Available as of v1.5.0

Harvester now supports provisioning of root volumes and data volumes using external Container Storage Interface (CSI) drivers. This enhancement allows you to select drivers that meet specific requirements, such as performance optimization or seamless integration with existing internal storage solutions.

:::important

Harvester has validated the following CSI drivers:

- Longhorn V2 Data Engine: `driver.longhorn.io`
- LVM: `lvm.driver.harvesterhci.io`
- NFS: `nfs.csi.k8s.io`
- Rook (RADOS Block Device): `rook-ceph.rbd.csi.ceph.com`

The validated CSI drivers have the following capabilities:

Storage Solution	VM Image	VM Rook Disk	VM Data Disk	Volume Export To VM Image	VM Template Generator	VM Live Migration	VM Snapshot	VM Backup
Longhorn v2 Data Engine	✔	✔	✔	✔	✔	✔	✖	✖
LVM	✔	✔	✔	✔	✔	✖	✔	✖
NFS	✔	✔	✔	✔	✔	✔	✖	✖
Rook (RBD)	✔	✔	✔	✔	✔	✔	✔	✖

:::

Prerequisites

To enable Harvester to function well, use CSI drivers that support the following capabilities:

- Volume expansion (online resizing)
- Snapshot creation (volume and virtual machine snapshots)
- Cloning (volume and virtual machine clones)
- Usage of Read-Write-Many (RWX) volumes for Live Migration

Create Harvester cluster

Harvester's operating system follows an immutable design, meaning that most OS files revert to their pre-configured state after a reboot. Therefore, you might need to perform additional configurations before installing the Harvester cluster for third-party CSI drivers.

Some CSI drivers require additional persistent paths on the host. You can add these paths to `os.persistent_state_paths`.

Some CSI drivers require additional software packages on the host. You can install these packages with `os.after_install_chroot_commands`.

:::note

Upgrading Harvester causes the changes to the OS in the `after-install-chroot` stage to be lost. You must also configure the `after-upgrade-chroot` to make your changes persistent across an upgrade. Refer to Runtime persistent changes before upgrading Harvester.

:::

Install the CSI driver

After installing the Harvester cluster is complete, refer to How can I access the kubeconfig file of the Harvester cluster? to get the kubeconfig of the cluster.

With the kubeconfig of the Harvester cluster, you can install the third-party CSI drivers into the cluster by following the installation instructions for each CSI driver. You must also refer to the CSI driver documentation to create the `StorageClass` and `VolumeSnapshotClass` in the Harvester cluster.

Configure Harvester Cluster

Before you can make use of Harvester's **Backup & Snapshot** features, you need to set up some essential configurations through the Harvester csi-driver-config setting. Follow these steps to make these configurations:

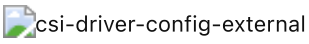
:::note

Backup currently only works with the Longhorn v1 Data Engine. If you are using other storage providers, you can skip the **Backup VolumeSnapshot Class Name** configuration.

For more information, see VM Backup Compatibility.

:::

1. Login to the Harvester UI, then navigate to **Advanced** > **Settings**.
2. Find and select **csi-driver-config**, and then select ⋮ > **Edit Setting** to access the configuration options.
3. Set the **Provisioner** to the third-party CSI driver in the settings.
4. Next, Configure the **Volume Snapshot Class Name**. This setting points to the name of the `VolumeSnapshotClass` used for creating volume snapshots or VM snapshots.


csi-driver-config-external

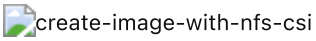
Use the CSI Driver

Once the CSI driver is installed and the Harvester cluster is configured, an external storage solution can be used in tasks that involve storage management.

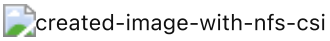
Virtual Machine Image Creation

You can use an external storage solution to store and manage virtual machine images.

When uploading a virtual machine image using the Harvester UI (**Image > Create**), you must select the StorageClass for the external storage solution on the **Storage** tab. In the following example, the StorageClass is **nfs-csi**.



Harvester stores the created image in the external storage solution.

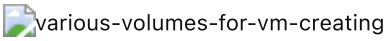


Virtual Machine Creation

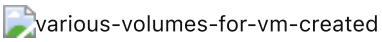
Your virtual machines can use root and data volumes in external storage.

When creating a virtual machine using the Harvester UI (**Virtual Machine > Create**), you must perform the following actions on the **Volumes** tab:

- Select a virtual machine image stored in the external storage solution, and then configure the required settings.
- Add a data volume.



In the following example, the root volume is created using NFS, and the data volume is created using the Longhorn V2 Data Engine.

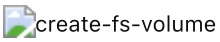


Volume Creation

You can create volumes in your external storage solution.

When creating a volume using the Harvester UI (**Volumes > Create**), you must perform the following actions:

- **Storage Class**: Select the target StorageClass, e.g. **nfs-csi**.
- **Volume Mode**: Select the corresponding volume mode, e.g. **Filesystem** for **nfs-csi**.



Advanced Topics

Storage Profiles

You can now use the CDI API to create custom storage profiles that simplify definition of data volumes. Storage profiles allow multiple data volumes to share the same provisioner settings.

The following is an example of an LVM storage profile:

```
apiVersion: cdi.kubevirt.io/v1beta1
kind: StorageProfile
metadata:
  name: lvm-node-1-striped
spec:
```

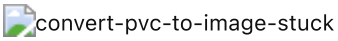
```
  claimPropertySets:
  - accessModes:
    - ReadWriteOnce
    volumeMode: Block
status:
  claimPropertySets:
  - accessModes:
    - ReadWriteOnce
    volumeMode: Block
  cloneStrategy: snapshot
  dataImportCronSourceFormat: pvc
  provisioner: lvm.driver.harvesterhci.io
  snapshotClass: lvm-snapshot
  storageClass: lvm-node-1-striped
```

For more information, see Storage Profiles in the CDI documentation.

You can define the above fields to override the default configuration showing on the status.

Limitations

- Backup support is currently limited to Longhorn V1 Data Engine volumes. Harvester is unable to create backups of volumes in external storage.
- There is a limitation in the CDI which prevents Harvester from converting attached PVCs to virtual machine images. Before exporting a volume in external storage, ensure that the PVC is not attached to workloads. This prevents the resulting image from getting stuck in the *Exporting* state.

 convert-pvc-to-image-stuck

How to deploy the NFS CSI driver

:::note

You can deploy the NFS CSI driver only when the NFS server is already installed and running.

If the server is already running, check the `squash` option. You must disable squashing of remote root users (`no_root_squash` or `no_all_squash`) because KubeVirt needs the QEMU UID/GID to ensure that the volume can be synced properly.

:::

1. Install the driver using the `csi-driver-nfs` Helm chart.

```
$ helm repo add csi-driver-nfs https://raw.githubusercontent.com/kubernetes-csi/csi-driver-nfs/master/charts
$ helm install csi-driver-nfs csi-driver-nfs/csi-driver-nfs --namespace kube-system --version v4.10.0
```

1. Create the StorageClass for NFS.

For more information about parameters, see Driver Parameters: Storage Class Usage in the Kubernetes NFS CSI Driver documentation.

```yaml
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: nfs-csi
provisioner: nfs.csi.k8s.io
parameters:
  server: <your-nfs-server-ip>
  share: <your-nfs-share>
  # csi.storage.k8s.io/provisioner-secret is only needed for providing mountOptions
in DeleteVolume
  # csi.storage.k8s.io/provisioner-secret-name: "mount-options"
  # csi.storage.k8s.io/provisioner-secret-namespace: "default"
reclaimPolicy: Delete
volumeBindingMode: Immediate
allowVolumeExpansion: true
mountOptions:
  - nfsvers=4.2
```

Once created, you can use the StorageClass to create virtual machine images, root volumes, and data volumes.

References

- Use Rook Ceph External Storage with Harvester
- Using NetApp Storage on Harvester
- Third Party Storage Support

Known Issues

1. Infinite Image Download Loop

The image download process loops endlessly when the StorageClass for the image uses the LVM CSI driver. This issue is related to the scratch volume, which is created by CDI and is used to temporarily store the image data. When the issue exists in your environment, you might find the following error messages in `importer-prime-xxx` pod logs:

```
E0418 01:59:51.843459       1 util.go:98] Unable to write file from dataReader: write
/scratch/tmpimage: no space left on device
E0418 01:59:51.861235       1 data-processor.go:243] write /scratch/tmpimage: no space
left on device
unable to write to file
kubevirt.io/containerized-data-importer/pkg/importer.streamDataToFile
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/pkg/importer/util.go:101
kubevirt.io/containerized-data-importer/pkg/importer.(*HTTPDataSource).Transfer
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/pkg/importer/http-datasource.go:162
kubevirt.io/containerized-data-importer/pkg/importer.
(*DataProcessor).initDefaultPhases.func2
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/pkg/importer/data-processor.go:173
```

```
kubevirt.io/containerized-data-importer/pkg/importer.
(*DataProcessor).ProcessDataWithPause
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/pkg/importer/data-processor.go:240
kubevirt.io/containerized-data-importer/pkg/importer.(*DataProcessor).ProcessData
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/pkg/importer/data-processor.go:149
main.handleImport
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/cmd/cdi-importer/importer.go:188
main.main
    /home/abuild/rpmbuild/BUILD/go/src/kubevirt.io/containerized-data-
importer/cmd/cdi-importer/importer.go:148
runtime.main
```

The message `no space left on device` indicates that the filesystem created using the scratch volume is not enough to store the image data. CDI creates the scratch volume based on the size of the target volume, but some space is lost to filesystem overhead. The default overhead value is `0.055` (equivalent to 5.5%), which is sufficient in most cases. However, if the image size is less than 1 GB and its virtual size is very close to the image size, the default overhead is likely to be insufficient.

The workaround is to increase the filesystem overhead to 20% using the following command:

```
# kubectl patch cdi cdi --type=merge -p '{"spec":{"config":{"filesystemOverhead":
{"global":"0.2"}}}}'
```

The image should be downloaded once the filesystem overhead is increased.

:::note

Increasing the overhead value does not affect the image PVC size. The scratch volume is deleted after the image is imported.

:::

Related issue: #7993 (See this comment.)