

## Private Cloud Requirements

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## Introduction to Private Cloud

With the Cloudera Machine Learning (CML) service, data scientists and partners can build and run machine learning experiments and workloads in a secure environment. CML on Private Cloud provides an identical experience to CML on Public Cloud, but running in your own on-premises data center.

Cloudera Machine Learning enables you to:

- Easily onboard a new tenant and provision an ML workspace in a shared OpenShift or ECS environment.
- Enable data scientists to access shared data on CDP Private Cloud Base and CDW.
- Leverage Spark-on-K8s to spin up and down Spark clusters on demand.

## Cloudera Machine Learning requirements (OCP)

To launch the Cloudera Machine Learning service, the OpenShift Container Platform (OCP) host must meet several requirements. Review the following CML-specific software, NFS server, and storage requirements.

### Requirements

If necessary, contact your Administrator to make sure the following requirements are satisfied:

1. If you are using OpenShift, the installed OpenShift Container Platform must be version 4.7 or 4.8. For ECS, refer to the Hardware and Software Requirements section in Installing and Managing a Private Cloud Experience Cluster 1.4.0.
2. CML assumes it has cluster-admin privileges on the cluster.
3. Storage:
  - a. 4 TB of persistent volume block storage per ML Workspace.
  - b. 1 TB of NFS space recommended per Workspace (depending on user files).
  - c. Access to NFS storage is routable from all pods running in the cluster.
  - d. For monitoring, recommended volume size is 60 GB.
4. A block storage class must be marked as default in the cluster. This may be rook-ceph-block, Portworx, or another storage system. Confirm the storage class by listing the storage classes (run `oc get sc`) in the cluster, and check that one of them is marked default.
5. If external NFS is used, the NFS directory and assumed permissions must be those of the `cdsw` user. For details see Using an External NFS Server in the Related information section at the bottom of this page.
6. If CML needs access to a database on the CDP Private Cloud Base cluster, then the user must be authenticated using Kerberos and must have Ranger policies set up to allow read/write operations to the default (or other specified) database.
7. Ensure that Kerberos is enabled for all services in the cluster. Custom Kerberos principals are not currently supported. For more information, see [Enabling Kerberos for authentication](#).
8. Forward and reverse DNS must be working.
9. DNS lookups to sub-domains and the ML Workspace itself should work.
10. In DNS, wildcard subdomains (such as `*.cml.yourcompany.com`) must be set to resolve to the master domain (such as `cml.yourcompany.com`). The TLS certificate (if TLS is used) must also include the wildcard subdomains. When a session or job is started, an engine is created for it, and the engine is assigned to a random, unique subdomain.
11. The external load balancer server timeout needs to be set to 5 min. Without this, creating a project in an ML workspace with `git clone` or with the API may result in API timeout errors. For workarounds, see Known Issue DSE-11837.
12. If you intend to access a workspace over https, see Deploy an ML Workspace with Support for TLS.
13. For non-TLS ML workspaces, websockets need to be allowed for port 80 on the external load balancer.

14. Only a TLS-enabled custom Docker Registry is supported. Ensure that you use a TLS certificate to secure the custom Docker Registry. The TLS certificate can be self-signed, or signed by a private or public trusted Certificate Authority (CA).
15. On OpenShift, due to a [Red Hat issue](#) with OpenShift Container Platform 4.3.x, the image registry cluster operator configuration must be set to Managed.
16. Check if storage is set up in the cluster image registry operator. See Known Issues DSE-12778 for further information.

For more information on requirements, see CDP Private Cloud Base Installation Guide.

## Hardware requirements

### Storage

The cluster must have persistent storage classes defined for both block and filesystem volumeModes of storage. Ensure that a block storage class is set up. The exact amount of storage classified as block or filesystem storage depends on the specific workload used:

- Machine Learning workload requirements for storage largely depend on the nature of your machine learning jobs. 4 TB of persistent volume block storage is required per Machine Learning Workspace instance for storing different kinds of metadata related to workspace configuration. Additionally, Machine Learning requires access to NFS storage routable from all pods running in the cluster (see below).
- Monitoring uses a large Prometheus instance to scrape workloads. Disk usage depends on scale of workloads. Recommended volume size is 60 GB.

	Local Storage (for example, ext4)	Block PV (for example, Ceph or Portworx)	NFS (for ML user project files)
Control Plane	N/A	250 GB	N/A
CML	N/A	4 TB per workspace	1 TB per workspace (dependent on size of ML user files)

### NFS

Cloudera Machine Learning (CML) requires NFS 4.0 for storing project files and folders. NFS storage is to be used only for storing project files and folders, and not for any other CML data, such as PostgreSQL database and LiveLog.

#### ECS requirements for NFS Storage

Cloudera managed ECS deploys and manages an internal NFS server based on LongHorn which can be used for CML. This is the recommended option for CML on ECS clusters. CML requires nfs-utils in order to mount longhorn-nfs provisioned mounts.

CML requires the nfs-utils package be installed in order to mount volumes provisioned by longhorn-nfs. The nfs-utils package is not available by default on every operating system. Check if nfs-utils is available, and ensure that it is present on all ECS cluster nodes.

Alternatively, the NFS server can be external to the cluster, such as a NetApp filer that is accessible from the private cloud cluster nodes.

#### OpenShift requirements for NFS storage

An internal user-space NFS server can be deployed into the cluster which serves a block storage device (persistent volume) managed by the cluster's software defined storage (SDS) system, such as Ceph or Portworx. This is the recommended option for CML on OpenShift. Alternatively, the NFS server can be external to the cluster, such as a NetApp filer that is accessible from the private cloud cluster nodes. NFS storage is to be used only for storing project files and folders, and not for any other CML data, such as PostgreSQL database and LiveLog.

CML does not support shared volumes, such as Portworx shared volumes, for storing project files. A read-write-once (RWO) persistent volume must be allocated to the internal NFS server (for example, NFS server provisioner) as the persistence layer. The NFS server uses the volume to dynamically provision read-write-many (RWX) NFS volumes for the CML clients.

### Related Information

[CDP Private Cloud Base Installation Guide](#)

[CDP Private Cloud Experiences Installation Software Requirements](#)

[Known Issues and Limitations](#)

[Deploy an ML Workspace with Support for TLS](#)

[Using an External NFS Server](#)

## Cloudera Machine Learning requirements (ECS)

There are minimal requirements when using Cloudera Machine Learning on ECS.

The primary requirement is to have 4 TB of storage space.

For further information, see the Hardware and Software Requirements section in *CDP Private Cloud Data Services installation overview*

### Related Information

[CDP Private Cloud Data Services installation overview](#)

## Get started with CML on Private Cloud

To get started as a user with Cloudera Machine Learning on your Private Cloud, follow the steps described below. They will show you how to set up a Project and work on some data.

### Before you begin

Make sure the Admin creates a new Workspace for you. If you are an Admin, see: [Provision an ML Workspace](#).



**Note:** Make sure that an Admin user logs into the Workspace first.

### Procedure

1. Log in to your workspace. On the Workspaces tab, click Launch Workspace.
2. Next, create a Project. See: [Creating a Project](#).
3. Once you have a Project, run a Session to start your work. See: [Launch a Session](#).
4. Test your access to the base cluster (Data Lake). See: [CDP-DC cluster connectivity test](#).
5. You can then run a Model. Learn about Models here: [Creating and Deploying a Model](#).
6. When you are finished with your workspace, your Admin can remove it, as described here: [Removing ML Workspaces](#).

## Test your connectivity to the CDP-DC cluster

Test that you can create a Project in your ML Workspace and access data that is stored in the data center cluster.

### Procedure

1. Create a new Project, using the PySpark template.
2. Create a new file called testdata.txt (use this exact filename).

3. Add 2-3 lines of any text in the file to serve as sample data.
4. Run the following Spark commands to test the connection.

```
from pyspark.sql import SparkSession

# Instantiate Spark-on-K8s Cluster
spark = SparkSession\
.builder\
.appName("Simple Spark Test")\
.config("spark.executor.memory", "8g")\
.config("spark.executor.cores", "2")\
.config("spark.driver.memory", "2g")\
.config("spark.executor.instances", "2")\
.getOrCreate()

# Validate Spark Connectivity
spark.sql("SHOW databases").show()
spark.sql('create table testcml (abc integer)').show()
spark.sql('insert into table testcml select t.* from (select 1) t').show()
spark.sql('select * from testcml').show()
# Stop Spark Session
spark.stop()
```

5. Run the following direct HDFS commands to test the connection.

```
# Run sample HDFS commands
# Requires an additional testdata.txt file to be created with sample data
in project home dir
!hdfs dfs -mkdir /tmp/testcml/
!hdfs dfs -copyFromLocal /home/cdsw/testdata.txt /tmp/testcml/
!hdfs dfs -cat /tmp/testcml/testdata.txt
```

### What to do next

If you get errors, then check with your Admin to make sure that your user ID is set up in the Hadoop Authentication settings to access the CDP-DC cluster, and that the correct Ranger permissions have been applied.

## Differences Between Public and Private Cloud

There are some differences in Cloudera Machine Learning functionality between Public and Private Cloud.

Feature	Public Cloud	Private Cloud 1.4.x
CML application control plane (infrastructure containers and workload containers)	Control plane is hosted on public cloud servers.	Control plane is hosted on customer's cluster.
Storage - CML internal state data (database, images, logs)	EBS on AWS, Azure Disks on Azure.	Software Defined Storage System, such as Ceph or Portworx.
Storage - User project files	EFS on AWS, external NFS on Azure.	Internal NFS storage is recommended.
Autoscaling	CPU/GPU nodes scale up and down as needed.	Autoscaling concept is different; Private Cloud shares a pooled set of resources among workloads.
Logging	Per-workspace diagnostic bundles can be downloaded from the workspace.	Diagnostic bundles are not supported at Workspace level, but can be downloaded from the control plane at the cluster level.
Monitoring dashboards	Provides four dashboards.	Provides two dashboards, for K8s Container and K8s Cluster.

Feature	Public Cloud	Private Cloud 1.4.x
NFS support	AWS uses EFS; Azure requires external NFS.	Internal NFS is recommended, external NFS is supported.
TLS support	TLS access to workspaces is supported.	TLS access is supported, but requires manual setup of certificate and other steps.
Hadoop Authentication	Uses FreeIPA	User needs to provide credentials to communicate with the CDP Private Base cluster.
Remote Access	Available from each workspace.	Not available in the workspace. Instead, the environment's kubeconfig file may be downloaded from Environments using the Download Kubernetes configuration action for the specified environment.
Roles	MLAdmin, MLUser	The corresponding roles are: EnvironmentAdmin, EnvironmentUser

## Limitations on Private Cloud

There are some limitations to keep in mind when you are working with Cloudera Machine Learning on Private Cloud.

The following features are not yet supported in CML Private Cloud:

- Logging is limited, and diagnostic bundles for each workspace cannot be downloaded from the workspace UI. Instead, diagnostic bundles for the entire cluster can be downloaded from the control plane.
- Monitoring on Private Cloud does not support node-level resource metrics, hence only K8s Cluster and K8s Container dashboards are available.
- CML does not support the NVIDIA Multi-Instance GPU (MIG) feature.

## Network File System (NFS)

A Network File System (NFS) is a protocol to access storage on a network that emulates accessing storage in a local file system. CML requires an NFS server for storing project files and folders, and the NFS export must be configured before you provision the first CML workspace in the cluster.

There are many different products or packages that can create an NFS in your private network. A Kubernetes cluster can host an internal NFS server, or an external NFS server can be installed on another cluster that is accessible by the private cloud cluster nodes. NFS storage is used only for storing project files and folders, and not for any other CML data, such as PostgreSQL database and livelog files.

CML does not support shared volumes, such as Portworx shared volumes, for storing project files. A read-write-once (RWO) persistent volume must be allocated to the internal NFS server (for example, NFS server provisioner) as the persistence layer. The NFS server uses the volume to dynamically provision read-write-many (RWX) NFS volumes for the CML clients.

An external NFS server option is currently the recommended option for Private Cloud production workloads. Not specifying an external NFS Server for your ML Workspace will use/require a deprecated internal NFS provisioner, which should only be used for small, proof-of-concept deployments. There are several options for setting up an internal NFS provisioner, described in the appendix. The Private Cloud Admin is responsible for setting up an NFS for use by your cluster.



**Note:** See *CDP Private Cloud Data Services Installation Software Requirements* for some information about installing NFS.



## Related Information

[CDP Private Cloud Experiences Installation Software Requirements](#)

## NFS Options for Private Cloud

Cloudera Machine Learning on Private Cloud requires a Network File System (NFS) server for storing project files and folders.

The recommended approach is to use an NFS server that is external to the cluster, such as a NetApp Filer appliance. In this case, you must manually create a directory for each workspace.

The NFS server must be configured before deploying the first CML workspace in the cluster. One important limitation is that CML does not support using shared volumes for storing project files. A read-write-once (RWO) persistent volume must be allocated to the internal NFS server (e.g., NFS server provisioner) as the persistence layer. The NFS server uses the volume to dynamically provision read-write-many (RWX) NFS volumes for the CML clients.

An alternative approach is to use an internal NFS server which is deployed into the cluster. This method uses a deprecated internal NFS provisioner, and it should only be used for small, proof-of-concept deployments. Solutions include NFS over Ceph using NFS Server Provisioner (NFS Ganesha) on OpenShift. On ECS, Cloudera manages and deploys an NFS which can be used for CML. The storage space for each workspace is transparently managed by the internal NFS server.

## Internal Network File System on OCP (Non-Production)

Learn about deploying, backing up, and uninstalling an internal NFS server on OpenShift Container Platform.

However, for production, an external NFS server is recommended. For more information, see *Using an External NFS Server*.

### Deploying NFS Server Provisioner on Rook Ceph

As an example, you can deploy the NFS Server Provisioner using the [Helm chart provided here](#).

- For the nfs storage class, set “allowVolumeExpansion=true”
- For the underlying persistent volume, specify a size of 1 TiB.
- On the block storage system class, rook-ceph-block in this case, set allowVolumeExpansion=true
- Download two yaml files here: [nfs-server-provisioner.yml](#) and [nfs-scc.yml](#).



**Note:** If your read-write-once block pv storage class is not rook-ceph-block, then replace rook-ceph-block with your preferred read-write-once block pv storage class in the nfs-server-provisioner.yml file below.



**Note:** In this example, the size of the underlying persistent volume is specified as 1 TiB. You are recommended to increase the size by 1 TiB for each additional ML workspace that will be created. For example, increase the size by 5 TiB for 5 ML workspaces.



**Note:** The yaml file below has a line that will download the nfs server image from quay.io/kubernetes\_incubator/nfs-provisioner:v2.3.0. If your installation is airgapped, download the file to a local repository and change the path accordingly.

1. Install Path 1: Installing using the oc command and yaml files:
  - a. If you do not have Tillerless Helm v2 set up, then you can simply apply the nfs-server-provisioner.yml file as follows: `$ oc create -f nfs-server-provisioner.yml -n cml-nfs`
2. Install Path 2: Installing using the oc command and Tillerless Helm v2:

```
$ oc delete scc nfs-scc
$ oc delete clusterrole cml-nfs-nfs-server-provisioner
$ oc delete clusterrolebinding cml-nfs-nfs-server-provisioner
```

```
$ oc delete namespace cml-nfs

$ helm tiller run cml-nfs -- helm delete cml-nfs --purge
$ oc delete scc nfs-scc securitycontextconstraints.security.openshift.io "nfs-scc" deleted
```

## Backing up Project Files and Folders

The block device backing the NFS server data must be backed up to protect the CML project files and folders. The backup mechanism would vary depending on the underlying block storage system and backup policies in place.

1. identify the underlying block storage to backup, first determine the NFS PV:

```
$ echo `kubectl get pvc -n cml-nfs -o jsonpath='{.items[0].spec.volumeName}'`
pvc-beclde27-753d-11ea-a287-4cd98f578292
```

2. For Rook Ceph, the RBD volume/image name is the name of the dynamically created persistent volume (pvc-3d3316b6-6cc7-11ea-828e-1418774847a1).

Ensure this volume is backed up using an appropriate backup policy.

## Uninstalling the NFS server on OpenShift

Uninstall the NFS server provisioner using either of the following commands.

Use this command if the NFS server provisioner was installed using oc and yaml files:

```
$ oc delete scc nfs-scc
$ oc delete clusterrole cml-nfs-nfs-server-provisioner
$ oc delete clusterrolebinding cml-nfs-nfs-server-provisioner
$ oc delete namespace cml-nfs
```

Use this command if the NFS server provisioner was installed using Helm:

```
$ helm tiller run cml-nfs -- helm delete cml-nfs --purge
$ oc delete scc nfs-scc securitycontextconstraints.security.openshift.io "nfs-scc" deleted
```

## Related Information

[Using an External NFS Server](#)

## Internal Network File System on ECS (Non-Production)

On ECS, NFS is part of the overall installation, and no additional setup steps are required. However, for production, an external NFS server is recommended. For more information, see *Using an External NFS Server*.

The internal NFS does not have a backup feature.

## Related Information

[Using an External NFS Server](#)

## Using an External NFS Server

You can install an NFS server that is external to the cluster.

### About this task

Currently, NFS version 4.1 is the recommended protocol to use for CML. The NFS client within CML must be able to mount the NFS storage with default options, and also assumes these export options:

```
rw,sync,no_root_squash,no_all_squash,no_subtree_check
```

### Before you begin

Before creating a CML workspace, the storage administrator must create a directory that will be exported to the cluster for storing ML project files for that workspace. Either a dedicated NFS export path, or a subdirectory in an existing export must be specified for each workspace.

Each CML workspace needs a unique directory that does not have files in it from a different or previous workspace. For example, if 10 CML workspaces are expected, the storage administrator will need to create 10 unique directories. Either one NFS export and 10 subdirectories within it need to be created, or 10 unique exports need to be created.

For example, to use a dedicated NFS share for a workspace named “workspace1” from NFS server “nfs\_server”, do the following:

### Procedure

1. Create NFS export directory “/workspace1”.
2. Change ownership for the exported directory
  - a) CML accesses this directory as a user with a UID and GID of 8536. Therefore, run `chown 8536:8536 /workspace1`
  - b) Make the export directory group-writeable and set the GID:  
`chmod g+srwx /workspace1`
3. Provide the NFS export path `nfs_server:/workspace1` when prompted by the CML Control Plane App while creating the workspace.
4. To use a subdirectory in an existing NFS share, say `nfs_server:/export`, do the following:
  - a) Create a subdirectory `/export/workspace1`
  - b) Change ownership: `chown 8536:8536 /export/workspace1`
  - c) Set GID and make directory group writeable: `chmod g+srwx /export/workspace1`
  - d) Provide the export path `nfs_server:/export/workspace1` when prompted by the CML Control Plane App.

### NFS share sizing

CML workloads are sensitive to latency and IO/s instead of throughput.

The minimum recommended file share size is 100 GB. The file share must support online volume capacity expansion. It must provide at least the following performance characteristics:

IO / s	3100
Throughput rate	110.0 MiBytes/s

## Deploy an ML Workspace with Support for TLS

You can provision an ML workspace with TLS enabled, so that it can be accessed via https.

### Before you begin

You need to obtain a certificate from the Certificate Authority used by your organization. This may be an internal certificate authority.

Additionally, you need a computer with CLI access to the cluster, and with `kubectl` installed.

### Procedure

1. Provision the ML Workspace. Follow the procedure [Provisioning ML Workspaces](#).



**Note:** Ensure you select Enable TLS.

2. Obtain the `.crt` and `.key` files for the certificate from your Certificate Authority.

The certificate URL is generally of the form: `<workspaceid>.<cluster>.<domain>.com`. Assuming an example URL for the certificate of `ml-30b43418-53c.cluster.yourcompany.com`, check that the certificate correctly shows the corresponding Common Name (CN) and Subject Alternative Names (SAN):

- CN: `ml-30b43418-53c.cluster.yourcompany.com`
- SAN: `*.ml-30b43418-53c.cluster.yourcompany.com`
- SAN: `ml-30b43418-53c.cluster.yourcompany.com`

3. Create a Kubernetes secret inside the previously provisioned ML workspace namespace, and name the secret `cml-tls-secret`.

On a machine with access to the `.crt` and `.key` files above, and access to the OpenShift cluster, run this command:

```
kubectl create secret tls cml-tls-secret --cert=<pathtocrt.crt> --key=<pathtokey.key> -o yaml --dry-run |
kubectl -n <cml-workspace-namespace> create -f -
```

You can replace or update certificates in the secret at any time.

4. In Admin Security Root CA configuration, add the root CA certificate to the workspace.

For example: `https://ml-def88113-acd.cluster.yourcompany.com/administration/security"`

### Results

The command creates routes to reflect the new state of ingress and secret, and enables TLS.

## Replace a Certificate

You can replace a certificate in a deployed namespace.

### About this task

#### Procedure

1. Obtain the new certificate `.crt` and `.key` files.
2. Run this command (example): `kubectl create secret tls cml-tls-secret --cert=<pathtocrt.crt> --key=<pathtokey.key> -o yaml --dry-run | kubectl -n <cml-workspace-namespace> replace -f -`

### What to do next

The certificate of an existing session does not get renewed. The new certificate only applies to newly created sessions.

## Deploy an ML Workspace with Support for TLS on ECS

On ECS, you can provision an ML workspace with TLS enabled, so that the workspace is accessible via `https`.

### About this task

You need to obtain a certificate from the Certificate Authority used by your organization. This may be an internal certificate authority. Additionally, you need a computer with CLI access to the cluster, and with `kubectl` installed.

## Procedure

1. Provision an ML workspace. See *Provision an ML Workspace* for more information.



**Note:** Ensure you select Enable TLS.

2. Obtain the .crt and .key files for the certificate from your Certificate Authority.

The certificate URL is generally of the form: <workspaceid>.<cluster>.<domain>.com. Assuming an example URL for the certificate of ml-30b43418-53c.cluster.yourcompany.com, check that the certificate correctly shows the corresponding Common Name (CN) and Subject Alternative Names (SAN):

- CN: ml-30b43418-53c.cluster.yourcompany.com
- SAN: \*.ml-30b43418-53c.cluster.yourcompany.com
- SAN: ml-30b43418-53c.cluster.yourcompany.com

3. Create or replace a Kubernetes secret inside the previously provisioned ML workspace namespace, then automatically upload the certificate.

Login to the Ecs Server role host and execute the following commands to accomplish these steps:

- a) `cd /opt/cloudera/parcels/ECS/bin/`
- b) `./cml_utils.sh -h`

Optional: A helper prompt appears, with explanation for the next command.

- c) `./cml_utils.sh upload-cert -n <namespace> -c <path_to_cert> -k <path_to_key>`

For example: `./cml_utils.sh upload-cert -n bb-tls-1 -c /tmp/ws-cert.crt -k /tmp/ws-key.key`



**Note:** To find the <namespace> of the workspace, go to the Machine Learning Workspaces UI, and in the Actions menu for the workspace, select View Workspace Details. Namespace is shown on the Details tab.

4. In Site Administration Security Root CA configuration, add the root CA certificate to the workspace.

For example: `https://ml-def88113-acd.apps.nf-01.os4cluster.yourcompany.com/administration/security`

## GPU node setup

In Kubernetes, you can taint nodes to affect how the node is scheduled. You can ensure that nodes that have a GPU are reserved exclusively for CML workloads that require a GPU.

To reserve a GPU node, assign a taint to the node.

### Openshift

On Openshift, specify the node taint `nvidia.com/gpu: true:NoSchedule` for any nodes that host GPUs and are required to be used only for GPU workloads.

### ECS

On ECS, set the node taint `nvidia.com/gpu: true:NoSchedule` in one of the following three ways:

1. During ECS installation: After adding the GPU host(s) to Cloudera Manager but prior to creation of the ECS cluster, visit the Host Configuration page, select the Dedicated GPU Node for Data Services checkbox and Save the configuration. Repeat for all hosts on which the taint is desired. Then, proceed with installation via the Add Cluster wizard.
2. During ECS upgrade: After upgrading Cloudera Manager (if applicable), set the host configuration as described above on one or more hosts in the ECS cluster. Then, proceed with upgrade via the Upgrade Cluster wizard.
3. Independently of ECS install or upgrade: Set the host configuration as described above on one or more hosts in the ECS cluster. Redeploy the client configuration on the ECS cluster. Finally, run the Reapply All Settings to Cluster command on the ECS service, which can be found in the Service Actions menu.