Use volumes

Volumes are the preferred mechanism for persisting data generated by and used by Docker containers. While [bind mounts](https://docs.docker.com/storage/bind-mounts/) are dependent on the directory structure and OS of the host machine, volumes are completely managed by Docker. Volumes have several advantages over bind mounts:

* Volumes are easier to back up or migrate than bind mounts.
* You can manage volumes using Docker CLI commands or the Docker API.
* Volumes work on both Linux and Windows containers.
* Volumes can be more safely shared among multiple containers.
* Volume drivers let you store volumes on remote hosts or cloud providers, to encrypt the contents of volumes, or to add other functionality.
* New volumes can have their content pre-populated by a container.
* Volumes on Docker Desktop have much higher performance than bind mounts from Mac and Windows hosts.

In addition, volumes are often a better choice than persisting data in a container’s writable layer, because a volume does not increase the size of the containers using it, and the volume’s contents exist outside the lifecycle of a given container.



If your container generates non-persistent state data, consider using a [tmpfs mount](https://docs.docker.com/storage/tmpfs/) to avoid storing the data anywhere permanently, and to increase the container’s performance by avoiding writing into the container’s writable layer.

Volumes use rprivate bind propagation, and bind propagation is not configurable for volumes.

Choose the -v or --mount flag

In general, --mount is more explicit and verbose. The biggest difference is that the -v syntax combines all the options together in one field, while the --mount syntax separates them. Here is a comparison of the syntax for each flag.

If you need to specify volume driver options, you must use --mount.

* **-v or --volume**: Consists of three fields, separated by colon characters (:). The fields must be in the correct order, and the meaning of each
* field is not immediately obvious.
  + In the case of named volumes, the first field is the name of the volume, and is unique on a given host machine. For anonymous volumes, the first field is omitted.
  + The second field is the path where the file or directory are mounted in the container.
  + The third field is optional, and is a comma-separated list of options, such as ro. These options are discussed below.
* **--mount**: Consists of multiple key-value pairs, separated by commas and each consisting of a <key>=<value> tuple. The --mount syntax is more verbose than -v or --volume, but the order of the keys is not significant, and the value of the flag is easier to understand.
  + The type of the mount, which can be [bind](https://docs.docker.com/storage/bind-mounts/), volume, or [tmpfs](https://docs.docker.com/storage/tmpfs/). This topic discusses volumes, so the type is always volume.
  + The source of the mount. For named volumes, this is the name of the volume. For anonymous volumes, this field is omitted. May be specified as source or src.
  + The destination takes as its value the path where the file or directory is mounted in the container. May be specified as destination, dst, or target.
  + The readonly option, if present, causes the bind mount to be [mounted into the container as read-only](https://docs.docker.com/storage/volumes/#use-a-read-only-volume).
  + The volume-opt option, which can be specified more than once, takes a key-value pair consisting of the option name and its value.

**Escape values from outer CSV parser**

If your volume driver accepts a comma-separated list as an option, you must escape the value from the outer CSV parser. To escape a volume-opt, surround it with double quotes (") and surround the entire mount parameter with single quotes (').

For example, the local driver accepts mount options as a comma-separated list in the o parameter. This example shows the correct way to escape the list.

$ docker service create \

--mount 'type=volume,src=<VOLUME-NAME>,dst=<CONTAINER-PATH>,volume-driver=local,volume-opt=type=nfs,volume-opt=device=<nfs-server>:<nfs-path>,"volume-opt=o=addr=<nfs-address>,vers=4,soft,timeo=180,bg,tcp,rw"'

--name myservice \

<IMAGE>

The examples below show both the --mount and -v syntax where possible, and --mount is presented first.

Differences between -v and --mount behavior

As opposed to bind mounts, all options for volumes are available for both --mount and -v flags.

When using volumes with services, only --mount is supported.

Create and manage volumes

Unlike a bind mount, you can create and manage volumes outside the scope of any container.

**Create a volume**:

$ docker volume create my-vol

**List volumes**:

$ docker volume ls

local my-vol

**Inspect a volume**:

$ docker volume inspect my-vol

[

{

"Driver": "local",

"Labels": {},

"Mountpoint": "/var/lib/docker/volumes/my-vol/\_data",

"Name": "my-vol",

"Options": {},

"Scope": "local"

}

]

**Remove a volume**:

$ docker volume rm my-vol

Start a container with a volume

If you start a container with a volume that does not yet exist, Docker creates the volume for you. The following example mounts the volume myvol2 into /app/ in the container.

The -v and --mount examples below produce the same result. You can’t run them both unless you remove the devtest container and the myvol2 volume after running the first one.

* --mount
* -v

$ docker run -d \

--name devtest \

--mount source=myvol2,target=/app \

nginx:latest

Use docker inspect devtest to verify that the volume was created and mounted correctly. Look for the Mounts section:

"Mounts": [

{

"Type": "volume",

"Name": "myvol2",

"Source": "/var/lib/docker/volumes/myvol2/\_data",

"Destination": "/app",

"Driver": "local",

"Mode": "",

"RW": true,

"Propagation": ""

}

],

This shows that the mount is a volume, it shows the correct source and destination, and that the mount is read-write.

Stop the container and remove the volume. Note volume removal is a separate step.

$ docker container stop devtest

$ docker container rm devtest

$ docker volume rm myvol2

Use a volume with docker-compose

A single docker compose service with a volume looks like this:

version: "3.9"

services:

frontend:

image: node:lts

volumes:

- myapp:/home/node/app

volumes:

myapp:

On the first invocation of docker-compose up the volume will be created. The same volume will be reused on following invocations.

A volume may be created directly outside of compose with docker volume create and then referenced inside docker-compose.yml as follows:

version: "3.9"

services:

frontend:

image: node:lts

volumes:

- myapp:/home/node/app

volumes:

myapp:

external: true

Start a service with volumes

When you start a service and define a volume, each service container uses its own local volume. None of the containers can share this data if you use the local volume driver, but some volume drivers do support shared storage. Docker for AWS and Docker for Azure both support persistent storage using the Cloudstor plugin.

The following example starts a nginx service with four replicas, each of which uses a local volume called myvol2.

$ docker service create -d \

--replicas=4 \

--name devtest-service \

--mount source=myvol2,target=/app \

nginx:latest

Use docker service ps devtest-service to verify that the service is running:

$ docker service ps devtest-service

ID NAME IMAGE NODE DESIRED STATE CURRENT STATE ERROR PORTS

4d7oz1j85wwn devtest-service.1 nginx:latest moby Running Running 14 seconds ago

Remove the service, which stops all its tasks:

$ docker service rm devtest-service

Removing the service does not remove any volumes created by the service. Volume removal is a separate step.

Syntax differences for services

The docker service create command does not support the -v or --volume flag. When mounting a volume into a service’s containers, you must use the --mount flag.

Populate a volume using a container

If you start a container which creates a new volume, as above, and the container has files or directories in the directory to be mounted (such as /app/ above), the directory’s contents are copied into the volume. The container then mounts and uses the volume, and other containers which use the volume also have access to the pre-populated content.

To illustrate this, this example starts an nginx container and populates the new volume nginx-vol with the contents of the container’s /usr/share/nginx/html directory, which is where Nginx stores its default HTML content.

The --mount and -v examples have the same end result.

* --mount
* -v

$ docker run -d \

--name=nginxtest \

--mount source=nginx-vol,destination=/usr/share/nginx/html \

nginx:latest

After running either of these examples, run the following commands to clean up the containers and volumes. Note volume removal is a separate step.

$ docker container stop nginxtest

$ docker container rm nginxtest

$ docker volume rm nginx-vol

Use a read-only volume

For some development applications, the container needs to write into the bind mount so that changes are propagated back to the Docker host. At other times, the container only needs read access to the data. Remember that multiple containers can mount the same volume, and it can be mounted read-write for some of them and read-only for others, at the same time.

This example modifies the one above but mounts the directory as a read-only volume, by adding ro to the (empty by default) list of options, after the mount point within the container. Where multiple options are present, separate them by commas.

The --mount and -v examples have the same result.

* --mount
* -v

$ docker run -d \

--name=nginxtest \

--mount source=nginx-vol,destination=/usr/share/nginx/html,readonly \

nginx:latest

Use docker inspect nginxtest to verify that the readonly mount was created correctly. Look for the Mounts section:

"Mounts": [

{

"Type": "volume",

"Name": "nginx-vol",

"Source": "/var/lib/docker/volumes/nginx-vol/\_data",

"Destination": "/usr/share/nginx/html",

"Driver": "local",

"Mode": "",

"RW": false,

"Propagation": ""

}

],

Stop and remove the container, and remove the volume. Volume removal is a separate step.

$ docker container stop nginxtest

$ docker container rm nginxtest

$ docker volume rm nginx-vol

Share data among machines

When building fault-tolerant applications, you might need to configure multiple replicas of the same service to have access to the same files.

There are several ways to achieve this when developing your applications. One is to add logic to your application to store files on a cloud object storage system like Amazon S3. Another is to create volumes with a driver that supports writing files to an external storage system like NFS or Amazon S3.

Volume drivers allow you to abstract the underlying storage system from the application logic. For example, if your services use a volume with an NFS driver, you can update the services to use a different driver, as an example to store data in the cloud, without changing the application logic.

Use a volume driver

When you create a volume using docker volume create, or when you start a container which uses a not-yet-created volume, you can specify a volume driver. The following examples use the vieux/sshfs volume driver, first when creating a standalone volume, and then when starting a container which creates a new volume.

Initial set-up

This example assumes that you have two nodes, the first of which is a Docker host and can connect to the second using SSH.

On the Docker host, install the vieux/sshfs plugin:

$ docker plugin install --grant-all-permissions vieux/sshfs

Create a volume using a volume driver

This example specifies a SSH password, but if the two hosts have shared keys configured, you can omit the password. Each volume driver may have zero or more configurable options, each of which is specified using an -o flag.

$ docker volume create --driver vieux/sshfs \

-o sshcmd=test@node2:/home/test \

-o password=testpassword \

sshvolume

Start a container which creates a volume using a volume driver

This example specifies a SSH password, but if the two hosts have shared keys configured, you can omit the password. Each volume driver may have zero or more configurable options. **If the volume driver requires you to pass options, you must use the --mount flag to mount the volume, rather than -v.**

$ docker run -d \

--name sshfs-container \

--volume-driver vieux/sshfs \

--mount src=sshvolume,target=/app,volume-opt=sshcmd=test@node2:/home/test,volume-opt=password=testpassword \

nginx:latest

Create a service which creates an NFS volume

This example shows how you can create an NFS volume when creating a service. This example uses 10.0.0.10 as the NFS server and /var/docker-nfs as the exported directory on the NFS server. Note that the volume driver specified is local.

NFSv3

$ docker service create -d \

--name nfs-service \

--mount 'type=volume,source=nfsvolume,target=/app,volume-driver=local,volume-opt=type=nfs,volume-opt=device=:/var/docker-nfs,volume-opt=o=addr=10.0.0.10' \

nginx:latest

NFSv4

docker service create -d \

--name nfs-service \

--mount 'type=volume,source=nfsvolume,target=/app,volume-driver=local,volume-opt=type=nfs,volume-opt=device=:/var/docker-nfs,"volume-opt=o=addr=10.0.0.10,rw,nfsvers=4,async"' \

nginx:latest

Create CIFS/Samba volumes

You can mount a Samba share directly in docker without configuring a mount point on your host.

docker volume create \

--driver local \

--opt type=cifs \

--opt device=//uxxxxx.your-server.de/backup \

--opt o=addr=uxxxxx.your-server.de,username=uxxxxxxx,password=\*\*\*\*\*,file\_mode=0777,dir\_mode=0777 \

--name cif-volume

Notice the addr option is required if using a hostname instead of an IP so docker can perform the hostname lookup.

Backup, restore, or migrate data volumes

Volumes are useful for backups, restores, and migrations. Use the --volumes-from flag to create a new container that mounts that volume.

Backup a container

For example, create a new container named dbstore:

$ docker run -v /dbdata --name dbstore ubuntu /bin/bash

Then in the next command, we:

* Launch a new container and mount the volume from the dbstore container
* Mount a local host directory as /backup
* Pass a command that tars the contents of the dbdata volume to a backup.tar file inside our /backup directory.

$ docker run --rm --volumes-from dbstore -v $(pwd):/backup ubuntu tar cvf /backup/backup.tar /dbdata

When the command completes and the container stops, we are left with a backup of our dbdata volume.

Restore container from backup

With the backup just created, you can restore it to the same container, or another that you made elsewhere.

For example, create a new container named dbstore2:

$ docker run -v /dbdata --name dbstore2 ubuntu /bin/bash

Then un-tar the backup file in the new container`s data volume:

$ docker run --rm --volumes-from dbstore2 -v $(pwd):/backup ubuntu bash -c "cd /dbdata && tar xvf /backup/backup.tar --strip 1"

You can use the techniques above to automate backup, migration and restore testing using your preferred tools.

Remove volumes

A Docker data volume persists after a container is deleted. There are two types of volumes to consider:

* **Named volumes** have a specific source from outside the container, for example awesome:/bar.
* **Anonymous volumes** have no specific source so when the container is deleted, instruct the Docker Engine daemon to remove them.

Remove anonymous volumes

To automatically remove anonymous volumes, use the --rm option. For example, this command creates an anonymous /foo volume. When the container is removed, the Docker Engine removes the /foo volume but not the awesome volume.

$ docker run --rm -v /foo -v awesome:/bar busybox top

Remove all volumes

To remove all unused volumes and free up space:

$ docker volume prune