note

You must define FsxLustreSettings if FsxLustre is specified for [StorageType](#).

**(Optional)** The settings for an FSx for Lustre file system.

#### FsxLustreSettings:

```
StorageCapacity: integer  
DeploymentType: string  
ImportedFileChunkSize: integer  
DataCompressionType: string  
ExportPath: string  
ImportPath: string  
WeeklyMaintenanceStartTime: string  
AutomaticBackupRetentionDays: integer  
CopyTagsToBackups: boolean  
DailyAutomaticBackupStartTime: string  
PerUnitStorageThroughput: integer  
BackupId: string # BackupId cannot coexist with some of the fields  
KmsKeyId: string  
FileSystemId: string # FileSystemId cannot coexist with other fields  
AutoImportPolicy: string  
DriveCacheType: string  
StorageType: string  
DeletionPolicy: string
```

**Update policy: If this setting is changed, the update is not allowed.**

### Note

If AWS Batch is used as a scheduler, FSx for Lustre is only available on the cluster head node.

## FsxLustreSettings properties

When the [DeletionPolicy](#) is set to Delete, a managed file system, with its data, is deleted if the cluster is deleted, or if the file system is removed with a cluster update.

For more information, see [Shared storage](#).

### StorageCapacity (**Required**, Integer)

Sets the storage capacity of the FSx for Lustre file system, in GiB. StorageCapacity is required if you're creating a new file system. Do not include StorageCapacity if BackupId or FileSystemId is specified.

- For SCRATCH\_2, PERSISTENT\_1, and PERSISTENT\_2 deployment types, valid values are 1200 GiB, 2400 GiB, and increments of 2400 GiB.
- For SCRATCH\_1 deployment type, valid values are 1200 GiB, 2400 GiB, and increments of 3600 GiB.

**Update policy: If this setting is changed, the update is not allowed.**

### DeploymentType (**Optional**, String)

Specifies the deployment type of the FSx for Lustre file system. Supported values are SCRATCH\_1, SCRATCH\_2, PERSISTENT\_1, and PERSISTENT\_2. The default value is SCRATCH\_2.

Choose SCRATCH\_1 and SCRATCH\_2 deployment types when you need temporary storage and shorter term processing of data. The SCRATCH\_2 deployment type provides in transit encryption of data and higher burst throughput capacity than SCRATCH\_1.

Choose PERSISTENT\_1 deployment type for longer term storage and for throughput focused workloads that aren't latency-sensitive. PERSISTENT\_1 supports encryption of data in transit. It's available in all AWS Regions where FSx for Lustre is available.

Choose PERSISTENT\_2 deployment type for longer term storage and for latency sensitive workloads that require the highest levels of IOPS and throughput. PERSISTENT\_2 supports SSD storage and offers higher PerUnitStorageThroughput (up to 1000 MB/s/TiB). PERSISTENT\_2 is available in a limited number of AWS Regions. For more information about deployment types and the list of AWS Regions where PERSISTENT\_2 is available, see [File system deployment options for FSx for Lustre](#) in the *Amazon FSx for Lustre User Guide*.

Encryption of data in transit is automatically enabled when you access SCRATCH\_2, PERSISTENT\_1, or PERSISTENT\_2 deployment type file systems from Amazon EC2 instances that support [this feature](#).

Encryption of data in transit for SCRATCH\_2, PERSISTENT\_1, and PERSISTENT\_2 deployment types is supported when accessed from supported instance types in supported AWS Regions. For more information, see [Encrypting data in transit](#) in the *Amazon FSx for Lustre User Guide*.

**Note**

Support for the PERSISTENT\_2 deployment type was added with AWS ParallelCluster version 3.2.0.

**Update policy: If this setting is changed, the update is not allowed.**

ImportedFileChunkSize (**Optional**, Integer)

For files that are imported from a data repository, this value determines the stripe count and maximum amount of data for each file (in MiB) that's stored on a single physical disk. The maximum number of disks that a single file can be striped across is limited by the total number of disks that make up the file system.

The default chunk size is 1,024 MiB (1 GiB) and can go as high as 512,000 MiB (500 GiB). Amazon S3 objects have a maximum size of 5 TB.

**Note**

This parameter isn't supported for file systems using the PERSISTENT\_2 deployment type. For instructions on how to configure data repositories associations, see [Linking your file system to an S3 bucket](#) in the *Amazon FSx for Lustre User Guide*.

**Update policy: If this setting is changed, the update is not allowed.**

DataCompressionType (**Optional**, String)

Sets the data compression configuration for the FSx for Lustre file system. The supported value is LZ4. LZ4 indicates that data compression is turned on with the LZ4 algorithm. When DataCompressionType isn't specified, data compression is turned off when the file system is created.

For more information, see [Lustre data compression](#).

**Update policy: This setting can be changed during an update.**

## ExportPath (Optional, String)

The path in Amazon S3 where the root of your FSx for Lustre file system is exported. This setting is only supported when the ImportPath parameter is specified. The path must use the same Amazon S3 bucket as specified in ImportPath. You can provide an optional prefix to which new and changed data is to be exported from your FSx for Lustre file system. If an ExportPath value is not provided, FSx for Lustre sets a default export path, `s3://import-bucket/FSxLustre[creation-timestamp]`. The timestamp is in UTC format, for example `s3://import-bucket/FSxLustre20181105T222312Z`.

The Amazon S3 export bucket must be the same as the import bucket specified by ImportPath. If you only specify a bucket name, such as `s3://import-bucket`, you get a 1:1 mapping of file system objects to Amazon S3 bucket objects. This mapping means that the input data in Amazon S3 is overwritten on export. If you provide a custom prefix in the export path, such as `s3://import-bucket/[custom-optional-prefix]`, FSx for Lustre exports the contents of your file system to that export prefix in the Amazon S3 bucket.

### Note

This parameter isn't supported for file systems using the PERSISTENT\_2 deployment type. Configure data repositories associations as described in [Linking your file system to an S3 bucket](#) in the *Amazon FSx for Lustre User Guide*.

### Update policy: If this setting is changed, the update is not allowed.

## ImportPath (Optional, String)

The path to the Amazon S3 bucket (including the optional prefix) that you're using as the data repository for your FSx for Lustre file system. The root of your FSx for Lustre file system will be mapped to the root of the Amazon S3 bucket you select. An example is `s3://import-bucket/optional-prefix`. If you specify a prefix after the Amazon S3 bucket name, only object keys with that prefix are loaded into the file system.

### Note

This parameter isn't supported for file systems using the PERSISTENT\_2 deployment type. Configure data repositories associations as described in [Linking your file system to an S3 bucket](#) in the *Amazon FSx for Lustre User Guide*.



**Update policy: If this setting is changed, the update is not allowed.**

WeeklyMaintenanceStartTime (**Optional**, String)

The preferred start time to perform weekly maintenance. It's in the "d:HH:MM" format in the UTC+0 time zone. For this format, d is the weekday number from 1 through 7, beginning with Monday and ending with Sunday. Quotation marks are required for this field.

**Update policy: This setting can be changed during an update.**

AutomaticBackupRetentionDays (**Optional**, Integer)

The number of days to retain automatic backups. Setting this to 0 disables automatic backups. The supported range is 0-90. The default is 0. This setting is only valid for use with PERSISTENT\_1 and PERSISTENT\_2 deployment types. For more information, see [Working with backups](#) in the *Amazon FSx for Lustre User Guide*.

**Update policy: This setting can be changed during an update.**

CopyTagsToBackups (**Optional**, Boolean)

If true, copy the tags for the FSx for Lustre file system to backups. This value defaults to false. If it's set to true, all tags for the file system are copied to all automatic and user-initiated backups where the user doesn't specify tags. If this value is true, and you specify one or more tags, only the specified tags are copied to backups. If you specify one or more tags when creating a user-initiated backup, no tags are copied from the file system, regardless of this value. This setting is only valid for use with PERSISTENT\_1 and PERSISTENT\_2 deployment types.

**Update policy: If this setting is changed, the update is not allowed.**

DailyAutomaticBackupStartTime (**Optional**, String)

A recurring daily time, in the HH:MM format. HH is the zero-padded hour of the day (00-23). MM is the zero-padded minute of the hour (00-59). For example, 05:00 specifies 5 A.M. daily. This setting is only valid for use with PERSISTENT\_1 and PERSISTENT\_2 deployment types.

**Update policy: This setting can be changed during an update.**

PerUnitStorageThroughput (**Required for PERSISTENT\_1 and PERSISTENT\_2 deployment types**, Integer)

Describes the amount of read and write throughput for each 1 tebibyte of storage, in MB/s/TiB. File system throughput capacity is calculated by multiplying file system storage

capacity (TiB) by the `PerUnitStorageThroughput` (MB/s/TiB). For a 2.4 TiB file system, provisioning 50 MB/s/TiB of `PerUnitStorageThroughput` yields 120 MB/s of file system throughput. You pay for the amount of throughput that you provision. This corresponds to the [PerUnitStorageThroughput](#) property.

Valid values:

PERSISTENT\_1 SSD storage: 50, 100, 200 MB/s/TiB.

PERSISTENT\_1 HDD storage: 12, 40 MB/s/TiB.

PERSISTENT\_2 SSD storage: 125, 250, 500, 1000 MB/s/TiB.

**Update policy: If this setting is changed, the update is not allowed.**

**BackupId (Optional, String)**

Specifies the ID of the backup to use for restoring the FSx for Lustre file system from an existing backup. When the `BackupId` setting is specified, the `AutoImportPolicy`, `DeploymentType`, `ExportPath`, `KmsKeyId`, `ImportPath`, `ImportedFileChunkSize`, `StorageCapacity`, and `PerUnitStorageThroughput` settings must not be specified. These settings are read from the backup. Additionally, the `AutoImportPolicy`, `ExportPath`, `ImportPath`, and `ImportedFileChunkSize` settings must not be specified. This corresponds to the [BackupId](#) property.

**Update policy: If this setting is changed, the update is not allowed.**

**KmsKeyId (Optional, String)**

The ID of the AWS Key Management Service (AWS KMS) key ID that's used to encrypt the FSx for Lustre file system's data for persistent FSx for Lustre file systems at rest. If not specified, the FSx for Lustre managed key is used. The `SCRATCH_1` and `SCRATCH_2` FSx for Lustre file systems are always encrypted at rest using FSx for Lustre managed keys. For more information, see [Encrypt](#) in the *AWS Key Management Service API Reference*.

**Update policy: If this setting is changed, the update is not allowed.**

**FileSystemId (Optional, String)**

Specifies the ID of an existing FSx for Lustre file system.

If this option is specified, only the `MountDir` and `FileSystemId` settings in the `FsxLustreSettings` are used. All other settings in the `FsxLustreSettings` are ignored.

**Note**

If AWS Batch scheduler is used, FSx for Lustre is only available on the head node.

**Note**

The file system must be associated to a security group that allows inbound and outbound TCP traffic through ports 988, 1021, 1022, and 1023.

Make sure that traffic is allowed between the cluster and file system by doing one of the following:

- Configure the security groups of the file system to allow the traffic to and from the CIDR or prefix list of cluster subnets.

**Note**

AWS ParallelCluster validates that ports are open and that the CIDR or prefix list is configured. AWS ParallelCluster doesn't validate the content of CIDR block or prefix list.

- Set custom security groups for cluster nodes by using [SlurmQueues / Networking / SecurityGroups](#) and [HeadNode / Networking / SecurityGroups](#). The custom security groups must be configured to allow traffic between the cluster and the file system.

**Note**

If all cluster nodes use custom security groups, AWS ParallelCluster only validates that the ports are open. AWS ParallelCluster doesn't validate that the source and destination are properly configured.

**Update policy: If this setting is changed, the update is not allowed.**

AutoImportPolicy (**Optional**, String)

When you create your FSx for Lustre file system, your existing Amazon S3 objects appear as file and directory listings. Use this property to choose how FSx for Lustre keeps your file and

directory listings up to date as you add or modify objects in your linked Amazon S3 bucket.

`AutoImportPolicy` can have the following values:

- `NEW` - Automatic import is on. FSx for Lustre automatically imports directory listings of any new objects added to the linked Amazon S3 bucket that do not currently exist in the FSx for Lustre file system.
- `NEW_CHANGED` - Automatic import is on. FSx for Lustre automatically imports file and directory listings of any new objects added to the Amazon S3 bucket and any existing objects that are changed in the Amazon S3 bucket after you choose this option.
- `NEW_CHANGED_DELETED` - Automatic import is on. FSx for Lustre automatically imports file and directory listings of any new objects added to the Amazon S3 bucket, any existing objects that are changed in the Amazon S3 bucket, and any objects that were deleted in the Amazon S3 bucket after you choose this option.

**Note**

Support for `NEW_CHANGED_DELETED` was added in AWS ParallelCluster version 3.1.1.

If `AutoImportPolicy` isn't specified, automatic import is off. FSx for Lustre only updates file and directory listings from the linked Amazon S3 bucket when the file system is created. FSx for Lustre doesn't update file and directory listings for any new or changed objects after choosing this option.

For more information, see [Automatically import updates from your S3 bucket](#) in the *Amazon FSx for Lustre User Guide*.

**Note**

This parameter isn't supported for file systems using the `PERSISTENT_2` deployment type. For instructions on how to configure data repositories associations, see [Linking your file system to an S3 bucket](#) in the *Amazon FSx for Lustre User Guide*.

**Update policy: If this setting is changed, the update is not allowed.**

`DriveCacheType` (**Optional**, String)

Specifies that the file system has an SSD drive cache. This can only be set if the `StorageType` setting is set to `HDD`, and the `DeploymentType` setting is set to `PERSISTENT_1`. This

corresponds to the [DriveCacheType](#) property. For more information, see [FSx for Lustre deployment options](#) in the *Amazon FSx for Lustre User Guide*.

The only valid value is READ. To disable the SSD drive cache, don't specify the `DriveCacheType` setting.

**Update policy: If this setting is changed, the update is not allowed.**

`StorageType` (**Optional**, String)

Sets the storage type for the FSx for Lustre file system that you're creating. Valid values are SSD and HDD.

- Set to SSD to use solid state drive storage.
- Set to HDD to use hard disk drive storage. HDD is supported on PERSISTENT deployment types.

The default value is SSD. For more information, see [Storage Type Options](#) in the *Amazon FSx for Windows User Guide* and [Multiple Storage Options](#) in the *Amazon FSx for Lustre User Guide*.

**Update policy: If this setting is changed, the update is not allowed.**


`DeletionPolicy` (**Optional**, String)

Specifies whether the file system should be retained or deleted when the file system is removed from the cluster or the cluster is deleted. The supported values are `Delete` and `Retain`. The default value is `Delete`.

When the [DeletionPolicy](#) is set to `Delete`, a managed file system, with its data, is deleted if the cluster is deleted, or if the file system is removed with a cluster update.

For more information, see [Shared storage](#).

**Update policy: This setting can be changed during an update.**

 **Note**

`DeletionPolicy` is supported starting with AWS ParallelCluster version 3.3.0.

`DataRepositoryAssociations` (**Optional**, String)

List of DRAs (up to 8 per file system)

Each data repository association must have a unique Amazon FSx file system directory and a unique S3 bucket or prefix associated with it.

You can not use [ExportPath](#) and [ImportPath](#) in the `FsxLustreSettings` at the same time as using DRAs.

**Update policy: This setting can be changed during an update.**

Name (**Required**, String)

The name of the DRA. You use this name when you update the settings.

**Update policy: If this setting is changed, the update is not allowed.**

BatchImportMetaDataOnCreate (**Optional**, Boolean)

A boolean flag indicating whether an import data repository task to import metadata should run after the data repository association is created. The task runs if this flag is set to `true`.

Default value: `false`

**Update policy: If this setting is changed, the update is not allowed.**

DataRepositoryPath (**Required**, String)

The path to the Amazon S3 data repository that will be linked to the file system. The path can be an S3 bucket or prefix in the format `s3://myBucket/myPrefix/`. This path specifies where in the S3 data repository files will be imported from or exported to.

Cannot overlap with other DRAs

Pattern: `^[^\u0000\u0085\u2028\u2029\r\n]{3,4357}$`

Minimum: 3

Maximum: 4357

**Update policy: If this setting is changed, the update is not allowed.**

FileSystemPath (**Required**, String)

A path on the Amazon FSx for Lustre file system that points to a high-level directory (such as `/ns1/`) or subdirectory (such as `/ns1/subdir/`) that will be mapped 1-1 with `DataRepositoryPath`. The leading forward slash in the name is required. Two data repository associations cannot have overlapping file system paths. For example, if a data repository is

associated with file system path `/ns1/`, then you cannot link another data repository with file system path `/ns1/ns2`.

This path specifies where in your file system files will be exported from or imported to. This file system directory can be linked to only one Amazon S3 bucket, and no other S3 bucket can be linked to the directory.

Cannot overlap with other DRAs

**Note**

If you specify only a forward slash (`/`) as the file system path, you can link only one data repository to the file system. You can only specify `/` as the file system path for the first data repository associated with a file system.

Pattern: `^[^\u0000\u0085\u2028\u2029\r\n]{1,4096}$`

Minimum: 1

Maximum: 4096

**Update policy: If this setting is changed, the update is not allowed.**

`ImportedFileChunkSize` (**Optional**, Integer)

For files imported from a data repository, this value determines the stripe count and maximum amount of data per file (in MiB) stored on a single physical disk. The maximum number of disks that a single file can be striped across is limited by the total number of disks that make up the file system or cache.

The default chunk size is 1,024 MiB (1 GiB) and can go as high as 512,000 MiB (500 GiB). Amazon S3 objects have a maximum size of 5 TB.

Minimum: 1

Maximum: 4096

**Update policy: This setting can be changed during an update.**

`AutoExportPolicy` (**Optional**, Array of strings)

The list can contain one or more of the following values:

- NEW - New files and directories are automatically exported to the data repository as they are added to the file system.
- CHANGED - Changes to files and directories on the file system are automatically exported to the data repository.
- DELETED - Files and directories are automatically deleted on the data repository when they are deleted on the file system.

You can define any combination of event types for your `AutoExportPolicy`.

Maximum: 3

**Update policy: This setting can be changed during an update.**

`AutoImportPolicy` (**Optional**, Array of strings)

The list can contain one or more of the following values:

- NEW - Amazon FSx automatically imports metadata of files added to the linked S3 bucket that do not currently exist in the FSx file system.
- CHANGED - Amazon FSx automatically updates file metadata and invalidates existing file content on the file system as files change in the data repository.
- DELETED - Amazon FSx automatically deletes files on the file system as corresponding files are deleted in the data repository.

You can define any combination of event types for your `AutoImportPolicy`.

Maximum: 3

**Update policy: This setting can be changed during an update.**

## FsxOntapSettings

### Note

You must define `FsxOntapSettings` if `FsxOntap` is specified for [StorageType](#).

**(Optional)** The settings for an FSx for ONTAP file system.

`FsxOntapSettings`:

`VolumeId`: *string*



## FsxOntapSettings properties

### VolumeId (Required, String)

Specifies the volume ID of the existing FSx for ONTAP system.

#### Note

- If an AWS Batch scheduler is used, FSx for ONTAP is only available on the head node.
- If the FSx for ONTAP deployment type is Multi-AZ, make sure that the head node subnet's route table is properly configured.
- Support for FSx for ONTAP was added in AWS ParallelCluster version 3.2.0.
- The file system must be associated to a security group that allows inbound and outbound TCP and UDP traffic through ports 111, 635, 2049, and 4046.

Make sure traffic is allowed between the cluster and file system by doing one of the following actions:

- Configure the security groups of the file system to allow the traffic to and from the CIDR or prefix list of cluster subnets.

#### Note

AWS ParallelCluster validates that ports are open and that the CIDR or prefix list is configured. AWS ParallelCluster doesn't validate the content of CIDR block or prefix list.

- Set custom security groups for cluster nodes by using [SlurmQueues / Networking / SecurityGroups](#) and [HeadNode / Networking / SecurityGroups](#). The custom security groups must be configured to allow traffic between the cluster and the file system.

#### Note

If all cluster nodes use custom security groups, AWS ParallelCluster only validates that the ports are open. AWS ParallelCluster doesn't validate that the source and destination are properly configured.

**Update policy: If this setting is changed, the update is not allowed.**

## FsxOpenZfsSettings

### Note

You must define FsxOpenZfsSettings if FsxOpenZfs is specified for [StorageType](#).

**(Optional)** The settings for a FSx for OpenZFS file system.

```
FsxOpenZfsSettings:  
  VolumeId: string
```

**Update policy: If this setting is changed, the update is not allowed.**

## FsxOpenZfsSettings properties

VolumeId (**Required**, String)

Specifies the volume ID of the existing FSx for OpenZFS system.

### Note

- If an AWS Batch scheduler is used, FSx for OpenZFS is only available on the head node.
- Support for FSx for OpenZFS was added in AWS ParallelCluster version 3.2.0.
- The file system must be associated to a security group that allows inbound and outbound TCP and UDP traffic through ports 111, 2049, 20001, 20002, and 20003.

Make sure that traffic is allowed between the cluster and file system by doing one of the following:

- Configure the security groups of the file system to allow the traffic to and from the CIDR or prefix list of cluster subnets.

**Note**

AWS ParallelCluster validates that ports are open and that the CIDR or prefix list is configured. AWS ParallelCluster doesn't validate the content of CIDR block or prefix list.

- Set custom security groups for cluster nodes by using [SlurmQueues](#) / [Networking](#) / [SecurityGroups](#) and [HeadNode](#) / [Networking](#) / [SecurityGroups](#). The custom security groups must be configured to allow traffic between the cluster and the file system.

**Note**

If all cluster nodes use custom security groups, AWS ParallelCluster only validates that the ports are open. AWS ParallelCluster doesn't validate that the source and destination are properly configured.

**Update policy: If this setting is changed, the update is not allowed.**

## FileCacheSettings

**Note**

You must define FileCacheSettings if FileCache is specified for [StorageType](#).

**(Optional)** The settings for a File Cache.

[FileCacheSettings](#):

[FileCacheId](#): *string*

**Update policy: If this setting is changed, the update is not allowed.**

## FileCacheSettings properties

FileCacheId (**Required**, String)

Specifies the File Cache ID of an existing File Cache.

**Note**

- File Cache doesn't support AWS Batch schedulers.
- Support for File Cache is added in AWS ParallelCluster version 3.7.0.
- The file system must be associated to a security group that allows inbound and outbound TCP traffic through port 988.

Make sure that traffic is allowed between the cluster and file system by doing one of the following:

- Configure the security groups of the File Cache to allow the traffic to and from the CIDR or prefix list of cluster subnets.

**Note**

AWS ParallelCluster validates that ports are open and that the CIDR or prefix list is configured. AWS ParallelCluster doesn't validate the content of CIDR block or prefix list.

- Set custom security groups for cluster nodes by using [SlurmQueues / Networking / SecurityGroups](#) and [HeadNode / Networking / SecurityGroups](#). The custom security groups must be configured to allow traffic between the cluster and the file system.

**Note**

If all cluster nodes use custom security groups, AWS ParallelCluster only validates that the ports are open. AWS ParallelCluster doesn't validate that the source and destination are properly configured.

**Update policy: If this setting is changed, the update is not allowed.**

## Iam section

**(Optional)** Specifies IAM properties for the cluster.

Iam:

Roles:

LambdaFunctionsRole: *string*

`PermissionsBoundary`: *string*

`ResourcePrefix`: *string*

**Update policy: This setting can be changed during an update.**

## Iam properties

`PermissionsBoundary` (**Optional**, String)

The ARN of the IAM policy to use as permissions boundary for all roles created by AWS ParallelCluster. For more information, see [Permissions boundaries for IAM entities](#) in the *IAM User Guide*. The format is `arn:${Partition}:iam::${Account}:policy/${PolicyName}`.

**Update policy: This setting can be changed during an update.**

`Roles` (**Optional**)

Specifies settings for the IAM roles used by the cluster.

**Update policy: This setting can be changed during an update.**

`LambdaFunctionsRole` (**Optional**, String)

The ARN of the IAM role to use for AWS Lambda. This overrides the default role attached to all Lambda functions backing AWS CloudFormation custom resources. Lambda needs to be configured as the principal allowed to assume the role. This will not override the role of Lambda functions used for AWS Batch. The format is `arn:${Partition}:iam::${Account}:role/${RoleName}`.

**Update policy: This setting can be changed during an update.**

`ResourcePrefix` (**Optional**)

Specifies a path or name prefix for IAM resources that are created by AWS ParallelCluster.

The resource prefix must follow the [naming rules specified by IAM](#):

- A name can contain up to 30 characters.
- A name can only be a string with no slash (/) characters.
- A path can be up to 512 characters.
- A path must start and end with a slash (/). It can contain multiple slashes (/) between the start and end slashes (/).

- You can combine the path and name `/path/name`.

Specify a name.

```
Iam:  
ResourcePrefix: my-prefix
```

Specify a path.

```
Iam:  
ResourcePrefix: /org/dept/team/project/user/
```

Specify a path and name.

```
Iam:  
ResourcePrefix: /org/dept/team/project/user/my-prefix
```

If you specify `/my-prefix`, an error is returned.

```
Iam:  
ResourcePrefix: /my-prefix
```

A configuration error is returned. A path must have two `/s`. A prefix by itself can't have `/s`.

**Update policy: If this setting is changed, the update is not allowed.**

## LoginNodes section

### Note

Support for LoginNodes is added in AWS ParallelCluster version 3.7.0.

**(Optional)** Specifies the configuration for the login nodes pool.

```
LoginNodes:  
  Pools:  
    - Name: string  
      Count: integer  
      InstanceType: string
```

```
GracetimePeriod: integer  
Image:  
  CustomAmi: string  
Ssh:  
  KeyName: string  
Networking:  
  SubnetIds:  
    - string  
  SecurityGroups:  
    - string  
  AdditionalSecurityGroups:  
    - string  
Iam:  
  InstanceRole: string  
  InstanceProfile: string  
  AdditionalIamPolicies:  
    - Policy: string
```

**Update policy:** The compute fleet must be stopped for this setting to be changed for an update.

## LoginNodes properties

## Pools properties

Defines groups of login nodes that have the same resource configuration. Only a single pool can be specified.

```
Pools:  
  - Name: string  
  Count: integer  
  InstanceType: string  
  GracetimePeriod: integer  
  Image:  
    CustomAmi: string  
  Ssh:  
    KeyName: string  
  Networking:  
    SubnetIds:  
      - string  
    SecurityGroups:  
      - string  
    AdditionalSecurityGroups:  
      - string
```

```
Iam:  
  InstanceRole: string  
  InstanceProfile: string  
  AdditionalIamPolicies:  
    - Policy: string
```

### Name (**Required** String)

Specifies the name of the LoginNodes pool. This is used to tag the LoginNodes resources.

**Update policy: If this setting is changed, the update is not allowed.**

### Count (**Required** Integer)

Specifies the number of login nodes to keep active.

**Update policy: This setting can be changed during an update.**

### InstanceType (**Required** String)

Specifies the Amazon EC2 instance type that's used for the login node. The architecture of the instance type must be the same as the architecture used for Slurm InstanceType setting.

**Update policy:** This setting can be changed if the login nodes pool is stopped.

### GracetimePeriod (**Optional** Integer)

Specifies the minimum amount of time in minutes that elapse between the notification to the logged in user that a login node is to be decommissioned and the actual stop event. Valid values for GracetimePeriod are from 3 up to 120 minutes. The default is 60 minutes.

#### **Note**

The triggering event involves interactions between multiple AWS services. Sometimes, network latency and propagation of the information might take some time so the grace time period may take longer than expected due to internal delays in AWS services.

**Update policy: This setting can be changed during an update.**

### Image (**Optional**)

Defines the image configuration for the login nodes.

```
Image:
```



```
CustomAmi: String
```

### CustomAmi (Optional String)

Specifies the custom AMI used to provision the login nodes. If not specified, the value defaults to the one specified in the [HeadNode section](#).

**Update policy: If this setting is changed, the update is not allowed.**

### Ssh (Optional)

Defines the ssh configuration for the login nodes.

```
Ssh:  
KeyName: string
```

### KeyName (Optional String)

Specifies the ssh key used to log in into the login nodes. If not specified, the value defaults to the one specified in the [HeadNode section](#).

**Update policy: If this setting is changed, the update is not allowed.**

### Networking (Required)

```
Networking:  
SubnetIds:  
- string  
SecurityGroups:  
- string  
AdditionalSecurityGroups:  
- string
```

### SubnetIds (Required [String])

The ID of existing subnet that you provision the login nodes pool in. You can only define one subnet.

**Update policy: If this setting is changed, the update is not allowed.**

### SecurityGroups (Optional [String])

A list of security groups to use for the login nodes pool. If no security groups are specified, AWS ParallelCluster creates security groups for you.

**Update policy: If this setting is changed, the update is not allowed.**

AdditionalSecurityGroups (**Optional** [String])

A list of additional security groups to use for the login nodes pool.

**Update policy: If this setting is changed, the update is not allowed.**

Iam (**Optional**)

Specifies either an instance role or an instance profile to use on the login nodes to override the default instance role or instance profile for the cluster.

```
Iam:  
  InstanceRole: string  
  InstanceProfile: string  
  AdditionalIamPolicies:  
    - Policy: string
```

InstanceProfile (**Optional** String)

Specifies an instance profile to override the default login node instance profile. You can't specify both InstanceProfile and InstanceRole. The format is `arn:Partition:iam::Account:instance-profile/InstanceProfileName`. If this is specified, the InstanceRole and AdditionalIamPolicies settings can't be specified.

**Update policy: If this setting is changed, the update is not allowed.**

InstanceRole (**Optional** String)

Specifies an instance role to override the default login node instance role. You can't specify both InstanceProfile and InstanceRole. The format is `arn:Partition:iam::Account:role/RoleName`. If this is specified, the S3Access and AdditionalIamPolicies settings can't be specified. If this is specified, the InstanceProfile and AdditionalIamPolicies settings can't be specified.

**Update policy: If this setting is changed, the update is not allowed.**

AdditionalIamPolicies (**Optional**)

```
AdditionalIamPolicies:  
  - Policy: string
```

An IAM policy Amazon Resource Name (ARN).

Specifies a list of Amazon Resource Names (ARNs) of IAM policies for Amazon EC2 . This list is attached to the root role used for the login node in addition to the permissions that are required by AWS ParallelCluster.

An IAM policy name and its ARN are different. Names can't be used.

If this is specified, the `InstanceProfile` and `InstanceRole` settings can't be specified. We recommend that you use `AdditionalIamPolicies` because `AdditionalIamPolicies` are added to the permissions that AWS ParallelCluster requires, and the `InstanceRole` must include all required permissions. The required permissions often change from release to release as features are added.

There's no default value.

**Update policy: If this setting is changed, the update is not allowed.**

Policy (**Required** [String])

**Update policy: If this setting is changed, the update is not allowed.**

## Monitoring section

**(Optional)** Specifies the monitoring settings for the cluster.

Monitoring:

Logs:

CloudWatch:

Enabled: *boolean*

RetentionInDays: *integer*

DeletionPolicy: *string*

Rotation:

Enabled: *boolean*

Dashboards:

CloudWatch:

Enabled: *boolean*

DetailedMonitoring: *boolean*

Alarms:

Enabled: *boolean*

**Update policy: This setting is not analyzed during an update.**

## Monitoring properties

### Logs (Optional)

The log settings for the cluster.

**Update policy: If this setting is changed, the update is not allowed.**

### CloudWatch (Optional)

The CloudWatch Logs settings for the cluster.

**Update policy: If this setting is changed, the update is not allowed.**

Enabled (**Required**, Boolean)

If `true`, cluster logs are streamed to CloudWatch Logs. The default value is `true`.

**Update policy: If this setting is changed, the update is not allowed.**

RetentionInDays (**Optional**, Integer)

The number of days to retain the log events in CloudWatch Logs. The default value is 180. The supported values are 0, 1, 3, 5, 7, 14, 30, 60, 90, 120, 150, 180, 365, 400, 545, 731, 1827, and 3653. A value of 0 will use the default CloudWatch log retention setting, i.e. never expire.

**Update policy: This setting can be changed during an update.**

DeletionPolicy (**Optional**, String)

Indicates whether to delete log events on CloudWatch Logs when the cluster is deleted. The possible values are `Delete` and `Retain`. The default value is `Retain`.

**Update policy: This setting can be changed during an update.**

### Rotation (Optional)

The log rotation settings for the cluster.

**Update policy: If this setting is changed, the update is not allowed.**

Enabled (**Required**, Boolean)

If `true`, log rotation is enabled. The default is `true`. When a AWS ParallelCluster configured log file reaches a certain size, it is rotated and a single backup is maintained. For more information, see [AWS ParallelCluster configured log rotation](#).

**Update policy: If this setting is changed, the update is not allowed.**

### Dashboards (Optional)

The dashboard settings for the cluster.

**Update policy: This setting can be changed during an update.**

### CloudWatch (Optional)

The CloudWatch dashboard settings for the cluster.

**Update policy: This setting can be changed during an update.**

Enabled (**Required**, Boolean)

If `true`, the CloudWatch dashboard is enabled. The default value is `true`.

**Update policy: This setting can be changed during an update.**

### DetailedMonitoring (Optional, Boolean)

If set to `true`, detailed monitoring is enabled for the compute fleet Amazon EC2 instances. When enabled, the Amazon EC2 console displays graphs for monitoring the instances at 1 minute intervals. There are added costs when this feature is enabled. The default is `false`.

For more information, see [Enable or turn off detailed monitoring for your instances](#) in the *Amazon EC2 User Guide for Linux Instances*.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

**Note**

DetailedMonitoring is added starting with AWS ParallelCluster version 3.6.0.

### Alarms (Optional)

CloudWatch Alarms for the cluster.

**Update policy: This setting can be changed during an update.**

Enabled (**Optional**)

If `true`, the CloudWatch Alarms for the cluster will be created. The default value is `true`.

**Update policy: This setting can be changed during an update.**

**Note**

Starting with AWS ParallelCluster version 3.8.0, the following alarms are created for the Head Node: Amazon EC2 Health Check, CPU/Memory/Disk utilization and a composite alarm including all the others.

## Tags section

**(Optional), Array** Defines the tags that are used by AWS CloudFormation and propagated to all the cluster resources. For more information, see [AWS CloudFormation resource tag](#) in the *AWS CloudFormation User Guide*.

Tags:

- Key: *string*
- Value: *string*

**Update policy: If this setting is changed, the update is not allowed.**

## Tags properties

Key (**Required**, String)

Defines the name of the tag.

**Update policy: If this setting is changed, the update is not allowed.**

Value (**Required**, String)

Defines the value of the tag.

**Update policy: If this setting is changed, the update is not allowed.**

## AdditionalPackages section

**(Optional)** Used to identify additional packages to install.

AdditionalPackages:

IntelSoftware:

`IntelHpcPlatform: boolean`

**Update policy: If this setting is changed, the update is not allowed.**

## IntelSoftware

**(Optional)** Defines the configuration for Intel select solutions.

`IntelSoftware:`

`IntelHpcPlatform: boolean`

**Update policy: If this setting is changed, the update is not allowed.**

## IntelSoftware properties

IntelHpcPlatform (**Optional**, Boolean)

If `true`, indicates that the [End user license agreement](#) for Intel Parallel Studio is accepted. This causes Intel Parallel Studio to be installed on the head node and shared with the compute nodes. This adds several minutes to the time it takes the head node to bootstrap. The `IntelHpcPlatform` setting is only supported on CentOS 7 .

**Update policy: If this setting is changed, the update is not allowed.**

## DirectoryService section

### Note

Support for `DirectoryService` was added in AWS ParallelCluster version 3.1.1.

**(Optional)** The directory service settings for a cluster that supports multiple user access.

AWS ParallelCluster manages permissions that support multiple user access to clusters with an Active Directory (AD) over Lightweight Directory Access Protocol (LDAP) supported by the [System Security Services Daemon \(SSSD\)](#). For more information, see [What is AWS Directory Service?](#) in the *AWS Directory Service Administration Guide*.

We recommend that you use LDAP over TLS/SSL (abbreviated LDAPS for short) to ensure that any potentially sensitive information is transmitted over encrypted channels.

**DirectoryService:**

**DomainName:** *string*  
**DomainAddr:** *string*  
**PasswordSecretArn:** *string*  
**DomainReadOnlyUser:** *string*  
**LdapTlsCaCert:** *string*  
**LdapTlsReqCert:** *string*  
**LdapAccessFilter:** *string*  
**GenerateSshKeysForUsers:** *boolean*  
**AdditionalSssdConfigs:** *dict*

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

**DirectoryService properties****Note**

If you plan to use AWS ParallelCluster in a single subnet with no internet access, see [AWS ParallelCluster in a single subnet with no internet access](#) for additional requirements.

**DomainName (Required, String)**

The Active Directory (AD) domain that you use for identity information.

DomainName accepts both the Fully Qualified Domain Name (FQDN) and LDAP Distinguished Name (DN) formats.

- FQDN example: corp.*example*.com
- LDAP DN example: DC=*corp*, DC=*example*, DC=*com*

This property corresponds to the sssd-ldap parameter that's called ldap\_search\_base.

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

**DomainAddr (Required, String)**

The URI or URIs that point to the AD domain controller that's used as the LDAP server. The URI corresponds to the SSSD-LDAP parameter that's called ldap\_uri. The value can be a comma separated string of URIs. To use LDAP, you must add ldap:// to the beginning of the each URI.



### Example values:

```
ldap://192.0.2.0,ldap://203.0.113.0      # LDAP
ldaps://192.0.2.0,ldaps://203.0.113.0  # LDAPS without support for certificate
  verification
ldaps://abcdef01234567890.corp.example.com # LDAPS with support for certificate
  verification
192.0.2.0,203.0.113.0                  # AWS ParallelCluster uses LDAPS by
  default
```

If you use LDAPS with certificate verification, the URIs must be hostnames.

If you use LDAPS without certificate verification or LDAP, URIs can be hostnames or IP addresses.

Use LDAP over TLS/SSL (LDAPS) to avoid transmission of passwords and other sensitive information over unencrypted channels. If AWS ParallelCluster doesn't find a protocol, it adds `ldaps://` to the beginning of each URI or hostname.

**[Update policy: The compute fleet must be stopped for this setting to be changed for an update.](#)**

### PasswordSecretArn (Required, String)

The Amazon Resource Name (ARN) of the AWS Secrets Manager secret that contains the `DomainReadOnlyUser` plaintext password. The content of the secret corresponds to `SSSD-LDAP` parameter that's called `ldap_default_authtok`.

#### Note

When creating a secret using the AWS Secrets Manager console be sure to select "Other type of secret", select plaintext, and only include the password text in the secret. For more information on how to use AWS Secrets Manager to create a secret refer to [Create an AWS Secrets Manager Secret](#)

The LDAP client uses the password to authenticate to the AD domain as a `DomainReadOnlyUser` when requesting identity information.

If the user has the permission to [DescribeSecret](#), `PasswordSecretArn` is validated. `PasswordSecretArn` is valid if the specified secret exists. If the user IAM policy doesn't include

DescribeSecret, PasswordSecretArn isn't validated and a warning message is displayed. For more information, see [Base AWS ParallelCluster pcluster user policy](#).

When the value of the secret changes, the cluster *isn't* automatically updated. To update the cluster for the new secret value, you must stop the compute fleet with the [the section called "pcluster update-compute-fleet"](#) command and then run the following command from within the head node.

```
$ sudo /opt/parallelcluster/scripts/directory_service/  
update_directory_service_password.sh
```

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

DomainReadOnlyUser (**Required**, String)

The identity that's used to query the AD domain for identity information when authenticating cluster user logins. It corresponds to SSSD-LDAP parameter that's called `ldap_default_bind_dn`. Use your AD identity information for this value.

Specify the identity in the form required by the specific LDAP client that's on the node:

- MicrosoftAD:

```
cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
```

- SimpleAD:

```
cn=ReadOnlyUser,cn=Users,dc=corp,dc=example,dc=com
```

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

LdapTlsCaCert (**Optional**, String)

The absolute path to a certificates bundle containing the certificates for every certification authority in the certification chain that issued a certificate for the domain controllers. It corresponds to the SSSD-LDAP parameter that's called `ldap_tls_cacert`.

A certificate bundle is a file that's composed of the concatenation of distinct certificates in PEM format, also known as DER Base64 format in Windows. It is used to verify the identity of the AD domain controller that is acting as the LDAP server.

AWS ParallelCluster isn't responsible for initial placement of certificates onto nodes. As the cluster administrator, you can configure the certificate in the head node manually after the cluster is created or you can use a [bootstrap script](#). Alternatively, you can use an Amazon Machine Image (AMI) that includes the certificate configured on the head node.

[Simple AD](#) doesn't provide LDAPS support. To learn how to integrate a Simple AD directory with AWS ParallelCluster, see [How to configure an LDAPS endpoint for Simple AD](#) in the *AWS Security Blog*.

**[Update policy: The compute fleet must be stopped for this setting to be changed for an update.](#)**

LdapTlsReqCert (**Optional**, String)

Specifies what checks to perform on server certificates in a TLS session. It corresponds to SSSD-LDAP parameter that's called `ldap_tls_reqcert`.

Valid values: `never`, `allow`, `try`, `demand`, and `hard`.

`never`, `allow`, and `try` enable connections to proceed even if problems with certificates are found.

`demand` and `hard` enable communication to continue if no problems with certificates are found.

If the cluster administrator uses a value that doesn't require the certificate validation to succeed, a warning message is returned to the administrator. For security reasons, we recommend that you don't disable certificate verification.

The default value is `hard`.

**[Update policy: The compute fleet must be stopped for this setting to be changed for an update.](#)**

LdapAccessFilter (**Optional**, String)

Specifies a filter to limit directory access to a subset of users. This property corresponds to the SSSD-LDAP parameter that's called `ldap_access_filter`. You can use it to limit queries to an AD that supports a large number of users.

This filter can block user access to the cluster. However, it doesn't impact the discoverability of blocked users.

If this property is set, the SSSD parameter `access_provider` is set to `ldap` internally by AWS ParallelCluster and must not be modified by [DirectoryService](#) / [AdditionalSssdConfigs](#) settings.

If this property is omitted and customized user access isn't specified in [DirectoryService](#) / [AdditionalSssdConfigs](#), all users in the directory can access the cluster.

Examples:

```
!"(cn=SomeUser*)" # denies access to every user with alias starting with "SomeUser"
"(cn=SomeUser*)" # allows access to every user with alias starting with "SomeUser"
"memberOf=cn=TeamOne,ou=Users,ou=CORP,dc=corp,dc=example,dc=com" # allows access
only to users in group "TeamOne".
```

### Update policy: The compute fleet must be stopped for this setting to be changed for an update.

`GenerateSshKeysForUsers` (**Optional**, Boolean)

Defines whether AWS ParallelCluster generates an SSH key for cluster users immediately after their initial authentication on the head node.

If set to `true`, an SSH key is generated and saved to `USER_HOME_DIRECTORY/.ssh/id_rsa`, if it doesn't exist, for every user after their first authentication on the head node.

For a user that has not yet been authenticated on the head node, first authentication can happen in the following cases:

- The user logs into the head node for the first time with her or his own password.
- In the head node, a sudoer switches to the user for the first time: `su USERNAME`
- In the head node, a sudoer runs a command as the user for the first time: `su -u USERNAME COMMAND`

Users can use the SSH key for subsequent logins to the cluster head node and compute nodes. With AWS ParallelCluster, password logins to cluster compute nodes are disabled by design. If a user hasn't logged into the head node, SSH keys aren't generated and the user won't be able to log in to compute nodes.

The default is `true`.

### Update policy: The compute fleet must be stopped for this setting to be changed for an update.

## AdditionalSssdConfigs (**Optional**, Dict)

A dict of key-value pairs containing SSSD parameters and values to write to the SSSD config file on cluster instances. For a full description of the SSSD configuration file, see the on-instance man pages for SSSD and related configuration files.

The SSSD parameters and values must be compatible with AWS ParallelCluster's SSSD configuration as described in the following list.

- `id_provider` is set to `ldap` internally by AWS ParallelCluster and must not be modified.
- `access_provider` is set to `ldap` internally by AWS ParallelCluster when [DirectoryService / LdapAccessFilter](#) is specified, and this setting must not be modified.

If [DirectoryService / LdapAccessFilter](#) is omitted, its `access_provider` specification is omitted also. For example, if you set `access_provider` to `simple` in [AdditionalSssdConfigs](#), then [DirectoryService / LdapAccessFilter](#) must not be specified.

The following configuration snippets are examples of valid configurations for `AdditionalSssdConfigs`.

This example enables debug level for SSSD logs, restricts the search base to a specific organizational unit, and disables credentials caching.

```
DirectoryService:
  ...
AdditionalSssdConfigs:
  debug_level: "0xFFF0"
  ldap_search_base: OU=Users,OU=CORP,DC=corp,DC=example,DC=com
  cache_credentials: False
```

This example specifies the configuration of an SSSD [simple](#) `access_provider`. Users from the `EngineeringTeam` are provided access to the directory. [DirectoryService / LdapAccessFilter](#) must not be set in this case.

```
DirectoryService:
  ...
AdditionalSssdConfigs:
  access_provider: simple
```

```
simple_allow_groups: EngineeringTeam
```

**Update policy: The compute fleet must be stopped for this setting to be changed for an update.**

## DeploymentSettings section

### Note

DeploymentSettings is added starting with AWS ParallelCluster version 3.4.0.

**(Optional)** Specifies the deployment settings configuration.

```
DeploymentSettings:
  LambdaFunctionsVpcConfig:
    SecurityGroupIds
      - string
    SubnetIds
      - string
  DisableSudoAccessForDefaultUser: Boolean
  DefaultUserHome: string # 'Shared' or 'Local'
```

## DeploymentSettings properties

### LambdaFunctionsVpcConfig

**(Optional)** Specifies the AWS Lambda functions VPC configurations. For more information, see [AWS Lambda VPC configuration in AWS ParallelCluster](#).

```
LambdaFunctionsVpcConfig:
  SecurityGroupIds
    - string
  SubnetIds
    - string
```

### LambdaFunctionsVpcConfig properties

#### SecurityGroupIds (Required, [String])

The list of Amazon VPC security group IDs that are attached to the Lambda functions.

**Update policy: If this setting is changed, the update is not allowed.**

SubnetIds (**Required**, [String])

The list of subnet IDs that are attached to the Lambda functions.

**Update policy: If this setting is changed, the update is not allowed.**

**Note**

The subnets and security groups must be in the same VPC.

### DisableSudoAccessForDefaultUser property

**Note**

This config Option is only supported with Slurm Clusters.

(Optional) If `True`, the sudo privileges of the default User will be disabled. This applies to all the nodes in the cluster.

```
# Main DeploymentSettings section in config yaml(applyes to HN, CF and LN)
DeploymentSettings:
  DisableSudoAccessForDefaultUser: True
```

To update the value of `DisableSudoAccessForDefaultUser`, you must stop the compute fleet and all login nodes.

**Update policy: The compute fleet and login nodes must be stopped for this setting to be changed for an update.**

### DefaultUserHome property

When set to `Shared`, the cluster will use the default setup and share the default user's directory across the cluster by `/home/<default user>`.

When set to `Local`, the head node, login nodes, and compute nodes will each have a separate local default user directory stored in `local/home/<default user>`.

## Build image configuration files

AWS ParallelCluster version 3 uses YAML 1.1 files for build image configuration parameters. Please confirm that indentation is correct to reduce configuration errors. For more information, see the YAML 1.1 spec at <https://yaml.org/spec/1.1/>.

These configuration files are used to define how your custom AWS ParallelCluster AMIs are built using EC2 Image Builder. Custom AMI building processes are triggered using the `pcluster build-image` command. For some example configuration files, see [https://github.com/aws/aws-parallelcluster/tree/release-3.0/cli/tests/pcluster/schemas/test\\_imagebuilder\\_schema/test\\_imagebuilder\\_schema](https://github.com/aws/aws-parallelcluster/tree/release-3.0/cli/tests/pcluster/schemas/test_imagebuilder_schema/test_imagebuilder_schema).

### Topics

- [Build image configuration file properties](#)
- [Build section](#)
- [Image section](#)
- [DeploymentSettings section](#)

## Build image configuration file properties

Region (**Optional**, String)

Specifies the AWS Region for the `build-image` operation. For example, `us-east-2`.

## Build section

**(Required)** Specifies the configuration in which the image will be built.

```
Build:
  Imds:
    ImdsSupport: string
    InstanceType: string
    SubnetId: string
    ParentImage: string
  Iam:
    InstanceRole: string
    InstanceProfile: string
    CleanupLambdaRole: string
    AdditionalIamPolicies:
```



```
- Policy: string
PermissionsBoundary: string
Components:
- Type: string
  Value: string
Tags:
- Key: string
  Value: string
SecurityGroupIds:
- string
UpdateOsPackages:
  Enabled: boolean
```

## Build properties

### InstanceType (**Required**, String)

Specifies the instance type for the instance used to build the image.

### SubnetId (**Optional**, String)

Specifies the ID of an existing subnet in which to provision the instance to build the image. The provided subnet requires internet access.

#### **Warning**

`pcluster build-image` uses the default VPC. If the default VPC has been deleted, perhaps by using AWS Control Tower or AWS Landing Zone, then the subnet ID must be specified.

### ParentImage (**Required**, String)

Specifies the base image. The parent image can be either a non AWS ParallelCluster AMI or an official AWS ParallelCluster AMI for the same version. You can't use a AWS ParallelCluster official or custom AMI from a different version of AWS ParallelCluster. The format must either be the ARN of a image `arn:Partition:imagebuilder:Region:Account:image/ImageName/ImageVersion` or an AMI ID `ami-12345678`.

### SecurityGroupIds (**Optional**, [String])

Specifies the list of security group IDs for the image.

## Ims

### Ims properties

**(Optional)** Specifies the Amazon EC2 ImageBuilder build and test instance metadata service (IMDS) settings.

```
Ims:  
ImsSupport: string
```

#### ImsSupport (**Optional**, String)

Specifies which IMDS versions are supported in the Amazon EC2 ImageBuilder build and test instances. Supported values are `v2.0` and `v1.0`. The default value is `v2.0`.

If `ImsSupport` is set to `v1.0`, both IMDSv1 and IMDSv2 are supported.

If `ImsSupport` is set to `v2.0`, only IMDSv2 is supported.

For more information, see [Use IMDSv2](#) in the *Amazon EC2 User Guide for Linux instances*.

**Update policy: If this setting is changed, the update is not allowed.**

#### Note

Starting with AWS ParallelCluster version 3.7.0, the `ImsSupport` default value is `v2.0`. We recommend that you set `ImsSupport` to `v2.0` and replace IMDSv1 with IMDSv2 in your custom actions calls.

Support for [Ims](#) / [ImsSupport](#) is added with AWS ParallelCluster version 3.3.0.

## Iam

### Iam properties

**(Optional)** Specifies the IAM resources for the image build.

```
Iam:  
InstanceRole: string  
InstanceProfile: string  
CleanupLambdaRole: string
```

**AdditionalIamPolicies:**

- **Policy:** *string*

**PermissionsBoundary:** *string***InstanceProfile (Optional, String)**

Specifies an instance profile to override the default instance profile for the EC2 Image Builder instance. InstanceProfile and InstanceRole and AdditionalIamPolicies cannot be specified together. The format is `arn:Partition:iam::Account:instance-profile/InstanceProfileName`.

**InstanceRole (Optional, String)**

Specifies an instance role to override the default instance role for the EC2 Image Builder instance. InstanceProfile and InstanceRole and AdditionalIamPolicies cannot be specified together. The format is `arn:Partition:iam::Account:role/RoleName`.

**CleanupLambdaRole (Optional, String)**

The ARN of the IAM role to use for the AWS Lambda function backing the AWS CloudFormation custom resource that removes build artifacts on build completion. Lambda needs to be configured as the principal allowed to assume the role. The format is `arn:Partition:iam::Account:role/RoleName`.

**AdditionalIamPolicies (Optional)**

Specifies additional IAM policies to attach to the EC2 Image Builder instance used to produce the custom AMI.

**AdditionalIamPolicies:**

- **Policy:** *string*

**Policy (Optional, [String])**

List of IAM policies. The format is `arn:Partition:iam::Account:policy/PolicyName`.

**PermissionsBoundary (Optional, String)**

The ARN of the IAM policy to use as permissions boundary for all roles created by AWS ParallelCluster. For more information on IAM permissions boundaries please refer to [Permissions boundaries for IAM entities](#) in the *IAM User Guide*. The format is `arn:Partition:iam::Account:policy/PolicyName`.

## Components

### Components properties

**(Optional)** Specifies Amazon EC2 ImageBuilder components to use during the AMI build process in addition to the ones provided by default by AWS ParallelCluster. Such components can be used to customize the AMI build process. For more information, see [AWS ParallelCluster AMI customization](#).

#### Components:

- Type: *string*
- Value: *string*

Type (**Optional**, String)

Specifies the type of the type-value pair for the component. Type can be `arn` or `script`.

Value (**Optional**, String)

Specifies the value of the type-value pair for the component. When type is `arn`, this is the ARN of a EC2 Image Builder component. When type is `script`, this is the `https` or `s3` link pointing to the script to use when creating the EC2 Image Builder component.

## Tags

### Tags properties

**(Optional)** Specifies the list of tags to be set in the resources used to build the AMI.

#### Tags:

- Key: *string*
- Value: *string*

Key (**Optional**, String)

Defines the name of the tag.

Value (**Optional**, String)

Defines the value of the tag.

## UpdateOsPackages

### UpdateOsPackages properties

**(Optional)** Specifies whether the operating system is updated before installing AWS ParallelCluster software stack.

UpdateOsPackages:

Enabled: *boolean*

### Enabled **(Optional, Boolean)**

If `true`, the OS is updated and rebooted before installing the AWS ParallelCluster software. The default is `false`.

#### **Note**

When `UpdateOsPackages` is enabled, all available OS packages are updated, including the kernel. As a customer, you are responsible for verifying that the update is compatible with the AMI dependencies that aren't included in the update.

For example, suppose you're building an AMI for AWS ParallelCluster version X.0 that's shipped with kernel version Y.0 and some component version Z.0. Suppose the available update includes updated kernel version Y.1 without updates to component Z.0. Before you enable `UpdateOsPackages`, it's your responsibility to verify that component Z.0 supports kernel Y.1.

## Image section

**(Optional)** Defines the image properties for the image build.

Image:

Name: *string*

RootVolume:

Size: *integer*

Encrypted: *boolean*

KmsKeyId: *string*

Tags:

- Key: *string*

Value: *string*

## Image properties

Name (**Optional**, String)

Specifies the name of the AMI. If not specified, the name used when calling the [pcluster build-image](#) command is used.

## Tags

### Tags properties

(**Optional**) Specifies key-value pairs for the image.

#### Tags:

- Key: *string*
- Value: *string*

Key (**Optional**, String)

Defines the name of the tag.

Value (**Optional**, String)

Defines the value of the tag.

## RootVolume

### RootVolume properties

(**Optional**) Specifies properties of the root volume for the image.

#### RootVolume:

- Size: *integer*
- Encrypted: *boolean*
- KmsKeyId: *string*

Size (**Optional**, Integer)

Specifies the size of the root volume for the image, in GiB. The default size is the size of the [ParentImage](#) plus 27 GiB.

## Encrypted (**Optional**, Boolean)

Specifies if the volume is encrypted. The default value is false.

## KmsKeyId (**Optional**, String)

Specifies the ARN of the AWS KMS key used to encrypt the volume. The format is

"arn:*Partition*:kms:*Region*:*Account*:key/*KeyId*."

## DeploymentSettings section

**(Optional)** Specifies the deployment settings configuration.

```
DeploymentSettings:  
  LambdaFunctionsVpcConfig:  
    SecurityGroupIds  
      - string  
    SubnetIds  
      - string
```

## DeploymentSettings properties

### LambdaFunctionsVpcConfig

**(Optional)** Specifies the AWS Lambda functions VPC configurations. For more information, see [AWS Lambda VPC configuration in AWS ParallelCluster](#).

```
LambdaFunctionsVpcConfig:  
  SecurityGroupIds  
    - string  
  SubnetIds  
    - string
```

## LambdaFunctionsVpcConfig properties

### SecurityGroupIds (**Required**, [String])

The list of Amazon VPC security group IDs that are attached to the Lambda functions.

**[Update policy: If this setting is changed, the update is not allowed.](#)**

### SubnetIds (**Required**, [String])

The list of subnet IDs that are attached to the Lambda functions.

### Update policy: If this setting is changed, the update is not allowed.

#### **Note**

The subnets and security groups must be in the same VPC.

#### **Note**

DeploymentSettings is added starting with AWS ParallelCluster version 3.4.0.

## AWS ParallelCluster API reference

This section provides descriptions, syntax, and usage examples for each of the AWS ParallelCluster API actions.

### Topics

- [buildImage](#)
- [createCluster](#)
- [deleteCluster](#)
- [deleteClusterInstances](#)
- [deleteImage](#)
- [describeCluster](#)
- [describeClusterInstances](#)
- [describeComputeFleet](#)
- [describeImage](#)
- [getClusterLogEvents](#)
- [getClusterStackEvents](#)
- [getImageLogEvents](#)
- [getImageStackEvents](#)
- [listClusters](#)
- [listClusterLogStreams](#)



- [listImageLogStreams](#)
- [listImages](#)
- [listOfficialImages](#)
- [updateCluster](#)
- [updateComputeFleet](#)

## buildImage

Create a custom AWS ParallelCluster image in an AWS Region.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
POST /v3/images/custom
{
  "imageConfiguration": "string",
  "imageId": "string",
  "dryrun": boolean,
  "region": "string",
  "rollbackOnFailure": boolean,
  "supressValidators": [ "string" ],
  "validationFailureLevel": "string"
}
```

### Request body

#### imageConfiguration

The image configuration as a YAML document.

Type: string

Required: Yes

### **imageId**

The ID of the image to build.

Type: string

Required: Yes

### **dryrun**

If set to `true`, only perform request validation without creating any resource. Use this parameter to validate the image configuration. The default is `false`.

Type: boolean

Required: No

### **region**

The AWS Region that you run the command to build the image in.

Type: string

Required: No

### **rollbackOnFailure**

If set to `true`, image stack rollback occurs if the image fails to create. The default is `false`.

Type: boolean

Required: No

### **suppressValidators**

Identify one or more configuration validators to suppress.

Type: list of strings

Format: (ALL | type: [A-Za-z0-9]+)

Required: No

### **validationFailureLevel**

The minimum validation level that causes image build to fail. The default is `ERROR`.

Type: string

Valid values: INFO | WARNING | ERROR

Required: No

## Response syntax

```
{
  "image": {
    "imageId": "string",
    "ec2AmiInfo": {
      "amiId": "string"
    },
    "region": "string",
    "version": "string",
    "cloudformationStackArn": "string",
    "imageBuildStatus": "BUILD_IN_PROGRESS",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS"
  },
  "validationMessages": [
    {
      "id": "string",
      "type": "string",
      "level": "INFO",
      "message": "string"
    }
  ]
}
```

## Response body

### image

#### imageId

The ID of the image.

Type: string

#### cloudformationStackArn

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

## **cloudformationStackStatus**

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS |  
UPDATE\_ROLLBACK\_FAILED | UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_ROLLBACK\_COMPLETE

## **ec2AmiInfo**

### **ami\_id**

The Amazon EC2 AMI ID.

Type: string

## **imageBuildStatus**

The image build status.

Type: string

Valid values: BUILD\_IN\_PROGRESS | BUILD\_FAILED | BUILD\_COMPLETE |  
DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE

## **region**

The AWS Region that the image is built in.

Type: string

## **version**

The AWS ParallelCluster version that's used to build the image.

Type: string

## **validationMessages**

A list of messages with a validation level lower than `validationFailureLevel`. The list of messages is collected during configuration validation.

**id**

The validator ID.

Type: string

**level**

The validation level.

Type: string

Valid values: INFO | WARNING | ERROR

**message**

A validation message.

Type: string

**type**

The type of validator.

Type: string

## Example

Python

**Request**

```
$ build_image(custom-image-id, custom-image-config.yaml)
```

**200 Response**

```
{
  'image': {
    'cloudformation_stack_arn': 'arn:aws:cloudformation:us-
east-1:123456789012:stack/custom-image-id/711b76b0-af81-11ec-a29f-0ee549109f1f',
    'cloudformation_stack_status': 'CREATE_IN_PROGRESS',
    'image_build_status': 'BUILD_IN_PROGRESS',
    'image_id': 'custom-image-id',
    'region': 'us-east-1',
    'version': '3.2.1'
  }
}
```

```
}  
}
```

## createCluster

Create a managed cluster in an AWS Region.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
POST /v3/clusters  
{  
  "clusterName": "string",  
  "clusterConfiguration": "string",  
  "dryrun": boolean,  
  "region": "string",  
  "rollbackOnFailure", boolean,  
  "suppressValidators": [ "string" ],  
  "validationFailureLevel": "string"  
}
```

### Request body

#### clusterConfiguration

The cluster configuration as a YAML document.

Type: string

Required: Yes

#### clusterName

The name of the cluster to create.

The name must start with an alphabetical character. The name can have up to 60 characters. If Slurm accounting is enabled, the name can have up to 40 characters.

Type: string

Required: Yes

### **dryrun**

If set to `true`, only perform request validation without creating any resource. Use this parameter to validate the cluster configuration. The default is `false`.

Type: boolean

Required: No

### **region**

The AWS Region that the cluster is in.

Type: string

Required: No

### **rollbackOnFailure**

If set to `true`, cluster stack rollback occurs if the cluster fails to create. The default is `true`.

Type: boolean

Required: No

### **suppressValidators**

Identify one or more configuration validators to suppress.

Type: list of strings

Format: (ALL | type: [A-Za-z0-9]+)

Required: No

### **validationFailureLevel**

The minimum validation level that causes cluster create to fail. The default is `ERROR`.

Type: string

Valid values: `INFO` | `WARNING` | `ERROR`

Required: No

## Response syntax

```
{
  "cluster": {
    "clusterName": "string",
    "region": "string",
    "version": "string",
    "cloudformationStackArn": "string",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "clusterStatus": "CREATE_IN_PROGRESS",
    "scheduler": {
      "type": "string",
      "metadata": {
        "name": "string",
        "version": "string"
      }
    }
  },
  "validationMessages": [
    {
      "id": "string",
      "type": "string",
      "level": "INFO",
      "message": "string"
    }
  ]
}
```

## Response body

### clusterName

The name of cluster.

Type: string

### cloudformationStackArn

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string



## **cloudformationStackStatus**

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS |  
UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS | UPDATE\_ROLLBACK\_FAILED |  
UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS | UPDATE\_ROLLBACK\_COMPLETE

## **clusterStatus**

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE | UPDATE\_FAILED

## **region**

The AWS Region that the cluster is created in.

Type: string

## **scheduler**

### **metadata**

The scheduler metadata

#### **name**

The name of the scheduler.

Type: string

#### **version**

The scheduler version.

Type: string

#### **type**

The scheduler type.

Type: string

## version

The AWS ParallelCluster version that's used to create the cluster.

Type: string

## validation\_messages

A list of messages with a validation level lower than `validationFailureLevel`. The list of messages is collected during configuration validation.

### id

The ID of the validator.

Type: string

### level

Type: string

Valid values: INFO | WARNING | ERROR

### message

A validation message.

Type: string

### type

The type of the validator.

Type: string

## Example

Python

### Request

```
$ create_cluster(cluster_name_3x, cluster-config.yaml)
```

### 200 Response

```
{
```

```
'cluster': {
  'cloudformation_stack_arn': 'arn:aws:cloudformation:us-
east-1:123456789012:stack/cluster-3x/e0462730-50b5-11ed-99a3-0a5ddc4a34c7',
  'cloudformation_stack_status': 'CREATE_IN_PROGRESS',
  'cluster_name': 'cluster-3x',
  'cluster_status': 'CREATE_IN_PROGRESS',
  'region': 'us-east-1',
  'scheduler': {
    'type': 'slurm'
  },
  'version': '3.2.1'
}
```

## deleteCluster

Initiate deleting a cluster.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
DELETE /v3/clusters/{clusterName}
{
  "region": "string"
}
```

### Request body

#### clusterName

The name of the cluster.

Type: string

Required: Yes

## region

The AWS Region that the cluster is deleted in.

Type: string

Required: No

## Response syntax

```
{
  "cluster": {
    "clusterName": "string",
    "region": "string",
    "version": "string",
    "cloudformationStackArn": "string",
    "cloudformationStackStatus": "DELETE_IN_PROGRESS",
    "clusterStatus": "DELETE_IN_PROGRESS",
    "scheduler": {
      "type": "string",
      "metadata": {
        "name": "string",
        "version": "string"
      }
    }
  }
}
```

## Response body

### cluster

A list of cluster instances

#### clusterName

The name of a cluster.

Type: string

#### cloudformationStackArn

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

### **cloudformationStackStatus**

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS |  
UPDATE\_ROLLBACK\_FAILED | UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_ROLLBACK\_COMPLETE

### **clusterStatus**

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE | UPDATE\_FAILED

### **region**

The AWS Region that the cluster is created in.

Type: string

### **scheduler**

#### **metadata**

The scheduler metadata.

#### **name**

The name of the scheduler.

Type: string

#### **version**

The scheduler version

Type: string

**type**

The scheduler type.

Type: string

**version**

The AWS ParallelCluster version that's used to create the cluster.

Type: string

**Example**

Python

**Request**

```
$ delete_cluster(cluster_name_3x)
```

**200 Response**

```
{
  'cluster': {
    'cloudformation_stack_arn': 'arn:aws:cloudformation:us-
east-1:123456789012:stack/cluster_name_3x/16b49540-ae5-11ec-8e18-0ac1d712b241',
    'cloudformation_stack_status': 'DELETE_IN_PROGRESS',
    'cluster_name': 'cluster_name_3x',
    'cluster_status': 'DELETE_IN_PROGRESS',
    'region': 'us-east-1',
    'version': '3.2.1'
  }
}
```

**deleteClusterInstances**

Initiate the forced termination of all cluster compute nodes. This action doesn't support AWS Batch clusters.

**Topics**

- [Request syntax](#)

- [Request body](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
DELETE /v3/clusters/{clusterName}/instances
{
  "force": boolean,
  "region": "string"
}
```

## Request body

### clusterName

The name of the cluster.

Type: string

Required: Yes

### force

If set to `true`, force the deletion when the cluster with the given name isn't found. The default is `false`.

Type: boolean

Required: No

### region

The AWS Region that the cluster is in.

Type: string

Required: No

## Response body

None

## Example

Python

### Request

```
$ delete_cluster_instances(cluster_name_3x)
```

### 200 Response

None

## deleteImage

Initiate deleting the custom AWS ParallelCluster image.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
DELETE /v3/images/custom/{imageId}
{
  "force": boolean,
  "region": "string"
}
```

### Request body

#### imageId

The ID of the image.

Type: string



Required: Yes

### **force**

If set to `true`, force the AMI delete. Use this parameter if there are instances using the AMI or if the AMI is shared. The default is `false`.

Type: boolean

Required: No

### **region**

The AWS Region that the image was created in.

Type: string

Required: No

## **Response syntax**

```
{
  "image": {
    "imageId": "string",
    "ec2AmiInfo": {
      "amiId": "string"
    },
    "region": "string",
    "version": "string",
    "cloudformationStackArn": "string",
    "imageBuildStatus": "DELETE_IN_PROGRESS",
    "cloudformationStackStatus": "DELETE_IN_PROGRESS"
  }
}
```

## **Response body**

### **image**

#### **cloudformationStackArn**

The Amazon resource name (ARN) of the main CloudFormation stack.

Type: string

## **cloudformationStackStatus**

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS |  
UPDATE\_ROLLBACK\_FAILED | UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_ROLLBACK\_COMPLETE

## **ec2AmiInfo**

### **amild**

The Amazon EC2 AMI ID.

Type: string

## **imageBuildStatus**

The image build status.

Type: string

Valid values: BUILD\_IN\_PROGRESS | BUILD\_FAILED | BUILD\_COMPLETE |  
DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE

## **imageId**

The ID of the image.

Type: string

## **region**

The AWS Region that the image is created in.

Type: string

## **version**

The AWS ParallelCluster version that's used to build the image.

Type: string

## Example

Python

### Request

```
$ delete_image(custom-image-id)
```

### 200 Response

```
{
  'image': {
    'image_build_status': 'DELETE_IN_PROGRESS',
    'image_id': 'custom-image-id',
    'region': 'us-east-1',
    'version': '3.2.1'
  }
}
```

## describeCluster

Get detailed information about an existing cluster.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/clusters/{clusterName}
{
```

```
"region": "string"
}
```

## Request body

### clusterName

The name of the cluster.

Type: string

Required: Yes

### region

The AWS Region that the cluster is in.

Type: string

Required: No

## Response syntax

### Note

`failureReason` has changed to `failures` starting with AWS ParallelCluster version 3.5.0.

```
{
  "clusterName": "string",
  "region": "string",
  "version": "string",
  "cloudFormationStackStatus": "CREATE_IN_PROGRESS",
  "clusterStatus": "CREATE_IN_PROGRESS",
  "scheduler": {
    "type": "string",
    "metadata": {
      "name": "string",
      "version": "string"
    }
  }
}
```

```
  },
  "cloudformationStackArn": "string",
  "creationTime": "2019-08-24T14:15:22Z",
  "lastUpdatedTime": "2019-08-24T14:15:22Z",
  "clusterConfiguration": {
    "url": "string"
  },
  "computeFleetStatus": "START_REQUESTED",
  "tags": [
    {
      "key": "string",
      "value": "string"
    }
  ],
  "headNode": {
    "instanceId": "string",
    "instanceType": "string",
    "launchTime": "2019-08-24T14:15:22Z",
    "privateIpAddress": "string",
    "publicIpAddress": "string",
    "state": "pending"
  },
  "failures": [
    {
      "failureCode": "string",
      "failureReason": "string"
    }
  ]
  "loginNodes": {
    "status": "string",
    "address": "string",
    "scheme": "string",
    "healthyNodes": integer,
    "unhealthyNodes": integer
  }
}
```

## Response body

### clusterName

The name of the cluster.

Type: string

**cloudformationStackArn**

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

**cloudformationStackStatus**

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS |  
UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS | UPDATE\_ROLLBACK\_FAILED |  
UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS | UPDATE\_ROLLBACK\_COMPLETE

**clusterConfiguration****url**

The URL of the cluster configuration file.

Type: string

**clusterStatus**

The cluster status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE | UPDATE\_FAILED

**computeFleetStatus**

The compute fleet status.

Type: string

Valid values: START\_REQUESTED | STARTING | RUNNING | PROTECTED |  
STOP\_REQUESTED | STOPPING | STOPPED | UNKNOWN | ENABLED | DISABLED

**creationTime**

Timestamp for when the cluster was created.

Type: datetime

**lastUpdatedTime**

Timestamp for when the cluster was last updated.

Type: datetime

**region**

The AWS Region that the cluster is created in.

Type: string

**tags**

The list of tags that are associated with the cluster.

**key**

Tag name.

Type: string

**tag**

Tag value.

Type: string

**version**

The AWS ParallelCluster version that's used to create the cluster.

Type: string

**failures**

The list of failures when the cluster stack is in CREATE\_FAILED status.

**failureCode**

The failure code when the cluster stack is in CREATE\_FAILED status.

Type: string

**failureReason**

The reason for the failure when the cluster stack is in CREATE\_FAILED status.

Type: string

**head\_node**

The cluster head node.

**instanceId**

The Amazon EC2 instance ID.

Type: string

**instanceType**

The Amazon EC2 instance type.

Type: string

**launchTime**

The time when the Amazon EC2 instance was launched.

Type: datetime

**privateIpAddress**

The cluster private IP address.

Type: string

**publicIpAddress**

The cluster public IP address.

Type: string

**state**

The head node instance status.

Type: string



Valid values: pending | running | shutting-down | terminated | stopping | stopped

## **scheduler**

### **metadata**

The scheduler metadata.

#### **name**

The name of the scheduler.

Type: string

#### **version**

The scheduler version.

Type: string

## **loginNodes**

### **status**

The login node status.

Type: string

Valid values: PENDING | FAILED | ACTIVE

### **address**

The login node address.

Type: string

### **scheme**

The login node scheme.

Type: string

### **healthy**

Number of healthy nodes.

Type: integer

## scheme

The number of unhealthy nodes.

Type: integer

## type

The scheduler type.

Type: string

## Example

Python

### Request

```
$ describe_cluster(cluster_name_3x)
```

### 200 Response

```
{
  'cloud_formation_stack_status': 'CREATE_COMPLETE',
  'cloudformation_stack_arn': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster_name_3x/16b49540-ae5-11ec-8e18-0ac1d712b241',
  'cluster_configuration': {
    'url': 'https://parallelcluster-....'
  },
  'cluster_name': 'cluster_name_3x',
  'cluster_status': 'CREATE_COMPLETE',
  'compute_fleet_status': 'RUNNING',
  'creation_time': datetime.datetime(2022, 3, 28, 22, 19, 9, 661000,
tzinfo=tzlocal()),
  'head_node': {
    'instance_id': 'i-abcdef01234567890',
    'instance_type': 't2.micro',
    'launch_time': datetime.datetime(2022, 3, 28, 22, 21, 56, tzinfo=tzlocal()),
    'private_ip_address': '172.31.56.3',
    'public_ip_address': '107.23.100.164',
    'state': 'running'
  },
}
```

```
'last_updated_time': datetime.datetime(2022, 3, 28, 22, 19, 9, 661000,
tzinfo=tzlocal()),
'region': 'us-east-1',
'tags': [
  {
    'key': 'parallelcluster:version', 'value': '3.2.1'
  }
],
'version': '3.2.1'
}
```

## describeClusterInstances

Describe the instances that belong to a cluster.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/clusters/{clusterName}/instances
{
  "nextToken": "string",
  "nodeType": "string",
  "queueName": "string",
  "region": "string"
}
```

### Request body

#### clusterName

The name of the cluster.

Type: string

Required: Yes

### **nextToken**

A token that's used for paginated requests.

Type: string

Required: No

### **nodeType**

Filter the instances by node type.

Type: string

Valid values: HeadNode, ComputeNode, LoginNode

Required: No

### **queueName**

Filter the instances by queue name.

Type: string

Required: No

### **region**

The AWS Region that the cluster is in.

Type: string

Required: No

## **Response syntax**

```
{
  "nextToken": "string",
  "instances": [
    {
      "instanceId": "string",
      "instanceType": "string",
```

```
    "launchTime": "2019-08-24T14:15:22Z",
    "privateIpAddress": "string",
    "publicIpAddress": "string",
    "state": "pending",
    "nodeType": "HeadNode",
    "queueName": "string"
  }
]
```

## Response body

### instances

The list of cluster instances.

#### **instanceId**

The Amazon EC2 instance ID.

Type: string

#### **instanceType**

The Amazon EC2 instance type.

Type: string

#### **launchTime**

The time when the Amazon EC2 instance was launched.

Type: datetime

#### **nodeType**

The node type.

Type: string

Valid values: HeadNode, ComputeNode, LoginNode

#### **publicIpAddress**

The cluster public IP address.

Type: string

### queueName

The name of the queue that the Amazon EC2 instance is backing a node in.

Type: string

### state

The node Amazon EC2 instance status.

Type: string

Valid values: pending | running | shutting-down | terminated | stopping | stopped

### nextToken

A token that's used for paginated requests.

Type: string

## Example

Python

### Request

```
$ describe_cluster_instances(cluster_name_3x)
```

### 200 Response

```
{
  'instances': [
    {
      'instance_id': 'i-abcdef01234567890',
      'instance_type': 't2.micro',
      'launch_time': datetime.datetime(2022, 3, 30, 14, 2, 7, tzinfo=tzlocal()),
      'node_type': 'HeadNode',
      'private_ip_address': '192.0.2.5',
      'public_ip_address': '198.51.100.180',
      'state': 'running'
    }
  ]
}
```

```
    }  
  ]  
}
```

## describeComputeFleet

Describe the status of the compute fleet.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/clusters/{clusterName}/computefleet  
{  
  "region": "string"  
}
```

### Request body

#### clusterName

The name of the cluster.

Type: string

Required: Yes

#### region

The AWS Region that the cluster is in.

Type: string

Required: No

## Response syntax

```
{
  "status": "START_REQUESTED",
  "lastStatusUpdatedTime": "2019-08-24T14:15:22Z"
}
```

## Response body

### status

Type: string

Valid values: START\_REQUESTED | STARTING | RUNNING | PROTECTED | STOP\_REQUESTED | STOPPING | STOPPED | UNKNOWN | ENABLED | DISABLED

### lastStatusUpdatedTime

The timestamp representing the last status update time.

Type: datetime

## Example

### Python

#### Request

```
$ describe_compute_fleet(cluster_name_3x)
```

#### 200 Response

```
{
  'last_status_updated_time': datetime.datetime(2022, 3, 28, 22, 27, 14,
  tzinfo=tzlocal()),
  'status': 'RUNNING'
}
```

## describelImage

Get detailed information about an existing image.



## Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
GET /v3/images/custom/{imageId}  
{  
  "region": "string"  
}
```

## Request body

### imageId

The ID of the image.

Type: string

Required: Yes

### region

The AWS Region that the image was created in.

Type: string

Required: No

## Response syntax

```
{  
  "imageId": "string",  
  "region": "string",  
  "version": "string",
```

```
"imageBuildStatus": "BUILD_IN_PROGRESS",
"imageBuildLogsArn": "string",
"cloudformationStackStatus": "CREATE_IN_PROGRESS",
"cloudformationStackStatusReason": "string",
"cloudformationStackArn": "string",
"creationTime": "2019-08-24T14:15:22Z",
"cloudformationStackCreationTime": "2019-08-24T14:15:22Z",
"cloudformationStackTags": [
  {
    "key": "string",
    "value": "string"
  }
],
"imageConfiguration": {
  "url": "string"
},
"imagebuilderImageStatus": "PENDING",
"imagebuilderImageStatusReason": "string",
"ec2AmiInfo": {
  "amiId": "string",
  "tags": [
    {
      "key": "string",
      "value": "string"
    }
  ],
  "amiName": "string",
  "architecture": "string",
  "state": "PENDING",
  "description": "string"
}
}
```

## Response body

### imageId

The ID of the image to retrieve detailed information for.

Type: string

### imageBuildStatus

The image build status.

Type: string

Valid values: BUILD\_IN\_PROGRESS | BUILD\_FAILED | BUILD\_COMPLETE |  
DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE

### **imageConfiguration**

#### **url**

The URL of the image configuration file.

Type: string

#### **region**

The AWS Region that the image is created in.

Type: string

#### **version**

The AWS ParallelCluster version that's used to build the image.

Type: string

#### **cloudformationStackArn**

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

#### **cloudformationStackCreationTime**

The timestamp for when the CloudFormation stack was created.

Type: datetime

#### **cloudformationStackStatus**

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS |

UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS | UPDATE\_ROLLBACK\_FAILED |  
UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS | UPDATE\_ROLLBACK\_COMPLETE

### **cloudformationStackStatusReason**

The reason for the CloudFormation stack status.

Type: string

### **cloudformationStackTags**

The list of tags for the CloudFormation stack.

#### **key**

The tag name.

Type: string

#### **value**

The tag value.

Type: string

### **creationTime**

Timestamp for when the image was created.

Type: datetime

### **ec2AmiInfo**

#### **amiId**

The Amazon EC2 AMI ID.

Type: string

#### **amiName**

The Amazon EC2 AMI name.

Type: string

#### **architecture**

The Amazon EC2 AMI architecture.

Type: string

**state**

The state of the Amazon EC2 AMI.

Type: string

Valid values: PENDING | AVAILABLE | INVALID | DEREGISTERED | TRANSIENT | FAILED | ERROR

**tags**

List of Amazon EC2 AMI Tags.

**key**

Tag name.

Type: string

**value**

Tag value.

Type: string

**imagebuilderImageStatus**

The ImageBuilder status.

Type: string

Valid values: PENDING | CREATING | BUILDING | TESTING | DISTRIBUTING | INTEGRATING | AVAILABLE | CANCELLED | FAILED | DEPRECATED | DELETED

**imagebuilderImageStatusReason**

Reason for the ImageBuilder Image status.

Type: string

**imageBuildLogsArn**

The Amazon Resource Name (ARN) of the logs for the image build process.

Type: string

## Example

### Python

#### Request

```
$ describe_image(custom-image-id)
```

#### 200 Response

```
{
  'cloudformation_stack_arn': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
custom-image-id/6accc570-b080-11ec-845e-0e2dc6386985',
  'cloudformation_stack_creation_time': datetime.datetime(2022, 3, 30, 23, 23, 33,
731000, tzinfo=tzlocal()),
  'cloudformation_stack_status': 'CREATE_IN_PROGRESS',
  'cloudformation_stack_tags': [
    {
      'key': 'parallelcluster:version', 'value': '3.2.1'
    },
    {
      'key': 'parallelcluster:image_name',
      'value': 'custom-image-id'
    },
    {
      'key': 'parallelcluster:custom-image-id',
      'value': 'custom-image-id'
    },
    {
      'key': 'parallelcluster:s3_bucket',
      'value': 'parallelcluster-abcdef01234567890-v1-do-not-delete'
    },
    {
      'key': 'parallelcluster:s3_image_dir',
      'value': 'parallelcluster/3.2.1/images/custom-image-id-1234567890abcdef0'
    },
    {
      'key': 'parallelcluster:build_log',
      'value': 'arn:aws:logs:us-east-1:123456789012:log-group:/aws/imagebuilder/
ParallelClusterImage-custom-image-id'
    },
    {
      'key': 'parallelcluster:build_config',
```

```
    'value': 's3://parallelcluster-abcdef01234567890-v1-do-not-delete/parallelcluster/3.2.1/images/custom-image-id-1234567890abcdef0/configs/image-config.yaml'
  }
],
'image_build_logs_arn': 'arn:aws:logs:us-east-1:123456789012:log-group:/aws/imagebuilder/ParallelClusterImage-alinux2-image',
'image_build_status': 'BUILD_IN_PROGRESS',
'image_configuration': {
  'url': 'https://parallelcluster-abcdef01234567890-v1-do-not-delete.s3.amazonaws.com/parallelcluster/3.2.1/images/custom-image-id-1234567890abcdef0/configs/image-config.yaml?... '
},
'image_id': 'custom-image-id',
'imagebuilder_image_status': 'PENDING',
'region': 'us-east-1',
'version': '3.2.1'
}
```

## getClusterLogEvents

Retrieve the events that are associated with a log stream.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/clusters/{clusterName}/logstreams/{logStreamName}
{
  "endTime": datetime,
  "limit": float,
  "nextToken": "string",
  "region": "string",
  "startFromHead": boolean,
```

```
"startTime": datetime
}
```

## Request body

### clusterName

The name of the cluster.

Type: string

Required: Yes

### logStreamName

The name of the log stream.

Type: string

Required: Yes

### endTime

The end of the time range, expressed in ISO 8601 format. Events with a timestamp equal to or later than this time are not included.

Type: datetime

Format: 2021-01-01T20:00:00Z

Required: No

### limit

The maximum number of log events returned. If you don't specify a value, the maximum is as many log events as can fit in a response size of 1 MB, up to 10,000 log events.

Type: float

Required: No

### nextToken

A token that's used for paginated requests.



Type: string

Required: No

### **region**

The AWS Region that the cluster is in.

Type: string

Required: No

### **startFromHead**

If set to `true`, the earliest log events are returned first. If the value is `false`, the latest log events are returned first. The default is `false`.

Type: boolean

Required: No

### **startTime**

The start of the time range, expressed in ISO 8601 format. Events with a timestamp equal to this time or later than this time are included.

Type: datetime

Format: 2021-01-01T20:00:00Z

Required: No

## **Response syntax**

```
{
  "nextToken": "string",
  "prevToken": "string",
  "events": [
    {
      "timestamp": "2019-08-24T14:15:22Z",
      "message": "string"
    }
  ]
}
```

## Response body

### events

List of filtered events.

#### message

The event message.

Type: string

#### timestamp

The event timestamp.

Type: datetime

### nextToken

A token that's used for paginated requests.

Type: string

### prevToken

A token that's used for paginated requests.

Type: string

## Example

### Python

#### Request

```
$ get_cluster_log_events(cluster_name_3x, log_stream_name=ip-192-0-2-26.i-  
abcdef01234567890.cfn-init)
```

#### 200 Response

```
"events": [  
  {  
    "message": "2022-09-22 16:40:15,127 [DEBUG] CloudFormation client initialized  
with endpoint https://cloudformation.us-east-1.amazonaws.com",
```

```
    "timestamp": "2022-09-22T16:40:15.127Z"
  },
  {
    "message": "2022-09-22 16:40:15,127 [DEBUG] Describing resource
HeadNodeLaunchTemplate in stack cluster_name_3x",
    "timestamp": "2022-09-22T16:40:15.127Z"
  },
  ...
]
```

## getClusterStackEvents

Retrieve the events that are associated with the stack for a cluster.

### Note

Starting in version 3.6.0, AWS ParallelCluster uses nested stacks to create the resources associated with queues and compute resources. The `GetClusterStackEvents` API and the `pcluster get-cluster-stack-events` command only return the cluster main stack events. You can view the cluster stack events, including those related to queues and compute resources, in the CloudFormation console.

## Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
GET /v3/clusters/{clusterName}/stackevents
{
  "nextToken": "string",
  "region": "string"
}
```

## Request body

### clusterName

The name of the cluster.

Type: string

Required: Yes

### nextToken

A token that's used for paginated requests.

Type: string

Required: No

### region

The AWS Region that the cluster is in.

Type: string

Required: No

## Response syntax

```
{
  "nextToken": "string",
  "events": [
    {
      "stackId": "string",
      "eventId": "string",
      "stackName": "string",
      "logicalResourceId": "string",
      "physicalResourceId": "string",
      "resourceType": "string",
      "timestamp": "2019-08-24T14:15:22Z",
      "resourceStatus": "CREATE_IN_PROGRESS",
      "resourceStatusReason": "string",
      "resourceProperties": "string",
      "clientRequestToken": "string"
    }
  ]
}
```

```
]
}
```

## Response body

### events

List of filtered events.

#### **clientRequestToken**

The token passed to the action that generated this event.

Type: string

#### **eventId**

The unique ID of this event.

Type: string

#### **logicalResourceId**

The logical name of the resource specified in the template.

Type: string

#### **physicalResourceId**

The name or unique identifier that's associated with the physical instance of the resource.

Type: string

#### **resourceProperties**

A BLOB of the properties that are used to create the resource.

Type: string

#### **resourceStatus**

The resource status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE |  
DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE | DELETE\_SKIPPED

| UPDATE\_IN\_PROGRESS | UPDATE\_FAILED | UPDATE\_COMPLETE | IMPORT\_FAILED  
| IMPORT\_COMPLETE | IMPORT\_IN\_PROGRESS | IMPORT\_ROLLBACK\_IN\_PROGRESS |  
IMPORT\_ROLLBACK\_FAILED | IMPORT\_ROLLBACK\_COMPLETE

**resourceStatusReason**

A success or failure message that's associated with the resource.

Type: string

**resourceType**

The type of resource.

Type: string

**stackId**

The unique ID name of the instance of the stack.

Type: string

**stackName**

The name that's associated with a stack.

Type: string

**timestamp**

The time when the status was updated.

Type: datetime

**nextToken**

A token that's used for paginated requests.

Type: string

**Example**

Python

**Request**

```
$ get_cluster_stack_events(cluster_name_3x)
```

## 200 Response

```
{
  'events': [
    {
      'event_id': '590b3820-b081-11ec-985e-0a7af5751497',
      'logical_resource_id': 'cluster_name_3x',
      'physical_resource_id': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster_name_3x/11a59710-b080-11ec-b8bd-129def1380e9',
      'resource_status': 'CREATE_COMPLETE',
      'resource_type': 'AWS::CloudFormation::Stack',
      'stack_id': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
cluster_name_3x/11a59710-b080-11ec-b8bd-129def1380e9',
      'stack_name': 'cluster_name_3x',
      'timestamp': datetime.datetime(2022, 3, 30, 23, 30, 13, 268000,
tzinfo=tzlocal())
    },
    ...
  ]
}
```

## getImageLogEvents

Retrieve the events that are associated with an image build.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/images/custom/{imageId}/logstreams/{logStreamName}
{
```

```
"endTime": datetime,  
"limit": float,  
"nextToken": "string",  
"region": "string",  
"startFromHead": boolean,  
"startTime": datetime  
}
```

## Request body

### imageId

The ID of the image.

Type: string

Required: Yes

### logStreamName

The name of the logstream.

Type: string

Required: Yes

### endTime

The end of the time range, expressed in ISO 8601 format. Events with a timestamp equal to or later than this time aren't included.

Type: datetime

Format: 2021-01-01T20:00:00Z

Required: No

### limit

The maximum number of log events returned. If you don't specify a value, the maximum is as many log events as can fit in a response size of 1 MB, up to 10,000 log events.

Type: float

Required: No



## nextToken

A token that's used for paginated requests.

Type: string

Required: No

## region

The AWS Region that the image in.

Type: string

Required: No

## startFromHead

If set to `true`, return the earliest log events first. If set to `false`, return the latest log events first. The default is `false`.

Type: boolean

Required: No

## startTime

The start of the time range, expressed in ISO 8601 format. Events with a timestamp equal to this time or later than this time are included.

Type: datetime

Format: `2021-01-01T20:00:00Z`

Required: No

## Response syntax

```
{
  "nextToken": "string",
  "prevToken": "string",
  "events": [
    {
      "timestamp": "2019-08-24T14:15:22Z",
```

```
    "message": "string"
  }
]
}
```

## Response body

### events

A list of filtered events.

#### message

The event message.

Type: string

#### timestamp

The event timestamp.

Type: datetime

### nextToken

A token that's used for paginated requests.

Type: string

### prevToken

A token that's used for paginated requests.

Type: string

## Example

Python

### Request

```
$ get_image_log_events(image_id, log_stream_name=3.2.1/1)
```

### 200 Response

```
"events": [  
  {  
    "message": "ExecuteBash: STARTED EXECUTION",  
    "timestamp": "2022-04-05T15:51:20.228Z"  
  },  
  {  
    "message": "ExecuteBash: Created temporary directory: /tmp/1234567890abcdef0",  
    "timestamp": "2022-04-05T15:51:20.228Z"  
  },  
  ...  
]
```

## getImageStackEvents

Retrieve the events that are associated with the stack for an image build.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/images/custom/{imageId}/stackevents  
{  
  "nextToken": "string",  
  "region": "string"  
}
```

### Request body

#### imageId

The ID of the image.

Type: string

Required: Yes

### **nextToken**

A token that's used for paginated requests.

Type: string

Required: No

### **region**

The AWS Region that the image is in.

Type: string

Required: No

## **Response syntax**

```
{
  "nextToken": "string",
  "events": [
    {
      "stackId": "string",
      "eventId": "string",
      "stackName": "string",
      "logicalResourceId": "string",
      "physicalResourceId": "string",
      "resourceType": "string",
      "timestamp": "2019-08-24T14:15:22Z",
      "resourceStatus": "CREATE_IN_PROGRESS",
      "resourceStatusReason": "string",
      "resourceProperties": "string",
      "clientRequestToken": "string"
    }
  ]
}
```

## **Response body**

### **events**

A list of filtered events.

**clientRequestToken**

The token passed to the action that generated this event.

Type: string

**eventId**

The unique ID of this event.

Type: string

**logicalResourceId**

The logical name of the resource specified in the template.

Type: string

**physicalResourceId**

The name or unique identifier that's associated with the physical instance of the resource.

Type: string

**resourceProperties**

A BLOB of the properties that are used to create the resource.

Type: string

**resourceStatus**

The resource status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE | DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE | DELETE\_SKIPPED | UPDATE\_IN\_PROGRESS | UPDATE\_FAILED | UPDATE\_COMPLETE | IMPORT\_FAILED | IMPORT\_COMPLETE | IMPORT\_IN\_PROGRESS | IMPORT\_ROLLBACK\_IN\_PROGRESS | IMPORT\_ROLLBACK\_FAILED | IMPORT\_ROLLBACK\_COMPLETE

**resourceStatusReason**

A success or failure message that's associated with the resource.

Type: string

**resourceType**

The type of resource.

Type: string

**stackId**

The unique ID name of the instance of the stack.

Type: string

**stackName**

The name that's associated with a stack.

Type: string

**timestamp**

The time when the status was updated.

Type: datetime

**nextToken**

A token that's used for paginated requests.

Type: string

**Example**

Python

**Request**

```
$ get_image_stack_events(image_id)
```

**200 Response**

```
{
  'events': [
    {
      'event_id': 'ParallelClusterImage-
CREATE_IN_PROGRESS-2022-03-30T23:26:33.499Z',
      'logical_resource_id': 'ParallelClusterImage',
```

```

    'physical_resource_id': 'arn:aws:imagebuilder:us-east-1:123456789012:image/
parallelclusterimage-alinux2-image/3.2.1/1',
    'resource_properties': {
        "InfrastructureConfigurationArn": "arn:aws:imagebuilder:us-
east-1:123456789012:infrastructure-configuration/parallelclusterimage-6accc570-
b080-11ec-845e-0e2dc6386985",
        "ImageRecipeArn": "arn:aws:imagebuilder:us-east-1:123456789012:image-recipe/
parallelclusterimage-alinux2-image/3.2.1",
        "DistributionConfigurationArn": "arn:aws:imagebuilder:us-
east-1:123456789012:distribution-configuration/parallelclusterimage-6accc570-
b080-11ec-845e-0e2dc6386985",
        "EnhancedImageMetadataEnabled": "false",
        "Tags": {
            "parallelcluster:image_name": "alinux2-
image", "parallelcluster:image_id": "alinux2-image"
        }
    },
    'resource_status': 'CREATE_IN_PROGRESS',
    'resource_status_reason': 'Resource creation Initiated',
    'resource_type': 'AWS::ImageBuilder::Image',
    'stack_id': 'arn:aws:cloudformation:us-east-1:123456789012:stack/alinux2-
image/6accc570-b080-11ec-845e-0e2dc6386985',
    'stack_name': 'alinux2-image',
    'timestamp': datetime.datetime(2022, 3, 30, 23, 26, 33, 499000,
tzinfo=tzlocal())
},
...
]
}

```

## listClusters

Retrieve a list of existing clusters.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
GET /v3/clusters
{
  "clusterStatus": "string",
  "nextToken": "string",
  "region": "string"
}
```

## Request body

### clusterStatus

Filter by cluster status. The default is all clusters.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | UPDATE\_IN\_PROGRESS |  
UPDATE\_COMPLETE | UPDATE\_FAILED

Required: no

### nextToken

A token that's used for paginated requests.

Type: string

Required: No

### region

The AWS Region of the clusters.

Type: string

Required: No

## Response syntax

```
{
```



```
"nextToken": "string",
"clusters": [
  {
    "clusterName": "string",
    "region": "string",
    "version": "string",
    "cloudformationStackArn": "string",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "clusterStatus": "CREATE_IN_PROGRESS",
    "scheduler": {
      "type": "string",
      "metadata": {
        "name": "string",
        "version": "string"
      }
    }
  }
]
}
```

## Response body

### clusters

#### cloudformationStackArn

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

#### cloudformationStackStatus

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS |  
UPDATE\_ROLLBACK\_FAILED | UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_ROLLBACK\_COMPLETE

**clusterName**

The name of the cluster.

Type: string

**clusterStatus**

The cluster status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE | UPDATE\_FAILED

**scheduler****metadata**

The scheduler metadata.

**name**

The name of the scheduler.

Type: string

**version**

The scheduler version.

Type: string

**type**

The type of scheduler.

Type: string

**region**

The AWS Region that the cluster is created in.

Type: string

**version**

The AWS ParallelCluster version that's used to create the cluster.

Type: string

## nextToken

A token that's used for paginated requests.

Type: string

## Example

Python

### Request

```
$ list_clusters()
```

### 200 Response

```
{
  'clusters':
  [
    {
      'cloudformation_stack_arn': 'arn:aws:cloudformation:us-
east-1:123456789012:stack/cluster_name_3x/16b49540-ae5-11ec-8e18-0ac1d712b241',
      'cloudformation_stack_status': 'CREATE_COMPLETE',
      'cluster_name': 'cluster_name_3x',
      'cluster_status': 'CREATE_COMPLETE',
      'region': 'us-east-1',
      'version': '3.2.1'
    },
    ...
  ]
}
```

## listClusterLogStreams

Retrieve the list of log streams that are associated with a cluster.

### Topics

- [Request syntax](#)

- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
GET /v3/clusters/{clusterName}/logstreams
{
  "filters": [ "string" ],
  "nextToken": "string",
  "region": "string"
}
```

## Request body

### clusterName

The name of the cluster.

Type: string

Required: Yes

### filters

Filter the log streams.

Accepted filters are:

- `private-dns-name`: The short form of the private DNS name of the instance (e.g. `ip-10-0-0-101`).
- `node-type`: Valid value: `HeadNode`.

Type: Array of strings unique

Format: `Name=a, Values=1 Name=b, Values=2, 3`

Required: No

### nextToken

A token that's used for paginated requests.

Type: string

Required: No

## region

The AWS Region that the cluster is in.

Type: string

Required: No

## Response syntax

```
{
  "nextToken": "string",
  "logStreams": [
    {
      "logStreamName": "string",
      "creationTime": "2019-08-24T14:15:22Z",
      "firstEventTimestamp": "2019-08-24T14:15:22Z",
      "lastEventTimestamp": "2019-08-24T14:15:22Z",
      "lastIngestionTime": "2019-08-24T14:15:22Z",
      "uploadSequenceToken": "string",
      "logStreamArn": "string"
    }
  ]
}
```

## Response body

### logStreams

A list of log streams.

#### creationTime

The time when the stream was created.

Type: datetime

#### firstEventTimestamp

The time of the first event of the stream.

Type: datetime

### **lastEventTimestamp**

The time of the last event of the stream. The lastEventTime value updates on an eventual consistency basis. It typically updates in less than an hour from ingestion, but in rare situations might take longer.

Type: datetime

### **lastIngestionTime**

The last ingestion time.

Type: datetime

### **logStreamArn**

The Amazon Resource Name (ARN) of the log stream.

Type: string

### **logStreamName**

Name of the log stream.

Type: string

### **uploadSequenceToken**

The sequence token.

Type: string

### **nextToken**

A token that's used for paginated requests.

Type: string

## **Example**

Python

### **Request**

```
$ list_cluster_log_streams(cluster_name_3x)
```

## 200 Response

```
{
  'log_streams': [
    {
      'creation_time': datetime.datetime(2022, 3, 30, 14, 7, 34, 354000,
tzinfo=tzlocal()),
      'first_event_timestamp': datetime.datetime(2022, 3, 30, 14, 6, 41, 444000,
tzinfo=tzlocal()),
      'last_event_timestamp': datetime.datetime(2022, 3, 30, 14, 25, 55, 462000,
tzinfo=tzlocal()),
      'last_ingestion_time': datetime.datetime(2022, 3, 30, 14, 49, 50, 62000,
tzinfo=tzlocal()),
      'log_stream_arn': 'arn:aws:logs:us-east-1:123456789012:log-group:/aws/
parallelcluster/cluster_name_3x:log-stream:ip-192-0-2-26.i-abcdef01234567890.cfn-
init',
      'log_stream_name': 'ip-192-0-2-26.i-abcdef01234567890.cfn-init',
      ...
      'upload_sequence_token': '####'
    },
    ...
  ]
}
```

## listImageLogStreams

Retrieve the list of log streams that's associated with an image.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/images/custom/{imageId}/logstreams
{
```

```
"nextToken": "string",  
"region": "string"  
}
```

## Request body

### imageId

The ID of the image.

Type: string

Required: Yes

### nextToken

A token that's used for paginated requests.

Type: string

Required: No

### region

The AWS Region that the image is in.

Type: string

Required: No

## Response syntax

```
{  
  "nextToken": "string",  
  "logStreams": [  
    {  
      "logStreamName": "string",  
      "creationTime": "2019-08-24T14:15:22Z",  
      "firstEventTimestamp": "2019-08-24T14:15:22Z",  
      "lastEventTimestamp": "2019-08-24T14:15:22Z",  
      "lastIngestionTime": "2019-08-24T14:15:22Z",  
      "uploadSequenceToken": "string",  
      "logStreamArn": "string"  
    }  
  ]  
}
```



```
}  
]  
}
```

## Response body

### logStreams

A list of log streams.

#### **creationTime**

The time when the stream was created.

Type: datetime

#### **firstEventTimestamp**

The time of the first event in the stream.

Type: datetime

#### **lastEventTimestamp**

The time of the last event of the stream. The `lastEventTime` value updates on an eventual consistency basis. It typically updates in less than an hour from ingestion, but in rare situations might take longer.

Type: datetime

#### **lastIngestionTime**

The last ingestion time.

Type: datetime

#### **logStreamArn**

The Amazon Resource Name (ARN) of the log stream.

Type: string

#### **logStreamName**

The name of the log stream.

Type: string

### **uploadSequenceToken**

The sequence token.

Type: string

### **next\_token**

A token that's used for paginated requests.

Type: string

## **Example**

Python

### **Request**

```
$ list_image_log_streams(custom-image-id)
```

### **200 Response**

```
{
  'log_streams': [
    {
      'creation_time': datetime.datetime(2022, 3, 29, 20, 29, 24, 875000,
tzinfo=tzlocal()),
      'first_event_timestamp': datetime.datetime(2022, 3, 29, 20, 29, 24, 775000,
tzinfo=tzlocal()),
      'last_event_timestamp': datetime.datetime(2022, 3, 29, 20, 38, 23, 944000,
tzinfo=tzlocal()),
      'last_ingestion_time': datetime.datetime(2022, 3, 29, 20, 51, 56, 26000,
tzinfo=tzlocal()),
      'log_stream_arn': 'arn:aws:logs:us-east-1:123456789012:log-group:/aws/
imagebuilder/ParallelClusterImage-alinux2-image:log-stream:3.2.1/1',
      'log_stream_name': '3.2.1/1',
      'upload_sequence_token': '####'
    },
    ...
  ]
}
```

# listImages

Retrieve the list of existing custom images.

## Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
GET /images/custom
{
  "imageStatus": "string",
  "nextToken": "string",
  "region": "string"
}
```

## Request body

### imageStatus

Filter images by the status provided.

Type: string

Valid values: AVAILABLE | PENDING | FAILED

Required: Yes

### nextToken

A token that's used for paginated requests.

Type: string

Required: No

## region

The AWS Region that images are in.

Type: string

Required: No

## Response syntax

```
{
  "nextToken": "string",
  "images": [
    {
      "imageId": "string",
      "ec2AmiInfo": {
        "amiId": "string"
      },
      "region": "string",
      "version": "string",
      "cloudformationStackArn": "string",
      "imageBuildStatus": "BUILD_IN_PROGRESS",
      "cloudformationStackStatus": "CREATE_IN_PROGRESS"
    }
  ]
}
```

## Response body

### images

A list of images.

#### cloudformationStackArn

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

#### cloudformationStackStatus

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS |  
UPDATE\_ROLLBACK\_FAILED | UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_ROLLBACK\_COMPLETE

**ec2AmiInfo****ami\_id**

The Amazon EC2 AMI ID.

Type: string

**imageBuildStatus**

The image build status.

Valid values: BUILD\_IN\_PROGRESS | BUILD\_FAILED | BUILD\_COMPLETE |  
DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE

Type: string

**imageId**

The ID of the image.

Type: string

**region**

The AWS Region that the image is created in.

Type: string

**version**

The AWS ParallelCluster version that's used to build the image.

Type: string

**nextToken**

A token that's used for paginated requests.

Type: string

## Example

Python

### Request

```
$ list_images("AVAILABLE")
```

### 200 Response

```
{
  'images': [
    {
      'ec2_ami_info': {
        'ami_id': 'ami-abcdef01234567890'
      },
      'image_build_status': 'BUILD_COMPLETE',
      'image_id': 'custom-image',
      'region': 'us-east-1',
      'version': '3.2.1'
    }
  ]
}
```

## listOfficialImages

Retrieve the list of AWS ParallelCluster official images.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
GET /v3/images/official
```

```
{
  "architecture": "string",
  "os": "string",
  "region": "string"
}
```

## Request body

### architecture

Filter by architecture. The default is no filtering.

Type: string

Valid values: x86\_64 | arm64

Required: No

### os

Filter by OS distribution. The default is no filtering.

Type: string

Valid values: alinux2 | centos7 | ubuntu2204 | ubuntu2004 | rhel8

Required: No

### region

The AWS Region that official images are listed in.

Type: string

Required: No

## Response syntax

```
{
  "images": [
    {
      "architecture": "string",
      "amiId": "string",
      "name": "string",
    }
  ]
}
```

```
    "os": "string",
    "version": "string"
  }
]
```

## Response body

### images

#### amild

The ID of the AMI.

Type: string

#### architecture

The AMI architecture.

Type: string

#### name

The name of the AMI.

Type: string

#### os

The AMI operating system.

Type: string

#### version

The AWS ParallelCluster version.

Type: string

## Example

Python

### Request



```
$ list_official_images()
```

## 200 Response

```
{
  'images': [
    {
      'ami_id': 'ami-015cfef4e0d6306b2',
      'architecture': 'x86_64',
      'name': 'aws-parallelcluster-3.2.1-ubuntu-2004-lts-hvm-x86_64-202202261505 '
      '2022-02-26T15-08-34.759Z',
      'os': 'ubuntu2004',
      'version': '3.2.1'
    },
    ...
  ]
}
```

## updateCluster

Update the cluster.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

### Request syntax

```
PUT /v3/clusters/{clusterName}
{
  "clusterConfiguration": "string",
  "dryrun": boolean,
  "forceUpdate": boolean,
  "region": "string",
```

```
"suppressValidators": "string",  
"validationFailureLevel": "string"  
}
```

## Request body

### **clusterConfiguration**

The cluster configuration as a YAML document.

Required: Yes

### **clusterName**

The name of the cluster.

Type: string

Required: Yes

### **dryrun**

If set to `true`, only perform request validation without creating any resource. Use this parameter to validate the cluster configuration and update requirements. The default is `false`.

Type: boolean

Required: No

### **forceUpdate**

If set to `true`, ignore the update validation errors and force the update. The default is `false`.

Type: boolean

Required: No

### **region**

The AWS Region that the cluster is in.

Type: string

Required: No

## suppressValidators

Identifies one or more configuration validators to suppress.

Type: string

Format: (ALL | type: [A-Za-z0-9]+)

Required: No

Example valid values: currentValue, requestedValue, message

## validationFailureLevel

The minimum validation level to cause the update to fail.

Type: string

Valid values: INFO | WARNING | ERROR

Required: No

## Response syntax

```
{
  "cluster": {
    "clusterName": "string",
    "region": "string",
    "version": "string",
    "cloudformationStackArn": "string",
    "cloudformationStackStatus": "UPDATE_IN_PROGRESS",
    "clusterStatus": "UPDATE_IN_PROGRESS",
    "scheduler": {
      "type": "string",
      "metadata": {
        "name": "string",
        "version": "string"
      }
    }
  },
  "validationMessages": [
    {
      "id": "string",
```

```
    "type": "string",
    "level": "INFO",
    "message": "string"
  }
],
"changeSet": [
  {
    "parameter": "string",
    "currentValue": "string",
    "requestedValue": "string"
  }
]
}
```

## Response body

### changeSet

The change set for the cluster update.

#### currentValue

The current value of the parameter to be updated.

Type: string

#### parameter

The parameter to be updated.

Type: string

#### requestedValue

The requested value for the parameter to be updated.

Type: string

### cluster

#### cloudformationStackArn

The Amazon Resource Name (ARN) of the main CloudFormation stack.

Type: string

**cloudformationStackStatus**

The CloudFormation stack status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| ROLLBACK\_IN\_PROGRESS | ROLLBACK\_FAILED | ROLLBACK\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_COMPLETE | UPDATE\_ROLLBACK\_IN\_PROGRESS |  
UPDATE\_ROLLBACK\_FAILED | UPDATE\_ROLLBACK\_COMPLETE\_CLEANUP\_IN\_PROGRESS  
| UPDATE\_ROLLBACK\_COMPLETE

**clusterName**

The name of cluster.

Type: string

**clusterStatus**

The cluster status.

Type: string

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE  
| DELETE\_IN\_PROGRESS | DELETE\_FAILED | DELETE\_COMPLETE |  
UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE | UPDATE\_FAILED

**region**

The AWS Region that the cluster is created in.

Type: string

**scheduler****metadata**

The scheduler metadata.

**name**

The name of the scheduler.

Type: string

**version**

The scheduler version.

Type: string

**type**

The scheduler type.

Type: string

**version**

AWS ParallelCluster version that's used to create the cluster.

Type: string

**validationMessages**

A list of messages with a validation level lower than `validationFailureLevel`. The list of messages is collected during configuration validation.

**id**

The ID of the validator.

Type: string

**level**

The validation level.

Type: string

Valid values: INFO | WARNING | ERROR

**message**

The validation message.

Type: string

**type**

The type of the validator.

Type: string

## Example

Python

### Request

```
$ update_cluster(cluster_name_3x, path/config-file.yaml)
```

### 200 Response

```
{
  'change_set': [
    {
      'current_value': '10',
      'parameter':
'Scheduling.SlurmQueues[queue1].ComputeResources[t2micro].MaxCount',
      'requested_value': '15'
    }
  ],
  'cluster': {
    'cloudformation_stack_arn': 'arn:aws:cloudformation:us-
east-1:123456789012:stack/test-api-cluster/e0462730-50b5-11ed-99a3-0a5ddc4a34c7',
    'cloudformation_stack_status': 'UPDATE_IN_PROGRESS',
    'cluster_name': 'cluster-3x',
    'cluster_status': 'UPDATE_IN_PROGRESS',
    'region': 'us-east-1',
    'scheduler': {
      'type': 'slurm'
    },
    'version': '3.2.1'
  }
}
```

## updateComputeFleet

Update the status of the cluster compute fleet.

### Topics

- [Request syntax](#)
- [Request body](#)
- [Response syntax](#)
- [Response body](#)
- [Example](#)

## Request syntax

```
PATCH /v3/clusters/{clusterName}/computefleet
{
  "status": "string",
  "region": "string"
}
```

## Request body

### clusterName

The name of the cluster.

Type: string

Required: Yes

### status

The compute fleet status.

Type: string

Valid values: START\_REQUESTED | STOP\_REQUESTED | ENABLED | DISABLED

Required: Yes

### region

The AWS Region that the cluster is in.

Type: string



Required: No

## Response syntax

```
{
  "status": "START_REQUESTED",
  "lastStatusUpdateTime": "2019-08-24T14:15:22Z"
}
```

## Response body

### status

The compute fleet status.

Type: string

Valid values: START\_REQUESTED | STARTING | RUNNING | PROTECTED | STOP\_REQUESTED | STOPPING | STOPPED | UNKNOWN | ENABLED | DISABLED

### lastStatusUpdateTime

The timestamp that represents the last status update time.

Type: datetime

## Example

Python

### Request

```
$ update_compute_fleet(cluster_name_3x, "START_REQUESTED")
```

### 200 Response

```
{
  'last_status_updated_time': datetime.datetime(2022, 3, 28, 22, 27, 14,
  tzinfo=tzlocal()),
```

```
'status': 'START_REQUESTED'  
}
```

## AWS ParallelCluster Python library API

Starting with AWS ParallelCluster version 3.5.0, you can access AWS ParallelCluster with the AWS ParallelCluster Python library. You can access the AWS ParallelCluster library in your `pccluster` environment or from within an AWS Lambda runtime. Learn how to access the AWS ParallelCluster API by using the AWS ParallelCluster Python library. The AWS ParallelCluster Python library offers the same functionality that the AWS ParallelCluster API delivers.

The AWS ParallelCluster Python library operations and parameters mirror those of the API parameters when converted to `snake_case` with no capital letters.

### Topics

- [AWS ParallelCluster Python library authorization](#)
- [Install the AWS ParallelCluster Python library](#)
- [Cluster API operations](#)
- [Compute fleet API operations](#)
- [Cluster and stack log operations](#)
- [Image API operations](#)
- [Image and stack log operations](#)
- [Example](#)
- [AWS Lambda for the AWS ParallelCluster Python library](#)

## AWS ParallelCluster Python library authorization

Specify credentials by using any of the standard ways that are valid for `boto3`. For more information, see the [boto3 documentation](#).

## Install the AWS ParallelCluster Python library

1. Install `pccluster` CLI version 3.5.0 or later by following the instructions given in [Setting up AWS ParallelCluster](#).

2. Import the `pcluster` module and start using the library, as shown in the following example:

```
import pcluster.lib as pc
pc.create_cluster(cluster_name="mycluster", cluster_configuration="config.yaml")
```

## Cluster API operations

### Topics

- [list\\_clusters](#)
- [create\\_cluster](#)
- [delete\\_cluster](#)
- [describe\\_cluster](#)
- [update\\_cluster](#)

### list\_clusters

```
list_clusters(region, next_token, cluster_status)
```

Retrieve the list of existing clusters.

#### Parameters:

##### **region**

Lists clusters deployed to a given AWS Region.

##### **next\_token**

The token to use for paginated requests.

##### **cluster\_status**

Filters by cluster status. The default is to list all clusters.

Valid values: CREATE\_IN\_PROGRESS | CREATE\_FAILED | CREATE\_COMPLETE |  
DELETE\_IN\_PROGRESS | DELETE\_FAILED | UPDATE\_IN\_PROGRESS | UPDATE\_COMPLETE |  
UPDATE\_FAILED

## create\_cluster

```
create_cluster(cluster_name, cluster_configuration, region, suppress_validators,
               validation_failure_level, dry_run, rollback_on_failure, wait)
```

Create a cluster in a given Region.

### Parameters:

#### **cluster\_name (required)**

The cluster name.

#### **cluster\_configuration (required)**

The cluster configuration as a Python data type.

#### **region**

The cluster AWS Region.

#### **suppress\_validators**

Identifies one or more cluster configuration validators to suppress.

Format: (ALL | type:[A-Za-z0-9]+)

#### **validation\_failure\_level**

The minimum validation level that causes the cluster creation to fail. The default is ERROR.

Valid values: INFO | WARNING | ERROR.

#### **dry\_run**

Performs the request validation without creating any resources. You can use this to validate the cluster configuration. The default is False.

#### **rollback\_on\_failure**

If set to True, AWS ParallelCluster automatically initiates a cluster stack rollback on failures. The default is True.

#### **wait**

If set to True, AWS ParallelCluster waits for the operation to complete. The default is False.

## delete\_cluster

```
delete_cluster(cluster_name, region, wait)
```

Delete a cluster in a given Region.

### Parameters:

#### **cluster\_name (required)**

The cluster name.

#### **region**

The cluster AWS Region.

#### **wait**

If set to True, waits for the operation to complete. The default is False.

## describe\_cluster

```
describe_cluster(cluster_name, region)
```

Get detailed information about an existing cluster.

### Parameters:

#### **cluster\_name (required)**

The cluster name.

#### **region**

The cluster AWS Region.

## update\_cluster

```
update_cluster(cluster_name, cluster_configuration, suppress_validators,  
validation_failure_level, region, force_update, dry_run, wait)
```

Update a cluster in a given Region.

### Parameters:

#### **cluster\_name (required)**

The cluster name.

#### **cluster\_configuration (required)**

The cluster configuration as a Python data type.

#### **suppress\_validators**

Identifies one or more cluster configuration validators to suppress.

Format: (ALL | type:[A-Za-z0-9]+)

#### **validation\_failure\_level**

The minimum validation level that causes the cluster update to fail. The default is ERROR.

Valid values: INFO | WARNING | ERROR

#### **region**

The cluster AWS Region.

#### **dry\_run**

Performs the request validation without creating or updating any resources. You can use this to validate the cluster configuration. The default is False.

#### **force\_update**

If set to True, forces the update by ignoring the update validation errors. The default is False.

#### **wait**

If set to True, waits for the operation to complete. The default is False.

## Compute fleet API operations

### Topics

- [describe\\_compute\\_fleet](#)
- [update\\_compute\\_fleet](#)
- [delete\\_cluster\\_instances](#)
- [describe\\_cluster\\_instances](#)

## describe\_compute\_fleet

```
describe_compute_fleet(cluster_name, region)
```

Describe the status of a cluster compute fleet for a given cluster.

### Parameters:

#### **cluster\_name (required)**

The cluster name.

#### **region**

Describes the compute fleet status for a cluster deployed to a given AWS Region.

## update\_compute\_fleet

```
update_compute_fleet(cluster_name, status, region)
```

Update the status of the cluster compute fleet.

### Parameters:

#### **cluster\_name (required)**

The cluster name.

#### **status (required)**

The status to update to.

Valid values: START\_REQUESTED | STOP\_REQUESTED | ENABLED | DISABLED

## **region**

The cluster AWS Region.

## **delete\_cluster\_instances**

```
delete_cluster_instances(cluster_name, region, force)
```

Delete a cluster in a given Region.

### **Parameters:**

#### **cluster\_name (required)**

The cluster name.

#### **region**

The cluster AWS Region.

#### **force**

If set to True, forces deletion when the cluster with the given `cluster_name` isn't found. The default is False.

## **describe\_cluster\_instances**

```
describe_cluster_instances(cluster_name, region, next_token, node_type, queue_name)
```

Describe a cluster's instances.

### **Parameters:**

#### **cluster\_name (required)**

The cluster name.

#### **region**

The cluster AWS Region.



**next\_token**

The token to use for paginated requests.

**node\_type**

Filters the instances by node\_type.

Valid values: HeadNode | ComputeNode

**queue\_name**

Filters the instances by queue name.

## Cluster and stack log operations

### Topics

- [list\\_cluster\\_log\\_streams](#)
- [get\\_cluster\\_log\\_events](#)
- [get\\_cluster\\_stack\\_events](#)

### list\_cluster\_log\_streams

```
list_cluster_log_streams(cluster_name, region, filters, next_token)
```

List log streams for a given cluster.

#### Parameters:

**cluster\_name (required)**

The cluster name.

**region**

The cluster AWS Region.

**filters**

Filters the cluster log streams.

Format: 'Name=a,Values=1 Name=b,Values=2,3'

**Accepted filters:****code-dns-name**

The short form of the private DNS name of the instance; for example, `ip-10-0-0-101`.

**node-type**

The node type.

Valid values: `HeadNode`

**next\_token**

The token to use for paginated requests.

**get\_cluster\_log\_events**

```
get_cluster_log_events(cluster_name, log_stream_name, region, next_token,
start_from_head, limit, start_time, end_time)
```

Get log events for a given cluster and log stream.

**Parameters:****cluster\_name (required)**

The cluster name.

**log\_stream\_name (required)**

The log stream name.

**region**

The cluster AWS Region.

**next\_token**

The token to use for paginated requests.

**start\_from\_head**

If set to `True`, AWS ParallelCluster returns the earliest log events first. If set to `False`, it returns the latest log events first. The default is `False`.

## limit

The maximum number of log events returned. If you don't specify a value, the maximum is the number of logs that can fit in a response size of 1 MB, up to 10,000 log events.

## start\_time

The start of the time range for log events, expressed in ISO 8601 format; for example, '2021-01-01T20:00:00Z'. Events with a timestamp equal to, or later than, this time are included.

## end\_time

The end of the time range for log events, expressed in ISO 8601 format; for example, '2021-01-01T20:00:00Z'. Events with a timestamp equal to, or later than, this time are not included.

## get\_cluster\_stack\_events

```
get_cluster_stack_events(cluster_name, region, next_token)
```

Get stack events for a given cluster.

### Parameters:

#### cluster\_name (required)

The cluster name.

#### region

The cluster AWS Region.

#### next\_token

The token to use for paginated requests.

## Image API operations

### Topics

- [list\\_images](#)
- [build\\_image](#)

- [delete\\_image](#)
- [describe\\_image](#)

## list\_images

```
list_images(image_status, region, next_token)
```

Retrieve the list of existing images.

### Parameters:

#### **image\_status (required)**

Filters by image status.

Valid values: AVAILABLE | PENDING | FAILED

#### **region**

Lists images built in a given AWS Region.

#### **next\_token**

Token to use for paginated requests.

## build\_image

```
build_image(image_configuration, image_id, suppress_validators,  
validation_failure_level, dry_run, rollback_on_failure, region)
```

Create a custom AWS ParallelCluster image in a given Region.

### Parameters:

#### **image\_configuration (required)**

The image configuration as Python data.

#### **image\_id (required)**

The image ID.

## **suppress\_validators**

Identifies one or more image configuration validators to suppress.

Format: (ALL | type:[A-Za-z0-9]+)

## **validation\_failure\_level**

The minimum validation level that causes the image creation to fail. The default is ERROR.

Valid values: INFO | WARNING | ERROR

## **dry\_run**

If set to `True`, AWS ParallelCluster performs the request validation without creating any resources. You can use this to validate the image configuration. The default is `False`.

## **rollback\_on\_failure**

If set to `True`, AWS ParallelCluster automatically initiates an image stack rollback on failures. The default is `False`.

## **region**

The image AWS Region.

## **delete\_image**

```
delete_image(image_id, region, force)
```

Delete an image in a given Region.

### **Parameters:**

#### **image\_id (required)**

The image ID.

#### **region**

The image AWS Region.

#### **force**

If set to `True`, AWS ParallelCluster forces deletion if instances are using the AMI or if the AMI is shared. The default is `False`.

## describe\_image

```
describe_image(image_id, region)
```

Get detailed information about an existing image.

### Parameters:

#### **image\_id (required)**

The image ID.

#### **region**

The image AWS Region.

## Image and stack log operations

### Topics

- [list\\_image\\_log\\_streams](#)
- [get\\_image\\_log\\_events](#)
- [get\\_image\\_stack\\_events](#)
- [list\\_official\\_images](#)

## list\_image\_log\_streams

```
list_image_log_streams(image_id, region, next_token)
```

List log streams for an image.

### Parameters:

#### **image\_id (required)**

The image ID.

#### **region**

The image AWS Region.

## **next\_token**

The token to use for paginated requests.

## **get\_image\_log\_events**

```
get_image_log_events(image_id, log_stream_name, region, next_token, start_from_head,
                    limit, start_time, end_time)
```

Get log events for a given image and log stream.

### **Parameters:**

#### **image\_id (required)**

The image ID.

#### **log\_stream\_name (required)**

The log stream name.

#### **region**

The image AWS Region.

#### **next\_token**

The token to use for paginated requests.

#### **start\_from\_head**

If set to `True`, AWS ParallelCluster returns the earliest log events first. If set to `False`, it returns the latest log events first. The default is `False`.

#### **limit**

The maximum number of log events returned. If you don't specify a value, the maximum is the number of logs that can fit in a response size of 1 MB, up to 10,000 log events.

#### **start\_time**

The start of the time range for log events, expressed in ISO 8601 format; for example, `'2021-01-01T20:00:00Z'`. Events with a timestamp equal to, or later than, this time are included.

## **end\_time**

The end of the time range for log events, expressed in ISO 8601 format; for example, '2021-01-01T20:00:00Z'. Events with a timestamp equal to, or later than, this time are not included.

## **get\_image\_stack\_events**

```
get_image_stack_events(image_id, region, next_token)
```

Get stack events for a given image.

### **Parameters:**

#### **image\_id (required)**

The image ID.

#### **region**

The image AWS Region.

#### **next\_token**

The token to use for paginated requests.

## **list\_official\_images**

```
list_official_images(region,os, architecture)
```

Retrieve the list of official AWS ParallelCluster images.

### **Parameters:**

#### **region**

The image AWS Region.

#### **os**

Filters by operating system distribution. The default is no filtering.



## architecture

Filters by architecture. The default is no filtering.

## Example

### Topics

- [Create a cluster](#)

### Create a cluster

When you run the following example script, with the given inputs stored in your environment, you create a cluster. The cluster configuration is created as a Python data type based on the [cluster configuration documentation](#).

```
import os
import pprint
import pcluster.lib as pc
pp = pprint.PrettyPrinter()

HEAD_NODE_SUBNET = os.environ["HEAD_NODE_SUBNET"]
COMPUTE_NODE_SUBNET = os.environ["HEAD_NODE_SUBNET"]
KEY_NAME = os.environ["KEY_NAME"]
CONFIG = {'Image': {'Os': 'alinux2'},
          'HeadNode': {'InstanceType': 't2.large',
                       'Networking': {'SubnetId': HEAD_NODE_SUBNET},
                       'Ssh': {'KeyName': KEY_NAME}},
          'Scheduling': {'Scheduler': 'slurm',
                         'SlurmQueues':
                         [{ 'Name': 'queue0',
                            'ComputeResources':
                            [{ 'Name': 'queue0-i0', 'InstanceType': 't2.micro',
                               'MinCount': 0, 'MaxCount': 10}],
                             'Networking': {'SubnetIds': [COMPUTE_NODE_SUBNET]}]
                         ]}}

pp.pprint(pc.create_cluster(cluster_name="mycluster", cluster_configuration=CONFIG))
```

### Output:

```
{'cluster': {'cloudformationStackArn': 'arn:aws:cloudformation:us-east-2:123456789012:stack/mycluster/00000000-aaaa-1111-999-000000000000',
            'cloudformationStackStatus': 'CREATE_IN_PROGRESS',
            'clusterName': 'mycluster',
            'clusterStatus': 'CREATE_IN_PROGRESS',
            'region': 'us-east-2',
            'scheduler': {'type': 'slurm'},
            'version': '3.7.0'}}
```

## AWS Lambda for the AWS ParallelCluster Python library

You can deploy a Lambda layer and runtime to access to the AWS ParallelCluster Python library. We host AWS ParallelCluster zip files that you can use by entering the link to the zip file as described in the following steps. Lambda uses the zip files to prepare the runtime environment to support access to the Python library. The AWS ParallelCluster Python library is added with AWS ParallelCluster version 3.5.0. You can only use the library for versions 3.5.0 and later.

The hosted zip file URL is in the format: `s3://aws-region-id-aws-parallelcluster/parallelcluster/3.7.0/layers/aws-parallelcluster/lambda-layer.zip`

## Get started accessing the AWS ParallelCluster Python library with AWS Lambda

### Create a Lambda layer

1. Log in to the AWS Management Console and navigate to the AWS Lambda console.
2. In the navigation pane, select **Layers**, then **Create layer**.
3. Enter a name for your layer and select **Upload a file from Amazon S3**.
4. Enter the URL to the zip file: `s3://aws-region-id-aws-parallelcluster/parallelcluster/3.7.0/layers/aws-parallelcluster/lambda-layer.zip`.
5. For **Compatible architectures**, choose the **x86\_64** architecture.
6. For **Compatible runtimes**, choose the **Python 3.9** runtime.
7. Choose **Create**.

### Use your Lambda layer

1. In the Lambda console navigation pane, select **Functions**, then **Create function**.
2. Enter a name for your function.

3. For **Runtime**, choose the **Python 3.9** runtime.
4. For **Architecture**, choose the **x86\_64** architecture.
5. Choose **Create function**.
6. After the function is created, choose **Layers** and select **Add a layer**.
7. Select **Custom layers** and choose the layer you created in previous steps.
8. Choose the layer version.
9. Choose **Add**.
10. Your Lambda needs permissions to manage clusters created with AWS ParallelCluster. Create a Lambda role with the permissions listed in [Base AWS ParallelCluster pcluster user policy](#).

You can now access AWS ParallelCluster from the Python library as described in [AWS ParallelCluster Python library API](#).

# How AWS ParallelCluster works

AWS ParallelCluster was built not only as a way to manage clusters, but as a reference on how to use AWS services to build your HPC environment.

## Topics

- [AWS ParallelCluster processes](#)
- [AWS services used by AWS ParallelCluster](#)
- [AWS ParallelCluster Internal directories](#)

## AWS ParallelCluster processes

This section applies to clusters that are deployed with Slurm. When used with this scheduler, AWS ParallelCluster manages compute node provisioning and removal by interacting with the underlying job scheduler.

For HPC clusters that are based on AWS Batch, AWS ParallelCluster relies on the capabilities provided by the AWS Batch for the compute node management.

### **clustermgtd**

The following tasks are performed by the cluster management daemon.

- Inactive partition clean-up
- Management of Slurm reservations and nodes associated to Capacity Blocks (see following section)
- Static capacity management: make sure static capacity is always up and healthy
- Sync scheduler with Amazon EC2 .
- Orphaned instance clean-up
- Restore scheduler node status on Amazon EC2 termination that happens outside of the suspend workflow
- Unhealthy Amazon EC2 instances management (failing Amazon EC2 health checks)
- Scheduled maintenance events management
- Unhealthy Scheduler nodes management (failing Scheduler health checks)

## Management of Slurm reservations and nodes associated to Capacity Blocks

ParallelCluster supports On-Demand Capacity Reservations (ODCR) and Capacity Blocks for Machine Learning (CB). Unlike ODCR, CB can have a future start time and is time-bound.

Clustermgtd searches for unhealthy nodes in a loop and terminates any Amazon EC2 instances that are down, replacing them with new instances if they are static nodes.

ParallelCluster manages static nodes associated with Capacity Blocks differently. AWS ParallelCluster creates a cluster even if the CB is not yet active, and instances are launched automatically once the CB is active.

The Slurm nodes corresponding to compute resources associated with CBs that are not yet active are kept in maintenance until the CB start time is reached. Slurm nodes will remain in a reservation/maintenance state associated with the Slurm admin user, which means they can accept jobs, but jobs will remain in pending until the Slurm reservation is removed.

Clustermgtd will automatically create/delete Slurm reservations, putting the related CB nodes in maintenance based on the CB state. When CB will be active, Slurm reservation will be removed, nodes will start and will become available for the pending jobs or for new jobs submissions.

When the CB end time is reached, nodes will be moved back to a reservation/maintenance state. It's up to users to resubmit/requeue the jobs to a new queue/compute-resource when CB is no longer active and instances are terminated.

### **clustermgtd**

The cluster status management daemon manages the compute fleet status update. Every minute it fetches the fleet status stored in a DynamoDB table and manages any STOP/START request.

### **computemgtd**

Compute management daemon (computemgtd) processes run on each of the cluster compute nodes. Every five (5) minutes, the compute management daemon confirms that the head node can be reached and is healthy. If five (5) minutes pass during which the head node cannot be reached or is not healthy, the compute node is shut down.

## AWS services used by AWS ParallelCluster

The following Amazon Web Services (AWS) services are used by AWS ParallelCluster.

## Topics

- [Amazon API Gateway](#)
- [AWS Batch](#)
- [AWS CloudFormation](#)
- [Amazon CloudWatch](#)
- [Amazon CloudWatch Events](#)
- [Amazon CloudWatch Logs](#)
- [AWS CodeBuild](#)
- [Amazon DynamoDB](#)
- [Amazon Elastic Block Store](#)
- [Amazon Elastic Compute Cloud](#)
- [Amazon Elastic Container Registry](#)
- [Amazon EFS](#)
- [Amazon FSx for Lustre](#)
- [Amazon FSx for NetApp ONTAP](#)
- [Amazon FSx for OpenZFS](#)
- [AWS Identity and Access Management](#)
- [AWS Lambda](#)
- [Amazon RDS](#)
- [Amazon Route 53](#)
- [Amazon Simple Notification Service](#)
- [Amazon Simple Storage Service](#)
- [Amazon VPC](#)
- [Elastic Fabric Adapter](#)
- [EC2 Image Builder](#)
- [NICE DCV](#)

## Amazon API Gateway

Amazon API Gateway is an AWS service for creating, publishing, maintaining, monitoring, and securing REST, HTTP, and WebSocket APIs at any scale

AWS ParallelCluster uses API Gateway to host the AWS ParallelCluster API.

For more information about AWS Batch, see <https://aws.amazon.com/api-gateway/> and <https://docs.aws.amazon.com/apigateway/>.

## AWS Batch

AWS Batch is an AWS managed job scheduler service. It dynamically provisions the optimal quantity and type of compute resources (for example, CPU or memory-optimized instances) in AWS Batch clusters. These resources are provisioned based on the specific requirements of your batch jobs, including volume requirements. With AWS Batch, you don't need to install or manage additional batch computing software or server clusters to run your jobs effectively.

AWS Batch is used only with AWS Batch clusters.

For more information about AWS Batch, see <https://aws.amazon.com/batch/> and <https://docs.aws.amazon.com/batch/>.

## AWS CloudFormation

AWS CloudFormation is an infrastructure-as-code service that provides a common language to model and provision AWS and third-party application resources in your cloud environment. It is the main service used by AWS ParallelCluster. Each cluster in AWS ParallelCluster is represented as a stack, and all resources required by each cluster are defined within the AWS ParallelCluster AWS CloudFormation template. In most cases, AWS ParallelCluster CLI commands directly correspond to AWS CloudFormation stack commands, such as create, update, and delete commands. Instances that are launched within a cluster make HTTPS calls to the AWS CloudFormation endpoint in the AWS Region where the cluster is launched.

For more information about AWS CloudFormation, see <https://aws.amazon.com/cloudformation/> and <https://docs.aws.amazon.com/cloudformation/>.

## Amazon CloudWatch

Amazon CloudWatch (CloudWatch) is a monitoring and observability service that provides you with data and actionable insights. These insights can be used to monitor your applications, respond to performance changes and service exceptions, and optimize resource utilization. In AWS ParallelCluster, CloudWatch is used for a dashboard, to monitor and log Docker image build steps and the output of the AWS Batch jobs.

Before AWS ParallelCluster version 2.10.0, CloudWatch was used only with AWS Batch clusters.

For more information about CloudWatch, see <https://aws.amazon.com/cloudwatch/> and <https://docs.aws.amazon.com/cloudwatch/>.

## Amazon CloudWatch Events

Amazon CloudWatch Events (CloudWatch Events) delivers a near real-time stream of system events that describe changes in Amazon Web Services (AWS) resources. Using simple rules that you can quickly set up, you can match events and route them to one or more target functions or streams. In AWS ParallelCluster, CloudWatch Events is used for AWS Batch jobs.

For more information about CloudWatch Events, see <https://docs.aws.amazon.com//eventbridge/latest/userguide/eb-cwe-now-eb>.

## Amazon CloudWatch Logs

Amazon CloudWatch Logs (CloudWatch Logs) is one of the core features of Amazon CloudWatch. You can use it to monitor, store, view, and search the log files for many of the components used by AWS ParallelCluster.

Before AWS ParallelCluster version 2.6.0, CloudWatch Logs was only used with AWS Batch clusters.

For more information, see [Integration with Amazon CloudWatch Logs](#).

## AWS CodeBuild

AWS CodeBuild (CodeBuild) is an AWS managed continuous integration service that compiles source code, runs tests, and produces software packages that are ready to deploy. In AWS ParallelCluster, CodeBuild is used to automatically and transparently build Docker images when clusters are created.

CodeBuild is used only with AWS Batch clusters.

For more information about CodeBuild, see <https://aws.amazon.com/codebuild/> and <https://docs.aws.amazon.com/codebuild/>.

## Amazon DynamoDB

Amazon DynamoDB (DynamoDB) is a fast and flexible NoSQL database service. It is used to store the minimal state information of the cluster. The head node tracks provisioned instances in a DynamoDB table.



DynamoDB is not used with AWS Batch clusters.

For more information about DynamoDB, see <https://aws.amazon.com/dynamodb/> and <https://docs.aws.amazon.com/dynamodb/>.

## Amazon Elastic Block Store

Amazon Elastic Block Store (Amazon EBS) is a high-performance block storage service that provides persistent storage for shared volumes. All Amazon EBS settings can be passed through the configuration. Amazon EBS volumes can either be initialized empty or from an existing Amazon EBS snapshot.

For more information about Amazon EBS, see <https://aws.amazon.com/ebs/> and <https://docs.aws.amazon.com/ebs/>.

## Amazon Elastic Compute Cloud

Amazon Elastic Compute Cloud (Amazon EC2 ) provides the computing capacity for AWS ParallelCluster. The head and compute nodes are Amazon EC2 instances. Any instance type that support HVM can be selected. The head and compute nodes can be different instance types. Moreover, if multiple queues are used, some or all of compute nodes can also be launched as a Spot Instance. Instance store volumes found on the instances are mounted as striped LVM volumes.

For more information about Amazon EC2 , see <https://aws.amazon.com/ec2/> and <https://docs.aws.amazon.com/ec2/>.

## Amazon Elastic Container Registry

Amazon Elastic Container Registry (Amazon ECR) is a fully managed Docker container registry that makes it easy to store, manage, and deploy Docker container images. In AWS ParallelCluster, Amazon ECR stores the Docker images that are built when clusters are created. The Docker images are then used by AWS Batch to run the containers for the submitted jobs.

Amazon ECR is used only with AWS Batch clusters.

For more information, see <https://aws.amazon.com/ecr/> and <https://docs.aws.amazon.com/ecr/>.

## Amazon EFS

Amazon Elastic File System (Amazon EFS) provides a simple, scalable, and fully managed elastic NFS file system for use with AWS Cloud services and on-premises resources. Amazon EFS is used

when the [EfsSettings](#) are specified. Support for Amazon EFS was added in AWS ParallelCluster version 2.1.0.

For more information about Amazon EFS, see <https://aws.amazon.com/efs/> and <https://docs.aws.amazon.com/efs/>.

## Amazon FSx for Lustre

FSx for Lustre provides a high-performance file system that uses the open-source Lustre file system. FSx for Lustre is used when the [FsxLustreSettings properties](#) are specified. Support for FSx for Lustre was added in AWS ParallelCluster version 2.2.1.

For more information about FSx for Lustre, see <https://aws.amazon.com/fsx/lustre/> and <https://docs.aws.amazon.com/fsx/>.

## Amazon FSx for NetApp ONTAP

FSx for ONTAP provides a fully managed shared storage system built on NetApp's popular ONTAP file system. FSx for ONTAP is used when [FsxOntapSettings properties](#) are specified. Support for FSx for ONTAP was added in AWS ParallelCluster version 3.2.0.

For more information about FSx for ONTAP, see <https://aws.amazon.com/fsx/netapp-ontap/> and <https://docs.aws.amazon.com/fsx/>.

## Amazon FSx for OpenZFS

FSx for OpenZFS provides a fully managed shared storage system built on the popular OpenZFS file system. FSx for OpenZFS is used when the [FsxOpenZfsSettings properties](#) are specified. Support for FSx for OpenZFS was added in AWS ParallelCluster version 3.2.0.

For more information about FSx for OpenZFS, see <https://aws.amazon.com/fsx/openzfs/> and <https://docs.aws.amazon.com/fsx/>.

## AWS Identity and Access Management

AWS Identity and Access Management (IAM) is used within AWS ParallelCluster to provide a least privileged IAM role for Amazon EC2 for the instance that is specific to each individual cluster. AWS ParallelCluster instances are given access only to the specific API calls that are required to deploy and manage the cluster.

With AWS Batch clusters, IAM roles are also created for the components that are involved with the Docker image building process when clusters are created. These components include the Lambda functions that are allowed to add and delete Docker images to and from the Amazon ECR repository. They also include the functions allowed to delete the Amazon S3 bucket that is created for the cluster and CodeBuild project. There are also roles for AWS Batch resources, instances, and jobs.

For more information about IAM, see <https://aws.amazon.com/iam/> and <https://docs.aws.amazon.com/iam/>.

## AWS Lambda

AWS Lambda (Lambda) runs the functions that orchestrate the creation of Docker images. Lambda also manages the cleanup of custom cluster resources, such as Docker images stored in the Amazon ECR repository and on Amazon S3.

For more information about Lambda, see <https://aws.amazon.com/lambda/> and <https://docs.aws.amazon.com/lambda/>.

## Amazon RDS

Amazon Relational Database Service (Amazon RDS) is a web service that makes it easier to set up, operate, and scale a relational database in the AWS Cloud.

AWS ParallelCluster uses Amazon RDS for AWS Batch and Slurm.

For more information about Amazon RDS, see <https://aws.amazon.com/rds/> and <https://docs.aws.amazon.com/rds/>.

## Amazon Route 53

Amazon Route 53 (Route 53) is used to create hosted zones with hostnames and fully qualified domain names for each of the compute nodes.

For more information about Route 53, see <https://aws.amazon.com/route53/> and <https://docs.aws.amazon.com/route53/>.

## Amazon Simple Notification Service

(Amazon SNS) is a managed service that provides message delivery from publishers to subscribers (also known as producers and consumers).

AWS ParallelCluster uses Amazon SNS for API hosting.

For more information about Amazon SNS, see <https://aws.amazon.com/sns/> and <https://docs.aws.amazon.com/sns/>.

## Amazon Simple Storage Service

Amazon Simple Storage Service (Amazon S3) stores AWS ParallelCluster templates located in each AWS Region. AWS ParallelCluster can be configured to allow CLI/SDK tools to use Amazon S3.

AWS ParallelCluster also creates an Amazon S3 bucket in your AWS account to store resources that are used by your clusters, such as the cluster configuration file. AWS ParallelCluster maintains one Amazon S3 bucket in each AWS Region that you create clusters in.

When you use AWS Batch cluster, an Amazon S3 bucket in your account is used for storing related data. For example, the bucket stores artifacts created when a Docker image and scripts are created from submitted jobs.

For more information, see <https://aws.amazon.com/s3/> and <https://docs.aws.amazon.com/s3/>.

## Amazon VPC

An Amazon VPC defines a network used by the nodes in your cluster.

For more information about Amazon VPC, see <https://aws.amazon.com/vpc/> and <https://docs.aws.amazon.com/vpc/>.

## Elastic Fabric Adapter

Elastic Fabric Adapter (EFA) is a network interface for instances that customers can use to run applications requiring high levels of inter-node communications at scale on AWS.

For more information about EC2 Image Builder, see <https://aws.amazon.com/hpc/efa/>.

## EC2 Image Builder

EC2 Image Builder is a fully managed AWS service that helps you to automate the creation, management, and deployment of customized, secure, and up-to-date server images.

AWS ParallelCluster uses Image Builder to create and manage AWS ParallelCluster images.

For more information about EC2 Image Builder, see <https://aws.amazon.com/image-builder/> and <https://docs.aws.amazon.com/imagebuilder/>.

## NICE DCV

NICE DCV is a high-performance remote display protocol that provides a secure way to deliver remote desktops and application streaming to any device over varying network conditions. NICE DCV is used when the [HeadNode section](#) / [Dcv](#) settings are specified. Support for NICE DCV was added in AWS ParallelCluster version 2.5.0.

For more information about NICE DCV, see <https://aws.amazon.com/hpc/dcv/> and <https://docs.aws.amazon.com/dcv/>.

## AWS ParallelCluster Internal directories

There are several internal directories that AWS ParallelCluster uses to share data within the cluster. The following directories are shared between the head node, compute nodes, and login nodes:

`/opt/slurm`

`/opt/intel`

`/opt/parallelcluster/shared` (only with compute nodes)

`/opt/parallelcluster/shared_login_nodes` (only with login nodes)

`/home` (unless specified in `SharedStorage`)

### Note

By default these directories are created on the head nodes EBS volume and shared as NFS exports to the compute and login nodes. Starting from AWS ParallelCluster 3.8 you can enable AWS ParallelCluster to create and manage an Amazon EFS filesystem to host and share these directories by setting the [SharedStorageType](#) parameter to `efs`.

When the cluster scales out, NFS exports via the EBS volume may pose performance bottlenecks. Using EFS, you can avoid NFS exports as your cluster scales out and avoid performance bottlenecks associated with them.

# Tutorials

The following tutorials show you how to get started with AWS ParallelCluster version 3, and provide best practice guidance for some common tasks.

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

## Topics

- [Running your first job on AWS ParallelCluster](#)
- [Building a custom AWS ParallelCluster AMI](#)
- [Integrating Active Directory](#)
- [Configuring shared storage encryption with an AWS KMS key](#)
- [Running jobs in a multiple queue mode cluster](#)
- [Using the AWS ParallelCluster API](#)
- [Creating a cluster with Slurm accounting](#)
- [Creating a cluster with an external SlurmDB accounting](#)
- [Reverting to a previous AWS Systems Manager document version](#)
- [Creating a cluster with AWS CloudFormation](#)
- [Deploying ParallelCluster API with Terraform](#)
- [Creating a cluster with Terraform](#)
- [Creating a custom AMI with Terraform](#)
- [AWS ParallelCluster UI Integration with Identity Center](#)

## Running your first job on AWS ParallelCluster

This tutorial walks you through running your first Hello World job on AWS ParallelCluster

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

## Prerequisites

- AWS ParallelCluster [is installed](#).
- The AWS CLI [is installed and configured](#).
- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) required to run the [pcluster](#) CLI.

## Verifying your installation

First, we verify that AWS ParallelCluster is correctly, including the Node.js dependency, installed and configured.

```
$ node --version
v16.8.0
$ pcluster version
{
  "version": "3.7.0"
}
```

This returns the running version of AWS ParallelCluster.

## Creating your first cluster

Now it's time to create your first cluster. Because the workload for this tutorial isn't performance intensive, we can use the default instance size of `t2.micro`. (For production workloads, you choose an instance size that best fits your needs.) Let's call your cluster `hello-world`.

```
$ pcluster create-cluster \
  --cluster-name hello-world \
  --cluster-configuration hello-world.yaml
```

**Note**

The AWS Region to use must be specified for most `pcluster` commands. If it's not specified in the `AWS_DEFAULT_REGION` environment variable, or the `region` setting in the `[default]` section of the `~/.aws/config` file, then the `--region` parameter must be provided on the `pcluster` command line.

If the output gives you a message about configuration, you need to run the following to configure AWS ParallelCluster:

```
$ pcluster configure --config hello-world.yaml
```

If the `pcluster create-cluster` command succeeds, you see output similar to the following:

```
{
  "cluster": {
    "clusterName": "hello-world",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:xxx:stack/xxx",
    "region": "...",
    "version": "...",
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}
```

You monitor the creation of the cluster using:

```
$ pcluster describe-cluster --cluster-name hello-world
```

The `clusterStatus` reports `"CREATE_IN_PROGRESS"` while the cluster is being created. The `clusterStatus` transitions to `"CREATE_COMPLETE"` when the cluster is created successfully. The output also provides us with the `publicIpAddress` and `privateIpAddress` of our head node.

## Logging into your head node

Use your OpenSSH pem file to log into your head node.

```
$ pcluster ssh --cluster-name hello-world -i /path/to/keyfile.pem
```



After you log in, run the command `sinfo` to verify that your compute nodes are set up and configured.

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
queue1*    up    infinite    10   idle~ queue1-dy-queue1t2micro-[1-10]
```

The output shows that we have one queue in our cluster, with up to ten nodes.

## Running your first job using Slurm

Next, we create a job that sleeps for a little while and then outputs its own hostname. Create a file called `hellojob.sh`, with the following contents.

```
#!/bin/bash
sleep 30
echo "Hello World from $(hostname)"
```

Next, submit the job using `sbatch`, and verify that it runs.

```
$ sbatch hellojob.sh
Submitted batch job 2
```

Now, you can view your queue and check the status of the job. The provisioning of a new Amazon EC2 instance is started in the background. You can monitor the status of the cluster instances with the `sinfo` command.

```
$ squeue
          JOBID PARTITION     NAME     USER ST       TIME  NODES NODELIST(REASON)
           2      queue1 hellojob ec2-user CF      3:30      1 queue1-dy-
queue1t2micro-1
```

The output shows that the job has been submitted to `queue1`. Wait 30 seconds for the job to finish, and then run `squeue` again.

```
$ squeue
          JOBID PARTITION     NAME     USER ST       TIME  NODES NODELIST(REASON)
```

Now that there are no jobs in the queue, we can check for output in our current directory.

```
$ ls -l
total 8
-rw-rw-r-- 1 ec2-user ec2-user 57 Sep  1 14:25 hellojob.sh
-rw-rw-r-- 1 ec2-user ec2-user 43 Sep  1 14:30 slurm-2.out
```

In the output, we see a "out" file. We can see output from our job:

```
$ cat slurm-2.out
Hello World from queue1-dy-queue1t2micro-1
```

The output also shows that our job ran successfully on instance `queue1-dy-queue1t2micro-1`.

In the cluster you just created, only the home directory is shared among all nodes of the cluster.

To learn more about creating and using clusters, see [Best practices](#).

If your application requires shared software, libraries, or data, consider the following options:

- Build a AWS ParallelCluster enabled custom AMI that includes your software as described in [Building a custom AWS ParallelCluster AMI](#).
- Use the [StorageSettings](#) option in the AWS ParallelCluster configuration file to specify a shared filesystem and store your installed software in the specified mount location.
- Use [Custom bootstrap actions](#) to automate the bootstrap procedure of each node of your cluster.

## Building a custom AWS ParallelCluster AMI

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

### Important

If you build a custom AMI, you must repeat the steps that you used to create your custom AMI with each new AWS ParallelCluster release.

Before reading further, we recommend that you first review the [Custom bootstrap actions](#) section. Determine if the modifications that you want to make can be scripted and supported with future AWS ParallelCluster releases.

Even though building a custom AMI in general isn't ideal, there are specific scenarios where building a custom AMI for AWS ParallelCluster is necessary. This tutorial covers how to build a custom AMI for these scenarios.

## Prerequisites

- AWS ParallelCluster [is installed](#).
- The AWS CLI [is installed and configured](#).
- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) required to run the [pcluster](#) CLI and build images.

## How to customize the AWS ParallelCluster AMI

There are two ways to build a custom AWS ParallelCluster AMI. One of these two methods is to build a new AMI using the AWS ParallelCluster CLI. Another method requires that you to make manual modifications to build a new AMI that's available under your AWS account.

## Build a custom AWS ParallelCluster AMI

If you have a customized AMI and software, you can apply the changes that are needed by AWS ParallelCluster on top of it. AWS ParallelCluster relies on the EC2 Image Builder service to build customized AMIs. For more information, see the [Image Builder User Guide](#).

Key points:

- The process takes about 1 hour. This time can vary if there are additional [Build / Components](#) to be installed at build time.
- The AMI is tagged with the versions of the main components. These include the kernel, scheduler, and [EFA](#) driver. A subset of the component versions are also reported in the AMI description.
- Starting from AWS ParallelCluster 3.0.0, a new set of CLI commands can be used to manage the lifecycle of images. This includes [build-image](#), [list-images](#), [describe-image](#), and [delete-image](#).

- This method is repeatable. You can re-run it to keep AMIs updated (for example, OS updates), and then use them when you update an existing cluster.

### Note

If you use this method in the AWS China Partition, you might get network errors. For example, you might see these errors from the `pcluster build-image` command when it downloads packages from GitHub or from an OS repository. If this happens, we recommend that you use one of the following alternative methods:

1. Follow the [Modify an AWS ParallelCluster AMI](#) approach that bypasses this command.
2. Build the image in another Partition and Region, such as `us-east-1`, and then store-restore it to move it to the China Region. For more information, see [Store and restore an AMI using S3](#) in the *Amazon EC2 User Guide*.

### Steps:

1. Configure your AWS account credentials so that the AWS ParallelCluster client can make calls to AWS API operations on your behalf. For a list of the required permissions, see [AWS Identity and Access Management permissions in AWS ParallelCluster](#).
2. Create a basic *build image* configuration file. To do this, specify the [InstanceType](#) to be used to build the image and the [ParentImage](#). These are used as the starting point to create the AMI. For more information about optional build parameters, see [Image Configuration](#).

```
Build:
  InstanceType: <BUILD_INSTANCE_TYPE>
  ParentImage: <BASE_AMI_ID>
```

3. Use the CLI command `pcluster build-image` to build an AWS ParallelCluster AMI starting from the AMI that you provide as the base.

```
$ pcluster build-image --image-id IMAGE_ID --image-configuration IMAGE_CONFIG.yaml --
region REGION
{
  "image": {
    "imageId": "IMAGE_ID",
    "imageBuildStatus": "BUILD_IN_PROGRESS",
```

```
"cloudformationStackStatus": "CREATE_IN_PROGRESS",
"cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
IMAGE_ID/abcd1234-ef56-gh78-ij90-1234abcd5678",
"region": "us-east-1",
"version": "3.7.0"
}
}
```

### Warning

`pcluster build-image` uses the default VPC. If you delete the default VPC using AWS Control Tower or AWS Landing Zone, the subnet ID must be specified in the image configuration file. For more information, see [SubnetId](#).

For a list of other parameters, see the [pcluster build-image](#) command reference page. The results of the preceding command are as follows:

- A CloudFormation stack is created based on the image configuration. The stack includes all of the EC2 Image Builder resources required for the build.
  - The created resources include the official Image Builder AWS ParallelCluster components that custom Image Builder components can be added to. To learn how to create custom components, see the [Custom AMIs examples](#) in the *HPC for Public Sector Customers Workshop*.
  - EC2 Image Builder launches a build instance, applies the AWS ParallelCluster cookbook, installs the AWS ParallelCluster software stack, and performs necessary configuration tasks. The AWS ParallelCluster cookbook is used to build and bootstrap AWS ParallelCluster.
  - The instance is stopped and a new AMI is created from it.
  - Another instance is launched from the newly created AMI. During the test phase, EC2 Image Builder runs tests that are defined in the Image Builder components.
  - If the build is successful, the stack is deleted. If the build fails, the stack is retained and available for inspection.
4. You can monitor the status of the build process by running the following command. After the build completes, you can run it to retrieve the AMI ID given in the response.

```
$ pcluster describe-image --image-id IMAGE_ID --region REGION

# BEFORE COMPLETE
{
  "imageConfiguration": {
```

```

    "url": "https://parallelcluster-1234abcd5678efgh-v1-do-not-
delete.s3.amazonaws.com/parallelcluster/3.7.0/images/IMAGE_ID-abcd1234efgh5678/
configs/image-config.yaml?...",
  },
  "imageId": "IMAGE_ID",
  "imagebuilderImageStatus": "BUILDING",
  "imageBuildStatus": "BUILD_IN_PROGRESS",
  "cloudformationStackStatus": "CREATE_IN_PROGRESS",
  "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/
IMAGE_ID/abcd1234-ef56-gh78-ij90-1234abcd5678",
  "region": "us-east-1",
  "version": "3.7.0",
  "cloudformationStackTags": [
    {
      "value": "3.7.0",
      "key": "parallelcluster:version"
    },
    {
      "value": "IMAGE_ID",
      "key": "parallelcluster:image_name"
    },
    ...
  ],
  "imageBuildLogsArn": "arn:aws:logs:us-east-1:123456789012:log-group:/aws/
imagebuilder/ParallelClusterImage-IMAGE_ID",
  "cloudformationStackCreationTime": "2022-04-05T21:36:26.176Z"
}

# AFTER COMPLETE
{
  "imageConfiguration": {
    "url": "https://parallelcluster-1234abcd5678efgh-v1-do-not-delete.s3.us-
east-1.amazonaws.com/parallelcluster/3.7.0/images/IMAGE_ID-abcd1234efgh5678/configs/
image-config.yaml?Signature=..."
  },
  "imageId": "IMAGE_ID",
  "imageBuildStatus": "BUILD_COMPLETE",
  "region": "us-east-1",
  "ec2AmiInfo": {
    "amiName": "IMAGE_ID 2022-04-05T21-39-24.020Z",
    "amiId": "ami-1234stuv5678wxyz",
    "description": "AWS ParallelCluster AMI for alinux2,
kernel-4.14.238-182.422.amzn2.x86_64, lustre-2.10.8-5.amzn2.x86_64,
efa-1.13.0-1.amzn2.x86_64, dcv-2021.1.10598-1.el7.x86_64, slurm-20-11-8-1",

```

```

    "state": "AVAILABLE",
    "tags": [
      {
        "value": "2021.3.11591-1.el7.x86_64",
        "key": "parallelcluster:dcv_version"
      },
      ...
    ],
    "architecture": "x86_64"
  },
  "version": "3.7.0"
}

```

5. To create your cluster, enter the AMI ID in the [CustomAmi](#) field in your cluster configuration.

## Troubleshooting and monitoring AMI creation process

Image creation completes in about an hour. You can monitor the process by running the [pcluster describe-image](#) command or log retrieval commands.

```
$ pcluster describe-image --image-id IMAGE_ID --region REGION
```

The [build-image](#) command creates a CloudFormation stack with all the Amazon EC2 resources that are required to build the image, and launches the EC2 Image Builder process.

After running the [build-image](#) command, it's possible to retrieve CloudFormation stack events by using [pcluster get-image-stack-events](#). You can filter results with the `--query` parameter to see the latest events. For more information, see [Filtering AWS CLI output](#) in the *AWS Command Line Interface User Guide*.

```

$ pcluster get-image-stack-events --image-id IMAGE_ID --region REGION --query
  "events[0]"
{
  "eventId": "ParallelClusterImage-CREATE_IN_PROGRESS-2022-04-05T21:39:24.725Z",
  "physicalResourceId": "arn:aws:imagebuilder:us-east-1:123456789012:image/
parallelclusterimage-IMAGE_ID/3.7.0/1",
  "resourceStatus": "CREATE_IN_PROGRESS",
  "resourceStatusReason": "Resource creation Initiated",
  "resourceProperties": "{\"InfrastructureConfigurationArn\":
\\\"arn:aws:imagebuilder:us-east-1:123456789012:infrastructure-configuration/
parallelclusterimage-abcd1234-ef56-gh78-ij90-1234abcd5678\\\", \"ImageRecipeArn\":

```

```
\ "arn:aws:imagebuilder:us-east-1:123456789012:image-recipe/parallelclusterimage-
IMAGE_ID/3.7.0\", \"DistributionConfigurationArn\": \"arn:aws:imagebuilder:us-
east-1:123456789012:distribution-configuration/parallelclusterimage-abcd1234-ef56-
gh78-ij90-1234abcd5678\", \"Tags\": {\"parallelcluster:image_name\": \"IMAGE_ID\",
\"parallelcluster:image_id\": \"IMAGE_ID\"}},
  \"stackId\": \"arn:aws:cloudformation:us-east-1:123456789012:stack/IMAGE_ID/abcd1234-
ef56-gh78-ij90-1234abcd5678\",
  \"stackName\": \"IMAGE_ID\",
  \"logicalResourceId\": \"ParallelClusterImage\",
  \"resourceType\": \"AWS::ImageBuilder::Image\",
  \"timestamp\": \"2022-04-05T21:39:24.725Z\"
}
```

After about 15 minutes, the stack events appear in the log event entry related to Image Builder creation. You can now list image log streams and monitor the Image Builder steps by using [pcluster list-image-log-streams](#) and [pcluster get-image-log-events](#) commands.

```
$ pcluster list-image-log-streams --image-id IMAGE_ID --region REGION \
  --query 'logStreams[*].logStreamName'

"3.7.0/1"
]

$ pcluster get-image-log-events --image-id IMAGE_ID --region REGION \
  --log-stream-name 3.7.0/1 --limit 3
{
  "nextToken": "f/36295977202298886557255241372854078762600452615936671762",
  "prevToken": "b/36295977196879805474012299949460899222346900769983430672",
  "events": [
    {
      "message": "ExecuteBash: FINISHED EXECUTION",
      "timestamp": "2022-04-05T22:13:26.633Z"
    },
    {
      "message": "Document arn:aws:imagebuilder:us-east-1:123456789012:component/
parallelclusterimage-test-abcd1234-ef56-gh78-ij90-1234abcd5678/3.7.0/1",
      "timestamp": "2022-04-05T22:13:26.741Z"
    },
    {
      "message": "TOE has completed execution successfully",
      "timestamp": "2022-04-05T22:13:26.819Z"
    }
  ]
}
```



```
}
```

Continue to check with the [describe-image](#) command until you see the BUILD\_COMPLETE status.

```
$ pcluster describe-image --image-id IMAGE_ID --region REGION
{
  "imageConfiguration": {
    "url": "https://parallelcluster-1234abcd5678efgh-v1-do-not-delete.s3.us-
east-1.amazonaws.com/parallelcluster/3.7.0/images/IMAGE_ID-abcd1234efgh5678/configs/
image-config.yaml?Signature=..."
  },
  "imageId": "IMAGE_ID",
  "imageBuildStatus": "BUILD_COMPLETE",
  "region": "us-east-1",
  "ec2AmiInfo": {
    "amiName": "IMAGE_ID 2022-04-05T21-39-24.020Z",
    "amiId": "ami-1234stuv5678wxyz",
    "description": "AWS ParallelCluster AMI for alinux2,
kernel-4.14.238-182.422.amzn2.x86_64, lustre-2.10.8-5.amzn2.x86_64,
efa-1.13.0-1.amzn2.x86_64, dcv-2021.1.10598-1.el7.x86_64, slurm-20-11-8-1",
    "state": "AVAILABLE",
    "tags": [
      {
        "value": "2021.3.11591-1.el7.x86_64",
        "key": "parallelcluster:dcv_version"
      },
      ...
    ],
    "architecture": "x86_64"
  },
  "version": "3.7.0"
}
```

If you need to troubleshoot a custom AMI creation issue, create an archive of the image logs as described in following steps.

It's possible to archive the logs in an Amazon S3 bucket or in a local file, depending on the --output parameter.

```
$ pcluster export-image-logs --image-id IMAGE_ID --region REGION \
--bucket BUCKET_NAME --bucket-prefix BUCKET_FOLDER
```

```
{
  "url": "https://BUCKET_NAME.s3.us-east-1.amazonaws.com/BUCKET-FOLDER/IMAGE_ID-
logs-202209071136.tar.gz?AWSAccessKeyId=..."
}

$ pcluster export-image-logs --image-id IMAGE_ID \
--region REGION --bucket BUCKET_NAME --bucket-prefix BUCKET_FOLDER --output-file /tmp/
archive.tar.gz
{
  "path": "/tmp/archive.tar.gz"
}
```

The archive contains the CloudWatch Logs Streams related to the Image Builder process and AWS CloudFormation stack events. The command might take several minutes to run.

## Managing Custom AMIs

Starting from AWS ParallelCluster 3.0.0, a new set of commands has been added in the CLI to build, monitor, and manage the image lifecycle. For more information about the commands, see [pcluster commands](#).

## Modify an AWS ParallelCluster AMI

This method consists of modifying an official AWS ParallelCluster AMI by adding customization on top of it. The base AWS ParallelCluster AMIs are updated with new releases. These AMIs have all of the components that are required for AWS ParallelCluster to function when it's installed and configured. You can start with one of these as your base.

Key points:

- This method is faster than the [build-image](#) command. However, it's a manual process and not automatically repeatable.
- With this method, you don't have access to the log retrieval and image lifecycle management commands that are available through the CLI.

Steps:

New Amazon EC2 console

1. Find the AMI that corresponds to the specific AWS Region that you use. To find it, use the [pcluster list-official-images](#) command with the `--region` parameter to select

the specific AWS Region and `--os` and `--architecture` parameters to filter for the desired AMI with the OS and architecture that you want to use. From the output, retrieve the Amazon EC2 Image ID.

2. Sign in to the AWS Management Console and open the Amazon EC2 console at <https://console.aws.amazon.com/ec2/>.
3. In the navigation pane, choose **Images**, and then **AMIs**. Search for the retrieved EC2 Image ID, select the AMI, and choose **Launch instance from AMI**.
4. Scroll down and choose your **Instance type**.
5. Choose your **Key pair** and **Launch Instance**.
6. Log in to your instance using the OS user and your SSH key.
7. Manually customize your instance to meet your requirements.
8. Run the following command to prepare your instance for AMI creation.

```
sudo /usr/local/sbin/ami_cleanup.sh
```

9. From the console, choose **Instance state** and **Stop instance**.

Navigate to **Instances**, choose the new instance, select **Instance state**, and **Stop instance**.

10. Create a new AMI from the instance using the Amazon EC2 console or AWS CLI [create-image](#).

### From the Amazon EC2 console

- a. Choose **Instances** in the navigation pane.
- b. Choose the instance that you created and modified.
- c. In **Actions**, choose **Image** and then **Create image**.
- d. Choose **Create Image**.

11. Enter the new AMI ID in the [CustomAmi](#) field in your cluster configuration and create a cluster.

### Old Amazon EC2 console

1. Find the AWS ParallelCluster AMI that corresponds to the specific AWS Region that you use. To find it you can use the [pcluster list-official-images](#) command with the `--region` parameter to select the specific AWS Region and `--os` and `--architecture` parameters to filter for the desired AMI with the OS and architecture that you want to use. From the output you can retrieve the Amazon EC2 Image ID.

2. Sign in to the AWS Management Console and open the Amazon EC2 console at <https://console.aws.amazon.com/ec2/>.
3. In the navigation pane, choose **Images**, and then **AMIs**. Set the filter for **Public images** and search for the retrieved EC2 Image ID, select the AMI, and choose **Launch**.
4. Choose your instance type and select **Next: Configure Instance Details** or **Review and Launch** to launch your instance.
5. Choose **Launch**, select your **Key pair**, and **Launch Instances**.
6. Log into your instance using the OS user and your SSH key. For more information, navigate to **Instances**, select the new instance and **Connect**.
7. Manually customize your instance to meet your requirements.
8. Run the following command to prepare your instance for AMI creation:

```
sudo /usr/local/sbin/ami_cleanup.sh
```

9. From the Amazon EC2 console, choose **Instances** in the navigation pane, select your new instance and choose **Actions, Instance State** and **Stop**.
10. Create a new AMI from the instance using the Amazon EC2 console or AWS CLI [create-image](#).

### From the Amazon EC2 console

- a. Choose **Instances** in the navigation pane.
  - b. Choose the instance you created and modified.
  - c. In **Actions**, choose **Image** and then **Create Image**.
  - d. Choose **Create Image**.
11. Enter the new AMI ID in the [CustomAmi](#) field in your cluster configuration and create a cluster.

## Integrating Active Directory

In this tutorial, you create a multiple user environment. This environment includes an AWS ParallelCluster that's integrated with an AWS Managed Microsoft AD (Active Directory) at `corp.example.com`. You configure an Admin user to manage the directory, a ReadOnly user to read the directory, and a `user000` user to log into the cluster. You can use either the automated path or the manual path to create the networking resources, an Active Directory (AD), and the Amazon EC2 instance that you use to configure the AD. Regardless of the path, the infrastructure


that you create is pre-configured to integrate AWS ParallelCluster using one of the following methods:

- LDAPS with certificate verification (recommended as the most secure option)
- LDAPS without certificate verification
- LDAP

LDAP by itself *doesn't* provide encryption. To ensure secure transmission of potentially sensitive information, we strongly recommend that you use LDAPS (LDAP over TLS/SSL) for clusters integrated with ADs. For more information, see [Enable server-side LDAPS using AWS Managed Microsoft AD](#) in the AWS Directory Service *Administration Guide*.

After you create these resources, proceed to configure and create your cluster integrated with your Active Directory (AD). After the cluster is created, log in as the user you created. For more information about the configuration that you create in this tutorial, see [Multiple user access to clusters](#) and the [DirectoryService](#) configuration section.

This tutorial covers how to create an environment that supports multiple user access to clusters. This tutorial doesn't cover how you create and use an AWS Directory Service AD. The steps that you take to set up an AWS Managed Microsoft AD in this tutorial are provided for testing purposes only. They *aren't* provided to replace the official documentation and best practices you can find at [AWS Managed Microsoft AD](#) and [Simple AD](#) in the *AWS Directory Service Administration Guide*.

 **Note**

Directory user passwords expire according to the directory password policy property definitions. For more information see [Supported policy settings](#). To reset directory passwords with AWS ParallelCluster, see [How to reset a user password and expired passwords](#).

 **Note**

The directory domain controller IP addresses can change due to domain controller changes and directory maintenance. If you chose the automated quick create method to create the directory infrastructure, you must manually align the load balancer in front of the directory

controllers when the directory IP addresses change. If you use the quick create method, the directory IP addresses aren't automatically aligned with the load balancers.

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

## Prerequisites

- AWS ParallelCluster [is installed](#).
- The AWS CLI [is installed and configured](#).
- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) required to run the `pcluster` CLI.

As you go through the tutorial, replace *inputs highlighted in red*, such as *region-id* and *d-abcdef01234567890*, with your own names and IDs. Replace *0123456789012* with your AWS account number.

## Step 1: Create the AD infrastructure

Choose the *Automated* tab to create the Active Directory (AD) infrastructure with an AWS CloudFormation quick create template.

Choose the *Manual* tab to manually create the AD infrastructure.

### Automated

1. Sign in to the AWS Management Console.
2. Open [CloudFormation Quick Create \(region us-east-1\)](#) to create the following resources in the CloudFormation console:
  - A VPC with two subnets and routing for public access, if no VPC is specified.
  - An AWS Managed Microsoft AD.
  - An Amazon EC2 instance that's joined to the AD that you can use to manage the directory.

3. In the **Quick create stack** page **Parameters** section, enter passwords for the following parameters:

- **AdminPassword**
- **ReadOnlyPassword**
- **UserPassword**

Make note of the passwords. You use them later on in this tutorial.

4. For **DomainName**, enter **corp.example.com**

5. For **Keypair**, enter the name of an Amazon EC2 key pair.

6. Check the boxes to acknowledge each of the access capabilities at the bottom of the page.

7. Choose **Create stack**.

8. After the CloudFormation stack has reached the **CREATE\_COMPLETE** state, choose the **Outputs** tab of the stack. Make a note of the output resource names and IDs because you need to use them in later steps. The outputs provide the information that's needed to create the cluster.

The screenshot shows the AWS CloudFormation console interface. On the left, a sidebar displays a list of stacks, with 'PclusterAD' selected and showing a 'CREATE\_COMPLETE' status. The main area shows the details for the stack 'PclusterAD-abcd123'. The 'Outputs' tab is active, displaying a table of 10 outputs. The table has columns for 'Key' and 'Value'.

| Key                               | Value                                                                          |
|-----------------------------------|--------------------------------------------------------------------------------|
| DomainAddrLdap                    | ldap://10.0.111.88,ldap://10.0.222.111                                         |
| DomainAddrLdaps                   | ldaps://corp.example.com                                                       |
| DomainCertificateArn              | arn:aws:acm:us-east-1:123456789012:certificate/1234abcd-ef56-78gh-ij90-abcd1   |
| DomainCertificateSecretArn        | arn:aws:secretsmanager:us-east-1:123456789012:secret:DomainCertificateSecret-f |
| DomainCertificateSecretReadPolicy | arn:aws:iam::123456789012:policy/DomainCertificateSecretReadPolicy-PclusterAD  |
| DomainName                        | corp.example.com                                                               |
| DomainReadOnlyUser                | cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com                     |
| PasswordSecretArn                 | arn:aws:secretsmanager:us-east-1:123456789012:secret>PasswordSecret-PclusterA  |
| PrivateSubnetIds                  | subnet-1234567890abcdef0,subnet-abcdef01234567890                              |
| VpcId                             | vpc-021345abcdef6789                                                           |

- To complete the exercises [\(Optional\) Step 2: Manage AD users and groups](#), you need the directory ID. Choose **Resources** and scroll down to make note of the directory ID.
- Continue at [\(Optional\) Step 2: Manage AD users and groups](#) or [Step 3: Create the cluster](#).

## Manual

Create a VPC for the directory service with two subnets in different Availability Zones and an AWS Managed Microsoft AD.

### Create the AD

#### Note

- The directory and domain name is `corp.example.com`. The short name is `CORP`.
- Change the Admin password in the script.
- The Active Directory (AD) takes at least 15 minutes to create.

Use the following Python script to create the VPC, subnets, and AD resources in your local AWS Region. Save this file as `ad.py` and run it.

```
import boto3
import time
from pprint import pprint

vpc_name = "PclusterVPC"
ad_domain = "corp.example.com"
admin_password = "asdfASDF1234"

Amazon EC2 = boto3.client("ec2")
ds = boto3.client("ds")
region = boto3.Session().region_name

# Create the VPC, Subnets, IGW, Routes
vpc = ec2.create_vpc(CidrBlock="10.0.0.0/16")["Vpc"]
vpc_id = vpc["VpcId"]
time.sleep(30)
ec2.create_tags(Resources=[vpc_id], Tags=[{"Key": "Name", "Value": vpc_name}])
subnet1 = ec2.create_subnet(VpcId=vpc_id, CidrBlock="10.0.0.0/17",
    AvailabilityZone=f"{region}a")["Subnet"]
```



```

subnet1_id = subnet1["SubnetId"]
time.sleep(30)
ec2.create_tags(Resources=[subnet1_id], Tags=[{"Key": "Name", "Value": f"{vpc_name}/
subnet1"}])
ec2.modify_subnet_attribute(SubnetId=subnet1_id, MapPublicIpOnLaunch={"Value": True})
subnet2 = ec2.create_subnet(VpcId=vpc_id, CidrBlock="10.0.128.0/17",
    AvailabilityZone=f"{region}b")["Subnet"]
subnet2_id = subnet2["SubnetId"]
time.sleep(30)
ec2.create_tags(Resources=[subnet2_id], Tags=[{"Key": "Name", "Value": f"{vpc_name}/
subnet2"}])
ec2.modify_subnet_attribute(SubnetId=subnet2_id, MapPublicIpOnLaunch={"Value": True})
igw = ec2.create_internet_gateway()["InternetGateway"]
ec2.attach_internet_gateway(InternetGatewayId=igw["InternetGatewayId"], VpcId=vpc_id)
route_table = ec2.describe_route_tables(Filters=[{"Name": "vpc-id", "Values":
    [vpc_id]}])["RouteTables"][0]
ec2.create_route(RouteTableId=route_table["RouteTableId"],
    DestinationCidrBlock="0.0.0.0/0", GatewayId=igw["InternetGatewayId"])
ec2.modify_vpc_attribute(VpcId=vpc_id, EnableDnsSupport={"Value": True})
ec2.modify_vpc_attribute(VpcId=vpc_id, EnableDnsHostnames={"Value": True})

# Create the Active Directory
ad = ds.create_microsoft_ad(
    Name=ad_domain,
    Password=admin_password,
    Description="ParallelCluster AD",
    VpcSettings={"VpcId": vpc_id, "SubnetIds": [subnet1_id, subnet2_id]},
    Edition="Standard",
)
directory_id = ad["DirectoryId"]

# Wait for completion
print("Waiting for the directory to be created...")
directories = ds.describe_directories(DirectoryIds=[directory_id])
["DirectoryDescriptions"]
directory = directories[0]
while directory["Stage"] in {"Requested", "Creating"}:
    time.sleep(3)
    directories = ds.describe_directories(DirectoryIds=[directory_id])
["DirectoryDescriptions"]
    directory = directories[0]

dns_ip_addrs = directory["DnsIpAddrs"]

```

```
pprint({"directory_id": directory_id,
       "vpc_id": vpc_id,
       "subnet1_id": subnet1_id,
       "subnet2_id": subnet2_id,
       "dns_ip_addrs": dns_ip_addrs})
```

The following is example output from the Python script.

```
{
  "directory_id": "d-abcdef01234567890",
  "dns_ip_addrs": ["192.0.2.254", "203.0.113.237"],
  "subnet1_id": "subnet-021345abcdef6789",
  "subnet2_id": "subnet-1234567890abcdef0",
  "vpc_id": "vpc-021345abcdef6789"
}
```

Make a note of the output resource names and IDs. You use them in later steps.

After the script completes, continue to the next step.

## Create an Amazon EC2 instance

### New Amazon EC2 console

1. Sign in to the AWS Management Console.
2. If you don't have a role with the policies listed in step 4 attached, open the IAM console at <https://console.aws.amazon.com/iam/>. Otherwise, skip to step 5.
3. Create the ResetUserPassword policy, replacing the red highlighted content with your AWS Region ID, Account ID, and the directory ID from the output of the script you ran to create the AD.

### ResetUserPassword

```
{
  "Statement": [
    {
      "Action": [
        "ds:ResetUserPassword"
      ],
      "Resource": "arn:aws:ds:region-id:123456789012:directory/d-abcdef01234567890",
    }
  ]
}
```

```
        "Effect": "Allow"
      }
    ]
  }
```

4. Create an IAM role with the following policies attached.
  - AWS managed policy [AmazonSSMManagedInstanceCore](#)
  - AWS managed policy [AmazonSSMDirectoryServiceAccess](#)
  - ResetUserPassword policy
5. Open the Amazon EC2 console at <https://console.aws.amazon.com/ec2/>.
6. In the **Amazon EC2 Dashboard**, choose **Launch Instance**.
7. In **Application and OS Images**, select a recent Amazon Linux 2 AMI.
8. For **Instance type**, choose t2.micro.
9. For **Key pair**, choose a key pair.
10. For **Network settings**, choose **Edit**.
11. For **VPC**, select the directory VPC.
12. Scroll down and select **Advanced details**.
13. In **Advanced details, Domain join directory**, choose **corp.example.com**.
14. For **IAM Instance profile**, choose the role you created in step 1 or a role with policies listed in step 4 attached.
15. In **Summary** choose **Launch instance**.
16. Make note of the Instance ID (for example, i-1234567890abcdef0) and wait for the instance to finish launching.
17. After the instance has launched, continue to the next step.

### Old Amazon EC2 console

1. Sign in to the AWS Management Console.
2. If you don't have a role with the policies listed in step 4 attached, open the IAM console at <https://console.aws.amazon.com/iam/>. Otherwise, skip to step 5.
3. Create the ResetUserPassword policy. Replace the red highlighted content with your AWS Region ID, AWS account ID, and the directory ID from the output of the script you ran to create the Active Directory (AD).

## ResetUserPassword

```
{
  "Statement": [
    {
      "Action": [
        "ds:ResetUserPassword"
      ],
      "Resource": "arn:aws:ds:region-id:123456789012:directory/d-
abcdef01234567890",
      "Effect": "Allow"
    }
  ]
}
```

4. Create an IAM role with the following policies attached.
  - AWS managed policy [AmazonSSMManagedInstanceCore](#)
  - AWS managed policy [AmazonSSMDirectoryServiceAccess](#)
  - ResetUserPassword policy
5. Open the Amazon EC2 console at <https://console.aws.amazon.com/ec2/>.
6. In the **Amazon EC2 Dashboard**, choose **Launch Instance**.
7. In **Application and OS Images**, select a recent Amazon Linux 2 AMI.
8. For **Instance type**, choose t2.micro.
9. For **Key pair**, choose a key pair.
10. In **Network settings**, choose **Edit**.
11. In **Network settings, VPC**, select the directory VPC.
12. Scroll down and select **Advanced details**.
13. In **Advanced details, Domain join directory**, choose **corp.example.com**.
14. In **Advanced details, Instance profile**, choose the role that you created in step 1 or a role with the policies that are listed in step 4 attached.
15. In **Summary** choose **Launch instance**.
16. Make note of the Instance ID (for example, i-1234567890abcdef0) and wait for the instance to finish launching.
17. After the instance has launched, continue to the next step.

## Join your instance to the AD

### 1. Connect to your instance and join the AD realm as admin.

Run the following commands to connect to the instance.

```
$ INSTANCE_ID="i-1234567890abcdef0"
```

```
$ PUBLIC_IP=$(aws ec2 describe-instances \
--instance-ids $INSTANCE_ID \
--query "Reservations[0].Instances[0].PublicIpAddress" \
--output text)
```

```
$ ssh -i ~/.ssh/keys/keypair.pem ec2-user@$PUBLIC_IP
```

### 2. Install necessary software and join the realm.

```
$ sudo yum -y install sssd realmd oddjob oddjob-mkhomedir adcli samba-common samba-
common-tools krb5-workstation openldap-clients policycoreutils-python
```

### 3. Replace the admin password with your admin password.

```
$ ADMIN_PW="asdfASDF1234"
```

```
$ echo $ADMIN_PW | sudo realm join -U Admin corp.example.com
Password for Admin:
```

If the preceding has succeeded, you're joined to the realm and can proceed to the next step.

## Add users to the AD

### 1. Create the ReadOnlyUser and an additional user.

In this step, you use [adcli](#) and [openldap-clients](#) tools that you installed in a preceding step.

```
$ echo $ADMIN_PW | adcli create-user -x -U Admin --domain=corp.example.com --
display-name=ReadOnlyUser ReadOnlyUser
```

```
$ echo $ADMIN_PW | adcli create-user -x -U Admin --domain=corp.example.com --  
display-name=user000 user000
```

## 2. Verify the users are created:

The directory DNS IP addresses are outputs of the Python script.

```
$ DIRECTORY_IP="192.0.2.254"
```

```
$ ldapsearch -x -h $DIRECTORY_IP -D Admin -w $ADMIN_PW -b  
"cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com"
```

```
$ ldapsearch -x -h $DIRECTORY_IP -D Admin -w $ADMIN_PW -b  
"cn=user000,ou=Users,ou=CORP,dc=corp,dc=example,dc=com"
```

By default, when you create a user with the `ad-cli`, the user is disabled.

## 3. Reset and activate the user passwords from your local machine:

Log out of your Amazon EC2 instance.

### Note

- `ro-p@ssw0rd` is the password of `ReadOnlyUser`, retrieved from AWS Secrets Manager.
- `user-p@ssw0rd` is the password of a cluster user that's provided when you connect (ssh) to the cluster.

The `directory-id` is an output of the Python script.

```
$ DIRECTORY_ID="d-abcdef01234567890"
```

```
$ aws ds reset-user-password \  
--directory-id $DIRECTORY_ID \  
--user-name "ReadOnlyUser" \  
--new-password "ro-p@ssw0rd" \  
--
```

```
--region "region-id"
```

```
$ aws ds reset-user-password \
--directory-id $DIRECTORY_ID \
--user-name "user000" \
--new-password "user-p@ssw0rd" \
--region "region-id"
```

#### 4. Add the password to a Secrets Manager secret.

Now that you created a `ReadOnlyUser` and set the password, store it in a secret that AWS ParallelCluster uses for validating logins.

Use Secrets Manager to create a new secret to hold the password for the `ReadOnlyUser` as the value. The secret value format must be plain text only (not JSON format). Make note of the secret ARN for future steps.

```
$ aws secretsmanager create-secret --name "ADSecretPassword" \
--region region_id \
--secret-string "ro-p@ssw0rd" \
--query ARN \
--output text
arn:aws:secretsmanager:region-id:123456789012:secret:ADSecretPassword-1234
```

## LDAPS with certificate verification (recommended) setup

Make a note of resource IDs. You use them in steps later on.

### 1. Generate domain certificate, locally.

```
$ PRIVATE_KEY="corp-example-com.key"
CERTIFICATE="corp-example-com.crt"
printf ".\n.\n.\n.\n.\n.\ncorp.example.com\n.\n" | openssl req -x509 -sha256 -nodes -
newkey rsa:2048 -keyout $PRIVATE_KEY -days 365 -out $CERTIFICATE
```

### 2. Store the certificate to Secrets Manager to make it retrievable from within the cluster later on.

```
$ aws secretsmanager create-secret --name example-cert \
--secret-string file://$CERTIFICATE \
```

```

--region region-id
{
  "ARN": "arn:aws:secretsmanager:region-id:123456789012:secret:example-
cert-123abc",
  "Name": "example-cert",
  "VersionId": "14866070-092a-4d5a-bcdd-9219d0566b9c"
}

```

3. Add the following policy to the IAM role that you created to join the Amazon EC2 instance to the AD domain.

#### PutDomainCertificateSecrets

```

{
  "Statement": [
    {
      "Action": [
        "secretsmanager:PutSecretValue"
      ],
      "Resource": [
        "arn:aws:secretsmanager:region-id:123456789012:secret:example-
cert-123abc",
      ],
      "Effect": "Allow"
    }
  ]
}

```

4. Import the certificate to AWS Certificate Manager (ACM).

```

$ aws acm import-certificate --certificate fileb://$CERTIFICATE \
--private-key fileb://$PRIVATE_KEY \
--region region-id
{
  "CertificateArn": "arn:aws:acm:region-
id:123456789012:certificate/343db133-490f-4077-b8d4-3da5bfd89e72"
}

```

5. Create and the load balancer that is put in front of the Active Directory endpoints.

```

$ aws elbv2 create-load-balancer --name CorpExampleCom-NLB \
--type network \
--scheme internal \

```



```

--subnets subnet-1234567890abcdef0 subnet-021345abcdef6789 \
--region region-id
{
  "LoadBalancers": [
    {
      "LoadBalancerArn": "arn:aws:elasticloadbalancing:region-
id:123456789012:loadbalancer/net/CorpExampleCom-NLB/3afe296bf4ba80d4",
      "DNSName": "CorpExampleCom-NLB-3afe296bf4ba80d4.elb.region-id.amazonaws.com",
      "CanonicalHostedZoneId": "Z2IF0LAFXWL04F",
      "CreatedTime": "2022-05-05T12:56:55.988000+00:00",
      "LoadBalancerName": "CorpExampleCom-NLB",
      "Scheme": "internal",
      "VpcId": "vpc-021345abcdef6789",
      "State": {
        "Code": "provisioning"
      },
      "Type": "network",
      "AvailabilityZones": [
        {
          "ZoneName": "region-idb",
          "SubnetId": "subnet-021345abcdef6789",
          "LoadBalancerAddresses": []
        },
        {
          "ZoneName": "region-ida",
          "SubnetId": "subnet-1234567890abcdef0",
          "LoadBalancerAddresses": []
        }
      ],
      "IpAddressType": "ipv4"
    }
  ]
}

```

## 6. Create the target group that's targeting the Active Directory endpoints.

```

$ aws elbv2 create-target-group --name CorpExampleCom-Targets --protocol TCP \
--port 389 \
--target-type ip \
--vpc-id vpc-021345abcdef6789 \
--region region-id
{
  "TargetGroups": [
    {

```

```

    "TargetGroupArn": "arn:aws:elasticloadbalancing:region-
id:123456789012:targetgroup/CorpExampleCom-Targets/44577c583b695e81",
    "TargetGroupName": "CorpExampleCom-Targets",
    "Protocol": "TCP",
    "Port": 389,
    "VpcId": "vpc-021345abcdef6789",
    "HealthCheckProtocol": "TCP",
    "HealthCheckPort": "traffic-port",
    "HealthCheckEnabled": true,
    "HealthCheckIntervalSeconds": 30,
    "HealthCheckTimeoutSeconds": 10,
    "HealthyThresholdCount": 3,
    "UnhealthyThresholdCount": 3,
    "TargetType": "ip",
    "IpAddressType": "ipv4"
  }
]
}

```

## 7. Register the Active Directory (AD) endpoints into the target group.

```

$ aws elbv2 register-targets --target-group-arn
arn:aws:elasticloadbalancing:region-id:123456789012:targetgroup/CorpExampleCom-
Targets/44577c583b695e81 \
--targets Id=192.0.2.254,Port=389 Id=203.0.113.237,Port=389 \
--region region-id

```

## 8. Create the LB listener with the certificate.

```

$ aws elbv2 create-listener --load-balancer-arn
arn:aws:elasticloadbalancing:region-id:123456789012:loadbalancer/net/
CorpExampleCom-NLB/3afe296bf4ba80d4 \
--protocol TLS \
--port 636 \
--default-actions
Type=forward,TargetGroupArn=arn:aws:elasticloadbalancing:region-
id:123456789012:targetgroup/CorpExampleCom-Targets/44577c583b695e81 \
--ssl-policy ELBSecurityPolicy-TLS-1-2-2017-01 \
--certificates CertificateArn=arn:aws:acm:region-
id:123456789012:certificate/343db133-490f-4077-b8d4-3da5bfd89e72 \
--region region-id
"Listeners": [
{

```

```

    "ListenerArn": "arn:aws:elasticloadbalancing:region-id:123456789012:listener/
net/CorpExampleCom-NLB/3afe296bf4ba80d4/a8f9d97318743d4b",
    "LoadBalancerArn": "arn:aws:elasticloadbalancing:region-
id:123456789012:loadbalancer/net/CorpExampleCom-NLB/3afe296bf4ba80d4",
    "Port": 636,
    "Protocol": "TLS",
    "Certificates": [
      {
        "CertificateArn": "arn:aws:acm:region-
id:123456789012:certificate/343db133-490f-4077-b8d4-3da5bfd89e72"
      }
    ],
    "SslPolicy": "ELBSecurityPolicy-TLS-1-2-2017-01",
    "DefaultActions": [
      {
        "Type": "forward",
        "TargetGroupArn": "arn:aws:elasticloadbalancing:region-
id:123456789012:targetgroup/CorpExampleCom-Targets/44577c583b695e81",
        "ForwardConfig": {
          "TargetGroups": [
            {
              "TargetGroupArn": "arn:aws:elasticloadbalancing:region-
id:123456789012:targetgroup/CorpExampleCom-Targets/44577c583b695e81"
            }
          ]
        }
      }
    ]
  }
}

```

## 9. Create the hosted zone to make the domain discoverable within the cluster VPC.

```

$ aws route53 create-hosted-zone --name corp.example.com \
  --vpc VPCRegion=region-id,VPCId=vpc-021345abcdef6789 \
  --caller-reference "ParallelCluster AD Tutorial"
{
  "Location": "https://route53.amazonaws.com/2013-04-01/hostedzone/
Z09020002B5MZQNXMSJUB",
  "HostedZone": {
    "Id": "/hostedzone/Z09020002B5MZQNXMSJUB",
    "Name": "corp.example.com.",
    "CallerReference": "ParallelCluster AD Tutorial",

```

```

    "Config": {
      "PrivateZone": true
    },
    "ResourceRecordSetCount": 2
  },
  "ChangeInfo": {
    "Id": "/change/C05533343BF3IKSORW1TQ",
    "Status": "PENDING",
    "SubmittedAt": "2022-05-05T13:21:53.863000+00:00"
  },
  "VPC": {
    "VPCRegion": "region-id",
    "VPCId": "vpc-021345abcdef6789"
  }
}

```

10. Create a file that's named `recordset-change.json` with the following content. `HostedZoneId` is the canonical hosted zone ID of the load balancer.

```

{
  "Changes": [
    {
      "Action": "CREATE",
      "ResourceRecordSet": {
        "Name": "corp.example.com",
        "Type": "A",
        "Region": "region-id",
        "SetIdentifier": "example-active-directory",
        "AliasTarget": {
          "HostedZoneId": "Z2IF0LAFXWL04F",
          "DNSName": "CorpExampleCom-NLB-3afe296bf4ba80d4.elb.region-
id.amazonaws.com",
          "EvaluateTargetHealth": true
        }
      }
    }
  ]
}

```

11. Submit the recordset change to the hosted zone, this time using the hosted zone ID.

```

$ aws route53 change-resource-record-sets --hosted-zone-id Z09020002B5MZQNMSJUB \
  --change-batch file://recordset-change.json

```

```
{
  "ChangeInfo": {
    "Id": "/change/C0137926I56R3GC7XW2Y",
    "Status": "PENDING",
    "SubmittedAt": "2022-05-05T13:40:36.553000+00:00"
  }
}
```

## 12. Create a policy document `policy.json` with the following content.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "secretsmanager:GetSecretValue"
      ],
      "Resource": [
        "arn:aws:secretsmanager:region-id:123456789012:secret:example-cert-abc123"
      ],
      "Effect": "Allow"
    }
  ]
}
```

## 13. Create a policy document that is named `policy.json` with the following content.

```
$ aws iam create-policy --policy-name ReadCertExample \
  --policy-document file://policy.json
{
  "Policy": {
    "PolicyName": "ReadCertExample",
    "PolicyId": "ANPAUUXUVBC42VZSI4LDY",
    "Arn": "arn:aws:iam::123456789012:policy/ReadCertExample-efg456",
    "Path": "/",
    "DefaultVersionId": "v1",
    "AttachmentCount": 0,
    "PermissionsBoundaryUsageCount": 0,
    "IsAttachable": true,
    "CreateDate": "2022-05-05T13:42:18+00:00",
    "UpdateDate": "2022-05-05T13:42:18+00:00"
  }
}
```

14. Continue to follow the steps at [\(Optional\) Step 2: Manage AD users and groups](#) or [Step 3: Create the cluster](#).

## (Optional) Step 2: Manage AD users and groups

In this step, you manage users and groups from an Amazon EC2 Amazon Linux 2 instance that's joined to the Active Directory (AD) domain.

If you followed the *automated* path, restart and log in to the AD joined instance that was created as part of the automation.

If you followed the *manual* path, restart and log in to the instance that you created and joined to the AD in preceding steps.

In these steps, you use the [adcli](#) and [openldap-clients](#) tools that were installed in the instance as part of a preceding step.

### Log in to an Amazon EC2 instance that is joined to the AD domain

1. From the Amazon EC2 console, select the untitled Amazon EC2 instance that was created in previous steps. The instance state might be **Stopped**.
2. If the instance state is **Stopped**, choose **Instance state** and then **Start instance**.
3. After the status checks pass, select the instance and choose **Connect** and SSH in to the instance.

### Manage users and groups when logged into an Amazon EC2 Amazon Linux 2 instance that's joined the AD

When you run the `adcli` commands with the `-U "Admin"` option, you're prompted to enter the AD Admin password. You include the AD Admin password as part of the `ldapsearch` commands.

1. Create a user.

```
$ adcli create-user "clusteruser" --domain "corp.example.com" -U "Admin"
```

2. Set a user password.

```
$ aws --region "region-id" ds reset-user-password --directory-id "d-  
abcdef01234567890" --user-name "clusteruser" --new-password "new-p@ssw0rd"
```

### 3. Create a group.

```
$ adcli create-group "clusterteam" --domain "corp.example.com" -U "Admin"
```

### 4. Add a user to a group.

```
$ adcli add-member "clusterteam" "clusteruser" --domain "corp.example.com" -U "Admin"
```

### 5. Describe users and groups.

Describe all users.

```
$ ldapsearch "(&(objectClass=user))" -x -h "192.0.2.254" -b "DC=corp,DC=example,DC=com" -D "CN=Admin,OU=Users,OU=CORP,DC=corp,DC=example,DC=com" -w "p@ssw0rd"
```

Describe a specific user.

```
$ ldapsearch "(&(objectClass=user)(cn=clusteruser))" -x -h "192.0.2.254" -b "DC=corp,DC=example,DC=com" -D "CN=Admin,OU=Users,OU=CORP,DC=corp,DC=example,DC=com" -w "p@ssw0rd"
```

Describe all users with a name pattern.

```
$ ldapsearch "(&(objectClass=user)(cn=user*))" -x -h "192.0.2.254" -b "DC=corp,DC=example,DC=com" -D "CN=Admin,OU=Users,OU=CORP,DC=corp,DC=example,DC=com" -w "p@ssw0rd"
```

Describe all users that are part of a specific group.

```
$ ldapsearch "(&(objectClass=user)(memberOf=CN=clusterteam,OU=Users,OU=CORP,DC=corp,DC=example,DC=com))" -x -h "192.0.2.254" -b "DC=corp,DC=example,DC=com" -D "CN=Admin,OU=Users,OU=CORP,DC=corp,DC=example,DC=com" -w "p@ssw0rd"
```

Describe all groups

```
$ ldapsearch "objectClass=group" -x -h "192.0.2.254" -b "DC=corp,DC=example,DC=com"
-D "CN=Admin,OU=Users,OU=CORP,DC=corp,DC=example,DC=com" -w "p@ssw0rd"
```

Describe a specific group

```
$ ldapsearch "(&(objectClass=group)(cn=clusterteam))"
-x -h "192.0.2.254" -b "DC=corp,DC=example,DC=com" -D
"CN=Admin,OU=Users,OU=CORP,DC=corp,DC=example,DC=com" -w "p@ssw0rd"
```

## 6. Remove a user from a group.

```
$ adcli remove-member "clusterteam" "clusteruser" --domain "corp.example.com" -U
"Admin"
```

## 7. Delete a user.

```
$ adcli delete-user "clusteruser" --domain "corp.example.com" -U "Admin"
```

## 8. Delete a group.

```
$ adcli delete-group "clusterteam" --domain "corp.example.com" -U "Admin"
```

## Step 3: Create the cluster

If you haven't exited the Amazon EC2 instance, do so now.

The environment is set up to create a cluster that can authenticate users against the Active Directory (AD).

Create a simple cluster configuration and provide the settings relevant to connecting to the AD. For more information, see the [DirectoryService](#) section.

Choose one of the following cluster configurations and copy it to a file that's named `ldaps_config.yaml`, `ldaps_nocert_config.yaml`, or `ldap_config.yaml`.

We recommend that you choose the LDAPS configuration with certificate verification. If you choose this configuration, you must also copy the bootstrap script to a file that's named `active-directory.head.post.sh`. And, you must store it in an Amazon S3 bucket as indicated in the configuration file.



## LDAPS with certificate verification configuration (recommended)

### Note

**The following components must be changed.**

- **KeyName:** One of your Amazon EC2 keypairs.
- **SubnetId / SubnetIds:** One of the subnet IDs provided in the output of the CloudFormation quick create stack (automated tutorial) or python script (manual tutorial).
- **Region:** The Region where you created the AD infrastructure.
- **DomainAddr:** This IP address is one of the DNS addresses of your AD service.
- **PasswordSecretArn:** The Amazon Resource Name (ARN) of the secret that contains the password for the DomainReadOnlyUser.
- **BucketName:** The name of the bucket that holds the bootstrap script.
- **AdditionalPolicies / Policy:** The Amazon Resource Name (ARN) of the read domain certification policy ReadCertExample.
- **CustomActions / OnNodeConfigured / Args:** The Amazon Resource Name (ARN) of secret that holds the domain certification policy.

For better security posture, we suggest to use the `HeadNode / Ssh / AllowedIps` configuration to limit the SSH access to the head node.

Region: *region-id*

Image:

Os: alinux2

HeadNode:

InstanceType: t2.micro

Networking:

SubnetId: *subnet-abcdef01234567890*

Ssh:

KeyName: *keypair*

Iam:

AdditionalIamPolicies:

- Policy: arn:aws:iam::*123456789012*:policy/ReadCertExample

S3Access:

```

- BucketName: my-bucket
  EnableWriteAccess: false
  KeyName: bootstrap/active-directory/active-directory.head.post.sh
CustomActions:
  OnNodeConfigured:
    Script: s3://my-bucket/bootstrap/active-directory/active-directory.head.post.sh
    Args:
      - arn:aws:secretsmanager:region-id:123456789012:secret:example-cert-123abc
      - /opt/parallelcluster/shared/directory_service/domain-certificate.crt
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue0
      ComputeResources:
        - Name: queue0-t2-micro
          InstanceType: t2.micro
          MinCount: 1
          MaxCount: 10
      Networking:
        SubnetIds:
          - subnet-abcdef01234567890
DirectoryService:
  DomainName: corp.example.com
  DomainAddr: ldaps://corp.example.com
  PasswordSecretArn: arn:aws:secretsmanager:region-id:123456789012:secret:ADSecretPassword-1234
  DomainReadOnlyUser: cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
  LdapTlsCaCert: /opt/parallelcluster/shared/directory_service/domain-certificate.crt
  LdapTlsReqCert: hard

```

## Bootstrap script

After you create the bootstrap file and before you upload it to your S3 bucket, run `chmod +x active-directory.head.post.sh` to give AWS ParallelCluster run permission.

```

#!/bin/bash
set -e

CERTIFICATE_SECRET_ARN="$1"
CERTIFICATE_PATH="$2"

[[ -z $CERTIFICATE_SECRET_ARN ]] && echo "[ERROR] Missing CERTIFICATE_SECRET_ARN" &&
exit 1

```

```
[[ -z $CERTIFICATE_PATH ]] && echo "[ERROR] Missing CERTIFICATE_PATH" && exit 1

source /etc/parallelcluster/cfnconfig
REGION="${cfn_region:?}"

mkdir -p $(dirname $CERTIFICATE_PATH)
aws secretsmanager get-secret-value --region $REGION --secret-id
$CERTIFICATE_SECRET_ARN --query SecretString --output text > $CERTIFICATE_PATH
```

## LDAPS without certificate verification configuration

### Note

#### The following components must be changed.

- **KeyName:** One of your Amazon EC2 keypairs.
- **SubnetId / SubnetIds:** One of the subnet IDs that's in the output of the CloudFormation quick create stack (automated tutorial) or python script (manual tutorial).
- **Region:** The Region where you created the AD infrastructure.
- **DomainAddr:** This IP address is one of the DNS addresses of your AD service.
- **PasswordSecretArn:** The Amazon Resource Name (ARN) of the secret that contains the password for the `DomainReadOnlyUser`.

For better security posture, we suggest to use the `HeadNode/Ssh/AllowedIps` configuration to limit the SSH access to the head node.

```
Region: region-id
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-abcdef01234567890
  Ssh:
    KeyName: keypair
Scheduling:
```

```
Scheduler: slurm
SlurmQueues:
- Name: queue0
  ComputeResources:
  - Name: queue0-t2-micro
    InstanceType: t2.micro
    MinCount: 1
    MaxCount: 10
  Networking:
  SubnetIds:
  - subnet-abcdef01234567890
DirectoryService:
  DomainName: corp.example.com
  DomainAddr: ldaps://corp.example.com
  PasswordSecretArn: arn:aws:secretsmanager:region-
id:123456789012:secret:ADSecretPassword-1234
  DomainReadOnlyUser: cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
  LdapTlsReqCert: never
```

## LDAP configuration

### Note

#### **The following components must be changed.**

- **KeyName:** One of your Amazon EC2 keypairs.
- **SubnetId / SubnetIds:** One of the subnet IDs provided in the output of the CloudFormation quick create stack (automated tutorial) or python script (manual tutorial).
- **Region:** The Region where you created the AD infrastructure.
- **DomainAddr:** This IP address is one of the DNS addresses of your AD service.
- **PasswordSecretArn:** The Amazon Resource Name (ARN) of the secret that contains the password for the `DomainReadOnlyUser`.

For better security posture, we suggest to use the `HeadNode/Ssh/AllowedIps` configuration to limit the SSH access to the head node.

```

Region: region-id
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
  Networking:
    SubnetId: subnet-abcdef01234567890
  Ssh:
    KeyName: keypair
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue0
      ComputeResources:
        - Name: queue0-t2-micro
          InstanceType: t2.micro
          MinCount: 1
          MaxCount: 10
      Networking:
        SubnetIds:
          - subnet-abcdef01234567890
DirectoryService:
  DomainName: dc=corp,dc=example,dc=com
  DomainAddr: ldap://192.0.2.254,ldap://203.0.113.237
  PasswordSecretArn: arn:aws:secretsmanager:region-id:123456789012:secret:ADSecretPassword-1234
  DomainReadOnlyUser: cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
  AdditionalSssdConfigs:
    ldap_auth_disable_tls_never_use_in_production: True

```

Create your cluster with the following command.

```

$ pcluster create-cluster --cluster-name "ad-cluster" --cluster-configuration "./ldaps_config.yaml"
{
  "cluster": {
    "clusterName": "pcluster",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:region-id:123456789012:stack/ad-cluster/1234567-abcd-0123-def0-abcdef0123456",
    "region": "region-id",
    "version": 3.7.0,
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}

```

```
}  
}
```

## Step 4: Connect to the cluster as a user

You can determine the status of the cluster with the following commands.

```
$ pcluster describe-cluster -n ad-cluster --region "region-id" --query "clusterStatus"
```

The output is as follows.

```
"CREATE_IN_PROGRESS" / "CREATE_COMPLETE"
```

When the status reaches "CREATE\_COMPLETE", log in with the created user name and password.

```
$ HEAD_NODE_IP=$(pcluster describe-cluster -n "ad-cluster" --region "region-id" --query  
headNode.publicIpAddress | xargs echo)
```

```
$ ssh user000@$HEAD_NODE_IP
```

You can log in without the password by providing the SSH key that was created for the new user at `/home/user000@HEAD_NODE_IP/.ssh/id_rsa`.

If the ssh command succeeded, you have successfully connected to the cluster as a user that's authenticated to use the Active Directory (AD).

## Step 5: Clean up

### 1. From your local machine, delete the cluster.

```
$ pcluster delete-cluster --cluster-name "ad-cluster" --region "region-id"  
{  
  "cluster": {  
    "clusterName": "ad-cluster",  
    "cloudformationStackStatus": "DELETE_IN_PROGRESS",  
    "cloudformationStackArn": "arn:aws:cloudformation:region-id:123456789012:stack/  
ad-cluster/1234567-abcd-0123-def0-abcdef0123456",  
    "region": "region-id",  
    "version": "3.7.0",  
    "clusterStatus": "DELETE_IN_PROGRESS"  
  }  
}
```

```
}
```

## 2. Check the progress of the cluster being deleted.

```
$ pcluster describe-cluster --cluster-name "ad-cluster" --region "region-id" --  
query "clusterStatus"  
"DELETE_IN_PROGRESS"
```

After the cluster is successfully deleted, proceed to the next step.

## Automated

### Delete the Active Directory resources

1. From <https://console.aws.amazon.com/cloudformation/>.
2. In the navigation pane, choose **Stacks**.
3. From the list of stacks, choose the AD stack (for example, `pcluster-ad`).
4. Choose **Delete**.

## Manual

1. **Delete the Amazon EC2 instance.**
  - a. From <https://console.aws.amazon.com/ec2/>, choose **Instances** in the navigation pane.
  - b. From the list of instances, choose the instance that you created to add users to the directory.
  - c. Choose **Instance state**, then **Terminate instance**.
2. **Delete the hosted zone.**
  - a. Create a `recordset-delete.json` with the following content. In this example, `HostedZoneId` is the canonical hosted zone ID of the load balancer.

```
{  
  "Changes": [  
    {  
      "Action": "DELETE",  
      "ResourceRecordSet": {  
        "Name": "corp.example.com",
```

```

    "Type": "A",
    "Region": "region-id",
    "SetIdentifier": "pcluster-active-directory",
    "AliasTarget": {
      "HostedZoneId": "Z2IFOLAFXWL04F",
      "DNSName": "CorpExampleCom-NLB-3afe296bf4ba80d4.elb.region-id.amazonaws.com",
      "EvaluateTargetHealth": true
    }
  }
}
]
}

```

- b. Submit the recordset change to the hosted zone using the hosted zone ID.

```

$ aws route53 change-resource-record-sets --hosted-zone-id Z09020002B5MZQNXSJUB \
  --change-batch file://recordset-delete.json
{
  "ChangeInfo": {
    "Id": "/change/C04853642A0TH2TJ5NLNI",
    "Status": "PENDING",
    "SubmittedAt": "2022-05-05T14:25:51.046000+00:00"
  }
}

```

- c. Delete the hosted zone.

```

$ aws route53 delete-hosted-zone --id Z09020002B5MZQNXSJUB
{
  "ChangeInfo": {
    "Id": "/change/C0468051QFABTVHMDEG9",
    "Status": "PENDING",
    "SubmittedAt": "2022-05-05T14:26:13.814000+00:00"
  }
}

```

### 3. Delete the LB listener.

```

$ aws elbv2 delete-listener \
  --listener-arn arn:aws:elasticloadbalancing:region-id:123456789012:listener/net/CorpExampleCom-NLB/3afe296bf4ba80d4/a8f9d97318743d4b --region region-id

```



#### 4. Delete the target group.

```
$ aws elbv2 delete-target-group \  
  --target-group-arn arn:aws:elasticloadbalancing:region-  
id:123456789012:targetgroup/CorpExampleCom-Targets/44577c583b695e81 --  
  region region-id
```

#### 5. Delete the load balancer.

```
$ aws elbv2 delete-load-balancer \  
  --load-balancer-arn arn:aws:elasticloadbalancing:region-  
id:123456789012:loadbalancer/net/CorpExampleCom-NLB/3afe296bf4ba80d4 --  
  region region-id
```

#### 6. Delete the policy that the cluster uses to read the certificate from Secrets Manager.

```
$ aws iam delete-policy --policy-arn arn:aws:iam::123456789012:policy/  
ReadCertExample
```

#### 7. Delete the secret that contains the domain certificate.

```
$ aws secretsmanager delete-secret \  
  --secret-id arn:aws:secretsmanager:region-id:123456789012:secret:example-  
cert-123abc \  
  --region region-id  
{  
  "ARN": "arn:aws:secretsmanager:region-id:123456789012:secret:example-cert-123abc",  
  "Name": "example-cert",  
  "DeletionDate": "2022-06-04T16:27:36.183000+02:00"  
}
```

#### 8. Delete the certificate from ACM.

```
$ aws acm delete-certificate \  
  --certificate-arn arn:aws:acm:region-  
id:123456789012:certificate/343db133-490f-4077-b8d4-3da5bfd89e72 --region region-id
```

#### 9. Delete the Active Directory (AD) resources.

a. Get the following resource IDs from the output of the python script `ad.py`:

- AD ID

- AD subnet IDs
  - AD VPC ID
- b. Delete the directory by running the following command.

```
$ aws ds delete-directory --directory-id d-abcdef0123456789 --region region-id
{
  "DirectoryId": "d-abcdef0123456789"
}
```

- c. List the security groups in the VPC.

```
$ aws ec2 describe-security-groups --filters '[{"Name":"vpc-id","Values":
["vpc-07614ade95ebad1bc"]}]' --region region-id
```

- d. Delete the custom security group.

```
$ aws ec2 delete-security-group --group-id sg-021345abcdef6789 --region region-id
```

- e. Delete the subnets.

```
$ aws ec2 delete-subnet --subnet-id subnet-1234567890abcdef --region region-id
```

```
$ aws ec2 delete-subnet --subnet-id subnet-021345abcdef6789 --region region-id
```

- f. Describe internet gateway.

```
$ aws ec2 describe-internet-gateways \
  --filters Name=attachment.vpc-id,Values=vpc-021345abcdef6789 \
  --region region-id
{
  "InternetGateways": [
    {
      "Attachments": [
        {
          "State": "available",
          "VpcId": "vpc-021345abcdef6789"
        }
      ],
      "InternetGatewayId": "igw-1234567890abcdef",
      "OwnerId": "123456789012",

```

```
    "Tags": []  
  }  
]  
}
```

- g. Detach the internet gateway.

```
$ aws ec2 detach-internet-gateway \  
  --internet-gateway-id igw-1234567890abcdef \  
  --vpc-id vpc-021345abcdef6789 \  
  --region region-id
```

- h. Delete the internet gateway.

```
$ aws ec2 delete-internet-gateway \  
  --internet-gateway-id igw-1234567890abcdef \  
  --region region-id
```

- i. Delete the VPC.

```
$ aws ec2 delete-vpc \  
  --vpc-id vpc-021345abcdef6789 \  
  --region region-id
```

- j. Delete the secret that contains the ReadOnlyUser password.

```
$ aws secretsmanager delete-secret \  
  --secret-id arn:aws:secretsmanager:region-  
id:123456789012:secret:ADSecretPassword-1234" \  
  --region region-id
```

## Configuring shared storage encryption with an AWS KMS key

Learn how to set up a customer managed AWS KMS key to encrypt and protect your data in the cluster file storage systems that are configured for AWS ParallelCluster.

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

AWS ParallelCluster supports following shared storage configuration options:

- [SharedStorage](#) / [EbsSettings](#) / [KmsKeyId](#)
- [SharedStorage](#) / [EfsSettings](#) / [KmsKeyId](#)
- [SharedStorage](#) / [FsxLustreSettings](#) / [KmsKeyId](#)

You can use these options to provide a customer managed AWS KMS key for Amazon EBS, Amazon EFS, and FSx for Lustre shared storage system encryption. To use them, you must create and configure an IAM policy for the following:

- [HeadNode](#) / [Iam](#) / [AdditionalIamPolicies](#) / [Policy](#)
- [Scheduler](#) / [SlurmQueues](#) / [Iam](#) / [AdditionalIamPolicies](#) / [Policy](#)

## Prerequisites

- AWS ParallelCluster [is installed](#).
- The AWS CLI [is installed and configured](#).
- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) that are required to run the [pcluster](#) CLI.

## Topics

- [Create the policy](#)
- [Configure and create the cluster](#)

## Create the policy

### Create a policy.

1. Go to the IAM Console: <https://console.aws.amazon.com/iam/home>.
2. Choose **Policies**.
3. Choose **Create policy**.

4. Choose the **JSON** tab and paste in the following policy. Make sure to replace all occurrences of *123456789012* with your AWS account ID and the key Amazon Resource Name (ARN) and AWS Region with that of your own.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "kms:DescribeKey",
        "kms:ReEncrypt*",
        "kms:CreateGrant",
        "kms:Decrypt"
      ],
      "Resource": [
        "arn:aws:kms:region-id:123456789012:key/abcd1234-ef56-gh78-ij90-
        abcd1234efgh5678"
      ]
    }
  ]
}
```

5. For this tutorial, name the policy `ParallelClusterKmsPolicy`, and then choose **Create Policy**.
6. Make a note of the policy ARN. You need it to configure your cluster.

## Configure and create the cluster

The following is an example cluster configuration that includes an Amazon Elastic Block Store shared file system with encryption.

```
Region: eu-west-1
Image:
  Os: alinux2
HeadNode:
  InstanceType: t2.micro
Networking:
```

```
SubnetId: subnet-abcdef01234567890
Ssh:
  KeyName: my-ssh-key
Iam:
  AdditionalIamPolicies:
    - Policy: arn:aws:iam::123456789012:policy/ParallelClusterKmsPolicy
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: q1
      ComputeResources:
        - Name: t2micro
          InstanceType: t2.micro
          MinCount: 0
          MaxCount: 10
      Networking:
        SubnetIds:
          - subnet-abcdef01234567890
      Iam:
        AdditionalIamPolicies:
          - Policy: arn:aws:iam::123456789012:policy/ParallelClusterKmsPolicy
SharedStorage:
  - MountDir: /shared/ebs1
    Name: shared-ebs1
    StorageType: Ebs
    EbsSettings:
      Encrypted: True
      KmsKeyId: abcd1234-ef56-gh78-ij90-abcd1234efgh5678
```

Replace the items in red text with your own values. Then, create a cluster that uses your AWS KMS key to encrypt your data in Amazon EBS.

The configuration is similar for Amazon EFS and FSx for Lustre file systems.

The Amazon EFS SharedStorage configuration is as follows.

```
...
SharedStorage:
  - MountDir: /shared/efs1
    Name: shared-efs1
    StorageType: Efs
    EfsSettings:
      Encrypted: True
```

```
KmsKeyId: abcd1234-ef56-gh78-ij90-abcd1234efgh5678
```

The FSx for Lustre SharedStorage configuration is as follows.

```
...
SharedStorage:
  - MountDir: /shared/fsx1
    Name: shared-fsx1
    StorageType: FsxLustre
    FsxLustreSettings:
      StorageCapacity: 1200
      DeploymentType: PERSISTENT_1
      PerUnitStorageThroughput: 200
      KmsKeyId: abcd1234-ef56-gh78-ij90-abcd1234efgh5678
```

## Running jobs in a multiple queue mode cluster

This tutorial covers how to run your first "Hello World" job on AWS ParallelCluster with [multiple queue mode](#).

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

### Prerequisites

- AWS ParallelCluster [is installed](#).
- The AWS CLI [is installed and configured](#).
- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) that are required to run the [pcluster](#) CLI.

## Configure your cluster

First, verify that AWS ParallelCluster is correctly installed by running the following command.

```
$ pcluster version
```

For more information about `pcluster` version, see [pcluster version](#).

This command returns the running version of AWS ParallelCluster.

Next, run `pcluster configure` to generate a basic configuration file. Follow all the prompts that follow this command.

```
$ pcluster configure --config multi-queue-mode.yaml
```

For more information about the `pcluster configure` command, see [pcluster configure](#).

After you complete this step, a basic configuration file named `multi-queue-mode.yaml` appears. This file contains a basic cluster configuration.

In the next step, you modify your new configuration file and launch a cluster with multiple queues.

#### Note

Some instances that this tutorial uses aren't free-tier eligible.

For this tutorial, modify your configuration file to match the following configuration. The items that are highlighted in red represent your configuration file values. Keep your own values.

```
Region: region-id
Image:
  Os: alinux2
HeadNode:
  InstanceType: c5.xlarge
Networking:
  SubnetId: subnet-abcdef01234567890
Ssh:
  KeyName: yourkeypair
Scheduling:
  Scheduler: slurm
  SlurmQueues:
  - Name: spot
    ComputeResources:
  - Name: c5xlarge
    InstanceType: c5.xlarge
    MinCount: 1
    MaxCount: 10
```



```
- Name: t2micro
  InstanceType: t2.micro
  MinCount: 1
  MaxCount: 10
Networking:
  SubnetIds:
    - subnet-abcdef01234567890
- Name: ondemand
  ComputeResources:
    - Name: c52xlarge
      InstanceType: c5.2xlarge
      MinCount: 0
      MaxCount: 10
Networking:
  SubnetIds:
    - subnet-021345abcdef6789
```

## Create your cluster

Create a cluster that's named `multi-queue-cluster` based on your configuration file.

```
$ pcluster create-cluster --cluster-name multi-queue-cluster --cluster-configuration
multi-queue-mode.yaml
{
  "cluster": {
    "clusterName": "multi-queue-cluster",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:123456789012:stack/
multi-queue-cluster/1234567-abcd-0123-def0-abcdef0123456",
    "region": "eu-west-1",
    "version": "3.7.0",
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}
```

For more information about the `pcluster create-cluster` command, see [pcluster create-cluster](#).

To check the status of the cluster, run the following command.

```
$ pcluster list-clusters
{
  "cluster": {
```

```

    "clusterName": "multi-queue-cluster",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:123456789012:stack/multi-queue-cluster/1234567-abcd-0123-def0-abcdef0123456",
    "region": "eu-west-1",
    "version": "3.7.0",
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}

```

When the cluster is created, the `clusterStatus` field shows `CREATE_COMPLETE`.

## Log in to the head node

Use your private SSH key file to log in to the head node.

```
$ pcluster ssh --cluster-name multi-queue-cluster -i ~/path/to/yourkeyfile.pem
```

For more information about `pcluster ssh`, see [pcluster ssh](#).

After logging in, run the `sinfo` command to verify that your scheduler queues are set up and configured.

For more information about `sinfo`, see [sinfo](#) in the *Slurm documentation*.

```

$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
spot*      up    infinite   18  idle~ spot-dy-c5xlarge-[1-9],spot-dy-t2micro-[1-9]
spot*      up    infinite    2  idle  spot-st-c5xlarge-1,spot-st-t2micro-1
ondemand   up    infinite   10  idle~ ondemand-dy-c52xlarge-[1-10]

```

The output shows that you have one `t2.micro` and one `c5.xlarge` compute node in the `idle` state that are available in your cluster.

Other nodes are all in the power saving state, indicated by the `~` suffix in node state, with no Amazon EC2 instances backing them. The default queue is indicated by a `*` suffix after its queue name. `spot` is your default job queue.

## Run job in multiple queue mode

Next, try to run a job to sleep for a while. The job later outputs its own hostname. Make sure that this script can be run by the current user.

```
$ tee <<EOF hellojob.sh
#!/bin/bash
sleep 30
echo "Hello World from \$(hostname)"
EOF

$ chmod +x hellojob.sh
$ ls -l hellojob.sh
-rwxrwxr-x 1 ec2-user ec2-user 57 Sep 23 21:57 hellojob.sh
```

Submit the job using the `sbatch` command. Request two nodes for this job with the `-N 2` option, and verify that the job submits successfully. For more information about `sbatch`, see [sbatch](#) in the *Slurm documentation*.

```
$ sbatch -N 2 --wrap "srun hellojob.sh"
Submitted batch job 1
```

You can view your queue and check the status of the job with the `squeue` command. Because you didn't specify a specific queue, the default queue (`spot`) is used. For more information about `squeue`, see [squeue](#) in the *Slurm documentation*.

```
$ squeue
JOBID PARTITION   NAME     USER  ST        TIME  NODES NODELIST(REASON)
   1     spot     wrap  ec2-user  R         0:10     2  spot-st-c5xlarge-1,spot-st-
t2micro-1
```

The output shows that the job is currently in a running state. Wait for the job to finish. This takes about 30 seconds. Then, run `squeue` again.

```
$ squeue
JOBID PARTITION   NAME     USER  ST        TIME  NODES NODELIST(REASON)
```

Now that the jobs in the queue have all finished, look for the output file that's named `slurm-1.out` in your current directory.

```
$ cat slurm-1.out
Hello World from spot-st-t2micro-1
Hello World from spot-st-c5xlarge-1
```

The output shows that the job ran successfully on the `spot-st-t2micro-1` and `spot-st-c5xlarge-1` nodes.

Now submit the same job by specifying constraints for specific instances with the following commands.

```
$ sbatch -N 3 -p spot -C "[c5.xlarge*1&t2.micro*2]" --wrap "srun hellojob.sh"
Submitted batch job 2
```

You used these parameters for `sbatch`:

- `-N 3`– requests three nodes.
- `-p spot`– submits the job to the `spot` queue. You can also submit a job to the `ondemand` queue by specifying `-p ondemand`.
- `-C "[c5.xlarge*1&t2.micro*2]"`– specifies the specific node constraints for this job. This requests one `c5.xlarge` node and two `t2.micro` nodes to be used for this job.

Run the `sinfo` command to view the nodes and queues. Queues in AWS ParallelCluster are called partitions in Slurm.

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
spot*      up    infinite   1  alloc# spot-dy-t2micro-1
spot*      up    infinite  17  idle~  spot-dy-c5xlarge-[2-10],spot-dy-t2micro-[2-9]
spot*      up    infinite   1  mix    spot-st-c5xlarge-1
spot*      up    infinite   1  alloc  spot-st-t2micro-1
ondemand   up    infinite  10  idle~  ondemand-dy-c52xlarge-[1-10]
```

The nodes are powering up. This is indicated by the `#` suffix on the node state. Run the `squeue` command to view information about the jobs in the cluster.

```
$ squeue
JOBID PARTITION   NAME     USER ST       TIME  NODES NODELIST(REASON)
   2    spot     wrap  ec2-user CF         0:04     3  spot-dy-c5xlarge-1,spot-dy-
t2micro-1,spot-st-t2micro-1
```

Your job is in the `CF` (`CONFIGURING`) state, waiting for instances to scale up and join the cluster.

After about three minutes, the nodes are available and the job enters the `R` (`RUNNING`) state.

```
$ squeue
JOBID PARTITION      NAME      USER ST      TIME  NODES NODELIST(REASON)
   2      spot      wrap ec2-user R      0:07     3 spot-dy-t2micro-1,spot-st-
c5xlarge-1,spot-st-t2micro-1
```

The job finishes, and all three nodes are in the `idle` state.

```
$ squeue
JOBID PARTITION      NAME      USER ST      TIME  NODES NODELIST(REASON)
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
spot*      up    infinite   17  idle~ spot-dy-c5xlarge-[1-9],spot-dy-t2micro-[2-9]
spot*      up    infinite    3  idle  spot-dy-t2micro-1,spot-st-c5xlarge-1,spot-st-
t2micro-1
ondemand   up    infinite   10  idle~ ondemand-dy-c52xlarge-[1-10]
```

Then, after no jobs remain in the queue, check for `slurm-2.out` in your local directory.

```
$ cat slurm-2.out
Hello World from spot-st-t2micro-1
Hello World from spot-dy-t2micro-1
Hello World from spot-st-c5xlarge-1
```

This is the final state of the cluster.

```
$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
spot*      up    infinite   17  idle~ spot-dy-c5xlarge-[1-9],spot-dy-t2micro-[2-9]
spot*      up    infinite    3  idle  spot-dy-t2micro-1,spot-st-c5xlarge-1,spot-st-
t2micro-1
ondemand   up    infinite   10  idle~ ondemand-dy-c52xlarge-[1-10]
```

After logging off of the cluster, you can clean up by running `pcluster delete-cluster`. For more information, see [pcluster list-clusters](#) and [pcluster delete-cluster](#).

```
$ pcluster list-clusters
{
  "clusters": [
    {
      "clusterName": "multi-queue-cluster",
      "cloudformationStackStatus": "CREATE_COMPLETE",
```

```
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:123456789012:stack/
multi-queue-cluster/1234567-abcd-0123-def0-abcdef0123456",
    "region": "eu-west-1",
    "version": "3.1.4",
    "clusterStatus": "CREATE_COMPLETE"
  }
]
}
$ pcluster delete-cluster -n multi-queue-cluster
{
  "cluster": {
    "clusterName": "multi-queue-cluster",
    "cloudformationStackStatus": "DELETE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:123456789012:stack/
multi-queue-cluster/1234567-abcd-0123-def0-abcdef0123456",
    "region": "eu-west-1",
    "version": "3.1.4",
    "clusterStatus": "DELETE_IN_PROGRESS"
  }
}
```

## Using the AWS ParallelCluster API

In this tutorial, you build and test the API with [Amazon API Gateway](#) and an AWS ParallelCluster CloudFormation template. Then, you use the example client available on GitHub to use the API. For more information about using the API, see the [AWS ParallelCluster API](#).

This tutorial was excerpted from the [HPC For Public Sector Customers Workshop](#).

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

### Prerequisites

- The AWS CLI is [installed](#) and configured in your compute environment.
- AWS ParallelCluster is installed in a virtual environment. For more information, see [Install AWS ParallelCluster in a virtual environment](#).

- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) that are required to run the [pcluster](#) CLI.

## Step 1: Build the API with Amazon API Gateway

Stay in your home user directory and activate your virtual environment:

1. Install a helpful JSON command line processor.

```
$ sudo yum groupinstall -y "Development Tools"
sudo yum install -y jq python3-devel
```

2. Run the following command to get your AWS ParallelCluster version and assign it to an environment variable.

```
$ PCLUSTER_VERSION=$(pcluster version | jq -r '.version')
echo "export PCLUSTER_VERSION=${PCLUSTER_VERSION}" |tee -a ~/.bashrc
```

3. Create an environment variable and assign your Region ID to it.

```
$ export AWS_DEFAULT_REGION="us-east-1"
echo "export AWS_DEFAULT_REGION=${AWS_DEFAULT_REGION}" |tee -a ~/.bashrc
```

4. Run the following commands to deploy the API.

```
API_STACK_NAME="pc-api-stack"
echo "export API_STACK_NAME=${API_STACK_NAME}" |tee -a ~/.bashrc
```

```
aws cloudformation create-stack \
  --region ${AWS_DEFAULT_REGION} \
  --stack-name ${API_STACK_NAME} \
  --template-url https://${AWS_DEFAULT_REGION}-aws-parallelcluster.s3.
  ${AWS_DEFAULT_REGION}.amazonaws.com/parallelcluster/${PCLUSTER_VERSION}/api/
  parallelcluster-api.yaml \
  --capabilities CAPABILITY_NAMED_IAM CAPABILITY_AUTO_EXPAND \
  --parameters ParameterKey=EnableIamAdminAccess,ParameterValue=true

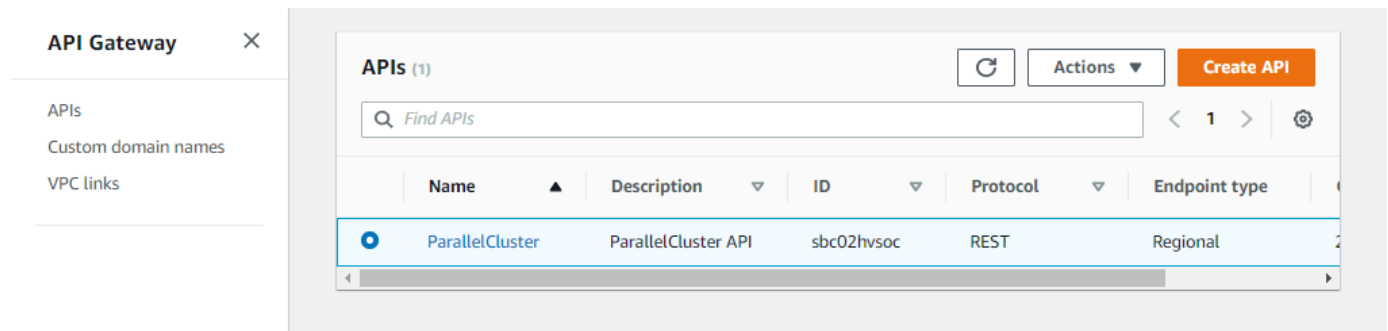
{
  "StackId": "arn:aws:cloudformation:us-east-1:123456789012:stack/my-api-
  stack/abcd1234-ef56-gh78-ei90-1234abcd5678"
```

```
}
```

After the process completes, proceed to the next step.

## Step 2: Test the API in the Amazon API Gateway console

1. Sign in to the AWS Management Console.
2. Navigate to the [Amazon API Gateway console](#).
3. Choose your API deployment.



4. Choose **Stages** and select a stage.



Amazon API Gateway APIs > ParallelCluster (sbc02hvsoc) > Stages > prod Show all hints ?

APIs Stages **Create** prod Stage Editor Delete Stage Configure Tags

Custom Domain Names beta prod Stage

VPC Links

**API: ParallelCluster**

Resources

**Stages**

Authorizers

Gateway Responses

Models

Resource Policy

Documentation

Dashboard

Settings

Usage Plans

API Keys

Client Certificates

Settings

Invoke URL: <https://sbc02hvsoc.execute-api.us-east-1.amazonaws.com/prod>

Settings Logs/Tracing Stage Variables SDK Generation Export

Deployment History Documentation History Canary

Cache Settings

Enable API cache

Default Method Throttling

Choose the default throttling level for the methods in this stage. Each method in this stage will respect these rate and burst settings. Your current account level throttling rate is **10000** requests per second with a burst of 5000 requests. [Read more about API Gateway throttling](#)

Enable throttling  ⓘ

Rate  requests per second

Burst  requests

Web Application Firewall (WAF) [Learn more.](#)

Select the Web ACL to be applied to this stage.

Web ACL  [Create Web ACL](#)

Client Certificate

Select the client certificate that API Gateway will use to call your integration endpoints in this stage.

Certificate

- Note the URL that API Gateway provides for accessing or invoking your API. It's highlighted in blue.
- Choose **Resources**, and select **GET** under **/clusters**.
- Choose the **TEST** icon and then scroll down and choose **TEST** icon.

APIs > ParallelCluster (sbc02hvsoc) > Resources > /v3/clusters (ulfkw2) > GET

Resources Actions ▾ /v3/clusters - GET - Method Execution

The screenshot displays the AWS API Gateway console for the `/v3/clusters` endpoint. On the left, a resource tree shows the hierarchy: `/v3` > `/clusters` > `GET`. The main area is titled `/v3/clusters - GET - Method Execution`. It features a `Client` box with a `TEST` button and a lightning bolt icon. To the right, the `Method Request` box shows the following details: `Auth: AWS IAM`, `ARN: arn:aws:execute-api:us-east-1:123456789012:sbc02hvsoc/*/GET/v3/clusters`, and `Query Strings: region, nextToken, clusterStatus`. Below it, the `Method Response` box contains the text `Select an integration response.` Arrows indicate the flow of data from the client to the request and back to the response.

The response to your `/clusters` GET appears.

APIs > ParallelCluster (sbc02hvsoc) > Resources > /v3/clusters (ulfkw2) > GET

Show all hints ?

Resources Actions

Method Execution /v3/clusters - GET - Method Test

Make a test call to your method. When you make a test call, API Gateway skips authorization and directly invokes your method

**Path**

No path parameters exist for this resource. You can define path parameters by using the syntax `{myPathParam}` in a resource path.

**Request:** /v3/clusters

**Status:** 200

**Latency:** 3203 ms

**Response Body**

```
{
  "clusters": [
    {
      "cloudformationStackArn": "arn:aws:cloudformation:us-east-1:123456789012:stack/test-cluster/4450d850-b684-11ec-84a7-0a047567c9f3",
      "cloudformationStackStatus": "CREATE_COMPLETE",
      "clusterName": "test-cluster",
      "clusterStatus": "CREATE_COMPLETE",
      "region": "us-east-1",
      "version": "3.1.2"
    }
  ]
}
```

**Query Strings**

`{clusters}`

param1=value1&param2=value2

**Headers**

`{clusters}`

Use a colon (:) to separate header name and value, and new lines to declare multiple headers. eg. `Accept:application/json`.

**Stage Variables**

No stage variables exist for this method.

**Client Certificate**

No client certificates have been generated.

**Response Headers**

```
{"Content-Length": "360", "X-Amzn-Trace-Id": "Root=1-62686455-c1cf243417b2721e33822ac5;Sampled=1", "Content-Type": "application/json"}
```

**Logs**

### Step 3: Prepare and test an example client to invoke the API

Clone the AWS ParallelCluster source code, cd to the api directory, and install the Python client libraries.

1. 

```
$ git clone -b v${PCLUSTER_VERSION} https://github.com/aws/aws-parallelcluster aws-parallelcluster-v${PCLUSTER_VERSION}
cd aws-parallelcluster-v${PCLUSTER_VERSION}/api
```

```
$ pip3 install client/src
```

2. Navigate back to your home user directory.
3. Export the API Gateway base URL that the client uses when running.

```
$ export PCLUSTER_API_URL=$( aws cloudformation describe-stacks
  --stack-name ${API_STACK_NAME} --query 'Stacks[0].Outputs[?
OutputKey==`ParallelClusterApiInvokeUrl`.OutputValue' --output text )
echo "export PCLUSTER_API_URL=${PCLUSTER_API_URL}" |tee -a ~/.bashrc
```

4. Export a cluster name that the client uses to create a cluster.

```
$ export CLUSTER_NAME="test-api-cluster"
echo "export CLUSTER_NAME=${CLUSTER_NAME}" |tee -a ~/.bashrc
```

5. Run the following commands to store the credentials that the example client uses to access the API.

```
$ export PCLUSTER_API_USER_ROLE=$( aws cloudformation describe-
stacks --stack-name ${API_STACK_NAME} --query 'Stacks[0].Outputs[?
OutputKey==`ParallelClusterApiUserRole`.OutputValue' --output text )
echo "export PCLUSTER_API_USER_ROLE=${PCLUSTER_API_USER_ROLE}" |tee -a ~/.bashrc
```

## Step 4: Copy client code script and run cluster tests

1. Copy the following example client code to `test_pcluster_client.py` in your home user directory. The client code makes requests to do the following:
  - Create the cluster.
  - Describe the cluster.
  - List the clusters.
  - Describe the compute fleet.
  - Describe the cluster instances.

```
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this
```

```
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modify,
# merge, publish, distribute, sublicense, and/or sell copies of the Software, and
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# OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE
# SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
#
# Author: Evan F. Bollig (Github: bollig)

import time, datetime
import os
import pcluster_client
from pprint import pprint
from pcluster_client.api import (
    cluster_compute_fleet_api,
    cluster_instances_api,
    cluster_operations_api
)
from pcluster_client.model.create_cluster_request_content import
    CreateClusterRequestContent
from pcluster_client.model.cluster_status import ClusterStatus
region=os.environ.get("AWS_DEFAULT_REGION")

# Defining the host is optional and defaults to http://localhost
# See configuration.py for a list of all supported configuration parameters.
configuration = pcluster_client.Configuration(
    host = os.environ.get("PCLUSTER_API_URL")
)
cluster_name=os.environ.get("CLUSTER_NAME")

# Enter a context with an instance of the API client
with pcluster_client.ApiClient(configuration) as api_client:
    cluster_ops = cluster_operations_api.ClusterOperationsApi(api_client)
    fleet_ops = cluster_compute_fleet_api.ClusterComputeFleetApi(api_client)
```

```
instance_ops = cluster_instances_api.ClusterInstancesApi(api_client)

# Create cluster
build_done = False
try:
    with open('cluster-config.yaml', encoding="utf-8") as f:
        body = CreateClusterRequestContent(cluster_name=cluster_name,
cluster_configuration=f.read())
        api_response = cluster_ops.create_cluster(body, region=region)
except pcluster_client.ApiException as e:
    print("Exception when calling create_cluster: %s\n" % e)
    build_done = True
time.sleep(60)

# Confirm cluster status with describe_cluster
while not build_done:
    try:
        api_response = cluster_ops.describe_cluster(cluster_name,
region=region)
        pprint(api_response)
        if api_response.cluster_status == ClusterStatus('CREATE_IN_PROGRESS'):
            print('. . . working . . .', end='', flush=True)
            time.sleep(60)
        elif api_response.cluster_status == ClusterStatus('CREATE_COMPLETE'):
            print('READY!')
            build_done = True
        else:
            print('ERROR!!!!')
            build_done = True
    except pcluster_client.ApiException as e:
        print("Exception when calling describe_cluster: %s\n" % e)

# List clusters
try:
    api_response = cluster_ops.list_clusters(region=region)
    pprint(api_response)
except pcluster_client.ApiException as e:
    print("Exception when calling list_clusters: %s\n" % e)

# DescribeComputeFleet
try:
    api_response = fleet_ops.describe_compute_fleet(cluster_name,
region=region)
    pprint(api_response)
```

```

except pcluster_client.ApiException as e:
    print("Exception when calling compute fleet: %s\n" % e)

# DescribeClusterInstances
try:
    api_response = instance_ops.describe_cluster_instances(cluster_name,
region=region)
    pprint(api_response)
except pcluster_client.ApiException as e:
    print("Exception when calling describe_cluster_instances: %s\n" % e)

```

## 2. Create a cluster configuration.

```
$ pcluster configure --config cluster-config.yaml
```

- The API Client library automatically detects configuration details from your environment variables (for example, `AWS_ACCESS_KEY_ID`, `AWS_SECRET_ACCESS_KEY`, or `AWS_SESSION_TOKEN`) or `$HOME/.aws`. The following command switches your current IAM role to the designated `ParallelClusterApiUserRole`.

```
$ eval $(aws sts assume-role --role-arn ${PCLUSTER_API_USER_ROLE} --role-session-name ApiTestSession | jq -r '.Credentials | "export AWS_ACCESS_KEY_ID=\(.AccessKeyId)\nexport AWS_SECRET_ACCESS_KEY=\(.SecretAccessKey)\nexport AWS_SESSION_TOKEN=\(.SessionToken)\n"')
```

### Error to watch for:

If you see an error similar to the following, you already assumed the `ParallelClusterApiUserRole` and your `AWS_SESSION_TOKEN` has expired.

```

An error occurred (AccessDenied) when calling the AssumeRole operation:
User: arn:aws:sts::XXXXXXXXXXXX:assumed-role/ParallelClusterApiUserRole-XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX/ApiTestSession
is not authorized to perform: sts:AssumeRole on resource:
arn:aws:iam::XXXXXXXXXXXX:role/ParallelClusterApiUserRole-XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX

```

Drop the role and then re-run the `aws sts assume-role` command to use the `ParallelClusterApiUserRole`.

```
$ unset AWS_SESSION_TOKEN
```

```
unset AWS_SECRET_ACCESS_KEY
unset AWS_ACCESS_KEY_ID
```

To provide your current user permissions for API access, you must [expand the Resource Policy](#).

4. Run the following command to test the example client.

```
$ python3 test_pcluster_client.py
{'cluster_configuration': 'Region: us-east-1\n'
                          'Image:\n'
                          '  Os: alinux2\n'
                          'HeadNode:\n'
                          '  InstanceType: t2.micro\n'
                          '  Networking . . . :\n'
                          '    SubnetId: subnet-1234567890abcdef0\n'
                          '  Ssh:\n'
                          '    KeyName: adpc\n'
                          'Scheduling:\n'
                          '  Scheduler: slurm\n'
                          '  SlurmQueues:\n'
                          '    - Name: queue1\n'
                          '      ComputeResources:\n'
                          '        - Name: t2micro\n'
                          '          InstanceType: t2.micro\n'
                          '          MinCount: 0\n'
                          '          MaxCount: 10\n'
                          '      Networking . . . :\n'
                          '        SubnetIds:\n'
                          '          - subnet-1234567890abcdef0\n',
  'cluster_name': 'test-api-cluster'}
{'cloud_formation_stack_status': 'CREATE_IN_PROGRESS',
  'cloudformation_stack_arn': 'arn:aws:cloudformation:us-east-1:123456789012:stack/test-api-cluster/abcd1234-ef56-gh78-ij90-1234abcd5678',
  'cluster_configuration': {'url': 'https://parallelcluster-021345abcdef6789-v1-do-not-delete...'},
  'cluster_name': 'test-api-cluster',
  'cluster_status': 'CREATE_IN_PROGRESS',
  'compute_fleet_status': 'UNKNOWN',
  'creation_time': datetime.datetime(2022, 4, 28, 16, 18, 47, 972000, tzinfo=tzlocal()),
  'last_updated_time': datetime.datetime(2022, 4, 28, 16, 18, 47, 972000, tzinfo=tzlocal()),
  'region': 'us-east-1',
  'tags': [{'key': 'parallelcluster:version', 'value': '3.1.3'}]}
```



```

'version': '3.1.3'}
.
.
.
. . . working . . . {'cloud_formation_stack_status': 'CREATE_COMPLETE',
'cloudformation_stack_arn': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
test-api-cluster/abcd1234-ef56-gh78-ij90-1234abcd5678',
'cluster_configuration': {'url': 'https://parallelcluster-021345abcdef6789-v1-do-
not-delete...'},
'cluster_name': 'test-api-cluster',
'cluster_status': 'CREATE_COMPLETE',
'compute_fleet_status': 'RUNNING',
'creation_time': datetime.datetime(2022, 4, 28, 16, 18, 47, 972000,
tzinfo=tzlocal()),
'head_node': {'instance_id': 'i-abcdef01234567890',
'instance_type': 't2.micro',
'launch_time': datetime.datetime(2022, 4, 28, 16, 21, 46,
tzinfo=tzlocal()),
'private_ip_address': '172.31.27.153',
'public_ip_address': '52.90.156.51',
'state': 'running'},
'last_updated_time': datetime.datetime(2022, 4, 28, 16, 18, 47, 972000,
tzinfo=tzlocal()),
'region': 'us-east-1',
'tags': [{'key': 'parallelcluster:version', 'value': '3.1.3'}],
'version': '3.1.3'}
READY!

```

## Step 5: Copy client code script and delete cluster

1. Copy the following example client code to `delete_cluster_client.py`. The client code makes a request to delete the cluster.

```

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# OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE
# SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
#
# Author: Evan F. Bollig (Github: bollig)

import time, datetime
import os
import pcluster_client
from pprint import pprint
from pcluster_client.api import (
    cluster_compute_fleet_api,
    cluster_instances_api,
    cluster_operations_api
)
from pcluster_client.model.create_cluster_request_content import
    CreateClusterRequestContent
from pcluster_client.model.cluster_status import ClusterStatus
region=os.environ.get("AWS_DEFAULT_REGION")

# Defining the host is optional and defaults to http://localhost
# See configuration.py for a list of all supported configuration parameters.
configuration = pcluster_client.Configuration(
    host = os.environ.get("PCLUSTER_API_URL")
)
cluster_name=os.environ.get("CLUSTER_NAME")

# Enter a context with an instance of the API client
with pcluster_client.ApiClient(configuration) as api_client:
    cluster_ops = cluster_operations_api.ClusterOperationsApi(api_client)

    # Delete the cluster
    gone = False
    try:
        api_response = cluster_ops.delete_cluster(cluster_name, region=region)
```

```

except pcluster_client.ApiException as e:
    print("Exception when calling delete_cluster: %s\n" % e)
time.sleep(60)

# Confirm cluster status with describe_cluster
while not gone:
    try:
        api_response = cluster_ops.describe_cluster(cluster_name,
region=region)
        pprint(api_response)
        if api_response.cluster_status == ClusterStatus('DELETE_IN_PROGRESS'):
            print('. . . working . . .', end='', flush=True)
            time.sleep(60)
    except pcluster_client.ApiException as e:
        gone = True
        print("DELETE COMPLETE or Exception when calling describe_cluster: %s
\n" % e)

```

## 2. Run the following command to delete the cluster.

```

$ python3 delete_cluster_client.py
{'cloud_formation_stack_status': 'DELETE_IN_PROGRESS',
'cloudformation_stack_arn': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
test-api-cluster/abcd1234-ef56-gh78-ij90-1234abcd5678',
'cluster_configuration': {'url': 'https://parallelcluster-021345abcdef6789-v1-do-
not-delete...'},
'cluster_name': 'test-api-cluster',
'cluster_status': 'DELETE_IN_PROGRESS',
'compute_fleet_status': 'UNKNOWN',
'creation_time': datetime.datetime(2022, 4, 28, 16, 50, 47, 943000,
tzinfo=tzlocal()),
'head_node': {'instance_id': 'i-abcdef01234567890',
'instance_type': 't2.micro',
'launch_time': datetime.datetime(2022, 4, 28, 16, 53, 48,
tzinfo=tzlocal()),
'private_ip_address': '172.31.17.132',
'public_ip_address': '34.201.100.37',
'state': 'running'},
'last_updated_time': datetime.datetime(2022, 4, 28, 16, 50, 47, 943000,
tzinfo=tzlocal()),
'region': 'us-east-1',
'tags': [{'key': 'parallelcluster:version', 'value': '3.1.3'}],
'version': '3.1.3'}
.

```

```

.
.
. . . working . . . {'cloud_formation_stack_status': 'DELETE_IN_PROGRESS',
'cloudformation_stack_arn': 'arn:aws:cloudformation:us-east-1:123456789012:stack/
test-api-cluster/abcd1234-ef56-gh78-ij90-1234abcd5678',
'cluster_configuration': {'url': 'https://parallelcluster-021345abcdef6789-v1-do-
not-delete...'},
'cluster_name': 'test-api-cluster',
'cluster_status': 'DELETE_IN_PROGRESS',
'compute_fleet_status': 'UNKNOWN',
'creation_time': datetime.datetime(2022, 4, 28, 16, 50, 47, 943000,
tzinfo=tzlocal()),
'last_updated_time': datetime.datetime(2022, 4, 28, 16, 50, 47, 943000,
tzinfo=tzlocal()),
'region': 'us-east-1',
'tags': [{'key': 'parallelcluster:version', 'value': '3.1.3'}],
'version': '3.1.3'}
. . . working . . . DELETE COMPLETE or Exception when calling describe_cluster:
(404)
Reason: Not Found
.
.
.
HTTP response body: {"message": "Cluster 'test-api-cluster' does not exist or
belongs to an incompatible ParallelCluster major version."}

```

3. After you are finished testing, unset the environment variables.

```

$ unset AWS_SESSION_TOKEN
unset AWS_SECRET_ACCESS_KEY
unset AWS_ACCESS_KEY_ID

```

## Step 6: Clean up

You can use the AWS Management Console or AWS CLI to delete your API.

1. From the AWS CloudFormation console, choose the API stack and then choose **Delete**.
2. Run the following command if using the AWS CLI.

Using AWS CloudFormation.

```
$ aws cloudformation delete-stack --stack-name ${API_STACK_NAME}
```

## Creating a cluster with Slurm accounting

Learn how to configure and create a cluster with Slurm accounting. For more information, see [Slurm accounting with AWS ParallelCluster](#).

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

In this tutorial, you use a [CloudFormation quick-create template \(us-east-1\)](#) to create an [Amazon Aurora](#) for MySQL serverless database. The template instructs CloudFormation to create all the necessary components to deploy an Amazon Aurora serverless database on the same VPC as the cluster. The template also creates a basic networking and security configuration for the connection between the cluster and the database.

### Note

Starting with version 3.3.0, AWS ParallelCluster supports Slurm accounting with the cluster configuration parameter [SlurmSettings](#) / [Database](#).

### Note

The quick-create template serves as an example. This template doesn't cover all possible use cases for a Slurm accounting database server. It's your responsibility to create a database server with the configuration and capacity appropriate for your production workloads.

### Prerequisites:

- AWS ParallelCluster [is installed](#).

- The AWS CLI [is installed and configured](#).
- You have an [Amazon EC2 key pair](#).
- You have an IAM role with the [permissions](#) that are required to run the [pcluster](#) CLI.
- The region that you deploy the quick-create template in supports Amazon Aurora MySQL serverless v2. For more information, see [Aurora Serverless v2 with Aurora MySQL](#).

## Step 1: Create the VPC and subnets for AWS ParallelCluster

To use the provided CloudFormation template for the Slurm accounting database, you must have the VPC for the cluster ready. You can do this manually or as part of the [Configure and create a cluster with the AWS ParallelCluster command line interface](#) procedure. If you already used AWS ParallelCluster, you might have a VPC ready for the deployment of the cluster and the database server.

## Step 2: Create the database stack

Use the [CloudFormation quick-create template\(us-east-1\)](#) to create a database stack for Slurm accounting. The template requires following inputs:

- Database server credentials, specifically the admin user name and password.
- Sizing of the Amazon Aurora serverless cluster. This depends on the expected cluster loading.
- Networking parameters, specifically the target VPC and subnets or CIDR blocks for the creation of the subnets.

Select appropriate credentials and size for your database server. For the networking options, you're required to use the same VPC that the AWS ParallelCluster cluster is deployed to. You can create the subnets for the database and pass them as input to the template. Or, provide two disjoint CIDR blocks for the two subnets and let the CloudFormation template create the two subnets for CIDR blocks. Make sure that the CIDR blocks don't overlap with existing subnets. If the CIDR blocks overlap with existing subnets, the stack fails to be created.

The database server takes several minutes to be created.

## Step 3: Create a cluster with Slurm accounting enabled

The provided CloudFormation template generates a CloudFormation stack with some defined outputs. From the AWS Management Console, you can view the outputs in the **Outputs** tab in the

CloudFormation stack view. To enable the Slurm accounting, some of these outputs must be used in the AWS ParallelCluster cluster configuration file:

- `DatabaseHost`: Used for the [SlurmSettings](#) / [Database](#) / [Uri](#) cluster config parameter.
- `DatabaseAdminUser`: Used for the [SlurmSettings](#) / [Database](#) / [UserName](#) cluster configuration parameter value.
- `DatabaseSecretArn`: Used for the [SlurmSettings](#) / [Database](#) / [PasswordSecretArn](#) cluster config parameter.
- `DatabaseClientSecurityGroup`: This is the security group that's attached to the head node of the cluster that's defined in the [HeadNode](#) / [Networking](#) / [SecurityGroups](#) configuration parameter.

Update your cluster configuration file Database parameters with the output values. Use the [pcluster](#) CLI to create the cluster.

```
$ pcluster create-cluster -n cluster-3.x -c path/to/cluster-config.yaml
```

After the cluster is created, you can start using Slurm accounting commands such as `sacctmgr` or `sacct`.

## Creating a cluster with an external SlurmDB accounting

Learn how to configure and create a cluster with external SlurmDB accounting. For more information, see [Slurm accounting with AWS ParallelCluster](#).

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

In this tutorial, you use a AWS CloudFormation quick-create template to create the necessary components to deploy a Slurmdbd instance on the same VPC as the cluster. The template creates a basic networking and security configuration for the connection between the cluster and the database.

**Note**

Starting with version 3.10.0, AWS ParallelCluster supports external Slurmdbd with the cluster configuration parameter `SlurmSettings / ExternalSlurmdbd`.

**Note**

The quick-create template serves as an example. This template doesn't cover all possible use cases. It's your responsibility to create an external Slurmdbd with the configuration and capacity appropriate for your production workloads.

**Prerequisites:**

- AWS ParallelCluster [is installed](#).
- The AWS CLI [is installed and configured](#).
- You have an [Amazon Elastic Compute Cloud key pair](#).
- You have an AWS Identity and Access Management role with the [permissions](#) that are required to run the `pcluster` CLI.
- You have a Slurm accounting database. To step through a tutorial of creating Slurm accounting database, follow steps 1 and 2 in [Create the Slurmdbd stack](#).

## Step 1: Create the Slurmdbd stack

In this tutorial, use a [CloudFormation quick-create template \(us-east-1\)](#) to create a Slurmdbd stack. The template requires following inputs:

**Networking**

- **VPCId:** The VPC ID to launch the Slurmdbd instance.
- **SubnetId:** The Subnet ID to launch the Slurmdbd instance.
- **PrivatePrefix:** The CIDR prefix of the VPC.
- **PrivateIp:** A secondary private IP to assign to the Slurmdbd instance.



## Database connection

- **DBMSClientSG:** The security group to be attach to the Slurmdbd instance. This security group should allows connections between the database server and the Slurmdbd instance.
- **DBMSDatabaseName:** The name of the database.
- **DBMSUsername:** The username to the database.
- **DBMSPasswordSecretArn:** The secret containing the password to the database.
- **DBMSUri:** The URI of the database server.

## Instance settings

- **InstanceType:** An instance type to use for the slurmdbd instance.
- **KeyName:** An Amazon EC2 key pair to use for the slurmdbd instance.

## Slurmdbd settings

- **AMIID:** An AMI of the Slurmdbd instance. The AMI should be a ParallelCluster AMI. The version of the ParallelCluster AMI determines the version of Slurmdbd.
- **MungeKeySecretArn:** The secret containing the munge key to use for authenticating communications between Slurmdbd and clusters.
- **SlurmdbdPort:** A port number that the slurmdbd uses.
- **EnableSlurmdbdSystemService:** Enables slurmdbd as system service and have it run when an instance launches.

### Warning

If the database was created by a different version of SlurmDB, do not use Slurmdbd as a system service.

If the database contains a large number of entries, the Slurm Database Daemon (SlurmDBD) may require tens of minutes to update the database and be unresponsive during this time interval.

Before upgrading SlurmDB, make a backup of the database. For more information, see the [Slurm documentation](#).

## Step 2: Create a cluster with external Slurmdbd enabled

The provided AWS CloudFormation template generates a AWS CloudFormation stack with some defined outputs.

From the AWS Management Console, view the **Outputs** tab in the AWS CloudFormation stack to review the entities created. To enable the Slurm accounting, some of these outputs must be used in the AWS ParallelCluster configuration file:

- **SlurmdbdPrivateIp**: Used for the [SlurmSettings](#) / [ExternalSlurmdbd](#) / [Host cluster config](#) parameter.
- **SlurmdbdPort**: Used for the [SlurmSettings](#) / [ExternalSlurmdbd](#) / [Port](#) cluster configuration parameter value.
- **AccountingClientSecurityGroup**: This is the security group that's attached to the head node of the cluster that's defined in the [HeadNode](#) / [Networking](#) / [AdditionalSecurityGroups](#) configuration parameter.

Additional, from the **Parameters** tab in the AWS CloudFormation stack view:

- **MungeKeySecretArn**: Used for the [SlurmSettings](#) / [MungeKeySecretArn](#) cluster configuration parameter value.

Update your cluster configuration file database parameters with the output values. Use the pcluster AWS CLI to create the cluster.

```
$ pcluster create-cluster -n cluster-3.x -c path/to/cluster-config.yaml
```

After the cluster is created, you can start using Slurm accounting commands such as `sacctmgr` or `sacct`.

### Warning

Traffic between ParallelCluster and the external SlurmDB is not encrypted. It is recommended to run the cluster and the external SlurmDB in a trusted network.

# Reverting to a previous AWS Systems Manager document version

Learn how to revert to a previous AWS Systems Manager document version. For more information about SSM documents, see [AWS Systems Manager Documents](#) in the *AWS Systems Manager User Guide*.

When using the AWS ParallelCluster command line interface (CLI) or API, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

The AWS ParallelCluster UI is built on a serverless architecture and you can use it within the AWS Free Tier category for most cases. For more information, see [AWS ParallelCluster UI costs](#).

## Prerequisites:

- An AWS account with permissions to manage SSM documents.
- The AWS CLI [is installed and configured](#).

## Revert to a previous SSM document version

1. In your terminal, run the following command to get the list of existing SSM documents that you own.

```
$ aws ssm list-documents --document-filter "key=Owner,value=Self"
```

2. Revert an SSM document to a previous version. In this example, we revert to a previous version of the `SessionManagerRunShell` document. You can use the SSM `SessionManagerRunShell` document to customize every SSM shell session that you initiate.
  - a. Find the `DocumentVersion` parameter for `SessionManagerRunShell` by running the following command:

```
$ aws ssm describe-document --name "SSM-SessionManagerRunShell"
{
  "Document": {
    "Hash": "...",
    "HashType": "Sha256",
    "Name": "SSM-SessionManagerRunShell",
```

```

    "Owner": "123456789012",
    "CreateDate": "2023-02-20T19:04:32.390000+00:00",
    "Status": "Active",
    "DocumentVersion": "1",
    "Parameters": [
      {
        "Name": "linuxcmd",
        "Type": "String",
        "Description": "The command to run on connection...",
        "DefaultValue": "if [ -d '/opt/parallelcluster' ]; then
source /opt/parallelcluster/cfnconfig; sudo su - $cfn_cluster_user; fi; /bin/
bash"
      }
    ],
    "PlatformTypes": [
      "Windows",
      "Linux",
      "MacOS"
    ],
    "DocumentType": "Session",
    "SchemaVersion": "1.0",
    "LatestVersion": "2",
    "DefaultVersion": "1",
    "DocumentFormat": "JSON",
    "Tags": []
  }
}

```

The latest version is 2.

- b. Revert to the previous version by running the following command:

```
$ aws ssm delete-document --name "SSM-SessionManagerRunShell" --document-  
version 2
```

3. Verify that the document version has been reverted by running the describe-document command again:

```
$ aws ssm describe-document --name "SSM-SessionManagerRunShell"
{
  "Document": {
    "Hash": "...",
    "HashType": "Sha256",

```

```
"Name": "SSM-SessionManagerRunShell",
"Owner": "123456789012",
"CreateDate": "2023-02-20T19:04:32.390000+00:00",
"Status": "Active",
"DocumentVersion": "1",
"Parameters": [
  {
    "Name": "linuxcmd",
    "Type": "String",
    "Description": "The command to run on connection...",
    "DefaultValue": "if [ -d '/opt/parallelcluster' ]; then source /
opt/parallelcluster/cfnconfig; sudo su - $cfn_cluster_user; fi; /bin/bash"
  }
],
"PlatformTypes": [
  "Windows",
  "Linux",
  "MacOS"
],
"DocumentType": "Session",
"SchemaVersion": "1.0",
"LatestVersion": "1",
"DefaultVersion": "1",
"DocumentFormat": "JSON",
"Tags": []
}
}
```

The latest version is 1.

## Creating a cluster with AWS CloudFormation

Learn how to create a cluster with an AWS ParallelCluster CloudFormation custom resource. For more information, see [AWS CloudFormation custom resource](#).

When using AWS ParallelCluster, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

### Prerequisites:

- The AWS CLI [is installed and configured](#).

- An [Amazon EC2 key pair](#).
- An IAM role with the [permissions](#) that are required to run the [pcluster](#) CLI.

## Cluster creation with a CloudFormation quick-create stack

In this tutorial, you use a quick-create stack to deploy a CloudFormation template that creates a cluster and the following AWS resources:

- A root CloudFormation stack created by using a CloudFormation quick-create stack.
- Nested CloudFormation stacks that include default policies, default VPC set up, and a custom resource provider.
- An example AWS ParallelCluster cluster stack and a cluster that you can log in to and run jobs.

### Create a cluster with AWS CloudFormation

1. Sign in to the AWS Management Console.
2. Open the CloudFormation [quick-create link](#) to create the following resources in the CloudFormation console:
  - A nested CloudFormation stack with a VPC with a public and private subnet for running the cluster head node and compute nodes, respectively.
  - A nested CloudFormation stack with an AWS ParallelCluster custom resource for managing the cluster.
  - A nested CloudFormation stack with the default policies for managing the cluster.
  - A root CloudFormation stack for the nested stacks.
  - An AWS ParallelCluster cluster with the Slurm scheduler and a defined number of compute nodes.

CloudFormation > Stacks > Create stack

## Quick create stack

### Template

Template URL  
[https://pcluster-cfn-us-east-2.s3.amazonaws.com/parallelcluster/3.5.0/templates/custom\\_resource/cluster-1-click.yaml](https://pcluster-cfn-us-east-2.s3.amazonaws.com/parallelcluster/3.5.0/templates/custom_resource/cluster-1-click.yaml)

Stack description  
 AWS ParallelCluster CloudFormation Cluster

### Stack name

Stack name

Stack name can include letters (A-Z and a-z), numbers (0-9), and dashes (-).

### Parameters

Parameters are defined in your template and allow you to input custom values when you create or update a stack.

AvailabilityZone  
 Availability zone where instances will be launched

KeyName  
 KeyPair to login to the head node

### Capabilities

**i** The following resource(s) require capabilities: [AWS::CloudFormation::Stack]

This template contains Identity and Access Management (IAM) resources. Check that you want to create each of these resources and that they have the minimum required permissions. In addition, they have custom names. Check that the custom names are unique within your AWS account. [Learn more](#)

For this template, AWS CloudFormation might require an unrecognized capability: {0}. Check the capabilities of these resources. [Learn more](#)

I acknowledge that AWS CloudFormation might create IAM resources with custom names.

I acknowledge that AWS CloudFormation might require the following capability: CAPABILITY\_AUTO\_EXPAND

Cancel

3. In the **Quick create stack Parameters** section, enter values for the following parameters:
  - a. For **KeyName**, enter the name of your Amazon EC2 key pair.
  - b. For **AvailabilityZone**, choose an AZ for your cluster nodes, for example, us-east-1a.

4. Check the boxes to acknowledge each of the access capabilities at the bottom of the page.
5. Choose **Create stack**.
6. Wait for the CloudFormation stack to reach the CREATE\_COMPLETE state.

## Cluster creation with the AWS CloudFormation Command Line Interface (CLI)

In this tutorial, you use the AWS Command Line Interface (CLI) for CloudFormation to deploy a CloudFormation template that creates a cluster.

### Create the following AWS resources:

- A root CloudFormation stack created by using a CloudFormation quick-create stack.
- Nested CloudFormation stacks that include default policies, default VPC setup, and a custom resource provider.
- An example AWS ParallelCluster cluster stack and a cluster that you can log in to and run jobs.

Replace *inputs highlighted in red*, such as *keypair*, with your own values.

### Create a cluster with AWS CloudFormation

1. Create a CloudFormation template named `cluster_template.yaml` with the following content:

```
AWSTemplateFormatVersion: '2010-09-09'
Description: >
  AWSParallelCluster CloudFormation Template

Parameters:
  KeyName:
    Description: KeyPair to login to the head node
    Type: AWS::EC2::KeyPair::KeyName

  AvailabilityZone:
    Description: Availability zone where instances will be launched
    Type: AWS::EC2::AvailabilityZone::Name
    Default: us-east-2a

Mappings:
```



```

ParallelCluster:
  Constants:
    Version: 3.7.0

Resources:
  PclusterClusterProvider:
    Type: AWS::CloudFormation::Stack
    Properties:
      TemplateURL: !Sub
        - https://${AWS::Region}-aws-parallelcluster.s3.${AWS::Region}.
          ${AWS::URLSuffix}/parallelcluster/${Version}/templates/custom_resource/cluster.yaml
        - { Version: !FindInMap [ParallelCluster, Constants, Version] }

  PclusterVpc:
    Type: AWS::CloudFormation::Stack
    Properties:
      Parameters:
        PublicCIDR: 10.0.0.0/24
        PrivateCIDR: 10.0.16.0/20
        AvailabilityZone: !Ref AvailabilityZone
      TemplateURL: !Sub
        - https://${AWS::Region}-aws-parallelcluster.s3.${AWS::Region}.
          ${AWS::URLSuffix}/parallelcluster/${Version}/templates/networking/public-private-
          ${Version}.cfn.json
        - { Version: !FindInMap [ParallelCluster, Constants, Version] }

  PclusterCluster:
    Type: Custom::PclusterCluster
    Properties:
      ServiceToken: !GetAtt [ PclusterClusterProvider , Outputs.ServiceToken ]
      ClusterName: !Sub 'c-${AWS::StackName}'
      ClusterConfiguration:
        Image:
          Os: alinux2
        HeadNode:
          InstanceType: t2.medium
          Networking:
            SubnetId: !GetAtt [ PclusterVpc , Outputs.PublicSubnetId ]
          Ssh:
            KeyName: !Ref KeyName
        Scheduling:
          Scheduler: slurm
          SlurmQueues:
            - Name: queue0

```

```

ComputeResources:
  - Name: queue0-cr0
    InstanceType: t2.micro
Networking:
  SubnetIds:
    - !GetAtt [ PclusterVpc , Outputs.PrivateSubnetId ]
Outputs:
  HeadNodeIp:
    Description: The Public IP address of the HeadNode
    Value: !GetAtt [ PclusterCluster, headNode.publicIpAddress ]

```

2. Run the following AWS CLI command to deploy the CloudFormation stack for cluster creation and management.

```

$ aws cloudformation deploy --template-file ./cluster_template.yaml \
  --stack-name mycluster \
  --parameter-overrides KeyName=keypair \
    AvailabilityZone=us-east-2b \
  --capabilities CAPABILITY_NAMED_IAM CAPABILITY_AUTO_EXPAND

```

## View CloudFormation cluster output

View the CloudFormation cluster output to obtain useful cluster details. The added `ValidationMessages` property provides access to validation messages from cluster create and update operations.

1. Navigate to the [CloudFormation console](#) and select the stack that includes your AWS ParallelCluster custom resource.
2. Choose **Stack details**, and select the **Outputs** tab.

| Key                | Value                                                                                                                                                                                                                              | Description                                            |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| HeadNodeIp         | 1.2.3.4                                                                                                                                                                                                                            | The Public IP address of the HeadNode                  |
| ValidationMessages | <pre> [{"level": "WARNING", "type": "KeyPairValidator", "message": "If you do not specify a key pair, you can't connect to the instance unless you choose an AMI that is configured to allow users another way to log in"}] </pre> | Any warnings from cluster create or update operations. |

Validation messages might be truncated. For more information about how to retrieve logs, see [AWS ParallelCluster troubleshooting](#).

## Access your cluster

Access the cluster.

### ssh into the cluster head node

1. After the CloudFormation stack deployment is complete, obtain the IP address of the head node with the following command:

```
$ HEAD_NODE_IP=$(aws cloudformation describe-stacks --stack-name=mycluster --query "Stacks|[0].Outputs[?OutputKey=='HeadNodeIp']|[0].OutputValue" --output=text)
```

You can also retrieve the head node IP address from **HeadNodeIp** parameter in the cluster stack **Outputs** tab in the CloudFormation console.

You can find the head node IP address here because it was added in the Outputs section of the cluster CloudFormation template, specifically for this example cluster.

2. Connect to the cluster head node by running the following command:

```
$ ssh -i keyname.pem ec2-user@$HEAD_NODE_IP
```

## Clean up

Delete the cluster.

1. Run the following AWS CLI command to delete the CloudFormation stack and cluster.

```
$ aws cloudformation delete-stack --stack-name=mycluster
```

2. Check the stack delete status by running the following command.

```
$ aws cloudformation describe-stacks --stack-name=mycluster
```

# Deploying ParallelCluster API with Terraform

In this tutorial, you will define a simple Terraform project to deploy a ParallelCluster API.

## Prerequisites

- Terraform v1.5.7+ is installed.
- IAM role with the permissions to deploy the ParallelCluster API. See [the section called “Required permissions”](#).

## Define a Terraform project

1. Create a directory called `my-pcluster-api`.

All files that you create will be within this directory.

2. Create the file `provider.tf` to configure the AWS provider.

```
provider "aws" {  
  region = var.region  
  profile = var.profile  
}
```

3. Create the file `main.tf` to define the resources using the ParallelCluster module.

```
module "parallelcluster_pcluster_api" {  
  source = "aws-tf/parallelcluster/aws//modules/pcluster_api"  
  version = "1.0.0"  
  
  region = var.region  
  api_stack_name = var.api_stack_name  
  api_version = var.api_version  
  deploy_pcluster_api = true  
  parameters = {  
    EnableIamAdminAccess = "true"  
  }  
}
```

4. Create the file `variables.tf` to define the variables that can be injected for this project.

```
variable "region" {
```

```
description = "The region the ParallelCluster API is deployed in."
type        = string
default     = "us-east-1"
}

variable "profile" {
  type        = string
  description = "The AWS profile used to deploy the clusters."
  default     = null
}

variable "api_stack_name" {
  type        = string
  description = "The name of the CloudFormation stack used to deploy the
ParallelCluster API."
  default     = "ParallelCluster"
}

variable "api_version" {
  type        = string
  description = "The version of the ParallelCluster API."
}
```

5. Create the file `terraform.tfvars` to set arbitrary values for the variables.

The file below deploys a ParallelCluster API 3.10.0 in `us-east-1` using the stack name `MyParallelClusterAPI-310`. You'll be able to reference this ParallelCluster API deployment using its stack name.

```
region = "us-east-1"
api_stack_name = "MyParallelClusterAPI-310"
api_version = "3.10.0"
```

6. Create the file `outputs.tf` to define the outputs returned by this project.

```
output "pcluster_api_stack_outputs" {
  value = module.parallelcluster_pcluster_api.stack_outputs
}
```

The project directory is:

```
my-pcluster-api
```

```
### main.tf - Terraform entrypoint to define the resources using the
ParallelCluster module.
### outputs.tf - Defines the outputs returned by Terraform.
### providers.tf - Configures the AWS provider.
### terraform.tfvars - Set the arbitrary values for the variables, i.e. region,
PCAPI version, PCAPI stack name
### variables.tf - Defines the variables, e.g. region, PCAPI version, PCAPI stack
name.
```

## Deploy the API

To deploy the API, run the standard Terraform commands in order.

1. Build the project:

```
terraform init
```

2. Define the deployment plan:

```
terraform plan -out tfplan
```

3. Deploy the plan:

```
terraform apply tfplan
```

## Required permissions

You need the following permissions to deploy the ParallelCluster API with Terraform:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "cloudformation:DescribeStacks",
        "cloudformation:GetTemplate"
      ],
      "Resource": "arn:PARTITION:cloudformation:REGION:ACCOUNT:stack/*",
      "Effect": "Allow",
      "Sid": "CloudFormationRead"
    }
  ]
}
```

```

    },
    {
      "Action": [
        "cloudformation:CreateStack",
        "cloudformation>DeleteStack",
        "cloudformation>CreateChangeSet"
      ],
      "Resource": "arn:PARTITION:cloudformation:REGION:ACCOUNT:stack/MyParallelClusterAPI*",
      "Effect": "Allow",
      "Sid": "CloudFormationWrite"
    },
    {
      "Action": [
        "cloudformation>CreateChangeSet"
      ],
      "Resource": [
        "arn:PARTITION:cloudformation:REGION:aws:transform/Include",
        "arn:PARTITION:cloudformation:REGION:aws:transform/Serverless-2016-10-31"
      ],
      "Effect": "Allow",
      "Sid": "CloudFormationTransformWrite"
    },
    {
      "Action": [
        "s3:GetObject"
      ],
      "Resource": [
        "arn:PARTITION:s3::*-aws-parallelcluster/parallelcluster/*/api/ParallelCluster.openapi.yaml",
        "arn:PARTITION:s3::*-aws-parallelcluster/parallelcluster/*/layers/aws-parallelcluster/lambda-layer.zip"
      ],
      "Effect": "Allow",
      "Sid": "S3ParallelClusterArtifacts"
    },
    {
      "Action": [
        "iam:CreateRole",
        "iam>DeleteRole",
        "iam:GetRole",
        "iam:CreatePolicy",
        "iam>DeletePolicy",

```

```

        "iam:GetPolicy",
        "iam:GetRolePolicy",
        "iam:AttachRolePolicy",
        "iam:DetachRolePolicy",
        "iam:PutRolePolicy",
        "iam>DeleteRolePolicy",
        "iam:ListPolicyVersions"
    ],
    "Resource": [
        "arn:PARTITION:iam::ACCOUNT:role/*",
        "arn:PARTITION:iam::ACCOUNT:policy/*"
    ],
    "Effect": "Allow",
    "Sid": "IAM"
},
{
    "Action": [
        "iam:PassRole"
    ],
    "Resource": [
        "arn:PARTITION:iam::ACCOUNT:role/ParallelClusterLambdaRole-*",
        "arn:PARTITION:iam::ACCOUNT:role/APIGatewayExecutionRole-*"
    ],
    "Effect": "Allow",
    "Sid": "IAMPassRole"
},
{
    "Action": [
        "lambda:CreateFunction",
        "lambda>DeleteFunction",
        "lambda:GetFunction",
        "lambda:PublishLayerVersion",
        "lambda>DeleteLayerVersion",
        "lambda:GetLayerVersion",
        "lambda:TagResource",
        "lambda:UntagResource"
    ],
    "Resource": [
        "arn:PARTITION:lambda:REGION:ACCOUNT:layer:PCLayer-*",
        "arn:PARTITION:lambda:REGION:ACCOUNT:function:*-
ParallelClusterFunction-*"
    ],
    "Effect": "Allow",
    "Sid": "Lambda"

```



```

    },
    {
      "Action": [
        "logs:CreateLogGroup",
        "logs>DeleteLogGroup",
        "logs:DescribeLogGroups",
        "logs:PutRetentionPolicy",
        "logs:TagLogGroup",
        "logs:UntagLogGroup"
      ],
      "Resource": [
        "arn:PARTITION:logs:REGION:ACCOUNT:log-group:/aws/lambda/*-
ParallelClusterFunction-*"
      ],
      "Effect": "Allow",
      "Sid": "Logs"
    },
    {
      "Action": [
        "apigateway:DELETE",
        "apigateway:GET",
        "apigateway:PATCH",
        "apigateway:POST",
        "apigateway:PUT",
        "apigateway:UpdateRestApiPolicy"
      ],
      "Resource": [
        "arn:PARTITION:apigateway:REGION:./restapis",
        "arn:PARTITION:apigateway:REGION:./restapis/*",
        "arn:PARTITION:apigateway:REGION:./tags/*"
      ],
      "Effect": "Allow",
      "Sid": "APIGateway"
    }
  ]
}

```

## Creating a cluster with Terraform

When using AWS ParallelCluster, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [the section called “AWS services used by AWS ParallelCluster”](#).

## Prerequisites

- Terraform v1.5.7+ is installed.
- [the section called “AWS ParallelCluster API”](#) v3.8.0+ is deployed in your account. See [the section called “Deploying ParallelCluster API with Terraform”](#).
- IAM role with the permissions to invoke the ParallelCluster API. See [Required permissions]

## Define a Terraform project

In this tutorial, you will define a simple Terraform project to deploy a cluster.

1. Create a directory called `my-clusters`.

All files that you create will be within this directory.

2. Create the file `terraform.tf` to import the ParallelCluster provider.

```
terraform {
  required_version = ">= 1.5.7"
  required_providers {
    pcluster = {
      source = "aws-tf/aws-parallelcluster"
      version = "1.0.0"
    }
  }
}
```

3. Create the file `providers.tf` to configure the ParallelCluster and AWS providers.

```
provider "aws" {
  region = var.region
  profile = var.profile
}

provider "aws-parallelcluster" {
  region      = var.region
  profile     = var.profile
  api_stack_name = var.api_stack_name
  use_user_role = true
}
```

4. Create the file `main.tf` to define the resources using the ParallelCluster module.

```
module "pcluster" {
  source = "aws-tf/aws/parallelcluster"
  version = "1.0.0"

  region          = var.region
  api_stack_name  = var.api_stack_name
  api_version     = var.api_version
  deploy_pcluster_api = false

  template_vars      = local.config_vars
  cluster_configs    = local.cluster_configs
  config_path        = "config/clusters.yaml"
}
```

5. Create the file `clusters.tf` to define multiple clusters as Terraform local variables.

#### Note

You can define multiple clusters within the `cluster_config` element. For every cluster, you can explicitly define the cluster properties within the local variables (see `DemoCluster01`) or reference an external file (see `DemoCluster02`).

To review the cluster properties that you can set within the configuration element, see [the section called "Cluster configuration file"](#).

To review the options that you can set for cluster creation, see [the section called "pcluster create-cluster"](#).

```
locals {
  cluster_configs = {
    DemoCluster01 : {
      region : local.config_vars.region
      rollbackOnFailure : false
      validationFailureLevel : "WARNING"
      suppressValidators : [
        "type:KeyPairValidator"
      ]
      configuration : {
        Region : local.config_vars.region
        Image : {
```

```
    Os : "alinux2"
  }
  HeadNode : {
    InstanceType : "t3.small"
    Networking : {
      SubnetId : local.config_vars.subnet
    }
    Iam : {
      AdditionalIamPolicies : [
        { Policy : "arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore" }
      ]
    }
  }
  Scheduling : {
    Scheduler : "slurm"
    SlurmQueues : [{
      Name : "queue1"
      CapacityType : "ONDEMAND"
      Networking : {
        SubnetIds : [local.config_vars.subnet]
      }
      Iam : {
        AdditionalIamPolicies : [
          { Policy : "arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore" }
        ]
      }
      ComputeResources : [{
        Name : "compute"
        InstanceType : "t3.small"
        MinCount : "1"
        MaxCount : "4"
      }]
    }]
    SlurmSettings : {
      QueueUpdateStrategy : "TERMINATE"
    }
  }
}
DemoCluster02 : {
  configuration : "config/cluster-config.yaml"
}
```

```
}

```

6. Create the file `config/clusters.yaml` to define multiple clusters as YAML configuration.

```
DemoCluster03:
  region: ${region}
  rollbackOnFailure: true
  validationFailureLevel: WARNING
  suppressValidators:
    - type:KeyPairValidator
  configuration: config/cluster-config.yaml
DemoCluster04:
  region: ${region}
  rollbackOnFailure: false
  configuration: config/cluster-config.yaml

```

7. Create the file `config/cluster_config.yaml`, which is a standard ParallelCluster config file where Terraform variables can be injected.

To review the cluster properties that you can set within the configuration element, see [the section called “Cluster configuration file”](#).

```
Region: ${region}
Image:
  Os: alinux2
HeadNode:
  InstanceType: t3.small
  Networking:
    SubnetId: ${subnet}
  Iam:
    AdditionalIamPolicies:
      - Policy: arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore
Scheduling:
  Scheduler: slurm
  SlurmQueues:
    - Name: queue1
      CapacityType: ONDEMAND
      Networking:
        SubnetIds:
          - ${subnet}
      Iam:
        AdditionalIamPolicies:
          - Policy: arn:aws:iam::aws:policy/AmazonSSMManagedInstanceCore

```

```
ComputeResources:
  - Name: compute
    InstanceType: t3.small
    MinCount: 1
    MaxCount: 5
SlurmSettings:
  QueueUpdateStrategy: TERMINATE
```

8. Create the file `clusters_vars.tf` to define the variables that can be injected into cluster configurations.

This file allows you to define dynamic values that can be used in cluster configurations, such as region and subnet.

This example retrieves values directly from the project variables, but you may need to use custom logic to determine them.

```
locals {
  config_vars = {
    subnet = var.subnet_id
    region = var.cluster_region
  }
}
```

9. Create the file `variables.tf` to define the variables that can be injected for this project.

```
variable "region" {
  description = "The region the ParallelCluster API is deployed in."
  type        = string
  default     = "us-east-1"
}

variable "cluster_region" {
  description = "The region the clusters will be deployed in."
  type        = string
  default     = "us-east-1"
}

variable "profile" {
  type        = string
  description = "The AWS profile used to deploy the clusters."
  default     = null
}
```

```
variable "subnet_id" {
  type      = string
  description = "The id of the subnet to be used for the ParallelCluster
instances."
}

variable "api_stack_name" {
  type      = string
  description = "The name of the CloudFormation stack used to deploy the
ParallelCluster API."
  default   = "ParallelCluster"
}

variable "api_version" {
  type      = string
  description = "The version of the ParallelCluster API."
}
```

10. Create the file `terraform.tfvars` to set arbitrary values for the variables.

The file below deploys the clusters in `eu-west-1` within the subnet `subnet-123456789`, using the existing ParallelCluster API 3.10.0, which is already deployed in `us-east-1` with stack name `MyParallelClusterAPI-310`.

```
region = "us-east-1"
api_stack_name = "MyParallelClusterAPI-310"
api_version = "3.10.0"

cluster_region = "eu-west-1"
subnet_id = "subnet-123456789"
```

11. Create the file `outputs.tf` to define the outputs returned by this project.

```
output "clusters" {
  value = module.parallelcluster_clusters.clusters
}
```

The project directory is:

```
my-clusters
### config
```

```
#   ### cluster-config.yaml - Cluster configuration, where terraform variables can
#   be injected..
#   ### clusters.yaml - File listing all the clusters to deploy.
### clusters.tf - Clusters defined as Terraform local variables.
### clusters_vars.tf - Variables that can be injected into cluster configurations.
### main.tf - Terraform entrypoint where the ParallelCluster module is configured.
### outputs.tf - Defines the cluster as a Terraform output.
### providers.tf - Configures the providers: ParallelCluster and AWS.
### terraform.tf - Import the ParallelCluster provider.
### terraform.tfvars - Defines values for variables, e.g. region, PCAPI stack name.
### variables.tf - Defines the variables, e.g. region, PCAPI stack name.
```

## Deploy the cluster

To deploy the cluster, run the standard Terraform commands in order.

### Note

This example assumes that you've already deployed the ParallelCluster API in your account.

#### 1. Build the project:

```
terraform init
```

#### 2. Define the deployment plan:

```
terraform plan -out tfplan
```

#### 3. Deploy the plan:

```
terraform apply tfplan
```

## Deploy the ParallelCluster API with clusters

If you haven't deployed the ParallelCluster API and you want to deploy it with the clusters, change the following files:

- `main.tf`



```

module "pcluster" {
  source = "aws-tf/aws/parallelcluster"
  version = "1.0.0"

  region          = var.region
  api_stack_name  = var.api_stack_name
  api_version     = var.api_version
  deploy_pcluster_api = true

  template_vars      = local.config_vars
  cluster_configs    = local.cluster_configs
  config_path        = "config/clusters.yaml"
}

```

- providers.tf

```

provider "aws-parallelcluster" {
  region  = var.region
  profile = var.profile
  endpoint = module.pcluster.pcluster_api_stack_outputs.ParallelClusterApiInvokeUrl
  role_arn = module.pcluster.pcluster_api_stack_outputs.ParallelClusterApiUserRole
}

```

## Required permissions

You need the following permissions to deploy a cluster with Terraform:

- assume the ParallelCluster API role, which is in charge of interacting with the ParallelCluster API
- describe the AWS CloudFormation stack of the ParallelCluster API to verify it exists and retrieve its parameters and outputs

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": "sts:AssumeRole",
      "Resource": "arn:PARTITION:iam::ACCOUNT:role/PCAPIUserRole-*",
      "Effect": "Allow",
      "Sid": "AssumePCAPIUserRole"
    }
  ]
}

```

```
    },
    {
      "Action": [
        "cloudformation:DescribeStacks"
      ],
      "Resource": "arn:PARTITION:cloudformation:REGION:ACCOUNT:stack/*",
      "Effect": "Allow",
      "Sid": "CloudFormation"
    }
  ]
}
```

## Creating a custom AMI with Terraform

When using AWS ParallelCluster, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [the section called “AWS services used by AWS ParallelCluster”](#).

### Prerequisites

- Terraform v1.5.7+ is installed.
- [the section called “AWS ParallelCluster API”](#) v3.8.0+ is deployed in your account. See [the section called “Creating a cluster with Terraform”](#).
- IAM role with the permissions to invoke the ParallelCluster API. See [the section called “Required permissions”](#).

## Define a Terraform project

In this tutorial, you will define a simple Terraform project to deploy a ParallelCluster custom AMI.

1. Create a directory called `my-amis`.

All files that you create will be within this directory.

2. Create the file `terraform.tf` to import the ParallelCluster provider.

```
terraform {
  required_version = ">= 1.5.7"
  required_providers {
    pcluster = {
```

```

    source = "aws-tf/aws-parallelcluster"
    version = "1.0.0"
  }
}

```

3. Create the file `providers.tf` to configure the ParallelCluster and AWS providers.

```

provider "aws" {
  region = var.region
  profile = var.profile
}

provider "aws-parallelcluster" {
  region          = var.region
  profile         = var.profile
  api_stack_name = var.api_stack_name
  use_user_role  = true
}

```

4. Create the file `main.tf` to define the resources using the ParallelCluster module.

To review the image properties that you can set within the `image_configuration` element, see [the section called "Build image configuration files"](#).

To review the options that you can set for image creation, for example `image_id` and `rollback_on_failure`, see [the section called "pcluster build-image"](#).

```

data "aws-parallelcluster_list_official_images" "parent_image" {
  region = var.region
  os     = var.os
  architecture = var.architecture
}

resource "aws-parallelcluster_image" "demo01" {
  image_id = "demo01"
  image_configuration = yamlencode({
    "Build":{
      "InstanceType": "c5.2xlarge",
      "ParentImage": data.aws-
parallelcluster_list_official_images.parent_image.official_images[0].amiId,
      "UpdateOsPackages": {"Enabled": false}
    }
  })
}

```

```
    })
    rollback_on_failure = false
  }
```

5. Create the file `variables.tf` to define the variables that can be injected for this project.

```
variable "region" {
  description = "The region the ParallelCluster API is deployed in."
  type        = string
  default     = "us-east-1"
}

variable "profile" {
  type        = string
  description = "The AWS profile used to deploy the clusters."
  default     = null
}

variable "api_stack_name" {
  type        = string
  description = "The name of the CloudFormation stack used to deploy the
ParallelCluster API."
  default     = "ParallelCluster"
}

variable "api_version" {
  type        = string
  description = "The version of the ParallelCluster API."
}

variable "os" {
  type        = string
  description = "The OS of the ParallelCluster image."
}

variable "architecture" {
  type        = string
  description = "The architecture of the ParallelCluster image."
}
```

6. Create the file `terraform.tfvars` to set you arbitrary values for the variables.

With the file below deploys the custom AMI in us-east-1 based on Amazon Linux 2 for x86\_64 architecture, using the existing ParallelCluster API 3.10.0 which is already deployed in us-east-1 with stack name MyParallelClusterAPI-310.

```
region = "us-east-1"
api_stack_name = "MyParallelClusterAPI-310"
api_version = "3.10.0"

os = "alinux2"
architecture = "x86_64"
```

7. Create the file `outputs.tf` to define the outputs returned by this project.

```
output "parent_image" {
  value = data.aws-
parallelcluster_list_official_images.parent_image.official_images[0]
}

output "custom_image" {
  value = aws-parallelcluster_image.demo01
}
```

The project directory is:

```
my-amis
### main.tf - Terraform entrypoint where the ParallelCluster module is configured.
### outputs.tf - Defines the cluster as a Terraform output.
### providers.tf - Configures the providers: ParallelCluster and AWS.
### terraform.tf - Import the ParallelCluster provider.
### terraform.tfvars - Defines values for variables, e.g. region, PCAPI stack name.
### variables.tf - Defines the variables, e.g. region, PCAPI stack name.
```

## Deploy the AMI

To deploy the AMI, run the standard Terraform commands in order.

1. Build the project:

```
terraform init
```

## 2. Define the deployment plan:

```
terraform plan -out tfplan
```

## 3. Deploy the plan:

```
terraform apply tfplan
```

## Required permissions

You need the following permissions to deploy a custom AMI with Terraform:

- assume the ParallelCluster API role, which is in charge of interacting with the ParallelCluster API
- describe the AWS CloudFormation stack of the ParallelCluster API, to verify it exists and retrieve its parameters and outputs

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": "sts:AssumeRole",
      "Resource": "arn:PARTITION:iam::ACCOUNT:role/PCAPIUserRole-*",
      "Effect": "Allow",
      "Sid": "AssumePCAPIUserRole"
    },
    {
      "Action": [
        "cloudformation:DescribeStacks"
      ],
      "Resource": "arn:PARTITION:cloudformation:REGION:ACCOUNT:stack/*",
      "Effect": "Allow",
      "Sid": "CloudFormation"
    }
  ]
}
```

# AWS ParallelCluster UI Integration with Identity Center

The goal of this tutorial is to demonstrate how to integrate AWS ParallelCluster UI with IAM Identity Center for a single sign-on solution that unifies users in Active Directory that can be shared with AWS ParallelCluster clusters.

When using AWS ParallelCluster, you only pay for the AWS resources that are created when you create or update AWS ParallelCluster images and clusters. For more information, see [AWS services used by AWS ParallelCluster](#).

## Prerequisites:

- An existing AWS ParallelCluster UI which can be installed following the instructions [here](#).
- An existing Managed Active Directory, preferably one that you will also use for [integrating with AWS ParallelCluster](#).

## Enable IAM Identity Center

If you already have an identity center connected to the your AWS Managed Microsoft AD (Active Directory) it can be used and you can skip to the section **Adding your Application to IAM Identity Center**.

If you do not already have an identity center connected to an AWS Managed Microsoft AD, follow the steps below to set it up.

### Enabling Identity Center

1. In the console, navigate to IAM Identity Center. (Make sure you are in the region in which you have your AWS Managed Microsoft AD.)
2. Click the **Enable** button, this may ask if you want to enable organizations, this is a requirement so you can select to enable it. **Note** : This will email the administrator of your account with a confirmation email that you should follow the link to confirm.

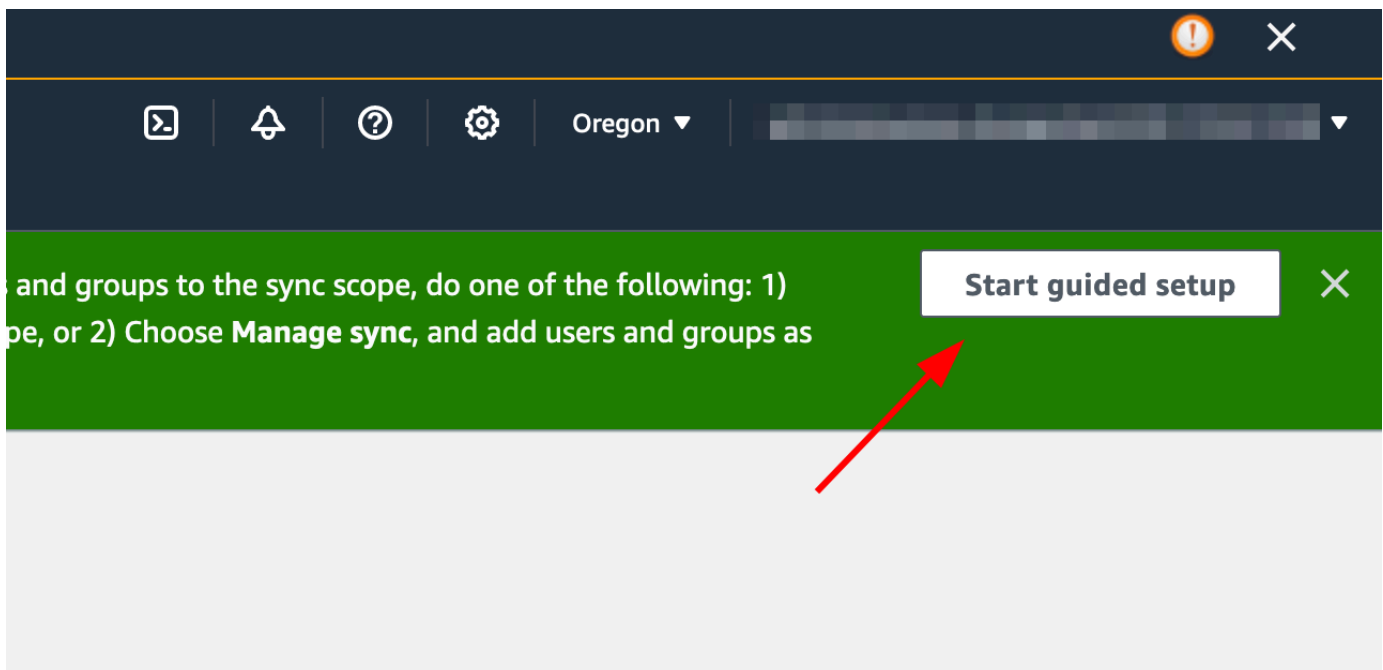
### Connecting Identity Center to Managed AD

1. On the next page after enabling identity center you should see Recommended Set Up Steps, under Step 1, select **Choose Your Identity Source**.

2. In the Identity Source section, click on the **Actions** drop down menu (in the top right), then select **Change Identity Source**.
3. Select **Active Directory**.
4. Under **Existing Directories**, choose your directory.
5. Click Next.
6. Review your changes, scroll to the bottom, type ACCEPT into the text box to confirm, then click **Change Identity Source**.
7. Wait for the changes to complete, then you should see a green banner at the top.

### Syncing users and groups to Identity Center

1. In the green banner click **Start Guided Setup** (button in the top right one)



2. In the **Configure Attribute Mappings**, click **Next**
3. In the Configure sync scope section, type in the name of the users you want synced to identity center, then click **Add**
4. Once finished adding users and groups, click **Next**



**Users**

Groups

**User**

corp.pcluster.com
▼

🔍

Add

**Added users and groups (4)** Remove

|                          | Username / Group name | Type | Domain            |
|--------------------------|-----------------------|------|-------------------|
| <input type="checkbox"/> | user1                 | User | corp.pcluster.com |
| <input type="checkbox"/> | user2                 | User | corp.pcluster.com |
| <input type="checkbox"/> | admin1                | User | corp.pcluster.com |
| <input type="checkbox"/> | admin2                | User | corp.pcluster.com |

Cancel

Previous

Next

5. Review your changes, then click **Save configuration**
6. If you see a warning in the next screen about users not being synced, select the **Resume sync button** in the top right.
7. Next, to enable users, In the **Users** tab on the left, select a user and then click **Enable user access > Enable user access**

**Note:** You may need to select Resume sync if you have a warning banner at the top and then wait for users to sync (try the refresh button to see if they are synced yet).

The screenshot displays the IAM Identity Center 'Users' page. On the left is a navigation menu with options like 'Dashboard', 'Users', 'Groups', 'Settings', 'Multi-account permissions', and 'Application assignments'. The main content area shows a table of users. At the top of the table, there are buttons for 'Delete users' and 'Manage sync', and a search bar with the text 'Find users'. The table has four columns: 'Username', 'Display name', 'Status', and 'MFA device'. There are four rows of users, each with a checkbox in the first column. The users are: user1@corp.pcluster.com, admin1@corp.pcluster.com, user2@corp.pcluster.com, and admin2@corp.pcluster.com. All users have a status of 'Enabled' (indicated by a green checkmark) and 'None' for MFA device.

| <input type="checkbox"/> | Username                 | Display name             | Status  | MFA device |
|--------------------------|--------------------------|--------------------------|---------|------------|
| <input type="checkbox"/> | user1@corp.pcluster.com  | user1@corp.pcluster.com  | Enabled | None       |
| <input type="checkbox"/> | admin1@corp.pcluster.com | admin1@corp.pcluster.com | Enabled | None       |
| <input type="checkbox"/> | user2@corp.pcluster.com  | user2@corp.pcluster.com  | Enabled | None       |
| <input type="checkbox"/> | admin2@corp.pcluster.com | admin2@corp.pcluster.com | Enabled | None       |

## Adding your Application to IAM Identity Center

Once you have synced your users with IAM Identity Center, you will need to add a new application. This configures which SSO enabled applications will be available from your IAM Identity Center portal. In this case, we will be adding AWS ParallelCluster UI as an application while IAM Identity Center will be the identity provider.

The next step will add the AWS ParallelCluster UI as an application in IAM Identity Center. AWS ParallelCluster UI is a web portal that helps the user to manage their clusters. For more information see [AWS ParallelCluster UI](#).

### Setting up the application in Identity Center

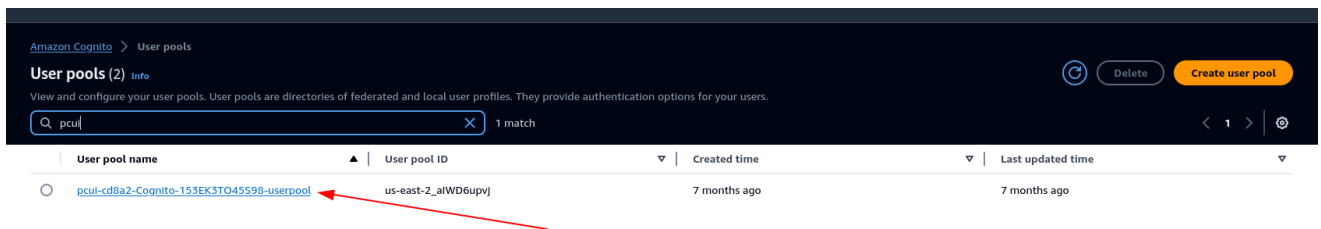
1. Under **IAM Identity Center > Applications** (found on the left menu bar, click on Applications)
2. Click **Add Application**
3. Select **Add custom SAML 2.0 application**
4. Click **Next**
5. Select the display name and description you would like to use (e.g. PCUI and AWS ParallelCluster UI)
6. Under **IAM Identity Center metadata**, copy the link for IAM Identity Center SAML metadata file and save for later, this will be used when configuring SSO on the web app

- Under **Application properties**, in the Application start URL, put your PCUI address. This can be found by going to the CloudFormation console, selecting the stack that corresponds to PCUI (e.g. parallelcluster-ui) and going to the **Outputs** tab to find ParallelClusterUIUrl

e.g. `https://m2iwazsi1j.execute-api.us-east-1.amazonaws.com`

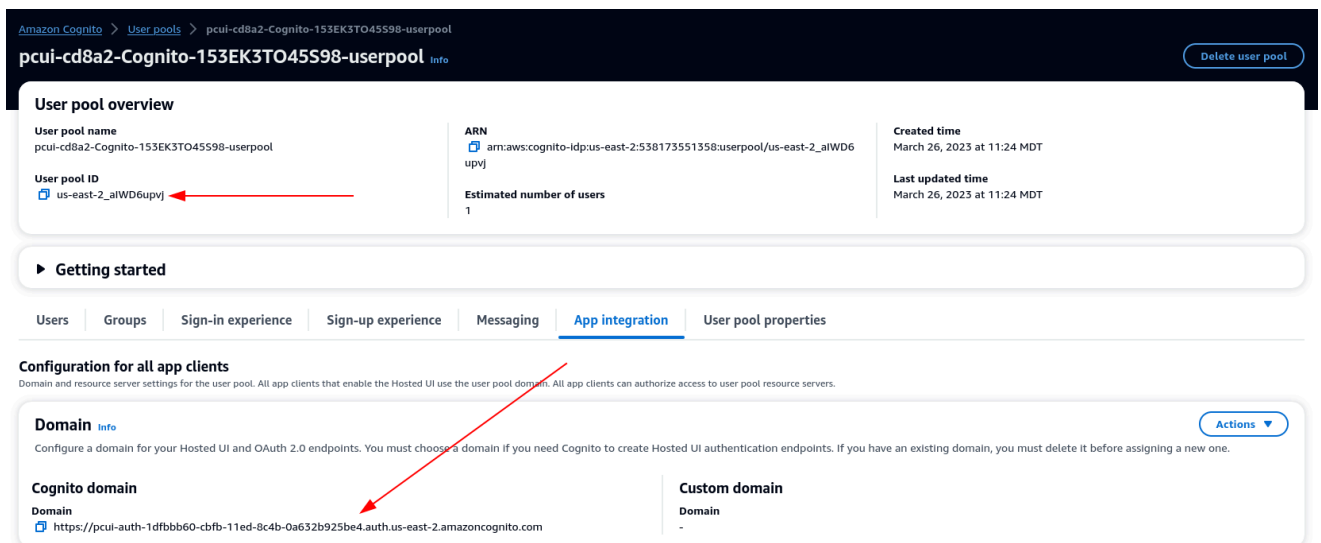
- Under **Application metadata**, choose **Manually type your metadata values**. Then provide the following values.

- Important:** Make sure to replace the domain-prefix, region, and userpool-id values with information that's specific to your environment.
- The domain prefix, region and userpool-id can be obtained by opening the **Amazon Cognito > User pools console**



- Select the user pool that corresponds to PCUI (which will have a User pool name like `pcui-cd8a2-Cognito-153EK3TO45S98-userpool`)

- Navigate to **App Integration**



- Application Assertion Consumer Service (ACS) URL: `https://<domain-prefix>.auth.<region>.amazoncognito.com/saml2/idpresponse`

Application SAML audience: `urn:amazon:cognito:sp:<userpool-id>`

10. Choose **Submit**. Then, go to the **Details** page for the application that you added.
11. Select the **Actions** dropdown list and choose **Edit attribute mappings**. Then, provide the following attributes.
  - a. User attribute in the application: **subject** (Note: **subject** is prefilled.) → Maps to this string value or user attribute in IAM Identity Center: **`\${user:email}`**, Format: **emailAddress**
  - b. User attribute in the application: **email** → Maps to this string value or user attribute in IAM Identity Center: **`\${user:email}`**, Format: **unspecified**

Attribute mappings for PCUI

Attributes you map here become part of the SAML assertion that is sent to the application. You can choose which user attributes in your application map to corresponding user attributes in your connected directory. [Learn more](#)

| User attribute in the application | Maps to this string value or user attribute in IAM Identity Center | Format       |                                       |
|-----------------------------------|--------------------------------------------------------------------|--------------|---------------------------------------|
| Subject                           | <input type="text" value="`\${user:email}`"/>                      | emailAddress |                                       |
| email                             | <input type="text" value="`\${user:email}`"/>                      | unspecified  | <input type="button" value="Remove"/> |

12. Save your changes.
13. Choose the **Assign Users** button and then assign your user to the application. These are the users in your Active Directory that will have access to the PCUI interface.

IAM Identity Center > Applications > PCUI

### PCUI

**Details** Actions ▾

|  |                      |                                       |
|--|----------------------|---------------------------------------|
|  | Display name<br>PCUI | Description<br>AWS ParallelCluster UI |
|--|----------------------|---------------------------------------|

**Assigned users (1)**

The following users and groups from your connected directory can access this application. [Learn more](#)

|                          | User/Group name                          | Type |
|--------------------------|------------------------------------------|------|
| <input type="checkbox"/> | <a href="#">admin1@corp.pcluster.com</a> | User |

## Configure IAM Identity Center as a SAML IdP in your user pool

1. In your user pool settings, select **Sign-in experience > Add identity provider**

Amazon Cognito > User pools > parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool

## parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool [Info](#)

[Delete user pool](#)

### User pool overview

|                                                                           |                                                                                                     |                                                           |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| <b>User pool name</b><br>parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool | <b>ARN</b><br><a href="#">am:aws:cognito-idp:us-east-1:538173551358:userpool/us-east-1_Bgyu7Lz6</a> | <b>Created time</b><br>November 5, 2023 at 12:32 MST      |
| <b>User pool ID</b><br><a href="#">us-east-1_Bgyu7LLz6</a>                | <b>Estimated number of users</b><br>1                                                               | <b>Last updated time</b><br>November 5, 2023 at 12:32 MST |

### ▶ Getting started

Users | Groups | [Sign-in experience](#) | Sign-up experience | Messaging | App integration | User pool properties

### Cognito user pool sign-in [Info](#)

Users can sign in using their email address, phone number, or user name. User attributes, group memberships, and security settings will be stored and configured in your user pool.

**Cognito user pool sign-in options**  
Email

### Federated identity provider sign-in (0) [Info](#)

Your app users can sign-in through external social identity providers like Facebook, Google, Amazon, or Apple, and through your on-prem directories via SAML or Open ID Connect.

[Delete](#) [Add identity provider](#) [View signing certificate](#)

| Identity provider     | Identity provider type | Created time | Last updated time |
|-----------------------|------------------------|--------------|-------------------|
| No identity providers |                        |              |                   |

[Add identity provider](#)

2. Choose a SAML IdP
3. For **Provider name** provide **IdentityCenter**
4. Under **Metadata document source** choose **Enter metadata document endpoint URL** and provide the URL copied during the Application setup of Identity Center
5. Under the **Attributes**, for email choose email

### SAML

Configure a SAML 2.0 identity provider for your user pool.

#### Register your app with your SAML provider

To connect a SAML provider to Cognito, add your user pool as a relying party or application with your SAML 2.0 identity provider, and upload a metadata document to Cognito.

---

#### Set up SAML federation with this user pool

**Provider name** [Info](#)  
Enter a friendly name for your SAML 2.0 identity provider.

**Identifiers - optional** [Info](#)  
Enter identifiers for this provider. Identifiers can be used to redirect users to the correct IdP in multitenant apps.

Separate each identifier by a comma

**Sign-out flow** [Info](#)  
 Add sign-out flow  
Enable simultaneous sign-out from the SAML provider and Cognito.

**Metadata document source** [Info](#)  
Provide a SAML metadata document. This document is issued by your SAML provider. It includes the issuer's name, expiration information, and keys that can be used to validate the response from the identity provider.

Upload metadata document  
 Enter metadata document endpoint URL

**Enter metadata document endpoint URL** [Info](#)

---

#### Map attributes between your SAML provider and your user pool

Your required attributes are mapped to the equivalent SAML attributes. Each attribute you add must be mapped to a SAML attribute.

| User pool attribute | SAML attribute |
|---------------------|----------------|
| email               | email          |

[Add another attribute](#)

[Cancel](#) [Add identity provider](#)

## 6. Select Add identity provider.

### Integrate the IdP with the user pool app client

1. Next, under the **App Integration** section of your user pool, choose the client listed under **App client list**

Amazon Cognito > User pools > parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool

## parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool Info Delete user pool

### User pool overview

|                                                                           |                                                                                      |                                                           |
|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------|
| <b>User pool name</b><br>parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool | <b>ARN</b><br>arn:aws:cognito-idp:us-east-1:123456789012:userpool/us-east-1_Bgyu7Lz6 | <b>Created time</b><br>November 5, 2023 at 12:32 MST      |
| <b>User pool ID</b><br>us-east-1_Bgyu7Lz6                                 | <b>Estimated number of users</b><br>1                                                | <b>Last updated time</b><br>November 5, 2023 at 12:32 MST |

### Getting started

Users | Groups | Sign-in experience | Sign-up experience | Messaging | **App integration** | User pool properties

### Configuration for all app clients

Domain and resource server settings for the user pool. All app clients that enable the Hosted UI use the user pool domain. All app clients can authorize access to user pool resource servers.

#### Domain Info Actions

Configure a domain for your Hosted UI and OAuth 2.0 endpoints. You must choose a domain if you need Cognito to create Hosted UI authentication endpoints. If you have an existing domain, you must delete it before assigning a new one.

|                                                                                                          |                      |
|----------------------------------------------------------------------------------------------------------|----------------------|
| <b>Cognito domain</b>                                                                                    | <b>Custom domain</b> |
| <b>Domain</b><br>https://pcul-auth-06f29200-7c12-11ee-b755-0e11297ecb0d.auth.us-east-1.amazoncognito.com | <b>Domain</b><br>-   |

#### Resource servers (0) Info Edit Delete Create resource server

Configure resource servers. A resource server is a remote server that authorizes access based on OAuth 2.0 scopes in an access token.

Search resource servers by name or ID

| Resource server name | Resource server identifier | Custom scopes |
|----------------------|----------------------------|---------------|
| No resource servers  |                            |               |

[Create resource server](#)

#### App client defaults

Hosted UI customization and advanced security settings for the user pool. You can customize the Hosted UI and advanced security in app clients to override the defaults.

#### Hosted UI customization Info Edit

Customize the hosted sign-up and sign-in pages to match your app's style and branding by uploading your own logo and customized CSS.

|                  |                        |
|------------------|------------------------|
| <b>Logo</b><br>- | <b>Custom CSS</b><br>- |
|------------------|------------------------|

#### Advanced security Info Enable

Configure advanced security features, including Cognito's automatic responses to suspicious user activity. Advanced security adds cost to your bill. [See pricing](#)

**Status**  
 Disabled

#### App client list

The app clients that integrate your apps with your user pool. Configure client overrides to user pool default configurations, and configure Amazon Pinpoint analytics.

#### App clients and analytics (1) Info Refresh Delete Create app client

Configure an app client. App clients are the user pool authentication resources attached to your app. Select an app client to configure the permitted authentication actions for an app.

Search app clients by name or ID

| App client name                                                     | Client ID |
|---------------------------------------------------------------------|-----------|
| <input type="radio"/> <a href="#">CognitoAppClient-ETqXbqI5wRVs</a> | ...       |

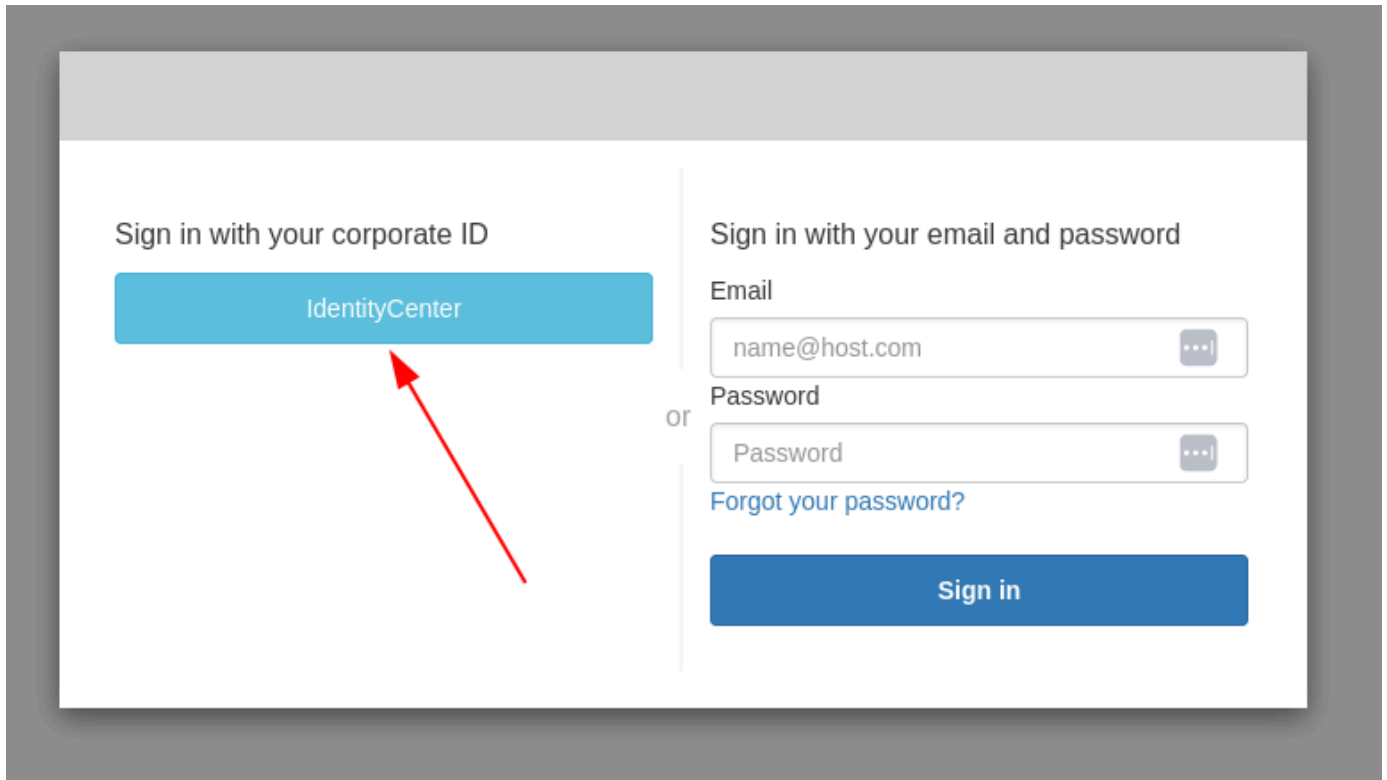
2. Under **Hosted UI** choose **Edit**
3. Under **Identity providers** choose **IdentityCenter** as well.
4. Choose **Save changes**

## Validate your setup

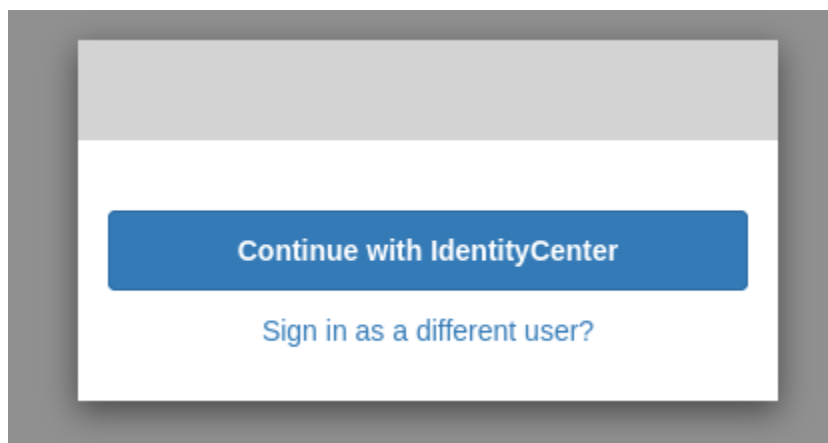
Adding your Application to IAM Identity Center

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1. Next we will validate the setup that we just created by logging in to PCUI. Sign in to your PCUI portal and you should now see an option to sign in with your Corporate ID:



2. Clicking the **IdentityCenter** button should take you to the IAM Identity Center IdP login followed by a page with your applications on it which includes PCUI, open that application.
3. Once you get to the following screen, your user will have been added to the Cognito user pool.



## Make your user an administrator

1. Now navigate to the **Amazon Cognito > User pools console** and select the newly created user which should have a prefix of identitycenter



**parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool** [Info](#) [Delete user pool](#)

### User pool overview

|                                                                           |                                                                                                     |                                                           |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| <b>User pool name</b><br>parallelcluster-ui-Cognito-ZQRNCGGD3MHU-userpool | <b>ARN</b><br><a href="#">am:aws:cognito-idp:us-east-1:000000000000:userpool/us-east-1_Bgyu7Lz6</a> | <b>Created time</b><br>November 5, 2023 at 12:32 MST      |
| <b>User pool ID</b><br><a href="#">us-east-1_Bgyu7LLz6</a>                | <b>Estimated number of users</b><br>2                                                               | <b>Last updated time</b><br>November 5, 2023 at 12:32 MST |

▶ **Getting started**

[Users](#) | [Groups](#) | [Sign-in experience](#) | [Sign-up experience](#) | [Messaging](#) | [App integration](#) | [User pool properties](#)

### Users (2) [Info](#)

View, edit, and create users in your user pool. Users that are enabled and confirmed can sign in to your user pool.

Property:   < 1 > [Settings](#)

| User name                                                | Email address            | Email verified | Confirmation status            | Status               |
|----------------------------------------------------------|--------------------------|----------------|--------------------------------|----------------------|
| <a href="#">c8f7eccc-e647-4227-afa2-080274ebfefe</a>     | user@amazon.com          | Yes            | <span>Confirmed</span>         | <span>Enabled</span> |
| <a href="#">identitycenter_admin1@corp.pcluster.c...</a> | admin1@corp.pcluster.com | No             | <span>External provider</span> | <span>Enabled</span> |

### Import users (0) [Info](#)

View and create user CSV Import jobs. Amazon Cognito can import users into this user pool from a specially-formatted CSV file. You can't import user passwords.

< 1 > [Settings](#)

| Job name                  | Status | Imported users | Skipped users | Failed users | CloudWatch logs | Created time |
|---------------------------|--------|----------------|---------------|--------------|-----------------|--------------|
| No user import jobs found |        |                |               |              |                 |              |

[Create import job](#)

2. Under **Group memberships** select **Add user to group**, choose **admin** and click **Add**.
3. Now when you click **Continue with IdentityCenter** you will be navigated to the AWS ParallelCluster UI page.

# AWS ParallelCluster troubleshooting

The AWS ParallelCluster community maintains a Wiki page that provides many troubleshooting tips on the [AWS ParallelCluster GitHub Wiki](#). For a list of known issues, see [Known issues](#).

## Topics

- [Trying to create a cluster](#)
- [Trying to run a job](#)
- [Trying to update a cluster](#)
- [Trying to access storage](#)
- [Trying to delete a cluster](#)
- [Trying to upgrade AWS ParallelCluster API stack](#)
- [Seeing errors in compute node initializations](#)
- [Troubleshooting cluster health metrics](#)
- [Troubleshooting cluster deployment issues](#)
- [Troubleshooting cluster deployment using Terraform](#)
- [Troubleshooting scaling issues](#)
- [Placement groups and instance launch issues](#)
- [Directories that cannot be replaced](#)
- [Troubleshooting issues in NICE DCV](#)
- [Troubleshooting issues in clusters with AWS Batch integration](#)
- [Troubleshooting multi-user integration with Active Directory](#)
- [Troubleshooting custom AMI issues](#)
- [Troubleshooting a cluster update timeout when cfn-hup isn't running](#)
- [Network troubleshooting](#)
- [Cluster update failed on onNodeUpdated custom action](#)
- [Seeing errors with custom Slurm configuration](#)
- [Cluster Alarms](#)
- [Additional support](#)

## Trying to create a cluster

When using AWS ParallelCluster version 3.5.0 and later to create a cluster, and a cluster creation failed with `--rollback-on-failure` set to `false`, use the [`pcluster describe-cluster`](#) CLI command to get status and failure information. In this case, the expected `clusterStatus` of the `pcluster describe-cluster` output is `CREATE_FAILED`. Check the `failures` section in the output to find the `failureCode` and `failureReason`. Then, in the following section, find the matching `failureCode` for additional troubleshooting help. For more information, see [`pcluster describe-cluster`](#).

In the following sections, we recommend that you check the logs on the head node, such as the `/var/log/cfn-init.log` and `/var/log/chef-client.log` files. For more information about AWS ParallelCluster logs and how to view them, see [Key logs for debugging](#) and [Retrieving and preserving logs](#).

If you don't have a `failureCode`, navigate to the AWS CloudFormation console to view the cluster stack. Check the `Status Reason` for the `HeadNodeWaitCondition` or failures on other resources to find additional failure details. For more information, see [View AWS CloudFormation events on CREATE\\_FAILED](#). Check the `/var/log/cfn-init.log` and `/var/log/chef-client.log` files on the head node.

### failureCode is OnNodeConfiguredExecutionFailure

- **Why did it fail?**

You provided a custom script in `OnNodeConfigured` of the head node section in the configuration to create a cluster. However, the custom script failed to run.

- **How to resolve?**

Check the `/var/log/cfn-init.log` file to learn more about the failure and how to fix the issue in your custom script. Near the end of this log, you might see run information related to the `OnNodeConfigured` script after the `Running` command `runpostinstall` message.

### failureCode is OnNodeConfiguredDownloadFailure

- **Why did it fail?**

You provided a custom script in `OnNodeConfigured` of the head node section in the configuration to create a cluster. However, the custom script failed to download.

- **How to resolve?**

Make sure that the URL is valid and that the access is correctly configured. For more information on the configuration of custom bootstrap scripts, see [Custom bootstrap actions](#).

Check the `/var/log/cfn-init.logfile`. Near the end of this log, you might see run information related to `OnNodeConfigured` script processing, including downloading, after the `Running` command `runpostinstall` message.

## **failureCode is OnNodeConfiguredFailure**

- **Why did it fail?**

You provided a custom script in `OnNodeConfigured` of the head node section in the configuration to create a cluster. However, the use of the custom script failed in the cluster deployment. An immediate cause can't be determined and additional investigation is needed.

- **How to resolve?**

Check the `/var/log/cfn-init.logfile`. Near the end of this log, you might see run information related to `OnNodeConfigured` script processing after the `Running` command `runpostinstall` message.

## **failureCode is OnNodeStartExecutionFailure**

- **Why did it fail?**

You provided a custom script in `OnNodeStart` of the head node section in the configuration to create a cluster. However, the custom script failed to run.

- **How to resolve?**

Check the `/var/log/cfn-init.log` file to learn more about the failure and how to fix the issue in your custom script. Near the end of this log, you might see run information related to the `OnNodeStart` script after the `Running` command `runpreinstall` message.

## failureCode is OnNodeStartDownloadFailure

- **Why did it fail?**

You provided a custom script in `OnNodeStart` of the head node section in the configuration to create a cluster. However, the custom script failed to download.

- **How to resolve?**

Make sure that the URL is valid and that the access is correctly configured. For more information on the configuration of custom bootstrap scripts, see [Custom bootstrap actions](#).

Check the `/var/log/cfn-init.logfile`. Near the end of this log, you might see run information related to `OnNodeStart` script processing, including downloading, after the Running command `runpreinstall` message.

## failureCode is OnNodeStartFailure

- **Why did it fail?**

You provided a custom script in the `OnNodeStart` of the head node section in the configuration to create a cluster. However, the use of the custom script failed in the cluster deployment. An immediate cause can't be determined and additional investigation is needed.

- **How to resolve?**

Check the `/var/log/cfn-init.logfile`. Near the end of this log, you might see run information related to `OnNodeStart` script processing after the Running command `runpreinstall` message.

## failureCode is EbsMountFailure

- **Why did it fail?**

The EBS volume defined in the cluster configuration failed to mount.

- **How to resolve?**

Check the `/var/log/chef-client.log` file for failure details.

## failureCode is EfsMountFailure

- **Why did it fail?**

The Amazon EFS volume defined in the cluster configuration failed to mount.

- **How to resolve?**

If you defined an existing Amazon EFS file system, make sure that traffic is allowed between the cluster and the file system. For more information, see [SharedStorage](#) / [EfsSettings](#) / [FileSystemId](#).

Check the `/var/log/chef-client.log` file for failure details.

## failureCode is FsxMountFailure

- **Why did it fail?**

The Amazon FSx file system defined in the cluster configuration failed to mount.

- **How to resolve?**

If you defined an existing Amazon FSx file system, make sure that traffic is allowed between the cluster and the file system. For more information, see [SharedStorage](#) / [FsxLustreSettings](#) / [FileSystemId](#).

Check the `/var/log/chef-client.log` file for failure details.

## failureCode is RaidMountFailure

- **Why did it fail?**

The RAID volumes defined in the cluster configuration failed to mount.

- **How to resolve?**

Check the `/var/log/chef-client.log` file for failure details.

## failureCode is AmiVersionMismatch

- **Why did it fail?**

The AWS ParallelCluster version used to create the custom AMI is different than the AWS ParallelCluster version used to configure the cluster. In the CloudFormation console, view the cluster CloudFormation stack details and check the Status Reason for the HeadNodeWaitCondition to get additional details on the AWS ParallelCluster versions and the AMI. For more information, see [View AWS CloudFormation events on CREATE\\_FAILED](#).

- **How to resolve?**

Make sure the AWS ParallelCluster version used to create the custom AMI is the same AWS ParallelCluster version used to configure the cluster. You can change either the custom AMI version or the `pcluster` CLI version to make them the same.

## failureCode is InvalidAmi

- **Why did it fail?**

The custom AMI is invalid because it wasn't built using AWS ParallelCluster.

- **How to resolve?**

Use the `pcluster build-image` command to create an AMI by making your AMI the parent image. For more information, see [pcluster build-image](#).

## failureCode is HeadNodeBootstrapFailure with failureReason Failed to set up the head node.

- **Why did it fail?**

An immediate cause can't be determined and additional investigation is needed. For example, it could be that the cluster is in protected status, and this could be caused by a failure to provision the static compute fleet.

- **How to resolve?**

Check the `/var/log/chef-client.log` file for failure details.

**Note**

If you see `RuntimeError` exception Cluster state has been set to `PROTECTED` mode due to failures detected in static node provisioning, the cluster is in protected status. For more information, see [How to debug protected mode](#).

## **failureCode is HeadNodeBootstrapFailure with failureReason Cluster creation timed out.**

- **Why did it fail?**

By default, there is a 30 minute time limit for cluster creation to complete. If cluster creation hasn't completed within this time frame, the cluster creation fails with a timeout error. The cluster creation can timeout for different reasons. For example, timeout failures can be caused by a head node creation failure, a network issue, custom scripts that take too long to run in the head node, an error in a custom script that runs in compute nodes, or long wait times for compute node provisioning. An immediate cause can't be determined and additional investigation is needed.

- **How to resolve?**

Check the `/var/log/cfn-init.log` and `/var/log/chef-client.log` files for failure details. For more information about AWS ParallelCluster logs and how to get them, see [Key logs for debugging](#) and [Retrieving and preserving logs](#).

You might discover the following in these logs.

- **Seeing `Waiting for static fleet capacity provisioning near the end of the chef-client.log`**

This indicates that the cluster creation timed out when waiting for static nodes to power up. For more information, see [Seeing errors in compute node initializations](#).

- **Seeing `OnNodeConfigured` or `OnNodeStart` head node script hasn't finished at the end of the `cfn-init.log`**

This indicates that the `OnNodeConfigured` or `OnNodeStart` custom script took a long time to run and caused a timeout error. Check your custom script for issues that might cause it to



run for a long time. If your custom script requires a long time to run, consider changing the timeout limit by adding a `DevSettings` section to your cluster configuration file, as shown in the following example:

```
DevSettings:
  Timeouts:
    HeadNodeBootstrapTimeout: 1800 # default setting: 1800 seconds
```

- **Can't find the logs, or the head node wasn't created successfully**

It's possible that the head node wasn't created successfully and the logs can't be found. In the CloudFormation console, view the cluster stack details to check for additional failure details.

## **failureCode is HeadNodeBootstrapFailure with failureReason Failed to bootstrap the head node.**

- **Why did it fail?**

An immediate cause can't be determined and additional investigation is needed.

- **How to resolve?**

Check the `/var/log/cfn-init.log` and `/var/log/chef-client.log` files.

## **failureCode is ResourceCreationFailure**

- **Why did it fail?**

The creation of some resources failed during the cluster creation process. The failure can occur for various reasons. For example, resource creation failures can be caused by capacity issues or a misconfigured IAM policy.

- **How to resolve?**

In the CloudFormation console, view the cluster stack to check for additional resource creation failure details.

## **failureCode is ClusterCreationFailure**

- **Why did it fail?**

An immediate cause can't be determined and additional investigation is needed.

- **How to resolve?**

In the CloudFormation console, view the cluster stack and check the Status Reason for the HeadNodeWaitCondition to find additional failure details.

Check the `/var/log/cfn-init.log` and `/var/log/chef-client.log` files.

## **Seeing WaitCondition timed out... in CloudFormation stack**

For more information, see [failureCode is HeadNodeBootstrapFailure with failureReason Cluster creation timed out..](#)

## **Seeing Resource creation cancelled in CloudFormation stack**

For more information, see [failureCode is ResourceCreationFailure.](#)

## **Seeing Failed to run cfn-init... or other errors in the AWS CloudFormation stack**

Check the `/var/log/cfn-init.log` and `/var/log/chef-client.log` for additional failure details.

## **Seeing chef-client.log ends with INFO: Waiting for static fleet capacity provisioning**

This is related to cluster creation timeout when waiting for static nodes to power up. For more information, see [Seeing errors in compute node initializations.](#)

## Seeing Failed to run preinstall or postinstall in cfn-init.log

You have an `OnNodeConfigured` or `OnNodeStart` script in the cluster configuration `HeadNode` section. The script isn't working correctly. Check the `/var/log/cfn-init.log` file for custom script error details.

## Seeing This AMI was created with xxx, but is trying to be used with xxx... in CloudFormation stack

For more information, see [failureCode is AmiVersionMismatch](#).

## Seeing This AMI was not baked by AWS ParallelCluster... in CloudFormation stack

For more information, see [failureCode is InvalidAmi](#).

## Seeing pcluster create-cluster command fails to run locally

Check the `~/.parallelcluster/pcluster-cli.log` in your local file system for failure details.

## Additional support

Follow the troubleshooting guidance in [Troubleshooting cluster deployment issues](#).

Check to see if your scenario is covered in [GitHub Known Issues](#) at AWS ParallelCluster on GitHub.

For additional support, see [Additional support](#).

## Trying to run a job

**srun interactive job fails with error srun: error:  
fwd\_tree\_thread: can't find address for <host>, check  
slurm.conf**

- Why did it fail?

You ran the `srun` command to submit a job, and then you increased the size of a queue by using the `pcluster update-cluster` command without restarting the Slurm daemons after the update completed.

Slurm organizes Slurm daemons in a tree hierarchy to optimize communication. This hierarchy is only updated when the daemons start.

Suppose you use `srun` to launch a job and then run the `pcluster update-cluster` command to increase the size of the queue. New compute nodes launch as part of the update. Then, Slurm queues your job to one of the new compute nodes. In this case, both the Slurm daemons and `srun` don't detect the new compute nodes. `srun` returns an error because it doesn't detect the new nodes.

- **How to resolve?**

Restart the Slurm daemons on all of the compute nodes, and then use `srun` to submit your job. You can schedule the Slurm daemons restart by running the `scontrol reboot` command that restarts the compute nodes. For more information, see [scontrol reboot](#) in the Slurm documentation. You can also manually restart the Slurm daemons on the compute nodes by requesting a restart of the corresponding `systemd` services.

## Job is stuck in CF state with `squeue` command

This might be an issue with dynamic nodes powering up. For more information, see [Seeing errors in compute node initializations](#).

## Running large scale jobs and seeing `nfsd: too many open connections, consider increasing the number of threads in /var/log/messages`

With a networked file system, when network limits are reached, I/O wait time also increases. This can result in soft lockups because the network is used to write data for both networking and I/O metrics.

With 5th generation instances, we use the ENA driver to expose packet counters. These counters count the packets shaped by AWS when the network reaches instance bandwidth limits. You can check these counters to see if they are greater than 0. If they are, then you have exceeded

your bandwidth limits. You can view these counters by running `ethtool -S eth0 | grep exceeded`.

Exceeding network limits is often a result of supporting too many NFS connections. This is one of the first things to check when you reach or exceed network limits.

For example, the following output shows dropped packages:

```
$ ethtool -S eth0 | grep exceeded
bw_in_allowance_exceeded: 38750610
bw_out_allowance_exceeded: 1165693
pps_allowance_exceeded: 103
contrack_allowance_exceeded: 0
linklocal_allowance_exceeded: 0
```

To avoid getting this message, consider changing the head node instance type to a more performant instance type. Consider moving your data storage to shared storage file systems that aren't exported as an NFS share, such as Amazon EFS or Amazon FSx. For more information, see [Shared storage](#) and the [Best Practices](#) at the AWS ParallelCluster Wiki on GitHub.

## Running an MPI job

### Enabling debug mode

To enable OpenMPI debug mode, see [What controls does Open MPI have that aid in debugging](#).

To enable IntelMPI debug mode, see [Other Environment Variables](#).

### Seeing MPI\_ERRORS\_ARE\_FATAL and OPAL ERROR in the job output

These error codes come from the MPI layer in your application. To learn how to get MPI debug logs from your application, see [Enabling debug mode](#).

A possible cause for this error is that your application has been compiled for a specific MPI implementation, such as OpenMPI, and you are trying to run it with a different MPI implementation, such as IntelMPI. Make sure you are both compiling and running your application with the same MPI implementation.

### Using `mpirun` with managed DNS disabled

For clusters created with [SlurmSettings](#) / [Dns](#) / [DisableManagedDns](#) and [UseEc2Hostnames](#) set to `true`, the Slurm node name isn't resolved by the DNS. Slurm can bootstrap MPI processes when

nodenames aren't enabled and if the MPI job is run in a Slurm context. We recommend following the guidance in the [Slurm MPI User's Guide](#) to run MPI jobs with Slurm.

## Trying to update a cluster

### `pcluster update-cluster` command fails to run locally

Check the `~/.parallelcluster/pcluster-cli.log` in your local file system for failure details.

### Seeing `clusterStatus` is `UPDATE_FAILED` with `pcluster describe-cluster` command

If the cluster stack update rolled back, check the `/var/log/chef-client.logs` file for error details.

Check to see if your issue is mentioned in [GitHub Known Issues](#) at AWS ParallelCluster on GitHub.

## The cluster update timed out

This could be an issue related to `cf-n-hup` not running. If the `cf-n-hup` demon is terminated by an external cause, it's not restarted automatically. If `cf-n-hup` isn't running, during a cluster update, the CloudFormation stack starts the update process as expected, but the update procedure isn't activated on the head node and the stack deployment eventually times out. For more information, see [Troubleshooting a cluster update timeout when `cf-n-hup` isn't running](#) to troubleshoot and recover from the issue.

## Trying to access storage

### Using an external Amazon FSx for Lustre file system

Make sure that traffic is allowed between the cluster and file system. The file system must be associated with a security group that allows inbound and outbound TCP traffic through ports 988, 1021, 1022, and 1023. For more information about how to set up security groups, see [FileSystemId](#).

### Using an external Amazon Elastic File System file system

Make sure that traffic is allowed between the cluster and file system. The file system must be associated with a security group that allows inbound and outbound TCP traffic through ports

988, 1021, 1022, and 1023. For more information about how to set up security groups, see [FileSystemId](#).

## Trying to delete a cluster

### The `pcluster delete-cluster` command fails to run locally

Check the `~/.parallelcluster/pcluster-cli.log` file in your local file system.

### The cluster stack fails to delete

If the cluster stack fails to delete, check the CloudFormation stack events message.

Check if your issue is mentioned in [GitHub Known Issues](#) at AWS ParallelCluster on GitHub.

## Trying to upgrade AWS ParallelCluster API stack

Check if your issue is mentioned in [GitHub Known Issues](#) at AWS ParallelCluster on GitHub.

## Seeing errors in compute node initializations

### Seeing Node bootstrap error in `clustermgtd.log`

The problem is related to compute nodes failing to bootstrap. For information on how to debug a cluster protected mode issue, see [How to debug protected mode](#).

### I configured on demand capacity reservations (ODCRs) or zonal Reserved Instances

#### ODCRs that include instances that have multiple network interfaces, such as P4d, P4de, and AWS Trainium (Trn)

In the cluster configuration file, check that the HeadNode is in a public subnet and that the compute nodes are in a private subnet.

## ODCRs are targeted ODCRS

Seeing **Unable to read file '/opt/slurm/etc/pcluster/run\_instances\_overrides.json'**. even though I already have `/opt/slurm/etc/pcluster/run_instances_overrides.json` in place by following the instructions given in [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#)

If you are using AWS ParallelCluster versions 3.1.1 to 3.2.1 with targeted ODCRs, and you are also using the [run instances override JSON file](#), it's possible that you don't have the JSON file formatted correctly. You could see an error in `clustermgtd.log`, such as the following:

```
Unable to read file '/opt/slurm/etc/pcluster/run_instances_overrides.json'.  
Using default: {} in /var/log/parallelcluster/clustermgtd.
```

Validate that the JSON file format is correct by running the following:

```
$ echo /opt/slurm/etc/pcluster/run_instances_overrides.json | jq
```

Seeing **Found RunInstances parameters override. in clustermgtd.log when cluster creation failed, or in slurm\_resume.log when run job failed**

If you are using [run instances override JSON file](#), check that you correctly set the queue name and the compute resources name in the `/opt/slurm/etc/pcluster/run_instances_overrides.json` file.

Seeing **An error occurred (InsufficientInstanceCapacity) in slurm\_resume.log when I fail to a run job, or in clustermgtd.log when I fail to create a cluster**

### Using PG-ODCR (Placement Group ODCR)

When creating an ODCR with an associated placement group, the same placement group name must be used in the configuration file. Set the corresponding [placement group name](#) in the cluster configuration.

### Using zonal Reserved Instances

If you are using zonal Reserved Instances with `PlacementGroup / Enabled` to `true` in the cluster configuration, you might see an error, such as the following:



We currently do not have sufficient `trn1.32xlarge` capacity in the Availability Zone you requested (`us-east-1d`). Our system will be working on provisioning additional capacity.

You can currently get `trn1.32xlarge` capacity by not specifying an Availability Zone in your request or choosing `us-east-1a`, `us-east-1b`, `us-east-1c`, `us-east-1e`, `us-east-1f`.

You might see this because the zonal Reserved Instances aren't placed in the same UC (or spine), which can cause insufficient capacity errors (ICEs) when using placement groups. You can check this case by disabling the `PlacementGroupGroup` setting in the cluster configuration to determine if the cluster can allocate the instances.

## Seeing An error occurred (`VcpuLimitExceeded`) in `slurm_resume.log` when I fail to run a job, or in `clustermgtd.log`, when I fail to create a cluster

Check the vCPU limits on your account for the specific Amazon EC2 instance type that you are using. If you see zero or fewer vCPUs than you are requesting, request an increase for your limits. For information about how to view current limits and request new limits, see [Amazon EC2 service quotas](#) in the *Amazon EC2 User Guide*.

## Seeing An error occurred (`InsufficientInstanceCapacity`) in `slurm_resume.log` when I fail to run a job, or in `clustermgtd.log`, when I fail to create a cluster

You are experiencing an insufficient capacity issue. Follow <https://aws.amazon.com/premiumsupport/knowledge-center/ec2-insufficient-capacity-errors/> to troubleshoot the issue.

## Seeing nodes are in DOWN state with Reason (`Code:InsufficientInstanceCapacity`)...

You are experiencing an insufficient capacity issue. Follow <https://aws.amazon.com/premiumsupport/knowledge-center/ec2-insufficient-capacity-errors/> to troubleshoot the issue. For more information about AWS ParallelCluster's fast insufficient capacity fail-over mode, see [Slurm cluster fast insufficient capacity fail-over](#).

## Seeing cannot change locale (en\_US.utf-8) because it has an invalid name in slurm\_resume.log

This can occur if you have an unsuccessful yum installation process that left the locale settings in an inconsistent state. For example, this can be caused when a user terminates the install process.

**To verify the cause, take the following actions:**

- Run `su - pcluster-admin`.

The shell shows an error, such as, `cannot change locale...no such file or directory`.

- Run `localedef --list`.

Returns an empty list or doesn't contain the default locale.

- Check the last yum command with `yum history` and `yum history info #ID`. Does the last ID have `Return-Code: Success`?

If the last ID doesn't have `Return-Code: Success`, the post-install scripts might not have run successfully.

To fix the issue, try rebuilding the locale with `yum reinstall glibc-all-langpacks`. After the rebuild, `su - pcluster-admin` doesn't show an error or warning if the issue is fixed.

## None of the previous scenarios apply to my situation

To troubleshoot compute node initialization issues, see [Troubleshooting node initialization issues](#).

Check to see if your scenario is covered in [GitHub Known Issues](#) at AWS ParallelCluster on GitHub.

For additional support, see [Additional support](#).

## Troubleshooting cluster health metrics

Cluster health metrics are added to the AWS ParallelCluster Amazon CloudWatch dashboard starting with AWS ParallelCluster version 3.6.0. In the following sections, you can learn about the dashboard health metrics, and actions you can take to troubleshoot and resolve issues.

## Topics

- [Seeing the Instance Provisioning Errors graph](#)
- [Seeing the Unhealthy Instance Errors graph](#)
- [Seeing the Compute Fleet Idle Time graph](#)

## Seeing the Instance Provisioning Errors graph

If you see a non-zero value in the Instance Provisioning Errors graph, then it means that the Amazon EC2 instance for backing slurm nodes failed to launch on the CreateFleet or RunInstance API.

### Seeing IAMPolicyErrors

- **What happened?**

A number of instances failed to launch, which is caused by insufficient permissions with error code `UnauthorizedOperation`.

- **How to resolve?**

If you have configured a custom [InstanceRole](#) or [InstanceProfile](#), check your IAM policies and verify that you are using the correct credentials.

Check the `clustermgtd` file for static node error details. Check the `slurm_resume.log` file for dynamic node error details. Use the details to learn more about the missing permissions that must be added.

### Seeing VcpuLimitErrors

- **What happened?**

AWS ParallelCluster failed to launch instances because it reached the vCPU limit on your AWS account for a specific Amazon EC2 instance type that you configured for cluster compute nodes.

- **How to resolve?**

Check for the `VcpuLimitExceeded` error in the `clustermgtd` file for static nodes, and check in the `slurm_resume.log` file for dynamic nodes to get additional details. To resolve this issue, you can request an increase to your vCPU limits. For more information about how to view current

limits and request new limits, see [Amazon Elastic Compute Cloud service quotas](#) in the *Amazon Elastic Compute Cloud User Guide for Linux Instances*.

## Seeing VolumeLimitErrors

- **What happened?**

You have reached your Amazon EBS volume limit on your AWS account, and AWS ParallelCluster is unable to launch instances with error code `InsufficientVolumeCapacity` or `VolumeLimitExceeded`.

- **How to resolve?**

Check the `clustermgtd` file for static nodes, and check the `slurm_resume.log` file for dynamic nodes to get additional volume limit details. To resolve this issue, you can use a different AWS Region, clean up existing volumes, or contact the AWS Support Center to submit a request to increase your Amazon EBS volume limit.

## Seeing InsufficientCapacityErrors

- **What happened?**

AWS ParallelCluster doesn't have sufficient capacity to launch Amazon EC2 instances to back nodes.

- **How to resolve?**

Check the `clustermgtd` file for static nodes, and check the `slurm_resume.log` file for dynamic nodes to get insufficient capacity error details. To troubleshoot the issue, follow the guidance at <https://aws.amazon.com/premiumsupport/knowledge-center/ec2-insufficient-capacity-errors/>.

## OtherInstanceLaunchFailures

- **What happened?**

The Amazon EC2 instance for backing compute nodes failed to launch with the `CreateFleet` or `RunInstance` API.

- **How to resolve?**

Check the `clustermgtd` file for static nodes, and check the `slurm_resume.log` file for dynamic nodes to get error details.

## Seeing the Unhealthy Instance Errors graph

- **What happened?**

A number of compute instances were launched but later terminated as unhealthy.

- **How to resolve?**

For more information about troubleshooting unhealthy nodes, see [Troubleshooting unexpected node replacements and terminations](#).

## Seeing InstanceBootstrapTimeoutError

- **What happened?**

An instance can't join the cluster within the `resume_timeout` (for dynamic nodes) or `node_replacement_timeout` (for static nodes). This can occur if the network isn't configured correctly for the compute nodes, or it can occur if custom scripts running on the compute node take too long to finish.

- **How to resolve?**

For dynamic nodes, check the `clustermgtd` log (`/var/log/parallelcluster/clustermgtd`) for the compute node IP address and errors such as the following:

```
Node bootstrap error: Resume timeout expires for node
```

For static nodes, check the `clustermgtd` log (`/var/log/parallelcluster/clustermgtd`) for the compute node IP address and errors such as the following:

```
Node bootstrap error: Replacement timeout expires for node ... in replacement.
```

For additional details, check the `/var/log/cloud-init-output.log` file for errors. You can retrieve problematic compute node IP addresses from the `clustermgtd` and `slurm_resume` log files.

## Seeing EC2HealthCheckErrors

- **What happened?**

An instance failed an Amazon EC2 health check.

- **How to resolve?**

For information about how to troubleshoot this issue, see [Troubleshoot instances with failed status checks](#).

## Seeing ScheduledEventHealthCheckErrors

- **What happened?**

An instance failed an Amazon EC2 scheduled event health check, and it's unhealthy.

- **How to resolve?**

For information about how to troubleshoot this issue, see [Scheduled events for your instances](#).

## Seeing NoCorrespondingInstanceErrors

- **What happened?**

AWS ParallelCluster can't find instances backing nodes. The nodes have likely self-terminated during bootstrap operations. [SlurmQueues](#) / [CustomActions](#) / [OnNodeStart](#) | [OnNodeConfigured](#) script, or network errors can produce NoCorrespondingInstanceErrors.

- **How to resolve?**

For additional details, check the `/var/log/cloud-init-output.log` for the compute node.

## Seeing the Compute Fleet Idle Time graph

### Seeing a MaxDynamicNodeIdleTime that is significantly longer than the Idle Time Scaledown threshold

- **What happened?**

Your instance isn't terminating properly. `MaxDynamicNodeIdleTime` shows the maximum time in seconds that a dynamic node, backed by an Amazon EC2 instance, is idle. The **Idle Time Scaledown** threshold is derived from the cluster configuration [ScaledownIdleTime](#) parameter. When a compute node has been idle for more than **Idle Time Scaledown** seconds, Slurm powers down the node and AWS ParallelCluster terminates the backing instance. In this case, something is preventing the instance termination.

- **How to resolve?**

For more information about this issue, see [Replacing, terminating, or powering down problematic instances and nodes](#) in [Troubleshooting scaling issues](#).

## Troubleshooting cluster deployment issues

If your cluster fails to be created and rolls back stack creation, you can look through the log files to diagnose the issue. The failure message likely looks like the following output:

```
$ pcluster create-cluster --cluster-name mycluster --region eu-west-1 \
--cluster-configuration cluster-config.yaml
{
  "cluster": {
    "clusterName": "mycluster",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:xxx:stack/
mycluster/1bf6e7c0-0f01-11ec-a3b9-024fcc6f3387",
    "region": "eu-west-1",
    "version": "3.7.0",
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}

$ pcluster describe-cluster --cluster-name mycluster --region eu-west-1
{
  "creationTime": "2021-09-06T11:03:47.696Z",
  ...
  "cloudFormationStackStatus": "ROLLBACK_IN_PROGRESS",
  "clusterName": "mycluster",
  "computeFleetStatus": "UNKNOWN",
  "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:xxx:stack/
mycluster/1bf6e7c0-0f01-11ec-a3b9-024fcc6f3387",
  "lastUpdatedTime": "2021-09-06T11:03:47.696Z",
```

```
"region": "eu-west-1",  
"clusterStatus": "CREATE_FAILED"  
}
```

## Topics

- [View AWS CloudFormation events on CREATE\\_FAILED](#)
- [Use the CLI to view log streams](#)
- [Re-create the failed cluster with rollback-on-failure](#)

## View AWS CloudFormation events on CREATE\_FAILED

You can use the console or the AWS ParallelCluster CLI to view CloudFormation events on CREATE\_FAILED errors to help find the root cause.

### Topics

- [View events in the CloudFormation console](#)
- [Use the CLI to view and filter CloudFormation events on CREATE\\_FAILED](#)

## View events in the CloudFormation console

To see more information about what caused the "CREATE\_FAILED" status, you can use the CloudFormation console.

### View CloudFormation error messages from the console.

1. Log in to the AWS Management Console and navigate to <https://console.aws.amazon.com/cloudformation>.
2. Select the stack named *cluster\_name*.
3. Choose the **Events** tab.
4. Check the **Status** for the resource that failed to create by scrolling through the list of resource events by **Logical ID**. If a subtask failed to create, work backwards to find the failed resource event.
5. As an example, if you see the following status message, you must use instance types that won't exceed your current vCPU limit or request more vCPU capacity.



```
2022-02-04 16:09:44 UTC-0800 HeadNode CREATE_FAILED You have requested more vCPU
capacity than your current vCPU limit of 0 allows
    for the instance bucket that the specified instance type belongs to. Please
visit http://aws.amazon.com/contact-us/ec2-request to request an adjustment to
this limit.
    (Service: AmazonEC2; Status Code: 400; Error Code: VcpuLimitExceeded; Request
ID: a9876543-b321-c765-d432-dcba98766789; Proxy: null).
```

## Use the CLI to view and filter CloudFormation events on CREATE\_FAILED

To diagnose the cluster creation issue, you can use the `pcluster get-cluster-stack-events` command by filtering for `CREATE_FAILED` status. For more information, see [Filtering AWS CLI output](#) in the *AWS Command Line Interface User Guide*.

```
$ pcluster get-cluster-stack-events --cluster-name mycluster --region eu-west-1 \
  --query 'events[?resourceStatus==`CREATE_FAILED`]'
[
  {
    "eventId": "3ccdedd0-0f03-11ec-8c06-02c352fe2ef9",
    "physicalResourceId": "arn:aws:cloudformation:eu-west-1:xxx:stack/
mycluster/1bf6e7c0-0f02-11ec-a3b9-024fcc6f3387",
    "resourceStatus": "CREATE_FAILED",
    "resourceStatusReason": "The following resource(s) failed to create: [HeadNode].",
    "stackId": "arn:aws:cloudformation:eu-west-1:xxx:stack/
mycluster/1bf6e7c0-0f02-11ec-a3b9-024fcc6f3387",
    "stackName": "mycluster",
    "logicalResourceId": "mycluster",
    "resourceType": "AWS::CloudFormation::Stack",
    "timestamp": "2021-09-06T11:11:51.780Z"
  },
  {
    "eventId": "HeadNode-CREATE_FAILED-2021-09-06T11:11:50.127Z",
    "physicalResourceId": "i-04e91cc1f4ea796fe",
    "resourceStatus": "CREATE_FAILED",
    "resourceStatusReason": "Received FAILURE signal with UniqueId
i-04e91cc1f4ea796fe",
    "resourceProperties": "{\"LaunchTemplate\":{\"Version\":\"1\",\"LaunchTemplateId
\":\"lt-057d2b1e687f05a62\"}}",
    "stackId": "arn:aws:cloudformation:eu-west-1:xxx:stack/
mycluster/1bf6e7c0-0f02-11ec-a3b9-024fcc6f3387",
```

```
    "stackName": "mycluster",
    "logicalResourceId": "HeadNode",
    "resourceType": "AWS::EC2::Instance",
    "timestamp": "2021-09-06T11:11:50.127Z"
  }
]
```

In the previous example, the failure was in the head node setup.

## Use the CLI to view log streams

To debug this kind of issue, you can list the log streams available from the head node with the [`pcluster list-cluster-log-streams`](#) by filtering for node-type and then analyzing the log streams content.

```
$ pcluster list-cluster-log-streams --cluster-name mycluster --region eu-west-1 \
--filters 'Name=node-type,Values=HeadNode'
{
  "logStreams": [
    {
      "logStreamArn": "arn:aws:logs:eu-west-1:xxx:log-group:/aws/parallelcluster/
mycluster-202109061103:log-stream:ip-10-0-0-13.i-04e91cc1f4ea796fe.cfn-init",
      "logStreamName": "ip-10-0-0-13.i-04e91cc1f4ea796fe.cfn-init",
      ...
    },
    {
      "logStreamArn": "arn:aws:logs:eu-west-1:xxx:log-group:/aws/parallelcluster/
mycluster-202109061103:log-stream:ip-10-0-0-13.i-04e91cc1f4ea796fe.chef-client",
      "logStreamName": "ip-10-0-0-13.i-04e91cc1f4ea796fe.chef-client",
      ...
    },
    {
      "logStreamArn": "arn:aws:logs:eu-west-1:xxx:log-group:/aws/parallelcluster/
mycluster-202109061103:log-stream:ip-10-0-0-13.i-04e91cc1f4ea796fe.cloud-init",
      "logStreamName": "ip-10-0-0-13.i-04e91cc1f4ea796fe.cloud-init",
      ...
    },
    ...
  ]
}
```

The two primary log streams that you can use to find initialization errors are the following:

- `cfn-init` is the log for the `cfn-init` script. First check this log stream. You're likely to see the `Command chef failed` error in this log. Look at the lines immediately before this line for more specifics connected with the error message. For more information, see [cfn-init](#).
- `cloud-init` is the log for [cloud-init](#). If you don't see anything in `cfn-init`, then try checking this log next.

You can retrieve the content of the log stream by using the [pcluster get-cluster-log-events](#) (note the `--limit 5` option to limit the number of retrieved events):

```
$ pcluster get-cluster-log-events --cluster-name mycluster \  
  --region eu-west-1 --log-stream-name ip-10-0-0-13.i-04e91cc1f4ea796fe.cfn-init \  
  --limit 5  
{  
  "nextToken": "f/36370880979637159565202782352491087067973952362220945409/s",  
  "prevToken": "b/36370880752972385367337528725601470541902663176996585497/s",  
  "events": [  
    {  
      "message": "2021-09-06 11:11:39,049 [ERROR] Unhandled exception during build:  
Command runpostinstall failed",  
      "timestamp": "2021-09-06T11:11:39.049Z"  
    },  
    {  
      "message": "Traceback (most recent call last):\n  File \"/opt/aws/bin/  
cfn-init\"", line 176, in <module>\n    worklog.build(metadata, configSets)\n  File \"/usr/lib/python3.7/site-packages/cfnbootstrap/construction.py\"", line  
135, in build\n    Contractor(metadata).build(configSets, self)\n  File \"/  
usr/lib/python3.7/site-packages/cfnbootstrap/construction.py\"", line 561, in  
build\n    self.run_config(config, worklog)\n  File \"/usr/lib/python3.7/  
site-packages/cfnbootstrap/construction.py\"", line 573, in run_config\n    CloudFormationCarpenter(config, self._auth_config).build(worklog)\n  File \"/usr/  
lib/python3.7/site-packages/cfnbootstrap/construction.py\"", line 273, in build\n    self._config.commands)\n  File \"/usr/lib/python3.7/site-packages/cfnbootstrap/  
command_tool.py\"", line 127, in apply\n    raise ToolError(u"Command %s failed\" %  
name)",  
      "timestamp": "2021-09-06T11:11:39.049Z"  
    },  
    {  
      "message": "cfnbootstrap.construction_errors.ToolError: Command runpostinstall  
failed",  
      "timestamp": "2021-09-06T11:11:39.049Z"  
    },  
  ]  
}
```

```
{
  "message": "2021-09-06 11:11:49,212 [DEBUG] CloudFormation client initialized
with endpoint https://cloudformation.eu-west-1.amazonaws.com",
  "timestamp": "2021-09-06T11:11:49.212Z"
},
{
  "message": "2021-09-06 11:11:49,213 [DEBUG] Signaling resource HeadNode in stack
mycluster with unique ID i-04e91cc1f4ea796fe and status FAILURE",
  "timestamp": "2021-09-06T11:11:49.213Z"
}
]
}
```

In the previous example, the failure is caused by a `runpostinstall` failure, so it is strictly related to the content of the custom bootstrap script used in the `OnNodeConfigured` configuration parameter of the [CustomActions](#).

## Re-create the failed cluster with `rollback-on-failure`

AWS ParallelCluster creates cluster CloudWatch log streams in log groups. You can view these logs in the CloudWatch console **Custom Dashboards** or **Log groups**. For more information, see [Integration with Amazon CloudWatch Logs](#) and [Amazon CloudWatch dashboard](#). If there are no log streams available, the failure might be caused by the [CustomActions](#) custom bootstrap script or an AMI-related issue. To diagnose the creation issue in this case, create the cluster again using [pcluster create-cluster](#), including the `--rollback-on-failure` parameter set to `false`. Then, use SSH to view the cluster, as shown in the following:

```
$ pcluster create-cluster --cluster-name mycluster --region eu-west-1 \
  --cluster-configuration cluster-config.yaml --rollback-on-failure false
{
  "cluster": {
    "clusterName": "mycluster",
    "cloudformationStackStatus": "CREATE_IN_PROGRESS",
    "cloudformationStackArn": "arn:aws:cloudformation:eu-west-1:xxx:stack/
mycluster/1bf6e7c0-0f01-11ec-a3b9-024fcc6f3387",
    "region": "eu-west-1",
    "version": "3.7.0",
    "clusterStatus": "CREATE_IN_PROGRESS"
  }
}
$ pcluster ssh --cluster-name mycluster
```

After you're logged into the head node, you should find three primary log files that you can use to find the error.

- `/var/log/cfn-init.log` is the log for the `cfn-init` script. First check this log. You're likely to see an error such as `Command chef failed` in this log. Look at the lines immediately before this line for more specifics connected with the error message. For more information, see [cfn-init](#).
- `/var/log/cloud-init.log` is the log for [cloud-init](#). If you don't see anything in `cfn-init.log`, then try checking this log next.
- `/var/log/cloud-init-output.log` is the output of commands that were run by [cloud-init](#). This includes the output from `cfn-init`. In most cases, you don't need to look at this log to troubleshoot this type of issue.

## Troubleshooting cluster deployment using Terraform

This section is relevant to clusters that were deployed using Terraform.

### ParallelCluster API not found

The planning could fail because the ParallelCluster API cannot be found. In this case, the returned error would be something like:

```
Planning failed. Terraform encountered an error while generating this plan.

#
# Error: Unable to retrieve ParallelCluster API cloudformation stack.
#
#   with provider["registry.terraform.io/aws-tf/aws-parallelcluster"],
#   on providers.tf line 6, in provider "aws-parallelcluster":
#     6: provider "aws-parallelcluster" {
#
# operation error CloudFormation: DescribeStacks, https response error StatusCode: 400,
RequestID: REQUEST_ID, api error ValidationError: Stack with id PCAPI_STACK_NAME does
not exist
```

To solve this error, deploy the ParallelCluster API in the account where the clusters are going to be created. See [the section called "Creating a cluster with Terraform"](#).

## User not authorized to call ParallelCluster API

The planning could fail because the IAM role/user you assumed to deploy your Terraform project doesn't have permissions to interact with the ParallelCluster API. In this case, the returned error would be something like:

```
Planning failed. Terraform encountered an error while generating this plan.
```

```
# Error: 403 Forbidden
#
#   with
#     module.parallelcluster_clusters.module.clusters[0].pcluster_cluster.managed_configs["DemoCluster"],
#   on .terraform/modules/parallelcluster_clusters/modules/clusters/main.tf line 35, in
#   resource "pcluster_cluster" "managed_configs":
#     35: resource "pcluster_cluster" "managed_configs" {
#
#   [{"Message": "User: USER_ARN is not authorized to perform: execute-api:Invoke on
#     resource: PC_API_REST_RESOURCE with an explicit deny"}
# }
```

To solve this error, configure the ParallelCluster Provider so that it uses the ParallelCluster API role to interact with the API.

```
provider "aws-parallelcluster" {
  region      = var.region
  profile     = var.profile
  api_stack_name = var.api_stack_name
  **use_user_role** **= true**
}
```

## Troubleshooting scaling issues

This section is relevant to clusters that were installed using AWS ParallelCluster version 3.0.0 and later with the Slurm job scheduler. For more information about configuring multiple queues, see [Configuration of multiple queues](#).

If one of your running clusters is experiencing issues, place the cluster in a STOPPED state by running the following command before you begin to troubleshoot. This prevents incurring any unexpected costs.

```
$ pcluster update-compute-fleet --cluster-name mycluster \  
  --status STOP_REQUESTED
```

You can list the log streams available from the cluster nodes by using the [pcluster list-cluster-log-streams](#) command and filtering by using the private-dns-name of one of the failing nodes or the head node:

```
$ pcluster list-cluster-log-streams --cluster-name mycluster --region eu-west-1 \  
  --filters 'Name=private-dns-name,Values=ip-10-0-0-101'
```

Then, you can retrieve the content of the log stream to analyze it by using the [pcluster get-cluster-log-events](#) command and passing the `--log-stream-name` corresponding to one of the key logs mentioned in the following section:

```
$ pcluster get-cluster-log-events --cluster-name mycluster \  
  --region eu-west-1 --log-stream-name ip-10-0-0-13.i-04e91cc1f4ea796fe.cfn-init
```

AWS ParallelCluster creates cluster CloudWatch log streams in log groups. You can view these logs in the CloudWatch console **Custom Dashboards** or **Log groups**. For more information, see [Integration with Amazon CloudWatch Logs](#) and [Amazon CloudWatch dashboard](#).

## Topics

- [Key logs for debugging](#)
- [Seeing InsufficientInstanceCapacity error in slurm\\_resume.log when I fail to run a job, or in clustermgtd.log when I fail to create a cluster](#)
- [Troubleshooting node initialization issues](#)
- [Troubleshooting unexpected node replacements and terminations](#)
- [Replacing, terminating, or powering down problematic instances and nodes](#)
- [Queue \(partition\) Inactive status](#)
- [Troubleshooting other known node and job issues](#)

## Key logs for debugging

The following table provides an overview of the key logs for the head node:

- `/var/log/cfn-init.log` - This is the AWS CloudFormation init log. It contains all commands that were run when an instance was set up. Use it to troubleshoot initialization issues.
- `/var/log/chef-client.log` - This is the Chef client log. It contains all commands that were run through Chef/CINC. Use it to troubleshoot initialization issues.
- `/var/log/parallelcluster/slurm_resume.log` - This is a ResumeProgram log. It launches instances for dynamic nodes. Use it to troubleshoot dynamic nodes launch issues.
- `/var/log/parallelcluster/slurm_suspend.log` - This is the SuspendProgram log. It's called when instances are terminated for dynamic nodes. Use it to troubleshoot dynamic nodes termination issues. When you check this log, you should also check the `clustermgtd` log.
- `/var/log/parallelcluster/clustermgtd` - This is the `clustermgtd` log. It runs as the centralized daemon that manages most cluster operation actions. Use it to troubleshoot any launch, termination, or cluster operation issues.
- `/var/log/slurmctld.log` - This is the Slurm control daemon log. AWS ParallelCluster doesn't make scaling decisions. Rather, it only attempts to launch resources to satisfy the Slurm requirements. It's useful for scaling and allocation issues, job-related issues, and any scheduler-related launch and termination issues.
- `/var/log/parallelcluster/compute_console_output` - This log records the console output from a sample subset of static compute nodes that have unexpectedly terminated. Use this log if static compute nodes terminate and the compute node logs aren't available in CloudWatch. The `compute_console_output` log content you receive is the same when you use the Amazon EC2 console or AWS CLI to retrieve the instance console output.

These are the key logs for the compute nodes:

- `/var/log/cloud-init-output.log` - This is the [cloud-init](#) log. It contains all commands that were run when an instance was set up. Use it to troubleshoot initialization issues.
- `/var/log/parallelcluster/computemgtd` - This is the `computemgtd` log. It runs on each compute node to monitor the node in the uncommon event that `clustermgtd` daemon on the head node is offline. Use it to troubleshoot unexpected termination issues.
- `/var/log/slurmd.log` - This is the Slurm compute daemon log. Use it to troubleshoot initialization and compute failure issues.



## Seeing `InsufficientInstanceCapacity` error in `slurm_resume.log` when I fail to run a job, or in `clustermgtd.log` when I fail to create a cluster

If the cluster uses a Slurm scheduler, you are experiencing an insufficient capacity issue. If there aren't enough instances available when an instance launch request is made, an `InsufficientInstanceCapacity` error is returned.

For static instance capacity, you can find the error in the `clustermgtd` log at `/var/log/parallelcluster/clustermgtd`.

For dynamic instance capacity, you can find the error in the `ResumeProgram` log at `/var/log/parallelcluster/slurm_resume.log`.

The message looks similar to the following example:

```
An error occurred (InsufficientInstanceCapacity) when calling the RunInstances/
CreateFleet operation...
```

Based on your use case, consider using one of the following methods to avoid getting these types of error messages:

- Disable the placement group if it's enabled. For more information, see [Placement groups and instance launch issues](#).
- Reserve capacity for the instances and launch them with ODCR (On-Demand Capacity Reservations). For more information, see [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#).
- Configure multiple compute resources with different instance types. If your workload doesn't require a specific instance type, you can leverage fast insufficient capacity fail over with multiple compute resources. For more information, see [Slurm cluster fast insufficient capacity fail-over](#).
- Configure multiple instance types in the same compute resource, and leverage the multiple instance type allocation. For more information about configuring multiple instances, see [Multiple instance type allocation with Slurm](#) and [Scheduling / SlurmQueues / ComputeResources / Instances](#).
- Move the queue to a different Availability Zone by changing the subnet ID in the cluster configuration [Scheduling / SlurmQueues / Networking / SubnetIds](#).

- If your workload isn't tightly coupled, span the queue across different Availability Zones. For more information about configuring multiple subnets, see [Scheduling](#) / [SlurmQueues](#) / [Networking](#) / [SubnetIds](#).

## Troubleshooting node initialization issues

This section covers how you can troubleshoot node initialization issues. This includes issues where the node fails to launch, power up, or join a cluster.

### Topics

- [Head node](#)
- [Compute nodes](#)

### Head node

Applicable logs:

- `/var/log/cfn-init.log`
- `/var/log/chef-client.log`
- `/var/log/parallelcluster/clustermgtd`
- `/var/log/parallelcluster/slurm_resume.log`
- `/var/log/slurmctld.log`

Check the `/var/log/cfn-init.log` and `/var/log/chef-client.log` logs or corresponding log streams. These logs contain all the actions that were run when the head node was set up. Most errors that occur during setup should have error messages located in the `/var/log/chef-client.log` log. If `OnNodeStart` or `OnNodeConfigured` scripts are specified in the configuration of the cluster, double check that the script runs successfully through log messages.

When a cluster is created, the head node must wait for the compute nodes to join the cluster before it can join the cluster. Because of this, if the compute nodes fail to join the cluster, then the head node also fails. You can follow one of these sets of procedures, depending on the type of compute nodes you use, to troubleshoot this type of issue:

## Compute nodes

- Applicable logs:
  - `/var/log/cloud-init-output.log`
  - `/var/log/slurmd.log`
- If a compute node is launched, first check `/var/log/cloud-init-output.log`, which should contain the setup logs similar to the `/var/log/chef-client.log` log on the head node. Most errors that occur during setup should have error messages located at the `/var/log/cloud-init-output.log` log. If pre-install or post-install scripts are specified in cluster configuration, check that they ran successfully.
- If you're using a custom AMI with modification to the Slurm configuration, then there might be a Slurm-related error that prevents the compute node from joining the cluster. For scheduler-related errors, check the `/var/log/slurmd.log` log.

### Dynamic compute nodes:

- Search the `ResumeProgram` log (`/var/log/parallelcluster/slurm_resume.log`) for your compute node name to see if `ResumeProgram` was ever called with the node. (If `ResumeProgram` wasn't ever called, you can check the `slurmctld` log (`/var/log/slurmctld.log`) to determine if Slurm ever tried to call `ResumeProgram` with the node).
- Note that incorrect permissions for `ResumeProgram` might cause `ResumeProgram` to fail silently. If you're using a custom AMI with modification to `ResumeProgram` setup, check that the `ResumeProgram` is owned by the `slurm` user and has the `744 (rwxr--r--)` permission.
- If `ResumeProgram` is called, check to see if an instance is launched for the node. If no instance was launched, you can see an error message that describes the launch failure.
- If the instance is launched, then there might have been a problem during the setup process. You should see the corresponding private IP address and instance ID from the `ResumeProgram` log. Moreover, you can look at corresponding setup logs for the specific instance. For more information about troubleshooting a setup error with a compute node, see the next section.

### Static compute nodes:

- Check the `clustermgtd` (`/var/log/parallelcluster/clustermgtd`) log to see if instances were launched for the node. If they weren't launched, there should be clear error message detailing the launch failure.

- If instance is launched, there's some issue during setup process. You should see the corresponding private IP address and instance ID from the ResumeProgram log. Moreover, you can look at the corresponding setup logs for the specific instance.

### Compute nodes backed by Spot Instances:

- If it's the first time you use Spot Instances and the job remains in a PD (pending state), double check the `/var/log/parallelcluster/slurm_resume.log` file. You'll probably find an error like the following:

```
2022-05-20 13:06:24,796 - [slurm_plugin.common:add_instances_for_nodes] - ERROR -  
Encountered exception when launching instances for nodes (x1) ['spot-dy-t2micro-2']:  
An error occurred (AuthFailure.ServiceLinkedRoleCreationNotPermitted) when calling  
the RunInstances operation: The provided credentials do not have permission to  
create the service-linked role for Amazon EC2 Spot Instances.
```

When using Spot Instances, an `AWSServiceRoleForEC2Spot` service-linked role must exist in your account. To create this role in your account using the AWS CLI, run the following command:

```
$ aws iam create-service-linked-role --aws-service-name spot.amazonaws.com
```

For more information, see [Working with Spot Instances](#) in the AWS ParallelCluster User Guide and [Service-linked role for Spot Instance requests](#) in the *Amazon EC2 User Guide*.

## Troubleshooting unexpected node replacements and terminations

This section continues to explore how you can troubleshoot node related issues, specifically when a node is replaced or terminated unexpectedly.

- **Applicable logs:**
  - `/var/log/parallelcluster/clustermgtd` (head node)
  - `/var/log/slurmctld.log` (head node)
  - `/var/log/parallelcluster/computemgtd` (compute node)

### Nodes replaced or terminated unexpectedly

- Check in the `clustermgtd` log (`/var/log/parallelcluster/clustermgtd`) to see if `clustermgtd` replaced or terminated a node. Note that `clustermgtd` handles all normal node maintenance action.
- If `clustermgtd` replaced or terminated the node, there should be a message detailing why this action was taken on the node. If the reason is scheduler related (for example, because the node is in `DOWN`), check in `slurmctld` log for more information. If the reason is Amazon EC2 related, there should be informative message detailing the Amazon EC2 related issue that required the replacement.
- If `clustermgtd` didn't terminate the node, first check if this was an expected termination by Amazon EC2, more specifically a spot termination. `computemgtd`, running on a compute node, can also terminate a node if `clustermgtd` is determined as unhealthy. Check `computemgtd` log (`/var/log/parallelcluster/computemgtd`) to see if `computemgtd` terminated the node.

## Nodes failed

- Check in `slurmctld` log (`/var/log/slurmctld.log`) to see why a job or a node failed. Note that jobs are automatically re-queued if a node failed.
- If `slurm_resume` reports that node is launched and `clustermgtd` reports after several minutes that there's no corresponding instance in Amazon EC2 for that node, the node might fail during setup. To retrieve the log from a compute (`/var/log/cloud-init-output.log`), do the following steps:
  - Submit a job to let Slurm spin up a new node.
  - After the node starts, enable termination protection using this command.

```
$ aws ec2 modify-instance-attribute --instance-id i-1234567890abcdef0 --disable-api-termination
```

- Retrieve the console output from the node with this command.

```
$ aws ec2 get-console-output --instance-id i-1234567890abcdef0 --output text
```

## Replacing, terminating, or powering down problematic instances and nodes

- **Applicable logs:**

- `/var/log/parallelcluster/clustermgtd` (head node)
- `/var/log/parallelcluster/slurm_suspend.log` (head node)
- In most cases, `clustermgtd` handles all expected instance termination action. Check in the `clustermgtd` log to see why it failed to replace or terminate a node.
- For dynamic nodes failing [SlurmSettings Properties](#), check in the `SuspendProgram` log to see if `SuspendProgram` was called by `slurmctld` with the specific node as argument. Note that `SuspendProgram` doesn't actually perform any action. Rather, it only logs when it's called. All instance termination and `NodeAddr` reset is done by `clustermgtd`. Slurm puts nodes back into a `POWER_SAVING` state after `SuspendTimeout` automatically.
- If compute nodes are failing continuously due to bootstrap failures, verify if they are being launched with [Slurm cluster protected mode](#) enabled. If protected mode isn't enabled, modify the protected mode settings to enable protected mode. Troubleshoot and fix the bootstrap script.

## Queue (partition) Inactive status

If you run `sinfo` and the output shows queues with `AVAIL` status of `inact`, your cluster might have [Slurm cluster protected mode](#) enabled and the queue has been set to the `INACTIVE` state for a pre-defined period of time.

## Troubleshooting other known node and job issues

Another type of known issue is that AWS ParallelCluster might fail to allocate jobs or make scaling decisions. With this type of issue, AWS ParallelCluster only launches, terminates, or maintains resources according to Slurm instructions. For these issues, check the `slurmctld` log to troubleshoot them.

## Placement groups and instance launch issues

To get the lowest inter-node latency, use a *placement group*. A placement group ensures that your instances are on the same networking backbone. If there aren't enough instances available when a request is made, an `InsufficientInstanceCapacity` error is returned. To reduce the possibility of receiving this error when using cluster placement groups, set the [SlurmQueues / Networking / PlacementGroup / Enabled](#) parameter to `false`.

For additional control over capacity access, consider [launching instances with ODCR \(On-Demand Capacity Reservations\)](#).

For more information, see [Troubleshooting instance launch issues](#) and [Placement groups roles and limitations](#) in the *Amazon EC2 User Guide for Linux Instances*.

## Directories that cannot be replaced

The following directories are shared between the nodes and cannot be replaced.

- `/home` - This includes the default user home folder (`/home/ec2_user` on Amazon Linux and RedHat, `/home/centos` on CentOS, and `/home/ubuntu` on Ubuntu).
- `/opt/intel` - This includes Intel MPI, Intel Parallel Studio, and related files.
- `/opt/slurm` - This includes Slurm Workload Manager and related files. (Conditional, only if Scheduler: `slurm`.)

## Troubleshooting issues in NICE DCV

### Topics

- [Logs for NICE DCV](#)
- [Ubuntu NICE DCV issues](#)

### Logs for NICE DCV

The logs for NICE DCV are written to files in the `/var/log/dcv/` directory. Reviewing these logs can help to troubleshoot issues.

The instance type should have at least 1.7 gibibytes (GiB) of RAM to run NICE DCV. Nano and micro instance types don't have enough memory to run NICE DCV.

AWS ParallelCluster creates NICE DCV log streams in log groups. You can view these logs in the CloudWatch console **Custom Dashboards** or **Log groups**. For more information, see [Integration with Amazon CloudWatch Logs](#) and [Amazon CloudWatch dashboard](#).

### Ubuntu NICE DCV issues

When running Gnome Terminal over a NICE DCV session on Ubuntu, you might not automatically have access to the user environment that AWS ParallelCluster makes available through the login shell. The user environment provides environment modules such as `openmpi` or `intelmpi`, and other user settings.

Gnome Terminal's default settings prevent the shell from starting as a login shell. This means that shell profiles aren't automatically sourced and the AWS ParallelCluster user environment isn't loaded.

To properly source the shell profile and access the AWS ParallelCluster user environment, do one of the following:

- **Change the default terminal settings:**
  1. Choose the **Edit** menu in the Gnome terminal.
  2. Select **Preferences**, then **Profiles**.
  3. Choose **Command** and select **Run Command as login shell**.
  4. Open a new terminal.
- **Use the command line to source the available profiles:**

```
$ source /etc/profile && source $HOME/.bashrc
```

## Troubleshooting issues in clusters with AWS Batch integration

This section is relevant to clusters with AWS Batch scheduler integration.

### Topics

- [Head node issues](#)
- [Compute issues](#)
- [Job failures](#)
- [Connect timeout on endpoint URL error](#)

### Head node issues

You can troubleshoot head node setup issues in the same way as a Slurm cluster (except for Slurm specific logs). For more information about these issues, see [Head node](#).

### Compute issues

AWS Batch manages the scaling and compute aspects of your services. If you encounter compute related issues, see the AWS Batch [troubleshooting](#) documentation for help.



## Job failures

If a job fails, you can run the [awsbout](#) command to retrieve the job output. You can also run the [awsbstat](#) command to obtain a link to the job logs stored by Amazon CloudWatch.

## Connect timeout on endpoint URL error

If multi-node parallel jobs fail with error: Connect timeout on endpoint URL:

- In the awsbout output log, check that the job is multi-node parallel from the output: Detected 3/3 compute nodes. Waiting for all compute nodes to start.
- Verify whether the compute nodes subnet is public.

Multi-node parallel jobs don't support the use of public subnets when using AWS Batch in AWS ParallelCluster. Use a private subnet for your compute nodes and jobs. For more information, see [Compute environment considerations](#) in the *AWS Batch User Guide*. To configure a private subnet for your compute nodes, see [AWS ParallelCluster with AWS Batch scheduler](#).

## Troubleshooting multi-user integration with Active Directory

This section is relevant to clusters integrated with an Active Directory.

If the Active Directory integration feature isn't working as expected the SSSD logs can provide useful diagnostic information. These logs are located in `/var/log/sss` on cluster nodes. By default, they're also stored in a cluster's Amazon CloudWatch log group.

### Topics

- [Active Directory specific troubleshooting](#)
- [Enable debug mode](#)
- [How to move from LDAPS to LDAP](#)
- [How to disable LDAPS server certificate verification](#)
- [How to log in with an SSH key rather than password](#)
- [How to reset a user password and expired passwords](#)
- [How to verify the joined domain](#)
- [How to troubleshoot issues with certificates](#)

- [How to verify that the integration with Active Directory is working](#)
- [How to troubleshoot logging in to compute nodes](#)
- [Known issues with SimCenter StarCCM+ jobs in a multi-user environment](#)
- [Known issues with username resolution](#)
- [How to resolve home directory create issues](#)

## Active Directory specific troubleshooting

This section is relevant to troubleshooting specific to an Active Directory type.

### Simple AD

- The DomainReadOnlyUser value must match the Simple AD directory base search for users:

```
cn=ReadOnlyUser,cn=Users,dc=corp,dc=example,dc=com
```

Note cn for Users.

- Default admin user is Administrator.
- Ldapsearch requires NetBIOS name before the username.

Ldapsearch syntax must be as follows:

```
$ ldapsearch -x -D "corp\\Administrator" -w "Password" -H ldap://192.0.2.103 \  
-b "cn=Users,dc=corp,dc=example,dc=com"
```

### AWS Managed Microsoft AD

- The DomainReadOnlyUser value must match the AWS Managed Microsoft AD directory base search for users:

```
cn=ReadOnlyUser,ou=Users,ou=CORP,dc=corp,dc=example,dc=com
```

- Default admin user is Admin.
- Ldapsearch syntax must be as follows:

```
$ ldapsearch -x -D "Admin" -w "Password" -H ldap://192.0.2.103 \  
-b "ou=Users,ou=CORP,dc=corp,dc=example,dc=com"
```

## Enable debug mode

Debug logs from SSSD can be useful to troubleshoot issues. To enable debug mode, you must update the cluster with the following changes made to the cluster configuration:

```
DirectoryService:
  AdditionalSssdConfigs:
    debug_level: "0x1ff"
```

## How to move from LDAPS to LDAP

Moving from LDAPS (LDAP with TLS/SSL) to LDAP is discouraged because LDAP alone doesn't provide any encryption. Nevertheless, it can be useful for testing purposes and troubleshooting.

You can restore the cluster to its previous configuration by updating the cluster with the previous configuration definition.

To move from LDAPS to LDAP, you must update the cluster with the following changes in the cluster configuration:

```
DirectoryService:
  LdapTlsReqCert: never
  AdditionalSssdConfigs:
    ldap_auth_disable_tls_never_use_in_production: True
```

## How to disable LDAPS server certificate verification

It can be useful to temporarily disable LDAPS server certificate verification on the head node, for testing or troubleshooting purposes.

You can restore the cluster to its previous configuration by updating the cluster with the previous configuration definition.

To disable the LDAPS server certificate verification, you must update the cluster with the following changes in the cluster configuration:

```
DirectoryService:
  LdapTlsReqCert: never
```

## How to log in with an SSH key rather than password

The SSH key is created in `/home/$user/.ssh/id_rsa` after the first time that you log in with a password. To log in with the SSH key, you must log in with your password, copy the SSH key locally, and then use it to SSH password-less as usual:

```
$ ssh -i $LOCAL_PATH_TO_SSH_KEY $username@$head_node_ip
```

## How to reset a user password and expired passwords

If a user loses access to a cluster, their [AWS Managed Microsoft AD password might have expired](#).

To reset the password, run the following command with a user and role having write permission on the directory:

```
$ aws ds reset-user-password \  
  --directory-id "d-abcdef01234567890" \  
  --user-name "USER_NAME" \  
  --new-password "NEW_PASSWORD" \  
  --region "region-id"
```

If you reset the password for the [DirectoryService](#) / [DomainReadOnlyUser](#):

1. Be sure to update the [DirectoryService](#) / [PasswordSecretArn](#) secret with the new password.
2. Update the cluster for the new secret value:
  - a. Stop the compute fleet with the `pcluster update-compute-fleet` command.
  - b. Run the following command from within the cluster head node.

```
$ sudo /opt/parallelcluster/scripts/directory_service/  
update_directory_service_password.sh
```

After the password reset and cluster update, the user's cluster access should be restored.

For more information, see [Reset a user password](#) in the *AWS Directory Service Administration Guide*.

## How to verify the joined domain

The following command must run from an instance that's joined to the domain, not the head node.

```
$ realm list corp.example.com \  
type: kerberos \  
realm-name: CORP.EXAMPLE.COM \  
domain-name: corp.example.com \  
configured: kerberos-member \  
server-software: active-directory \  
client-software: sssd \  
required-package: oddjob \  
required-package: oddjob-mkhomedir \  
required-package: sssd \  
required-package: adcli \  
required-package: samba-common-tools \  
login-formats: %U \  
login-policy: allow-realm-logins
```

## How to troubleshoot issues with certificates

When LDAPS communication isn't working, it can be due to errors in the TLS communication, which in turn can be due to issues with certificates.

### Notes about certificates:

- The certificate specified in cluster config `LdapTlsCaCert` must be a bundle of PEM certificates containing the certificates for the whole certificate of authority (CA) chain that issued certificates for the domain controllers.
- A bundle of PEM certificates is a file made of the concatenation of PEM certificates.
- A certificate in PEM format (typically used in Linux) is equivalent to a certificate in base64 DER format (typically exported by Windows).
- If the certificate for domain controllers is issued by a subordinate CA, then the certificate bundle must contain the certificate of both the subordinate and root CA.

### Troubleshooting verification steps:

The following verification steps assume that the commands are run from within the cluster head node and that the domain controller is reachable at `SERVER:PORT`.

To troubleshoot an issue that's related to certificates, follow these verification steps:

## Verification steps:

### 1. Check the connection to the Active Directory domain controllers:

Verify that you can connect to a domain controller. If this step succeeds, then the SSL connection to the domain controller succeeds and the certificate is verified. Your issue isn't related to certificates.

If this step fails, go ahead with next verification.

```
$ openssl s_client -connect SERVER:PORT -CAfile PATH_TO_CA_BUNDLE_CERTIFICATE
```

### 2. Check the certificate verification:

Verify that the local CA certificate bundle can validate the certificate provided by the domain controller. If this step succeeds, then your issue isn't related to certificates, but to other networking issues.

If this step fails, go ahead with next verification.

```
$ openssl verify -verbose -  
CAfile PATH_TO_CA_BUNDLE_CERTIFICATE PATH_TO_A_SERVER_CERTIFICATE
```

### 3. Check the certificate provided by the Active Directory domain controllers:

Verify that the content of the certificate provided by the domain controllers is as expected. If this step succeeds, you probably have issues with the CA certificate used to verify controllers, go to the next troubleshooting step.

If this step fails, you must correct the certificate issued for the domain controllers and re-execute the troubleshooting steps.

```
$ openssl s_client -connect SERVER:PORT -showcerts
```

### 4. Check the content of a certificate:

Verify that the content of the certificate that's provided by the domain controllers is as expected. If this step succeeds, you probably have issues with the CA certificate used to verify controller's, go to the next troubleshooting step.

If this step fails, you must correct the certificate issued for the domain controllers and rerun the troubleshooting steps.

```
$ openssl s_client -connect SERVER:PORT -showcerts
```

## 5. Check the content of the local CA certificate bundle:

Verify that the content of the local CA certificate bundle used to validate domain controllers certificate is as expected. If this step succeeds, you probably have issues with the certificate that are provided by the domain controllers.

If this step fails, you must correct CA certificate bundle issued for the domain controllers and rerun the troubleshooting steps.

```
$ openssl x509 -in PATH_TO_A_CERTIFICATE -text
```

## How to verify that the integration with Active Directory is working

If the following two checks succeed, the integration with the Active Directory is working.

### Checks:

#### 1. You can discover users defined in the directory:

From within the cluster head node, as an `ec2-user`:

```
$ getent passwd $ANY_AD_USER
```

#### 2. You can SSH into the head node providing the user password:

```
$ ssh $ANY_AD_USER@$HEAD_NODE_IP
```

If check one fails, we expect check two to fail also.

Additional troubleshooting checks:

- Verify that the user exists in the directory.
- Enable [debug logging](#).

- Consider temporarily disabling encryption by [moving from LDAPS to LDAP](#) to rule out LDAPS issues.

## How to troubleshoot logging in to compute nodes

This section is relevant to logging in to compute nodes in clusters integrated with Active Directory.

With AWS ParallelCluster, password logins to cluster compute nodes are disabled by design.

All users must use their own SSH key to log in to compute nodes.

Users can retrieve their SSH key in the head node after first authentication (for example login), if [GenerateSshKeysForUsers](#) is enabled in the cluster configuration.

When users authenticate on the head node for the first time, they can retrieve SSH keys that are automatically generated for them as directory users. Home directories for the user are also created. This can also happen the first time a sudo-user switches to a user in the head node.

If a user hasn't logged into the head node, SSH keys aren't generated and the user won't be able to log in to compute nodes.

## Known issues with SimCenter StarCCM+ jobs in a multi-user environment

This section is relevant to jobs launched in a multi-user environment by Simcenter StarCCM+ computational fluid dynamics software from Siemens.

If you run StarCCM+ v16 jobs configured to use the embedded IntelMPI, by default the MPI processes are bootstrapped using SSH.

Due to a known [Slurm bug](#) that causes username resolution to be wrong, jobs might fail with an error like `error setting up the bootstrap proxies`. This bug only impacts AWS ParallelCluster versions 3.1.1 and 3.1.2.

To prevent this from occurring, force IntelMPI to use Slurm as MPI bootstrap method. Export the environment variable `I_MPI_HYDRA_BOOTSTRAP=slurm` into the job script that launches StarCCM+, as described in the [IntelMPI official documentation](#).

## Known issues with username resolution

This section is relevant to retrieving usernames within jobs.



Due to a known [bug in Slurm](#), the username retrieved within a job process might be nobody if you run a job without `srun`. This bug only impacts AWS ParallelCluster versions 3.1.1 and 3.1.2.

For example, if you run the command `sbatch --wrap 'srun id'` as a directory user, the correct username is returned. However, if you run the `sbatch --wrap 'id'` as a directory user, nobody might be returned as the username.

You can use the following workarounds.

1. Launch your job with `'srun'` instead of `'sbatch'`, if possible.
2. Enable SSSD enumeration by setting the [AdditionalSssdConfigs](#) in cluster configuration as follows.

```
AdditionalSssdConfigs:
  enumerate: true
```

## How to resolve home directory create issues

This section is relevant to home directory creation issues.

If you see errors like the one shown in the following example, a home directory wasn't created for you when you first logged in to the head node. Or, a home directory wasn't created for you when you first switched from a sudoer to an Active Directory user in the head node.

```
$ ssh AD_USER@$HEAD_NODE_IP
/opt/parallelcluster/scripts/generate_ssh_key.sh failed: exit code 1

  _|  _|_ )
 _| (    /  Amazon Linux 2 AMI
  _|\_|_|_|

https://aws.amazon.com/amazon-linux-2/
Could not chdir to home directory /home/PclusterUser85: No such file or directory
```

The home directory create failure can be caused by the `odjjob` and `odjjob-mkhomedir` packages installed in the cluster head node.

Without a home directory and SSH key, the user can't submit jobs or SSH into the cluster nodes.

If you need the oddjob packages in your system, verify that the oddjob service is running and refresh the PAM config files to make sure that the home directory is created. To do this, run the commands in the head node as shown in the following example.

```
sudo systemctl start oddjobd
sudo authconfig --enablemkhomedir --updateall
```

If you don't need the oddjob packages in your system, uninstall them and refresh the PAM config files to make sure that the home directory is created. To do this, run the commands in the head node as shown in the following example.

```
sudo yum remove -y oddjob oddjob-mkhomedir
sudo authconfig --enablemkhomedir --updateall
```

## Troubleshooting custom AMI issues

When you use a custom AMI, you can see the following warnings:

```
"validationMessages": [
  {
    "level": "WARNING",
    "type": "CustomAmiTagValidator",
    "message": "The custom AMI may not have been created by pcluster. You can ignore
this warning if the AMI is shared or copied from another pcluster AMI. If the
AMI is indeed not created by pcluster, cluster creation will fail. If the cluster
creation fails, please go to https://docs.aws.amazon.com/parallelcluster/latest/ug/troubleshooting.html#troubleshooting-stack-creation-failures for troubleshooting."
  },
  {
    "level": "WARNING",
    "type": "AmiOsCompatibleValidator",
    "message": "Could not check node AMI ami-0000012345 OS and cluster OS alinux2
compatibility, please make sure they are compatible before cluster creation and update
operations."
  }
]
```

If you're sure that the correct AMI is being used, you can ignore these warnings.

If you don't want to see these warnings in the future, tag the custom AMI with the following tags, where *my-os* is one of *alinux2*, *ubuntu2204*, *ubuntu2004*, *centos7*, or *rhel8* and *"3.7.0"* is the *pcluster* version in use:

```
$ aws ec2 create-tags \  
  --resources ami-yourcustomAmi \  
  --tags Key="parallelcluster:version",Value="3.7.0" \  
  Key="parallelcluster:os",Value="my-os"
```

## Troubleshooting a cluster update timeout when *cfn-hup* isn't running

The *cfn-hup* helper is a daemon that detects changes in resource metadata and runs user-specified actions when a change is detected. This is how you make configuration updates on your running Amazon EC2 instances through the *UpdateStack* API action.

Currently the *cfn-hup* daemon is launched by the *supervisord*. But after launch, the *cfn-hup* process is detached from *supervisord* control. If the *cfn-hup* demon is killed by an external actor, it's not restarted automatically. If *cfn-hup* isn't running, during a cluster update, the CloudFormation stack starts the update process as expected but the update procedure isn't activated on the head node and the stack eventually goes into timeout. From the cluster logs / *var/log/chef-client*, you can see that the update recipe is never invoked.

### Check and restart *cfn-hup* in case of failures

1. On the head node, check if *cfn-hup* is running:

```
$ ps aux | grep cfn-hup
```

2. Check *cfn-hup* log /*var/log/cfn-hup.log* and /*var/log/supervisord.log* on the head node.
3. If *cfn-hup* isn't running, try restarting it by running:

```
$ sudo /opt/parallelcluster/pyenv/versions/cookbook_virtualenv/bin/supervisorctl \  
start cfn-hup
```

# Network troubleshooting

## Cluster in a single public subnet issues

Check the `cloud-init-output.log` from one of the compute nodes. If you find something like the following that indicates the node is stuck in Slurm initialization, it is most likely due to a missing DynamoDB VPC endpoint. Add the DynamoDB endpoint. For more information see [AWS ParallelCluster in a single subnet with no internet access](#).

```
ruby_block[retrieve compute node info] action run[2022-03-11T17:47:11+00:00] INFO:
  Processing ruby_block[retrieve compute node info] action run (aws-parallelcluster-
slurm::init line 31)
```

## Cluster update failed on onNodeUpdated custom action

When a [HeadNode](#) / [CustomActions](#) / [OnNodeUpdated](#) script fails, the update fails and the script is not run at rollback time. It's your responsibility to manually perform the cleanups needed after the rollback is completed. For example, if the `OnNodeUpdated` script changes the status of a field in a configuration file (for example, from `true` to `false`) and then fails, you need to manually restore that field value to the pre-update state (for example, `false` to `true`). For more information, see [Custom bootstrap actions](#).

## Seeing errors with custom Slurm configuration

Starting in AWS ParallelCluster version 3.6.0, you can no longer target single prolog or epilog scripts by including them in a custom Slurm configuration. In AWS ParallelCluster version 3.6.0 and later versions, you must locate custom prolog and epilog scripts in the respective Prolog and Epilog folders. These folders are configured by default to point to:

- Prolog points to `/opt/slurm/etc/scripts/prolog.d/`.
- Epilog points to `/opt/slurm/etc/scripts/epilog.d/`.

We recommend that you keep the `90_pcluster_health_check_manager` prolog script and the `90_pcluster_noop` epilog script in place.

Slurm runs the scripts in reverse alphabetical order. Both the Prolog and Epilog folder must contain at least one file. For more information, see [Slurmprolog and epilog](#) and [Slurm configuration customization](#).

## Cluster Alarms

Cluster health monitoring is essential for ensuring optimal performance. AWS ParallelCluster enables you to monitor multiple CloudWatch based alarms for the cluster's head node.

This section provides detail for each type of Head node cluster alarms including its naming conventions, specific conditions that trigger alarms, and suggested troubleshooting steps.

The naming convention for cluster alarms is CLUSTER\_NAME-COMPONENT-METRIC, e.g. `mycluster-HeadNode-Cpu`.

- `CLUSTER_NAME-HeadNode`: signals the overall status of the head node. It is red if at least one of the alarms below is.
- `CLUSTER_NAME-HeadNode-Health`: red if there is at least one Amazon EC2 Health Check failure. In case of alarm, we suggest to have a look at [Troubleshoot instances with failed status checks](#).
- `CLUSTER_NAME-HeadNode-Cpu`: red if CPU utilization is greater than 90%. In case of alarm, check the processes that are consuming the CPU the most with `ps -aux --sort=-%cpu | head -n 10`.
- `CLUSTER_NAME-HeadNode-Mem`: red if memory utilization is greater than 90%. In case of alarm, check the processes that are consuming the memory the most with `ps -aux --sort=-%mem | head -n 10`.
- `CLUSTER_NAME-HeadNode-Disk`: red if the occupied disk space is greater than 90% on path `/`. In case of alarm, check the folders consuming the majority of the space with `du -h --max-depth=2 / 2> /dev/null | sort -hr`.

## Additional support

For a list of known issues, see the main [GitHub Wiki](#) page or the [issues](#) page.

For more urgent issues, contact AWS Support or open a [new GitHub issue](#).

# AWS ParallelCluster support policy

AWS ParallelCluster supports multiple releases at the same time. Every AWS ParallelCluster release has a scheduled End of Support Life (EOSL) date. After the EOSL date, no further support or maintenance is provided for that release.

AWS ParallelCluster uses a `major.minor.patch` version scheme. New features, performance improvements, security updates, and bug fixes are included in new minor version releases for the latest major version release. Minor versions are backward compatible within a major version. For critical issues, AWS provides fixes through patch releases, but only for the latest minor versions of releases that have not reached EOSL. If you want to use the updates from a new version release, you need to upgrade to the new minor or patch version.

| AWS ParallelCluster versions | End of supported life (EOSL) date |
|------------------------------|-----------------------------------|
| 3.0.x                        | 3/31/2023                         |
| 3.1.x                        | 8/31/2023                         |
| 3.2.x                        | 1/31/2024                         |
| 3.3.x                        | 5/31/2024                         |
| 3.4.x                        | 6/28/2024                         |
| 3.5.x                        | 8/31/2024                         |
| 3.6.x                        | 11/30/2024                        |
| 3.7.x                        | 2/28/2025                         |
| 3.8.x                        | 6/30/2025                         |
| 3.9.x                        | 09/05/2025                        |
| 3.10.x                       | 12/27/2025                        |

# Security in AWS ParallelCluster

Cloud security at AWS is the highest priority. As an AWS customer, you benefit from a data center and network architecture that is built to meet the requirements of the most security-sensitive organizations.

Security is a shared responsibility between AWS and you. The [shared responsibility model](#) describes this as security *of* the cloud and security *in* the cloud:

- **Security of the cloud** – AWS is responsible for protecting the infrastructure that runs AWS services in the AWS Cloud. AWS also provides you with services that you can use securely. Third-party auditors regularly test and verify the effectiveness of our security as part of the [AWS Compliance Programs](#). To learn about the compliance programs that apply to AWS ParallelCluster, see [AWS Services in Scope by Compliance Program](#).
- **Security in the cloud** – Your responsibility is determined by the specific AWS service or services that you use. You are also responsible for several other related factors including the sensitivity of your data, your company's requirements, and applicable laws and regulations.

This documentation describes how you should apply the shared responsibility model when using AWS ParallelCluster. The following topics show you how to configure AWS ParallelCluster to meet your security and compliance objectives. You also learn how to use AWS ParallelCluster in a way that helps you to monitor and secure your AWS resources.

## Topics

- [Security information for services used by AWS ParallelCluster](#)
- [Data protection in AWS ParallelCluster](#)
- [Identity and Access Management for AWS ParallelCluster](#)
- [Compliance validation for AWS ParallelCluster](#)
- [Enforcing a Minimum Version of TLS 1.2](#)

## Security information for services used by AWS ParallelCluster

- [Security in Amazon EC2](#)
- [Security in Amazon API Gateway](#)
- [Security in AWS Batch](#)

- [Security in AWS CloudFormation](#)
- [Security in Amazon CloudWatch](#)
- [Security in AWS CodeBuild](#)
- [Security in Amazon DynamoDB](#)
- [Security in Amazon ECR](#)
- [Security in Amazon ECS](#)
- [Security in Amazon EFS](#)
- [Security in FSx for Lustre](#)
- [Security in AWS Identity and Access Management \(IAM\)](#)
- [Security in EC2 Image Builder](#)
- [Security in AWS Lambda](#)
- [Security in Amazon Route 53](#)
- [Security in Amazon SNS](#)
- [Security in Amazon SQS \(For AWS ParallelCluster version 2.x.\)](#)
- [Security in Amazon S3](#)
- [Security in Amazon VPC](#)

## Data protection in AWS ParallelCluster

The AWS [shared responsibility model](#) applies to data protection in AWS ParallelCluster. As described in this model, AWS is responsible for protecting the global infrastructure that runs all of the AWS Cloud. You are responsible for maintaining control over your content that is hosted on this infrastructure. You are also responsible for the security configuration and management tasks for the AWS services that you use. For more information about data privacy, see the [Data Privacy FAQ](#). For information about data protection in Europe, see the [AWS Shared Responsibility Model and GDPR](#) blog post on the *AWS Security Blog*.

For data protection purposes, we recommend that you protect AWS account credentials and set up individual users with AWS IAM Identity Center or AWS Identity and Access Management (IAM). That way, each user is given only the permissions necessary to fulfill their job duties. We also recommend that you secure your data in the following ways:

- Use multi-factor authentication (MFA) with each account.
- Use SSL/TLS to communicate with AWS resources. We require TLS 1.2 and recommend TLS 1.3.



- Set up API and user activity logging with AWS CloudTrail.
- Use AWS encryption solutions, along with all default security controls within AWS services.
- Use advanced managed security services such as Amazon Macie, which assists in discovering and securing sensitive data that is stored in Amazon S3.
- If you require FIPS 140-2 validated cryptographic modules when accessing AWS through a command line interface or an API, use a FIPS endpoint. For more information about the available FIPS endpoints, see [Federal Information Processing Standard \(FIPS\) 140-2](#).

We strongly recommend that you never put confidential or sensitive information, such as your customers' email addresses, into tags or free-form text fields such as a **Name** field. This includes when you work with AWS ParallelCluster or other AWS services using the console, API, AWS CLI, or AWS SDKs. Any data that you enter into tags or free-form text fields used for names may be used for billing or diagnostic logs. If you provide a URL to an external server, we strongly recommend that you do not include credentials information in the URL to validate your request to that server.

## Data encryption

A key feature of any secure service is that information is encrypted when it is not being actively used.

### Encryption at rest

AWS ParallelCluster does not itself store any customer data other than the credentials it needs to interact with the AWS services on the user's behalf.

For data on the nodes in the cluster, data can be encrypted at rest.

For Amazon EBS volumes, encryption is configured using the [EbsSettings](#)/Encrypted and [EbsSettings](#)/KmsKeyId settings in the [EbsSettings](#) section. For more information, see [Amazon EBS encryption](#) in the Amazon EC2 User Guide.

For Amazon EFS volumes, encryption is configured using the [EfsSettings](#)/Encrypted and [EfsSettings](#)/KmsKeyId settings in the [EfsSettings](#) section. For more information, see [How encryption at rest works](#) in the *Amazon Elastic File System User Guide*.

For FSx for Lustre file systems, encryption of data at rest is automatically enabled when creating an Amazon FSx file system. For more information, see [Encrypting data at rest](#) in the *Amazon FSx for Lustre User Guide*.

For instance types with NVMe volumes, the data on NVMe instance store volumes is encrypted using an XTS-AES-256 cipher implemented on a hardware module on the instance. The encryption keys are generated using the hardware module and are unique to each NVMe instance storage device. All encryption keys are destroyed when the instance is stopped or terminated and cannot be recovered. You cannot disable this encryption and you cannot provide your own encryption key. For more information, see [Encryption at rest](#) in the *Amazon EC2 User Guide*.

If you use AWS ParallelCluster to invoke an AWS service that transmits customer data to your local computer for storage, then refer to the Security and Compliance chapter in that service's User Guide for information on how that data is stored, protected, and encrypted.

## Encryption in transit

By default, all data transmitted from the client computer running AWS ParallelCluster and AWS service endpoints is encrypted by sending everything through a HTTPS/TLS connection. Traffic between the nodes in the cluster can be automatically encrypted, depending on the instance types selected. For more information, see [Encryption in transit](#) in the *Amazon EC2 User Guide*.

## See also

- [Data protection in Amazon EC2](#)
- [Data protection in EC2 Image Builder](#)
- [Data protection in AWS CloudFormation](#)
- [Data protection in Amazon EFS](#)
- [Data protection in Amazon S3](#)
- [Data protection in FSx for Lustre](#)

## Identity and Access Management for AWS ParallelCluster

AWS ParallelCluster uses roles to access your AWS resources and their services. The instance and user policies that AWS ParallelCluster uses to grant permissions are documented at [AWS Identity and Access Management permissions in AWS ParallelCluster](#).

The only major difference is how you authenticate when using a standard user and long-term credentials. Although an user requires a password to access an AWS service's console, that same user requires an access key pair to perform the same operations using AWS ParallelCluster. All other short-term credentials are used in the same way they are used with the console.

The credentials used by AWS ParallelCluster are stored in plaintext files and are **not** encrypted.

- The `$HOME/.aws/credentials` file stores long-term credentials required to access your AWS resources. These include your access key ID and secret access key.
- Short-term credentials, such as those for roles that you assume, or that are for AWS IAM Identity Center services, are also stored in the `$HOME/.aws/cli/cache` and `$HOME/.aws/sso/cache` folders, respectively.

### Mitigation of Risk

- We strongly recommend that you configure your file system permissions on the `$HOME/.aws` folder and its child folders and files to restrict access to only authorized users.
- Use roles with temporary credentials wherever possible to reduce the opportunity for damage if the credentials are compromised. Use long-term credentials only to request and refresh short-term role credentials.

## Compliance validation for AWS ParallelCluster

Third-party auditors assess the security and compliance of AWS services as part of multiple AWS compliance programs. Using AWS ParallelCluster to access a service does not alter that service's compliance.

For a list of AWS services in scope of specific compliance programs, see [AWS services in scope by compliance program](#). For general information, see [AWS compliance programs](#).

You can download third-party audit reports using the AWS Artifact. For more information, see [Downloading reports in AWS Artifact](#).

Your compliance responsibility when using AWS ParallelCluster is determined by the sensitivity of your data, your company's compliance objectives, and applicable laws and regulations. AWS provides the following resources to help with compliance:

- [Security and compliance quick start guides](#) – These deployment guides discuss architectural considerations and provide steps for deploying security- and compliance-focused baseline environments on AWS.
- [Architecting for HIPAA security and Compliance on Amazon Web Services AWS Whitepaper](#) – This whitepaper describes how companies can use AWS to create HIPAA-compliant applications.

- [AWS compliance resources](#) – This collection of workbooks and guides might apply to your industry and location.
- [Evaluating resources with rules](#) in the *AWS Config Developer Guide* – The AWS Config service assesses how well your resource configurations comply with internal practices, industry guidelines, and regulations.
- [AWS Security Hub](#) – This AWS service provides a comprehensive view of your security state within AWS that helps you check your compliance with security industry standards and best practices.

## Enforcing a Minimum Version of TLS 1.2

To add increased security when communicating with AWS services, you should configure your AWS ParallelCluster to use TLS 1.2 or later. When you use AWS ParallelCluster, Python is used to set the TLS version.

To ensure AWS ParallelCluster uses no TLS version earlier than TLS 1.2, you might need to recompile OpenSSL to enforce this minimum and then recompile Python to use the newly built OpenSSL.

## Determine Your Currently Supported Protocols

First, create a self-signed certificate to use for the test server and the Python SDK using OpenSSL.

```
$ openssl req -subj '/CN=localhost' -x509 -newkey rsa:4096 -nodes -keyout key.pem -out cert.pem -days 365
```

Then spin up a test server using OpenSSL.

```
$ openssl s_server -key key.pem -cert cert.pem -www
```

In a new terminal window, create a virtual environment and install the Python SDK.

```
$ python3 -m venv test-env
source test-env/bin/activate
pip install botocore
```

Create a new Python script named `check.py` that uses the SDK's underlying HTTP library.

```
$ import urllib3
```

```
URL = 'https://localhost:4433/'

http = urllib3.PoolManager(
    ca_certs='cert.pem',
    cert_reqs='CERT_REQUIRED',
)
r = http.request('GET', URL)
print(r.data.decode('utf-8'))
```

Run your new script.

```
$ python check.py
```

This displays details about the connection made. Search for "Protocol : " in the output. If the output is "TLSv1.2" or later, the SDK defaults to TLS v1.2 or later. If it's an earlier version, you need to recompile OpenSSL and recompile Python.

However, even if your installation of Python defaults to TLS v1.2 or later, it's still possible for Python to renegotiate to a version earlier than TLS v1.2 if the server doesn't support TLS v1.2 or later. To check that Python doesn't automatically renegotiate to earlier versions, restart the test server with the following.

```
$ openssl s_server -key key.pem -cert cert.pem -no_tls1_3 -no_tls1_2 -www
```

If you're using an earlier version of OpenSSL, you might not have the `-no_tls_3` flag available. If this is the case, remove the flag because the version of OpenSSL you're using doesn't support TLS v1.3. Then rerun the Python script.

```
$ python check.py
```

If your installation of Python correctly doesn't renegotiate for versions earlier than TLS 1.2, you should receive an SSL error.

```
$ urllib3.exceptions.MaxRetryError: HTTPSConnectionPool(host='localhost',
port=4433): Max retries exceeded with url: / (Caused by SSLError(SSLError(1, '[SSL:
UNSUPPORTED_PROTOCOL] unsupported protocol (_ssl.c:1108)')))
```

If you're able to make a connection, you need to recompile OpenSSL and Python to disable negotiation of protocols earlier than TLS v1.2.

## Compile OpenSSL and Python

To ensure that AWS ParallelCluster doesn't negotiate for anything earlier than TLS 1.2, you need to recompile OpenSSL and Python. To do this, copy the following content to create a script and run it.

```
#!/usr/bin/env bash
set -e

OPENSSL_VERSION="1.1.1d"
OPENSSL_PREFIX="/opt/openssl-with-min-tls1_2"
PYTHON_VERSION="3.8.1"
PYTHON_PREFIX="/opt/python-with-min-tls1_2"

curl -O "https://www.openssl.org/source/openssl-$OPENSSL_VERSION.tar.gz"
tar -xzf "openssl-$OPENSSL_VERSION.tar.gz"
cd openssl-$OPENSSL_VERSION
./config --prefix=$OPENSSL_PREFIX no-ssl3 no-tls1 no-tls1_1 no-shared
make > /dev/null
sudo make install_sw > /dev/null

cd /tmp
curl -O "https://www.python.org/ftp/python/$PYTHON_VERSION/Python-$PYTHON_VERSION.tgz"
tar -xzf "Python-$PYTHON_VERSION.tgz"
cd Python-$PYTHON_VERSION
./configure --prefix=$PYTHON_PREFIX --with-openssl=$OPENSSL_PREFIX --disable-shared > /dev/null
make > /dev/null
sudo make install > /dev/null
```

This compiles a version of Python that has a statically linked OpenSSL that doesn't automatically negotiate anything earlier than TLS 1.2. This also installs OpenSSL in the `/opt/openssl-with-min-tls1_2` directory and installs Python in the `/opt/python-with-min-tls1_2` directory. After you run this script, confirm installation of the new version of Python.

```
$ /opt/python-with-min-tls1_2/bin/python3 --version
```

This should print out the following.

```
Python 3.8.1
```

To confirm this new version of Python doesn't negotiate a version earlier than TLS 1.2, rerun the steps from [Determine Your Currently Supported Protocols](#) using the newly installed Python version (that is, `/opt/python-with-min-tls1_2/bin/python3`).

# Release notes and document history

The following table describes the major updates and new features for the *AWS ParallelCluster User Guide*. We also update the documentation frequently to address the feedback that you send us.

| Change                                                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Date          |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <a href="#">AWS ParallelCluster version 3.10.0 released</a> | <p>We're excited to announce the release of AWS ParallelCluster 3.10.0</p> <p>To upgrade, type <code>sudo pip install --upgrade aws-parallelcluster</code> .</p> <p>Enhancements:</p> <ul style="list-style-type: none"><li>• Add new configuration section <code>Scheduling/SlurmSettings/ExternalSlurmdbd</code> to connect the cluster to an external Slurmdbd.</li><li>• Allow <code>build-image</code> to be run in an isolated network.</li><li>• Add support for Amazon Linux 2023.</li><li>• Add support for <code>price-capacity-optimized</code> as an <code>AllocationStrategy</code> .</li><li>• Add validator to prevent the use of <code>PlacementGroups</code> with <code>CapacityBlocks</code>.</li></ul> | June 27, 2024 |



## Changes:

- CentOS 7 is no longer supported.
- Upgrade Cinc Client to version to 18.4.12 from 18.2.7.
- Upgrade munge to version 0.5.16 (from 0.5.15).
- Upgrade Pmix to 5.0.2 (from 4.2.9).
- Upgrade third-party cookbook dependencies:
  - apt-7.5.22 (from apt-7.5.14)
  - openssh-2.11.12 (from openssh-2.11.3)
- Remove third-party cookbook: selinux-6.1.12.
- Upgrade EFA installer to 1.32.0.
  - Efa-driver: efa-2.8.0-1
  - Efa-config: efa-config-1.16-1
  - Efa-profile: efa-profile-1.7-1
  - Libfabric-aws: libfabric-aws-1.21.0-1
  - Rdma-core: rdma-core-50.0-1
  - Open MPI: openmpi40-aws-4.1.6-3 and

openmpi50-aws-5.0.  
2-12

- Upgrade NVIDIA driver to version 535.183.01 (from 535.154.05).
- Upgrade Python to 3.9.19 (from 3.9.17).
- Upgrade Intel MPI Library to 2021.12.1.8 (from 2021.9.0.43482).

#### Bug fixes:

- Fix Data Repository Associations configuration to make `AutoExportPolicy` and `AutoImportPolicy` optional.
- Fixed an issue during cluster deletion that now completes compute fleet cleanup when instances are either in shutting-down or terminated state. This is to avoid cluster deletion failures for instance types with longer termination cycles.
- Allow cloudwatch dashboard to be enabled and alarms to be disabled in the `Monitoring` section of the cluster config.

- Allow ParallelCluster Custom Resource to suppress validators using `PclusterCluster/SuppressValidators` .
- Removed `/etc/profile.d/pcluster.sh` so that it's not executed at every user login and `cfn_bootstrap_virtualenv` isn't added in `PATH` environment variable.
- Fix ParallelCluster API spec by replacing field `failureReason` with `failures` in `DescribeCluster` response.
- Fix ParallelCluster API spec by adding the CloudFormation stack status that were missing: `IMPORT_*`, `REVIEW_IN_PROGRESS` , and `UPDATE_FAILED` .
- Fix an issue that prevented cluster updates from including EFS filesystems with encryption in transit.
- Fix an issue that prevented `slurmctld` and `slurmdbd` services from restarting on head node reboot when EFS is used for shared internal data.

- On Ubuntu systems, remove default logrotate configuration for cloud-init log files that clashed with the configuration coming from Parallelcluster.
- Fix image build failure with RHEL 8.10 or newer.

### [Terraform Provider for AWS ParallelCluster 1.0.0 released](#)

We're excited to announce the release of Terraform Provider for AWS ParallelCluster 1.0.0.

June 26, 2024

Features:

- [Full changelog](#)

### [Terraform Module for AWS ParallelCluster 1.0.0 released](#)

We're excited to announce the release of Terraform Module for AWS ParallelCluster 1.0.0.

June 26, 2024

Features:

- [Full changelog](#)

[AWS ParallelCluster version 3.9.3 released](#)

We're excited to announce the release of AWS ParallelCluster 3.9.3 June 19, 2024

To upgrade, type `sudo pip install --upgrade aws-parallelcluster`

Features:

- Added support for FSx Lustre as a shared storage type in `us-iso-east-1` .

Bug fixes:

- Remove `cloud_dns` from the `SlurmctlD` Parameters in the Slurm config to avoid Slurm fanout issues.

This isn't required, since we set the IP addresses on instance launch.

[AWS ParallelCluster version 3.9.2 released](#)

We're excited to announce the release of AWS ParallelCluster 3.9.2 May 28, 2024

Features:

- Upgrade Slurm to 23.11.7 (from 23.11.4).
- For more details, see the CHANGELOG [3.9.2](#) on GitHub.

[AWS ParallelCluster UI version 2024.05.0 released](#)

AWS ParallelCluster UI version 2024.05.0 released. May 14, 2024

Bug Fixes:

- Fixed a bug in the frontend blocking the UI when the user opens the Job Status panel.
- [Full Changelog](#)

[AWS ParallelCluster UI version 2024.04.0 released](#)

AWS ParallelCluster UI version 2024.04.0 released. April 17, 2024

Features:

- Added support for AWS ParallelCluster version 3.9.1
- [Full Changelog](#)

[AWS ParallelCluster version 3.9.1 released](#)

We're excited to announce the release of AWS ParallelCluster 3.9.1 April 11, 2024

To upgrade, enter the following: `sudo pip install --upgrade aws-parallelcluster`

Bug fixes

- Remove recursive deletion of shared storage mountdir when unmounting filesystems as part of update-cluster operation.

## [AWS ParallelCluster version 3.9.1 released](#)

We're excited to announce the release of AWS ParallelCluster 3.9.1 April 11, 2024

To upgrade, enter the following: `sudo pip install --upgrade aws-parallelcluster`

### Bug fixes

- Remove recursive deletion of shared storage mountdir when unmounting filesystems as part of update-cluster operation.

[AWS ParallelCluster UI version 2024.03.0 released](#)

AWS ParallelCluster UI version March 12, 2024  
2024.03.0 released.

Features:

- Added support for AWS ParallelCluster version 3.9.0
- Added support for Ubuntu 22.04 and Red Hat Enterprise Linux 9
- Deprecated Ubuntu 18.04

Bugfixes

- Fixed issue causing some clusters to not appear when using many clusters

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.



## [AWS ParallelCluster version 3.9.0 released](#)

We're excited to announce the release of AWS ParallelCluster 3.9.0 March 5, 2024

To upgrade, enter the following: `sudo pip install --upgrade aws-parallelcluster`

Enhancements:

- Add the configuration parameter `DeploymentSettings/DefaultUserHome` to allow users to move the default user's home directory to `/local/home` instead of `/home` (default).
- Permit to update `MinCount`, `MaxCount`, `Queue` and `ComputeResource` configuration parameters without the need to stop the compute fleet. It's now possible to update them by setting `Scheduling/SlurmSettings/QueueUpdateStrategy` to `TERMINATE`. AWS ParallelCluster will terminate only the nodes removed during a resize of the cluster capacity performed through a cluster update.

- Permit to update the external shared storage of type Efs, FsxLustre, FsxOntap, FsxOpenZfs and FileCache without replacing the compute and login fleet.
- Add support for RHEL9.
- Add support for Rocky Linux 9 as CustomAmi created through build-image process. No public official AWS ParallelCluster Rocky9 Linux AMI is made available at this time.
- Remove CommunicationParameters from the Custom Slurm Settings deny list.
- Add DeploymentSettings/DisableSudoAccessForDefaultUser parameter to disable sudo access of default user in supported OSes.
- Changes to FSx for Lustre file systems created by ParallelCluster: Change the Lustre server version to 2.15.
- Add possibility to choose between Open and Closed Source Nvidia Drivers when building an AMI,

through the `['cluster']['nvidia']['kernel_open']` cookbook node attribute.

- \* Add a `clustermgtd` config option `ec2_instance_missing_max_count` to allow a configurable amount of retries for eventual Amazon EC2 `describe_instances` consistency with run instances.

## Changes

- Upgrade Slurm to 23.11.4 (from 23.02.7).
- Upgrade NVIDIA driver to version 535.154.05.
- Add support for Python 3.11, 3.12 in `pcluster CLI` and `aws-parallelcluster-batch-cli`.
- Build network interfaces using network card index from `NetworkCardIndex` list of Amazon EC2 `DescribeInstances` response, instead of looping over `MaximumNetworkCards` range.
- Fail cluster creation when using instance types P3, G3, P2 and G2 because their GPU architecture

is not compatible with Open Source Nvidia Drivers (OpenRM) introduced as part of 3.8.0 release.

- Upgrade third-party cookbook dependencies: nfs-5.1.2 (from nfs-5.0.0)
- Upgrade EFA installer to 1.30.0.
  - Efa-driver: efa-2.6.0-1
  - Efa-config: efa-config-1.15-1
  - Efa-profile: efa-profile-1.6-1
  - Libfabric-aws: libfabric-aws-1.19.0
  - Rdma-core: rdma-core-46.0-1
  - Open MPI: openmpi40-aws-4.1.6-2 and openmpi50-aws-5.0.0-11
- Upgrade NICE DCV to version 2023.1-16388.
  - server: 2023.1.16388-1
  - xdcv: 2023.1.565-1
  - gl: 2023.1.1047-1
  - web\_viewer: 2023.1.16388-1

## Bug fixes

- Fix issue making job fail when submitted as active directory user from login nodes. The issue was caused by an incomplete configuration of the integration with the external Active Directory on the head node.
- Refactor IAM policies defined in CloudFormation template `parallelcluster-policies.yaml` to prevent ParallelCluster API deployment failure caused by policies exceeding IAM limits.
- Fix issue making login nodes fail to bootstrap when the head node takes more time than expected in writing keys.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster UI version  
2024.02.0 released](#)

AWS ParallelCluster UI version February 8, 2024  
2024.02.0 released

Changes:

- Updated the Lambda runtime environment to Python v3.9

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster UI version 2023.12.0 released](#)

AWS ParallelCluster UI version December 21, 2023  
2023.12.0 released.

Features:

- Added support for PCUI deployment with private networking.
- Added possibility to optionally apply a Permissions Boundary to every IAM role created by the PCUI and PCAPI infrastructures
- Added possibility to optionally apply a prefix to every IAM role and policy created by the PCUI and PCAPI infrastructure.
- Added support for ParallelCluster version 3.8.0, without feature parity in the wizard.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster version 3.8.0 released](#)

AWS ParallelCluster version 3.8.0 released.

December 19, 2023

Enhancements:

- Add support for Amazon EC2 Capacity Blocks for ML.
- Add support for Rocky Linux 8 as CustomAmi created through build-image process. No public official AWS ParallelCluster Rocky8 Linux AMI is made available at this time.
- Add Scheduling/ScalingStrategy parameter to control the cluster scaling strategy to use when launching Amazon EC2 instances for Slurm compute nodes. Possible values are all-or-nothing , greedy-all-or-nothing , best-effort , with all-or-nothing being the default.
- Add HeadNode/SharedStorageType parameter to use EFS storage instead of NFS exports from the head node root volume for intra-cluster shared file system resources: ParallelCluster,



Intel, Slurm, and /home data. This enhancement reduces the load on the head node networking.

- Allow for mounting /home as an EFS or FSx external shared storage via the `SharedStorage` section of the config file.
- Add new parameter `SlurmSettings/MungeKeySecretArn` to permit to use an external user-defined MUNGE key from AWS Secrets Manager.
- Add `Monitoring/Alarms/Enabled` parameter to toggle Amazon CloudWatch Alarms for the cluster.
- Add head node alarms to monitor Amazon EC2 health checks, CPU utilization and the overall status of the head node, and add them to the CloudWatch Dashboard created with the cluster.
- Add support for Data Repository Associations when using `PERSISTENT_2` as `DeploymentType` for a managed FSx for Lustre.

- Add Scheduling/SlurmSettings/Database/DatabaseName parameter to allow users to specify a custom name for the database on the database server to be used for Slurm accounting.
- Make InstanceType an optional configuration parameter when configuring CapacityReservationTarget/CapacityReservationId in the compute resource.
- Add possibility to specify a prefix for IAM roles and policies created by AWS ParallelCluster API.
- Add possibility to specify a permissions boundary to be applied for IAM roles and policies created by AWS ParallelCluster API.

## Changes

- Upgrade Slurm to 23.02.7 (from 23.02.6).
- Upgrade NVIDIA driver to version 535.129.03.
- Upgrade CUDA Toolkit to version 12.2.2.

- Use Open Source NVIDIA GPU drivers (OpenRM) as NVIDIA kernel module for Linux instead of NVIDIA closed source module.
- Remove support of `all_or_nothing_batch` configuration parameter in the Slurm resume program, in favor of the new `Scheduling/ScalingStrategy` cluster configuration.
- Changed cluster alarms naming convention to `'[cluster-name]-[component-name]-[metric]'`.
- Change default EBS volume types in ADC regions from `gp2` to `gp3`, for both the root and additional volumes.
- The optional permissions boundary for the AWS ParallelCluster API is now applied to every IAM role created by the API infrastructure.
  - Upgrade EFA installer to `1.29.1`.
  - Efa-driver: `efa-2.6.0-1`
  - Efa-config: `efa-config-1.15-1`

- Efa-profile: efa-profile-1.5-1
- Libfabric-aws: libfabric-aws-1.19.0-1
- Rdma-core: rdma-core-46.0-1
- Open MPI: openmpi40-aws-4.1.6-1
- Upgrade GDRCopy to version 2.4 in all supported OSes, except for Centos 7 where version 2.3.1 is used.
- Upgrade aws-cfn-bootstrap to version 2.0-28.
- Add support for Python 3.10 in aws-parallelcluster-batch-cli.

#### Bug fixes

- Fix inconsistent scaling configuration after cluster update rollback when modifying the list of instance types declared in the Compute Resources.
- Fix users SSH keys generation when switching users without root privilege in clusters integrated with an external LDAP server through cluster configuration files.

- Fix disabling Slurm power save mode when setting `ScaledownIdleTime = -1`.
- Fix hard-coded path to Slurm installation dir in `update_slurm_database_password.sh` script for Slurm Accounting.

[AWS ParallelCluster version 3.7.2 released](#)

AWS ParallelCluster version 3.7.2 released.

October 25, 2023

Changes:

- Upgrade Slurm to 23.02.6.

[AWS ParallelCluster UI version 2023.10.0 released](#)

AWS ParallelCluster UI version October 20, 2023  
2023.10.0 released.

Features:

- Added support for ParallelCluster 3.7.2 with feature parity in the wizard limited to FSx File Cache and memory based scheduling compatibility with multiple instance types.

Bug fixes:

- Fixed issue causing UI errors when PCUI does not have permissions to interact with Cost Explorer.

Improvements

- Improved security by reducing the access token TTL from 10 minutes to 5 minutes.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster version 3.7.1 released](#)

AWS ParallelCluster version 3.7.1 released.

September 22, 2023

#### Changes:

- Upgrade Slurm to 23.02.5 (from 23.02.4).
  - Upgrade Pmix to 4.2.6 (from 3.2.3).
  - Upgrade libjwt to 1.15.3 (from 1.12.0).
- Upgrade EFA installer to 1.26.1, fixing RDMA writedata issue in P5.
  - Efa-driver: efa-2.5.0-1 .
  - Efa-config: efa-config-1.15-1 .
  - Efa-profile: efa-profile-1.5-1 .
  - Libfabric-aws: libfabric-aws-1.18.2-1 .
  - ERdma-core: rdma-core-46.0-1 .
  - Open MPI: openmpi40-aws-4.1.5-4 .

[AWS ParallelCluster version 3.7.0 released](#)

AWS ParallelCluster version 3.7.0 released.

August 30, 2023

Enhancements:

- Support configuration of static and dynamic node priorities in compute resources by using a AWS ParallelCluster configuration YAML file.
- Add support for Ubuntu 22. RSA keys are not supported by default.
- Add the queue configuration setting `JobExclusiveAllocation` to allocate nodes in a partition exclusively to a single job at any given time.
- Allow Override `aws-parallelcluster-node` package at cluster create and cluster update time. For the head node, this applies for cluster update. Useful for development purposes only.
- Avoid NFS server start on compute nodes.
- Add support for log-in nodes.
- Allow memory-based scheduling when multiple



instance types are specified for a Slurm Compute Resource.

- Add support to mount existing Amazon File Cache as shared storage.

#### Changes:

- Assign Slurm dynamic nodes a priority (weight) of 1000 by default. By doing this, Slurm can prioritize idle static nodes over idle dynamic nodes.
- Make `aws-parallelcluster-node` daemons only handle AWS ParallelCluster managed Slurm partitions.
- Increase `EFS-utils` watchdog poll interval to 10 seconds. This change applies when `EncryptionInTransit` is set to `true`, which is the only condition that causes the watchdog to run.
- Upgrade the EFA installer to 1.25.1.
  - Efa-driver: `efa-2.5.0-1` (from `efa-2.1.1g`)

- Efa-config: efa-config-1.15-1 (from efa-config-1.13-1 )
- Efa-profile: efa-profile-1.5-1 (no change)
- Libfabric-aws: libfabric-aws-1.18.1-0 (from libfabric-aws-1.17.1-1 )
- Rdma-core: rdma-core-46.0-1 (from rdma-core-43.0-1 )
- Open MPI: openmpi40-aws-4.1.5-4 (from openmpi40-aws-4.1.5-1 )
- Upgrade Slurm to version 23.02.4.
- Change the default value of Imds/ImdsSupport from v1.0 to v2.0.
- Deprecate Ubuntu 18.
- Update the default root volume size to 40 GB to account for limits on Centos 7.
- Restrict permission on file /tmp/wait\_condition\_handle.txt within the head node so that only root can read it.
- Create a Slurm partition -nodelist mapping JSON file to be used by the

node package daemons to recognize PC-managed Slurm partitions and nodelists.

- Upgrade NVIDIA driver to version 535.54.03.
- Upgrade CUDA library to version 12.2.0.
- Upgrade NVIDIA Fabric manager to nvidia-fabricmanager-535.
- Upgrade ARM PL to version 23.04.1 for Ubuntu 22.04 only.
- Upgrade NICE DCV to version 2023.0-15487 .
  - Server: 2023.0.15487-1
  - xdcv: 2023.0.551-1
  - gl: 2023.0.1039-1
  - web\_viewer: 2023.0.15487-1

#### Bug fixes:

- Add validation to the ScaledownIdleTime value, to prevent setting a value lower than -1.
- Fix cluster create failure with Ubuntu Deep Learning AMI on GPU instances with DCV enabled.

- Fix issue causing dangling IAM policies to be created when creating ParallelCluster CloudFormation custom resource provider with CustomLambdaRole.
- Fix an issue that was causing misalignment of compute nodes DNS name on instances with multiple network interfaces, when using `SlurmSettings/Dns/UseEc2Hostnames` equals to `True`

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

### [Documentation only release](#)

AWS ParallelCluster version 3 specific user guide published.

July 17, 2023

Documentation only release:

- AWS ParallelCluster version 3 has its own separate user guide.

[AWS ParallelCluster version 3.6.1 released](#)

AWS ParallelCluster version 3.6.1 released.

July 5, 2023

#### Changes:

- Avoid duplication of nodes seen by `clustermgtd` if compute nodes are added to multiple Slurm partitions.

#### Bug fixes:

- Remove hard coding of root volume device name (`/dev/sda1` and `/dev/xvda`) and retrieve it from the AMI(s) used during `create-cluster`.
- Fix cluster create failure when using CloudFormation custom resource with `ElasticIp` set to `True`.
- Fix cluster create and update failures when using a AWS CloudFormation custom resource with large configuration files.
- Fix an issue that prevented `ptrace` protection from being disabled on Ubuntu and that didn't permit Cross Memory Attach (CMA) in `libfabric`.

- Fix fast insufficient capacity fail-over logic when using multiple instance types and no instances are returned.

For details of the changes, see the CHANGelog files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster UI version 2023.06.0 released](#)

AWS ParallelCluster UI version June 7, 2023  
2023.06.0 released.

Changes:

- Upgraded the default AWS ParallelCluster API version to 3.6.0.

Bug fixes:

- Fixed broken deployment for AWS GovCloud (US-West) Region.
- Split panel now correctly loads cluster details after creation has started.

Notes:

- The Cost Monitoring feature is not available in AWS GovCloud (US) Regions.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster version 3.6.0 released](#)

AWS ParallelCluster version 3.6.0 released.

May 22, 2023

Documentation:

- Add documentation for the [AWS ParallelCluster Python library API](#).

Enhancements:

- Add support for RHEL8.
- Add an [AWS CloudFormation custom resource](#) for creating and managing clusters with CloudFormation.
- Add support for [customizing the cluster Slurm configuration](#) in the AWS ParallelCluster configuration YAML file.
- Build Slurm with support for LUA.
- Increase the limit on the maximum number of queues per cluster from 10 to 50. Each queue can have up to 50 compute resources. Each cluster can have up to 50 compute resources.
- Add support for specifying a sequence of multiple [custom action scripts](#)



for an event configured in `OnNodeStart`, `OnNodeConfigured`, and `OnNodeUpdated` parameters.

- Add new configuration section `HealthChecks / Gpu`, for applying GPU health checks on a compute node before a job is run.
- Add support for Tags in the `SlurmQueues` and `SlurmQueues / ComputeResources` configuration.
- Add support for [DetailedMonitoring](#) in the Monitoring configuration.
- Add `mem_used_percent` and `disk_used_percent` metrics for head node memory and root volume disk utilization tracking in the AWS ParallelCluster [CloudWatch dashboard](#), and set up alarms for monitoring these metrics.
- Add [log rotation](#) support for AWS ParallelCluster managed logs.
- Track common compute node errors and dynamic

node longest idle time in the [CloudWatch Dashboard](#).

- Enforce the DCV Authenticator Server to use at least TLS-1.2 protocol when creating the SSL Socket.
- Install the [NVIDIA Data Center GPU Manager \(DCGM\)](#) package on all supported operating systems except aarch64 centos7 and alinux2.
- Load the kernel module [nvidia-vm](#) by default to provide Unified Virtual Memory (UVM) functionality to the CUDA driver.
- Install the [NVIDIA Persistence Daemon](#) as a system service.

#### Changes:

- Upgrade Slurm to version 23.02.2 (from version 22.05.8).
- Upgrade munge to version 0.5.15 (from version 0.5.14).
- Set the Slurm TreeWidth to 30.
- Set the Slurm prolog and epilog configurations to target directory /opt/slurm/etc/scripts/

prolog.d/ and /opt/  
slurm/etc/scripts/  
epilog.d/ respectively.

- Set Slurm BatchStar  
tTimeout to 3 minutes  
maximum for running  
Prolog scripts during  
compute node registration.
- Increase the default  
RetentionInDays of  
CloudWatch logs from 14  
to 180 days.
- Upgrade the EFA installer to  
1.22.1.
  - Dkms: 2.8.3-2
  - Efa-driver: efa-2.1.1g  
(no change)
  - Efa-config: efa-confi  
g-1.13-1 (no change)
  - Efa-profile: efa-profi  
le-1.5-1 (no change)
  - Libfabric-aws:  
libfabric-aws-1.17  
.1-1 (from libfabric  
-aws-1.17.0-1 )
  - Rdma-core: rdma-core  
-43.0-1 (no change)
  - Open MPI: openmpi40  
-aws-4.1.5-1 (no  
change)
- Upgrade the Lustre client  
version to 2.12 on Amazon  
Linux 2. Lustre client 2.12  
has been installed on

Ubuntu 20.04, 18.04, and CentOS >= 7.7.

- Upgrade the Lustre client version to 2.10.8 on CentOS 7.6.
- Upgrade the NVIDIA driver to version 470.182.03 (from version 470.141.03 ).
- Upgrade the NVIDIA Fabric Manager to version 470.182.03 (from version 470.141.03 ).
- Upgrade the NVIDIA CUDA Toolkit to version 11.8.0 (from version 11.7.1).
- Upgrade the NVIDIA CUDA sample to version 11.8.0.
- Upgrade the Intel MPI Library to Version 2021 Update 9 (from Version 2021 Update 6). For more information, see [Intel® MPI Library 2021 Update 9](#).
- Upgrade NICE DCV to version 2023.0-15022 (from version 2022.2-14521 ).
  - server: 2023.0.15022-1 (from version 2022.2-14521-1 ).
  - xdcv: 2023.0.547-1 (from version 2022.2.519-1 ).

- `gl: 2023.0.1027-1`  
(from version `2022.2.1012-1` ).
- `web_viewer: 2023.0.15022-1` (from version `2022.2.14521-1` ).
- Upgrade `aws-cfn-bootstrap` to version `2.0-24`.
- Upgrade image used by the CodeBuild environment when building container images for AWS Batch clusters:
  - `aws/codebuild/amazonlinux2-x86_64-standard:4.0` (from `aws/codebuild/amazonlinux2-x86_64-standard:3.0` ).
  - `aws/codebuild/amazonlinux2-aarch64-standard:2.0` (from `aws/codebuild/amazonlinux2-aarch64-standard:1.0` ).

#### Bug fixes:

- Fix Amazon EFS and Amazon FSx network security group validators to avoid reporting false errors.
- Fix missing tagging of resources created by Image

Builder during the build-image operation.

- Fix update policy for MaxCount to always perform numerical comparisons on the MaxCount property.
- Fix IP alignment on compute node instances with multiple network cards.
- Fix replacement of StoragePass in the `slurm_parallelcluster_slurmdbd.conf` when a queue parameter update is performed and the Slurm accounting configurations are not updated.
- Fix issue that causes dangling security groups to be created when creating a cluster with an existing EFS file system.
- Fix issue causing the `cfnhup` daemon to fail when it gets restarted.
- Consider dynamic nodes with `INVALID_REG` flag as bootstrap failures for Slurm protected mode. Static nodes failing Slurm registration are already treated as

bootstrap failures after the  
node\_replacement\_t  
imeout .

For details of the changes, see  
the CHANGelog files for the  
[aws-parallelcluster](#), [aws-paral  
lelcluster-cookbook](#), and [aws-  
parallelcluster-node](#) packages  
on GitHub.

[AWS ParallelCluster UI version 2023.05.0 released](#)

AWS ParallelCluster UI version May 16, 2023  
2023.05.0 released.

Enhancements:

- Starting with AWS ParallelCluster version 3.6.0, add support for RHEL 8.
- Add cluster cost monitoring.
- Starting with AWS ParallelCluster version 3.6.0, increase queue and compute resource quotas.

Changes:

- Improved the cluster creation wizard user interface.
- Increased the speed of AWS ParallelCluster UI deployment.
- Improved the interface for adding a new user.
- Queues are in the head node subnet by default.

Bug fixes:

- Switch to the correct region after cluster creation completes.



- Fix the loading indicator display in the "Edit cluster" feature.
- Fix cluster creation when the EBS SnapshotId property is removed.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster UI version 2023.04.0 released](#)

AWS ParallelCluster UI version April 17, 2023  
2023.04.0 released.

Enhancements:

- Cluster create wizard re-design.
- Cluster logs page re-design.
- Add custom name setting for shared storage.
- Add multiple storage selection when adding storage to a cluster.
- Add `DeletionPolicy` support for Amazon EFS and FSx for Lustre.
- Add `ImdsSupport` setting in cluster configuration.
- Add support for C7 instance types.
- Added tutorial [Reverting to a previous AWS Systems Manager document version](#).

Changes:

- Cluster configuration YAML up to 1MB in size.
- User isn't logged out due to an authorization with Boto3 IAM temporary credentials.

- Disabled multi-threading options when an HPC instance is selected.
- Removed disable rollback on cluster create page.
- User is prevented from using the AWS ParallelCluster UI until the required information is provided.
- Up to 10 queues can be added.
- The `SSM-SessionManagerRunShell` document is not overwritten during AWS ParallelCluster UI installation.

#### Bug fixes:

- Fix broken reset password link.
- Fix broken delete stack caused by `EcrPrivateRepository` not being empty
- Fixed initialization issue of the Generate SSH Keys check-box in Multiple user management properties section.
- Fixed crash caused by a job with undefined properties.
- Fixed SCRATCH FSx settings.

- Fixed Start and Stop instances button, still enabled after being clicked once.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster-ui](#) package on GitHub.

[AWS ParallelCluster version 3.5.1 released](#)

AWS ParallelCluster version 3.5.1 released.

March 29, 2023

Enhancements:

- Add a stand-alone pcluster CLI [installer executable](#).

Changes:

- Upgrade EFA installer to 1.22.0.
  - Efa-driver: efa-2.1.1g (from efa-2.1.1-1 )
  - Efa-config: efa-config-1.13-1 (from efa-config-1.12-1)
  - Efa-profile: efa-profile-1.5-1 (no change)
- Libfabric-aws: libfabric-aws-1.17.0-1 (from libfabric-aws-1.16.1amzn3.0-1 )
- Rdma-core: rdma-core-43.0-1 (no change)
- Open MPI: openmpi40-aws-4.1.5-1 (from openmpi40-aws-4.1.4-3 )

Upgrade NICE DCV to version 2022.2-14521 .

- server: 2022.2.14521-1
- xdcv: 2022.2.519-1
- gl: 2022.2.1012-1
- web\_viewer: 2022.2.14521-1

#### Bug fixes:

- Fix potential node launch failures caused by pattern matching between `MountDir` and `/etc/exports` when removing shared Amazon EBS volumes as part of a cluster update.
- Fix to prevent `compute_console_output` log file truncation at every `clustermgtd` iteration.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version 3.5.0 released](#)

AWS ParallelCluster version 3.5.0 released.

February 20, 2023

Enhancements:

- Access and manage clusters with the [AWS ParallelCluster UI](#).
- Add versioned AWS ParallelCluster policies in a CloudFormation template that you can reference in your workloads.
- Add a AWS ParallelCluster Python library that you can use with your own code.
- Add logging of compute node console output to Amazon CloudWatch on compute node bootstrap failure.
- Add failures field containing failure code and reason to `describe-cluster` output when cluster creation fails.
- Add validators to prevent malicious string injection while calling the subprocess module.
- Fail cluster creation if cluster status changes to `PROTECTED` while provisioning static nodes.

## Changes:

- Upgrade to Slurm version 22.05.8 (from version 22.05.7)
- Upgrade EFA installer to 1.21.0.
  - Efa-driver: efa-2.1.1-1 (from efa-2.1)
  - Efa-config: efa-config-1.12-1 (from efa-config-1.11-1)
  - Efa-profile: efa-profile-1.5-1 (no change)
  - Libfabric-aws: libfabric-aws-1.16.1amzn3.0-1 (from libfabric-aws-1.16.1 )
  - Rdma-core: rdma-core-43.0-1 (from rdma-core-43.0-2 )
  - Open MPI: openmpi40-aws-4.1.4-3 (no change)
- Make Slurm controller logs more verbose and enable additional logging for the Slurm power save plugin.

## Bug fixes:

- Fix cluster database creation by verifying that the cluster name is not



longer than 40 characters when Slurm accounting is enabled.

- Fix an issue in `clustermgtd` that caused compute nodes, rebooted through Slurm, to be replaced if the Amazon EC2 instance status checks fail.
- Fix an issue that prevented compute nodes, with capacity reservations shared by other accounts, from launching because of an incorrect IAM policy on the head node.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), [aws-parallelcluster-node](#), and [aws-parallelcluster-ui](#) packages on GitHub.

[AWS ParallelCluster version 3.4.1 released](#)

AWS ParallelCluster version 3.4.1 released.

January 13, 2023

Bug fixes:

- Fix a Slurm scheduler issue that could cause the incorrect application of updates to its internal registry of compute nodes. As a result if this issue, EC2 instances could become unavailable or could be backed by an incorrect instance type.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version 3.4.0 released](#)

AWS ParallelCluster version 3.4.0 released.

December 22, 2022

Enhancements:

- Add support for launching nodes across multiple availability zones to increase capacity availability.
- Add support for specifying multiple subnets for each queue to increase capacity availability.
- Add new configuration parameter in [Iam](#) / [ResourcePrefix](#) to specify a prefix for path and name of IAM resources created by AWS ParallelCluster.
- Add new configuration section [DeploymentSettings](#) / [LambdaFunctionsVpcConfig](#) for specifying the Vpc config used by AWS ParallelCluster Lambda functions.
- Add the ability to specify a custom script to run in the head node during a cluster update. The script can be specified with [HeadNode](#)

[/ CustomActions /](#)  
[OnNodeUpdated](#) when  
using Slurm as scheduler.

#### Changes:

- Remove creation of Amazon EFS mount targets for existing file systems.
- Mount EFS file systems using `amazon-efs-utils`. EFS file systems can be mounted using in-transit encryption and an IAM authorized user.
- Install `stunnel 5.67` on CentOS7 and Ubuntu to support EFS in-transit encryption.
- Upgrade EFA installer to `1.20.0` (from `1.18.0`).
  - Efa-driver: `efa-2.1` (from `efa-1.16.0-1` )
  - Efa-config: `efa-config-1.11-1` (no change)
  - Efa-profile: `efa-profile-1.5-1` (no change)
  - Libfabric-aws:  
`libfabric-aws-1.16.1` (from `libfabric-aws-1.16.0~amzn4.0-1` )
  - Rdma-core: `rdma-core-43.0-2` from (`rdma-core-41.0-2` )

- Open MPI: `openmpi40-aws-4.1.4-3` from `(openmpi40-aws-4.1.4-2)`
- Upgrade Slurm to version `22.05.7` (from `22.05.5`).
- Upgrade Python to `3.9.16` and `3.7.16`. (from `3.9.15` and `3.7.13`).
- With Slurm `22.05.7`, dynamic nodes in `IDLE` `+CLOUD+COMPLETING` `+POWER_DOWN+NOT_RESPONDING` status aren't considered unhealthy.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version 3.3.1 released](#)

AWS ParallelCluster version 3.3.1 released.

December 2, 2022

Changes:

- Official AWS ParallelCluster product AMIs are now available after Amazon EC2 deprecation at two years.
- Increase memory size of the AWS ParallelCluster API Lambda to 2048 in order to reduce cold start penalties and avoid timeouts.

Bug fixes:

- Prevent replacement of managed FSx for Lustre file systems and loss of data on cluster updates that include changes to the compute fleet subnet ID.
- [SharedStorage](#) DeletionPolicy applies to cluster update actions.

For details of the changes, see the CHANGELOG file for the [aws-parallelcluster](#) package on GitHub.

[AWS ParallelCluster documentation only hpc6id note](#)

AWS ParallelCluster  
documentation-only update

December 2, 2022

- AWS ParallelCluster doesn't support the hpc6id instance type for the [HeadNode](#) / [InstanceType](#) setting.

[AWS ParallelCluster version 3.1.5 released](#)

AWS ParallelCluster version 3.1.5 released.

November 16, 2022

#### Enhancements:

- Fix Slurm issue that prevents idle nodes termination.
- Upgrade EFA installer to 1.18.0
  - Efa-driver: efa-1.16.0-1
  - Efa-config: efa-config-1.11-1 (from efa-config-1.9-1 )
  - Efa-profile: efa-profile-1.5-1 (no change)
  - Libfabric-aws: libfabric-aws-1.16.0~amzn4.0-1 (from libfabric-1.13.2 ).
  - Rdma-core: rdma-core-41.0-2 (from rdma-core-37.0 )
  - Open MPI: openmpi40-aws-4.1.4-2 (from openmpi40-aws-4.1.1-2 )

#### Changes:

- Add `lambda:ListTags` and `lambda:Un`



`tagResource` to the `ParallelClusterUserRole` used by the AWS ParallelCluster API stack for a cluster update.

- Upgrade Intel MPI Library to Version 2021 Update 6 (from Version 2021 Update 4). For more information, see [Intel® MPI Library 2021 Update 6](#).
- Upgrade NVIDIA driver to version 470.141.03 (from 470.103.01).
- Upgrade NVIDIA Fabric Manager to version 470.141.03 (from 470.103.01).

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version 3.3.0 released](#)

AWS ParallelCluster version 3.3.0 released.

November 2, 2022

Enhancements:

- Add support for multiple instance allocation configuration for a compute resource when using Slurm as a scheduler. For more information, see [Multiple instance type allocation with Slurm](#).
- Add support for adding and removing [SharedStorage](#) with a cluster update, using an updated configuration. For more information, see [Shared storage](#).
- Add new configuration parameter `DeletionPolicy` for [Efs](#) and [FsxLustre](#) shared storage settings to support storage retention.
- Add support for Slurm accounting with new configuration parameter [Scheduling](#) / [SlurmSettings](#) / [Database](#). For more information, see [Slurm](#)

[accounting with AWS ParallelCluster.](#)

- Add support for On-Demand Capacity Reservations (ODCR) and capacity reservation resource groups. For more information, see [Launch instances with On-Demand Capacity Reservations \(ODCR\)](#).
- Add new configuration parameter to specify the IMDS version to support in a cluster or build image infrastructure in the cluster, [Imds](#) / [ImdsSupport](#), and build, [Imds](#) / [ImdsSupport](#), configurations.
- Add support for [Networking](#) / [PlacementGroup](#) in the [SlurmQueues](#) / [ComputeResources](#) section.
- Add support for instances with multiple network interfaces that are limited to only one ENI per device.
- Improve validation of networking for external Amazon EFS file systems by checking the CIDR block in the attached security group.

- Add validator to check if configured instance types support placement groups.
- Configure NFS threads to be  $\min(256, \max(8, \text{num\_cores} * 4))$  to ensure better stability and performance.
- Move NFS installation at build time to reduce configuration time.
- Enable server-side encryption for the EcrImageBuilder SNS topic that's created when deploying AWS ParallelCluster API and is used to notify on docker image build events.

#### Changes:

- Change the behavior of [SlurmQueues](#) / [Networking](#) / [PlacementGroup](#) Enabled. It now creates a unique managed placement group for each compute resource instead of a single managed placement group for all compute resources.
- Add support for [SlurmQueues](#) / [Networking](#) / [PlacementGroup](#) / [Name](#)

as the preferred naming method.

- Move head node tags from Launch Template to instance definition to avoid head node replacement on tags updates.
- Disable multithreading through script executed by `cloud-init` and not through `CpuOptions` set in the Launch Template.
- Upgrade Python to version 3.9 and NodeJS to version 16 in the API infrastructure, API Docker container, and cluster Lambda resources.
- Remove support for Python 3.6 in `aws-parallelcluster-batch-cli`.
- Upgrade Slurm to version 22.05.5 (from 21.08.8-2).
- Upgrade NVIDIA driver to version 470.141.03 (from 470.129.06).
- Upgrade NVIDIA Fabric Manager to version 470.141.03 (from 470.129.06).
- Upgrade NVIDIA CUDA Toolkit to version 11.7.1 (from 11.4.4).

- Upgrade Python used in AWS ParallelCluster virtualenvs from 3.7.13 to 3.9.15.
- Upgrade EFA installer to version 1.18.0.
  - Efa-driver: efa-1.16.0-1 (no change)
  - Efa-config: efa-config-1.11-1 (from efa-config-1.10-1 )
  - Efa-profile: efa-profile-1.5-1 (no change)
  - Libfabric-aws: libfabric-aws-1.16.0~amzn4.0-1 (from libfabric-aws-1.16.0~amzn2.0-1 ).
  - Rdma-core: rdma-core-41.0-2 (from rdma-core-37.0 )
  - Open MPI: openmpi40-aws-4.1.4-2 (from openmpi40-aws-4.1.1-2 )
- Upgrade NICE DCV to version 2022.1-13300 (from 2022.0-12760 ).
- Enable suppression of the SingleSubnetValidator for Queues.
- Do not replace DRAIN nodes when nodes are in

COMPLETING state as  
Epilog may be still running.

#### Bug fixes:

- Fix validation of filters parameter in the AWS ParallelCluster `ListClusterLogStreams` command to fail when incorrect filters are passed.
- Fix validation of parameter [SharedStorage](#) / [EfsSettings](#) to fail validation when `FileSystemId` is specified along with other [SharedStorage](#) / [EfsSettings](#) parameters. Previously, `FileSystemId` wasn't included.
- Fix cluster update when changing the order of [SharedStorage](#) together with other changes in the configuration.
- Fix `UpdateParallelClusterLambdaRole` in the AWS ParallelCluster API to upload logs to CloudWatch.
- Fix Cinc not using the local CA certificates bundle when installing packages before any cookbooks are executed.

- Fix a hang in upgrading ubuntu with pcluster build-image when `Build:UpdateOsPackages:Enabled:true` is set.
- Fix parsing of YAML cluster configuration by failing on duplicate keys.

For details of the changes, see the CHANGelog files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster documentation only API reference added.](#)

AWS ParallelCluster documentation-only update

October 27, 2022

- Added the version 3 [AWS ParallelCluster API reference](#) to the documentation.



[AWS ParallelCluster version  
3.2.1 released](#)

AWS ParallelCluster version  
3.2.1 released.

October 3, 2022

Enhancements:

- Improve the logic to associate the host routing tables to the different network cards to better support Amazon EC2 instances with several NICs.

Changes:

- Upgrade NVIDIA driver to version 470.141.03.
- Upgrade NVIDIA Fabric Manager to version 470.141.03.
- Disable cron job tasks `man-db` and `mlocate`, which may have a negative impact on node performance.
- Upgrade Intel MPI Library to 2021.6.0.602.
- Upgrade Python from 3.7.10 to 3.7.13 in response to this security risk.

Bug fixes:

- Avoid failing on `DescribeCluster` when

cluster configuration is not available.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version 3.2.0 released](#)

AWS ParallelCluster version 3.2.0 released.

July 27, 2022

Enhancements:

- Add support for [memory-based scheduling](#) in Slurm.
  - Configure compute nodes real memory in the Slurm cluster configuration.
  - Add new configuration parameter [Scheduling / SlurmSettings / EnableMemoryBasedScheduling](#) to enable memory-based scheduling in Slurm.
  - Add new configuration parameter [Scheduling / SlurmQueues / ComputeResources / SchedulableMemory](#) to override the default value of the memory seen by the scheduler on compute nodes.
- Improve flexibility on cluster configuration updates to avoid the stop and start of the entire cluster whenever possible. Add new configuration parameter [Scheduling / SlurmSettings /](#)

[QueueUpdateStrategy](#) to set the preferred strategy to use when compute nodes need a configuration update and replacement.

- Improve fail-over mechanism over available compute resources when hitting insufficient capacity issues with Amazon EC2 instances. [Disable compute nodes by a configurable amount of time](#) when a node launch fails due to insufficient capacity.
- Add support to mount existing [FSx for ONTAP](#) and [FSx for OpenZFS](#) file systems.
- Add support to mount multiple instances of existing [Amazon Elastic File Systems, FSx for Lustre, FSx for ONTAP, and FSx for OpenZFS](#) file systems.
- Add support for [FSx for Lustre Persistent\\_2 deployment type](#) when creating a new file system.
- Prompt user to enable EFA for supported instance types when using the [pcluster configure](#) wizard.

- Add support for rebooting compute nodes using Slurm.
- Improve handling of Slurm power states to also account for manual powering down of nodes.
- Install NVIDIA GDRCopy 2.3 into the product AMIs to enable low-latency GPU memory copy.

#### Changes:

- Upgrade EFA installer to version 1.17.2.
  - EFA driver: efa-1.16.0-1
  - EFA configuration: efa-config-1.10-1
  - EFA profile: efa-profile-1.5-1
  - Libfabric: libfabric-aws-1.16.0~amzn2.0-1
  - RDMA core: rdma-core-41.0-2
  - Open MPI: openmpi40-aws-4.1.4-2
- Upgrade NICE DCV to version 2022.0-12760.
- Upgrade NVIDIA driver to version 470.129.06.

- Upgrade NVIDIA Fabric Manager to version 470.129.06.
- Change default EBS volume types from gp2 to gp3 in both the root and additional volumes.
- Changes to FSx for Lustre file systems created by AWS ParallelCluster:
  - Change the default deployment type to Scratch\_2 .
  - Change the Lustre server version to 2.12.
- Doesn't require [Placement Group](#) / [Enabled](#) to be set to true when passing an existing Placement Group / Id.
- Doesn't allow setting PlacementGroup / Id when PlacementGroup / Enabled is explicitly set to false.
- Add parallelcluster:cluster-name tag to all resources created by AWS ParallelCluster.
- Add lambda:ListTags and lambda:UntagResource to ParallelClusterUserRole used by the AWS

ParallelCluster API stack for cluster update.

- Restrict IPv6 access to IMDS to root and cluster admin users only, when configuration parameter `HeadNode / Imds / Secured` is enabled.
- With a custom AMI, use the AMI root volume size instead of the ParallelCluster default of 35 GiB. The value can be changed in cluster configuration file.
- Automatic disabling of the compute fleet when the configuration parameter `Scheduling / SlurmQueues / ComputeResources / SpotPrice` is lower than the minimum required Spot request fulfillment price.
- Show `requested_value` and `current_value` values in the change set when adding or removing a section during an update.
- Disable `aws-ubuntu-eni-helper` service, available in Deep Learning AMIs, to avoid conflicts with `configure_nw_interface.sh` when configuring instances with multiple network cards.

- Remove support for Python 3.6.
- Set MTU to 9001 for all the network interfaces when configuring instances with multiple network cards.
- Remove the trailing dot when configuring the compute node FQDN.
- Manage static nodes in `POWERING_DOWN` .
- Doesn't replace dynamic node in `POWER_DOWN` as jobs may be still running.
- Restart `clustermgtd` and `slurmctld` daemons at cluster update time only when `Scheduling` parameters are updated in the cluster configuration.
- Update `slurmctld` and `slurmd` systemd service files.
- Restrict IPv6 access to IMDS to root and cluster admin users only, when configuration parameter `HeadNode / Imds / Secured` is enabled.
- Set Slurm configuration `AuthInfo=cred_expire=70` to reduce the time requeued jobs must wait before starting again when nodes are not available.



- Upgrade third-party cookbook dependencies:
  - apt-7.4.2 (from apt-7.4.0)
  - line-4.5.2 (from line-4.0.1)
  - openssh-2.10.3 (from openssh-2.9.1)
  - pyenv-3.5.1 (from pyenv-3.4.2)
  - selinux-6.0.4 (from selinux-3.1.1)
  - yum-7.4.0 (from yum-6.1.1)
  - yum-epel-4.5.0 (from yum-epel-4.1.2)

#### Bug fixes:

- Fix the default behavior to skip the AWS ParallelCluster validation and test steps when building a custom AMI.
- Fix file handle leak in `computemgtd`.
- Fix race condition that was sporadically causing launched instances to be immediately terminated because they were not yet available in the EC2 `DescribeInstances` response.
- Fix support for the `DisableSimultaneous`

sMultithreading parameter on instance types with Arm processors.

- Fix AWS ParallelCluster API stack update failure when upgrading from a previous version. Add resource pattern used for the `ListImagePipelineImages` Action in the `EcrImageDeletionLambdaRole` .
- Fix AWS ParallelCluster API adding missing permissions needed to import or export from Amazon S3 when creating an FSx for Lustre file system.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster documentation-only updates this year to date](#)

AWS ParallelCluster documentation-only updates.

July 6, 2022

New sections:

- [Best practices: budget alerts V3](#)
- [Best practices: moving a cluster to a new AWS ParallelCluster minor or patch version V3](#)
- [Working with Amazon S3 V3](#)
- [Working with Spot Instances V3](#)
- [Slurm cluster protected mode V3](#)
- [AWS ParallelCluster resources and tagging V3](#)
- [Amazon CloudWatch dashboard V3](#)
- [Integration with Amazon CloudWatch Logs V3](#)
- [Elastic Fabric Adapter V3](#)
- [AWS ParallelCluster AMI customization V3](#)
- [Launch instances with On-Demand Capacity Reservations \(ODCR\) V3](#)
- [AMI patching and Amazon EC2 instance replacement V3](#)

- [How AWS ParallelCluster works V3](#)
- [Configuring shared storage encryption with an AWS KMS key V3](#)
- [Running jobs in a multiple queue mode cluster V3](#)
- [Using the AWS ParallelCluster API V3](#)

Section updates:

- [Best practices: network performance V3](#): Added best practices for using Elastic Fabric Adaptor.
- [AWS Identity and Access Management permissions in AWS ParallelCluster V3](#): Various updates and added [Additional AWS ParallelCluster pcluster user policy when using Amazon FSx for Lustre](#).
- [AWS ParallelCluster troubleshooting V3](#): Various updates.

[AWS ParallelCluster version 3.1.4 released](#)

AWS ParallelCluster version 3.1.4 released.

May 16, 2022

Enhancements:

- Add validation for [DirectoryService](#) / [PasswordSecretArn](#) to fail if the secret doesn't exist.

Add support for enabling JWT authentication Slurm.

Changes:

- Upgrade Slurm to version 21.08.8-2.
- Build Slurm with JWT support.
- Doesn't require [Placement Group](#) / [Enabled](#) to be set to true when passing an existing Placement Group / Id.
- Add `lambda:TagResource` to `ParallelClusterUserRole` used by ParallelCluster API stack for cluster creation and image creation.

Bug fixes:

- Fix the ability to export a cluster's logs when using the `export-cluster-logs` command with the `--filters` option.
- Fix AWS Batch Docker entry point to use `/home` shared directory to coordinate Multi-node-Parallel job execution.
- Reset node address when setting Slurm unhealthy static node to down to avoid treating static node failed with insufficient capacity as a bootstrap failure node.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version 3.1.3 released](#)

AWS ParallelCluster version 3.1.3 released.

April 20, 2022

Enhancements:

- Execute SSH key creation alongside with the creation of HOME directory, for example, during SSH login, when switching to another user and when executing a command as another user.
- Add support for both FQDN and LDAP Distinguished Names in the configuration parameter [Directory Service / DomainName](#). The new validator now checks both the syntaxes.
- New `update_directory_service_password.sh` script deployed on the head node supports the manual update of the Active Directory password in the SSSD configuration. The password is retrieved by the AWS Secrets Manager as from the cluster configuration.
- Add support to deploy API infrastructure in environments without a default VPC.

## Changes:

- Disable deeper C-States in x86\_64 official AMIs and AMIs created through `build-image` command, to guarantee high performance and low latency.
- OS package updates and security fixes.
- Change Amazon Linux 2 base images to use AMIs with Kernel 5.10.

## Bug fixes:

- Fix `build-image` stack in `DELETE_FAILED` after image built successful, due to new EC2 Image Builder policies.
- Fix the configuration parameter [Directory Service](#) / [DomainAddr](#) conversion to `ldap_uri` SSSD property when it contains multiples domain addresses .

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), and [aws-parallelcluster-cookbook](#) packages on GitHub.



[AWS ParallelCluster version  
3.1.2 released](#)

AWS ParallelCluster version  
3.1.2 released.

March 2, 2022

Changes:

- Upgrade Slurm to version 21.08.6 (from 21.08.5).

Bug fixes:

- Fix the update of `/etc/hosts` file on compute nodes when a cluster is deployed in subnets without internet access.
- Fix compute nodes bootstrap to wait for ephemeral drives initialization before joining the cluster.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#) package on GitHub.

[AWS ParallelCluster version 3.1.1 released](#)

AWS ParallelCluster version 3.1.1 released.

February 10, 2022

- Add support for multiple user cluster environments by [integrating with Active Directory \(AD\) domains](#) managed through AWS Directory Service.
- Add support for [UseEc2Hostnames](#) in the cluster configuration file. When set to true, use Amazon EC2 default hostnames (e.g. ip-1-2-3-4) for compute nodes.
- Add support for cluster creation in [subnets with no internet access](#).
- Add support for multiple compute instance types per queue.
- Add support for GPU scheduling with Slurm on ARM instances with NVIDIA cards.
- Add abbreviated flags for `cluster-name` (`-n`), `region` (`-r`), `image-id` (`-i`) and `cluster-configuration / image-configuration` (`-c`) to the AWS ParallelCluster CLI.

- Add support for NEW\_CHANGED\_DELETE D option for FSx for Lustre [AutoImportPolicy](#) parameter.
- Add parallelcluster:compute-resource-name tag to EC2 LaunchTemplates resources used by compute nodes.
- Improve security groups created within the cluster to allow inbound connections from custom security groups when SecurityGroups parameters are specified for some head node and/or queues.
- Install NVIDIA drivers and CUDA library for ARM.

#### Changes:

- Upgrade Slurm to version 21.08.5 (from 20.11.8).
- Upgrade Slurm plugin to version 21.08 (from 20.11).
- Upgrade NICE DCV to version 2021.3-11591 (from 2021.1-10851 ).
- Upgrade NVIDIA driver to version 470.103.01 (from 470.57.02 ).

- Upgrade NVIDIA Fabric manager to version 470.103.01 (from 470.57.02 ).
- Upgrade CUDA to version 11.4.4 (from 11.4.0).
- [Intel MPI](#) updated to Version 2021 Update 4 (updated from Version 2019 Update 8). For more information, see [Intel® MPI Library 2021 Update 4](#).
- Upgrade PMIx to version 3.2.3 (from 3.1.5).
- Remove dumping of failed compute nodes to /home/logs/compute . Compute nodes log files are available in CloudWatch and in Amazon EC2 console logs.
- Enable potential to suppress SlurmQueues and ComputeResources length validators.
- Disable package update at instance launch time on Amazon Linux 2.
- Disable Amazon EC2 ImageBuilder enhanced image metadata when building AWS ParallelCluster custom images.
- Explicitly set cloud-init datasource to be EC2. This

saves boot time for Ubuntu and CentOS platforms.

- Use compute resource name rather than instance type in compute fleet launch template name.
- Redirect stderr and stdout to CLI log file to prevent unwanted text in the pcluster CLI output.
- Move the configure/install recipes to separate cookbooks that are called from the main one. Existing entrypoints are maintained and backwards compatible.
- Download dependencies of Intel HPC platform during AMI build time to avoid contacting internet during cluster creation time.
- Do not strip - from compute resource name when configuring Slurm nodes.
- Do not configure GPUs in Slurm when NVIDIA driver is not installed.
- Fix `ecs:ListContainerInstances` permission in `BatchUserRole` .
- Fix exporting of cluster logs when there is no

- prefix specified, previously exported to a None prefix.
- Fix rollback not being performed in case of cluster update failure.
  - Fix `ecs:ListContainerInstances` permission in `BatchUserRole` .
  - Fix `RootVolume` schema for the `HeadNode` by raising an error if an unsupported `KmsKeyId` is specified.
  - Fix Amazon FSx missing metrics to be displayed in CloudWatch Dashboard.
  - Fix `EfaSecurityGroupValidator` . Previously, it had potential to produce false failures when custom security groups were provided and EFA was enabled.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#), and [aws-parallelcluster-node](#) packages on GitHub.

[AWS ParallelCluster version  
3.0.3 released](#)

AWS ParallelCluster version  
3.0.3 released.

January 17, 2022

- Disable log4j-cve-2021-44228-hotpatch agent (Log4jHotPatch ) on Amazon Linux 2 to avoid potential performance degradation. For more information, see [Amazon Linux Hotpatch Announcement for Apache Log4j](#).

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster](#) and [aws-parallelcluster-cookbook](#) packages on GitHub.

[AWS ParallelCluster version 3.0.2 released](#)

AWS ParallelCluster version 3.0.2 released.

November 5, 2021

Upgrade [Elastic Fabric Adapter](#) installer to 1.14.1

- EFA config: `efa-config-1.9-1` (from `efa-config-1.9` )
- EFA profile: `efa-profile-1.5-1` (from `efa-profile-1.5` )
- EFA Kernel module: `efa-1.14.2` (from `efa-1.13.0` )
- RDMA core: `rdma-core-37.0` (from `rdma-core-35` )
- Libfabric: `libfabric-1.13.2` (from `libfabric-1.13.0` )
- Open MPI: `openmpi40-aws-4.1.1-2` (no change)

GPUDirect RDMA is always enabled if supported by the instance type. The [GdrSupport](#) configuration option has no effect.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-paral](#)



[elcluster-cookbook](#) and [aws-parallelcluster-node](#) packages on GitHub.

## [AWS ParallelCluster version 3.0.1 released](#)

AWS ParallelCluster version 3.0.1 released.

October 27, 2021

### Cluster configuration migration tool

- Customers can now migrate their cluster configurations from the AWS ParallelCluster version 2 format to the YAML-based AWS ParallelCluster version 3 format. For more information, see [pcluster3-config-converter](#).

### Head node can be stopped

- After stopping the compute fleet, the head node can be stopped and later restarted using the Amazon EC2 console or the [stop-instances](#) AWS CLI command.

### Default AWS Region read from ~/.aws/config file

- For the [pcluster](#) command, if the AWS Region is not specified in the configuration file, in the environment, or on the command line, the default AWS Region specified in

the `region` setting in the `[default]` section of the `~/.aws/config` file is used.

For details of the changes, see the `CHANGELOG` files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#) and [aws-parallelcluster-node](#) packages on GitHub.

## [AWS ParallelCluster version 3.0.0 released](#)

AWS ParallelCluster version 3.0.0 released.

September 10, 2021

Support for cluster management via Amazon API Gateway

- Customers can now manage and deploy clusters through HTTP endpoints with Amazon API Gateway. This opens up new possibilities for scripted or event-driven workflows.

The AWS ParallelCluster command line interface (CLI) has also been redesigned for compatibility with this API and includes a new JSON output option. This new functionality makes it possible for customers to implement similar building block capabilities using the CLI as well.

Improved custom AMI creation

- Customers now have access to a more robust process for creating and managing custom AMIs using EC2

Image Builder. Custom AMIs can now be managed through a separate AWS ParallelCluster configuration file, and can be created using the [pcluster build-image](#) command in the AWS ParallelCluster command line interface.

For details of the changes, see the CHANGELOG files for the [aws-parallelcluster](#), [aws-parallelcluster-cookbook](#) and [aws-parallelcluster-node](#) packages on GitHub.