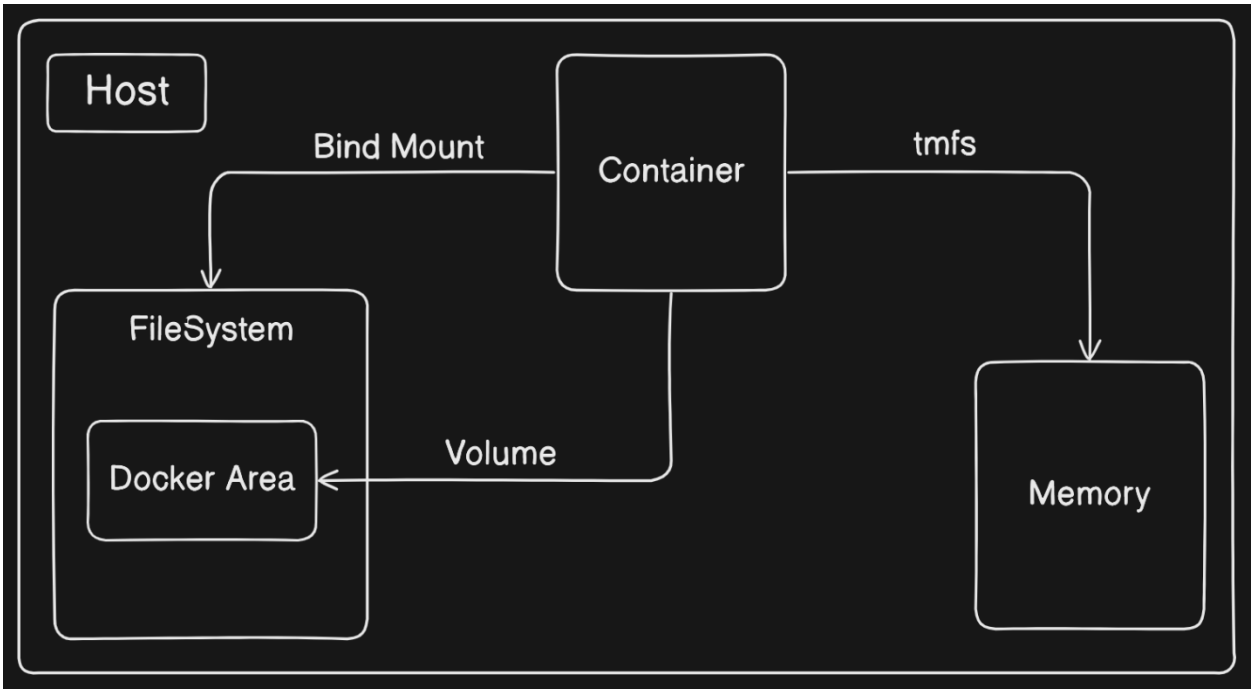
Working with Docker Volumes

Docker Volume is a mechanism in Docker that allows you to persist data even after a container is deleted or recreated. It provides a way to store data outside of the container's filesystem, so that data is not lost when the container is restarted or deleted.



Why do we need Docker Volumes?

When you run a container, it has its own filesystem, which is ephemeral. This means that any data written to the container's filesystem will be lost when the container is deleted or restarted. Docker Volumes provide a way to decouple the data from the container's filesystem, so that data can be preserved even when the container is recreated.

How do Docker Volumes work?

A Docker Volume is a directory that is **shared** between the host machine and a container. When you create a volume, Docker creates a directory on the host machine, and mounts it to a directory inside the container. This allows data to be written to the volume, which is persisted even when the container is deleted or recreated.

Example Scenerio: Using Docker volumes with a NoSQL Database (Apache Cassandra)

In this scenario, we will use Docker to create and manage a single-node Cassandra cluster. We'll create a keyspace, delete the container, and then recover the keyspace on a new node in another container using Docker volumes. Follow the detailed steps below:

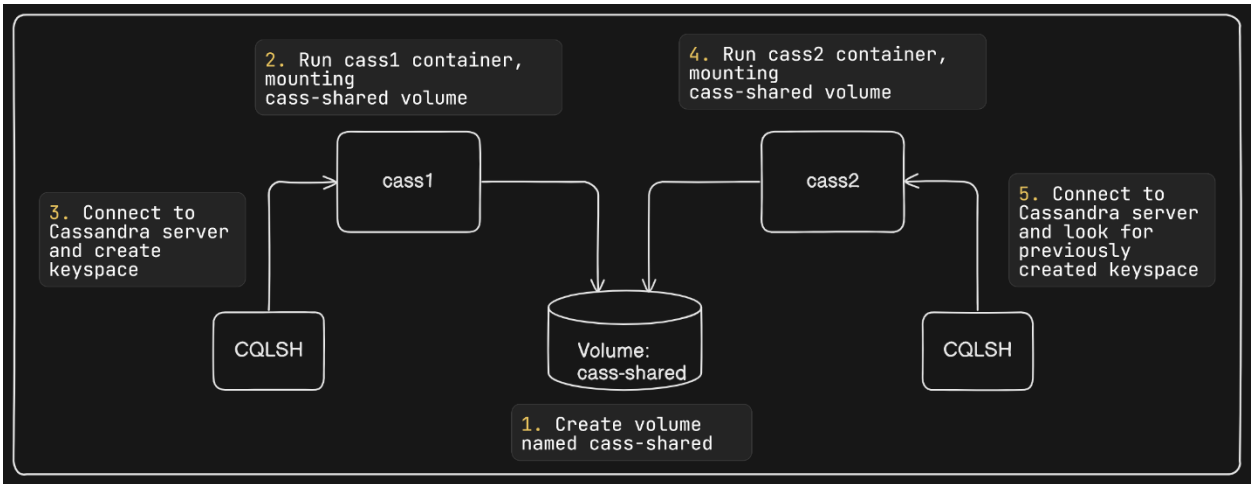
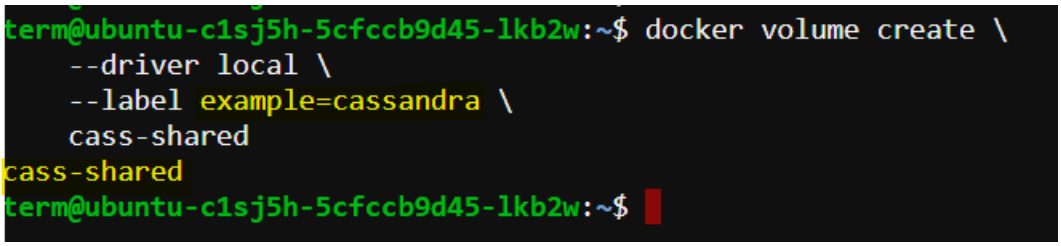


Fig: Overview

Step 1: Create Docker Volume

First, we will create a Docker volume that will store the Cassandra database files. This volume will use disk space on the local machine.

```
docker volume create \
  --driver local \
  --label example=cassandra \
  cass-shared
```



Explanation:

- **docker volume create:** Command to create a Docker volume.
- **--driver local:** Specifies that the volume should use the local driver.
- **--label example=cassandra:** Adds a label to the volume for easier management and identification.
- **cass-shared:** The name of the volume.

Step 2: Run a Cassandra Container

Next, run a Cassandra container and mount the previously created volume to the container.

```
docker run -d \
  --volume cass-shared:/var/lib/cassandra/data \
  --name cass1 \
  cassandra:2.2
```

```
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker run -d \
    --volume cass-shared:/var/lib/cassandra/data \
    --name cass1 \
    cassandra:2.2
Unable to find image 'cassandra:2.2' locally
2.2: Pulling from library/cassandra
35807b77a593: Pull complete
93d71b8f96bb: Pull complete
b6a858f02311: Pull complete
baff0a18b53b: Pull complete
1abb4abff8c7: Pull complete
ef4d0c404e96: Pull complete
f87427648c5b: Pull complete
b7dfd75caf76: Pull complete
ef996cf87903: Pull complete
Digest: sha256:99f8579937aeea75d0e4f2ad055dfed587f03eebdebfde3666420c1162206503
Status: Downloaded newer image for cassandra:2.2
016b2ce03efd1dab628c47488641f945a2510f36ce4bdfc8c3f7326223957ca9
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$
```

Explanation:

- **ocker run -d:** Runs the container in detached mode.
- **--volume cass-shared:/var/lib/cassandra/data:** Mounts the cass-shared volume to /var/lib/cassandra/data inside the container.
- **--name cass1:** Names the container cass1.
- **cassandra:2.2:** Uses the Cassandra image version 2.2 from Docker Hub.

Step 3: Connect to the Cassandra Container

Use the Cassandra client tool (CQLSH) to connect to the running Cassandra server.

```
docker run -it --rm \
  --link cass1:cass \
  cassandra:2.2 \
  cqlsh cass
```

Explanation:

- **docker run -it --rm:** Runs the container interactively and removes it after exit.
- **--link cass1:cass:** Links the client container to the cass1 container.
- **cassandra:2.2:** Uses the Cassandra image version 2.2.
- **cqlsh cass:** Runs the CQLSH command line tool to connect to the Cassandra server.

Now you can inspect or modify your Cassandra database from the CQLSH command line. First, look for a keyspace named docker_hello_world:

```
select *
from system.schema_keyspaces
where keyspace_name = 'docker_hello_world';
```

Explanation:

- **select * from system.schema_keyspaces where keyspace_name = 'docker_hello_world';:** Queries the system schema for the docker_hello_world keyspace.

```
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker run -it --rm \
    --link cass1:cass \
    cassandra:2.2 \
    cqlsh cass
Connected to Test Cluster at cass:9042.
[cqlsh 5.0.1 | Cassandra 2.2.19 | CQL spec 3.3.1 | Native protocol v4]
Use HELP for help.
cqlsh> select *
   ... from system.schema_keyspaces
   ... where keyspace_name = 'docker_hello_world';

 keyspace_name | durable_writes | strategy_class | strategy_options
---------------+----------------+----------------+------------------

(0 rows)
cqlsh>
```

Cassandra should return an *empty* list. This means the database hasn't been *modified* by the example.

Step 04: Create and Verify a Keyspace

Inside the CQLSH shell, create a keyspace named docker_hello_world.

```
create keyspace docker_hello_world
with replication = {
  'class' : 'SimpleStrategy',
  'replication_factor': 1
};
```

Explanation:

- **create keyspace:** Creates a new keyspace.
- **docker_hello_world**: The name of the keyspace.
- **with replication = { 'class' : 'SimpleStrategy', 'replication_factor': 1 }:** Specifies the replication strategy and factor.

Verify the keyspace creation:

```
select *
from system.schema_keyspaces
where keyspace_name = 'docker_hello_world';
```

If the keyspace was created successfully, you will see the entry in the query result.

```
cqlsh> create keyspace docker_hello_world
   ... with replication = {
   ...     'class' : 'SimpleStrategy',
   ...     'replication_factor': 1
   ... };
cqlsh> select *
   ... from system.schema_keyspaces
   ... where keyspace_name = 'docker_hello_world';

 keyspace_name      | durable_writes | strategy_class                              | strategy_options
--------------------+----------------+---------------------------------------------+----------------------------
 docker_hello_world |           True | org.apache.cassandra.locator.SimpleStrategy | {"replication_factor":"1"}

(1 rows)
cqlsh>
```

Step 5: Stop and Remove the Cassandra Container

Exit the CQLSH shell and remove the Cassandra container.

Quit

docker stop cass1

docker rm -vf cass1

```
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker stop cass1
cass1
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker rm -vf cass1
cass1
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$
```

Explanation:

- **quit**: Exits the CQLSH shell.
- **docker stop cass1**: Stops the cass1 container.
- **docker rm -vf cass1**: Removes the cass1 container forcefully and deletes associated resources.

Step 6: Test Data Recovery

Create a new Cassandra container and attach the volume to it.

```
docker run -d \
  --volume cass-shared:/var/lib/cassandra/data \
  --name cass2 \
  cassandra:2.2
```

```
term@ubuntu-c1sj5h-5cfccb9d45-1kb2w:~$ docker run -d \
    --volume cass-shared:/var/lib/cassandra/data \
    --name cass2 \
    cassandra:2.2
fbc1708dbd1e89bccfe6f37f2f420106054f650a83fee9fa0739b10e7ecda2f0
term@ubuntu-c1sj5h-5cfccb9d45-1kb2w:~$ docker ps
CONTAINER ID   IMAGE           COMMAND                  CREATED          STATUS          PORTS                                          NAMES
fbc1708dbd1e   cassandra:2.2   "docker-entrypoint.s…"   53 seconds ago   Up 49 seconds   7000-7001/tcp, 7199/tcp, 9042/tcp, 9160/tcp    cass2
term@ubuntu-c1sj5h-5cfccb9d45-1kb2w:~$
```

Connect to the new Cassandra container using CQLSH.

```
docker run -it --rm \
  --link cass2:cass \
  cassandra:2.2 \
  cqlsh cass
```

Query the keyspace to verify data persistence.

```
select *
from system.schema_keyspaces
where keyspace_name = 'docker_hello_world';
```

If the keyspace docker_hello_world is listed in the result, it confirms that the data persisted in the cass-shared volume

```
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker run -it --rm \
    --link cass2:cass \
    cassandra:2.2 \
    cqlsh cass
Connected to Test Cluster at cass:9042.
[cqlsh 5.0.1 | Cassandra 2.2.19 | CQL spec 3.3.1 | Native protocol v4]
Use HELP for help.
cqlsh> select *
   ... from system.schema_keyspaces
   ... where keyspace_name = 'docker_hello_world';

 keyspace_name      | durable_writes | strategy_class                              | strategy_options
--------------------+----------------+---------------------------------------------+----------------------------
 docker_hello_world |           True | org.apache.cassandra.locator.SimpleStrategy | {"replication_factor":"1"}

(1 rows)
cqlsh>
```

Step 7: Clean Up

Exit the CQLSH shell and remove the containers and volume.

quit

docker rm -vf cass2

docker volume rm cass-shared

Explanation:

- **quit**: Exits the CQLSH shell.
- **docker rm -vf cass2**: Removes the cass2 container forcefully.
- **docker volume rm cass-shared**: Deletes the cass-shared volume.

```
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker ps
CONTAINER ID   IMAGE          COMMAND                  CREATED         STATUS         PORTS                                          NAMES
fbc1708dbd1e   cassandra:2.2  "docker-entrypoint.s…"   4 minutes ago   Up 4 minutes   7000-7001/tcp, 7199/tcp, 9042/tcp, 9160/tcp    cass2
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker volume ls
DRIVER    VOLUME NAME
local     cass-shared
local     e133c86aa234ae41ca0e53f58c281f8d84128698f370414f2033bd0e04e75b26
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker rm -vf cass2
cass2
term@ubuntu-c1sj5h-5cfccb9d45-lkb2w:~$ docker volume rm cass-shared
cass-shared
```

Summary

In this scenario, we have:

- Created a Docker volume.
- Ran a Cassandra container with the volume mounted.
- Connected to the Cassandra container using CQLSH.
- Created and verified a keyspace.
- Stopped and removed the Cassandra container.
- Tested data recovery by creating a new container and verifying the keyspace.
- Cleaned up by removing the containers and volume.

This demonstrates how to use Docker volumes for data persistence in a Cassandra database, ensuring that data remains available even after the container is deleted.