Docker

What is Docker ?

Docker is an open platform for developing, shipping, and running applications. Docker enables you to separate your applications from your infrastructure so you can deliver software quickly. Docker provides the ability to package and run an application in a loosely isolated environment called a container.

CONTAINERS

Containers are an abstraction at the app layer that packages code and dependencies together. Multiple containers can run on the same machine and share the OS kernel with other containers, each running as isolated processes in user space. Containers take up less space than VMs (container images are typically tens of MBs in size), can handle more applications and require fewer VMs and Operating systems.

VIRTUAL MACHINES

Virtual machines (VMs) are an abstraction of physical hardware turning one server into many servers. The hypervisor allows multiple VMs to run on a single machine. Each VM includes a full copy of an operating system, the application, necessary binaries and libraries – taking up tens of GBs. VMs can also be slow to boot.

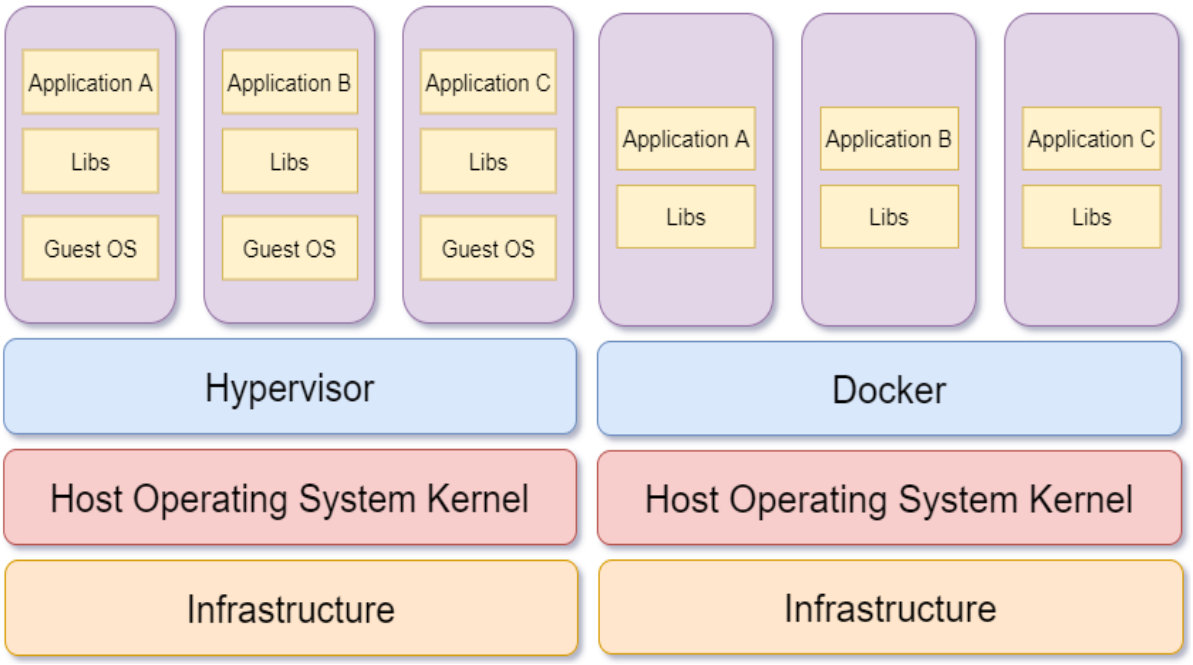
What is Image ?

A Docker image is a read-only template that contains a set of instructions for creating a container that can run on the Docker platform. It provides a convenient way to package up applications and preconfigured server environments, which you can use for your own private use or share publicly with other Docker users. Docker images are also the starting point for anyone using Docker for the first time.

Virtualization - Hardware is dedicated upfront

Containerization - No dedicated hardware upfront

Containerization involves encapsulating or packaging up software code and all its dependencies so that it can run uniformly and consistently on any infrastructure.



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Let's consider a real life scenario here
Book Management Application
store information regarding all the books you own, and can also serve the purpose of a book lending system for your friends.
If you make a list of the dependencies, that list may look as follows:

- Node.js
- Express.js
- SQLite3

Taking all these into account, the final list of dependencies is as follows:

- Node.js
- Express.js
- SQLite3
- Python 2 or 3
- C/C++ tool-chain

What if you have a teammate who uses Windows while you're using Linux.
That is the idea behind containerization: putting your applications inside a self-contained package, making it portable and reproducible across various environments.Or the fact that popular technologies like nginx are not well optimized to run on Windows. Some technologies like Redis don't even come pre-built for Windows.

All these issues can be solved if only you could somehow:

- Develop and run the application inside an isolated environment (known as a container) that matches your final dPut your application inside a single file (known as an image) along with all its dependencies and necessary deployment configurations.
- And share that image through a central server (known as a registry) that is accessible by anyone with proper authorization.
- deployment environment.

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In comparison to the traditional virtualization functionalities of hypervisors, Docker containers eliminate the need for a separate guest operating system for every new virtual machine.

Docker implements a high-level API to provide lightweight containers that run processes in isolation.

A Docker container enables rapid deployment with minimum run-time requirements. It also ensures better management and simplified portability.
This helps developers and operations team in rapid deployment of an application.

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Create Ubuntu Machine on AWS

All Traffic - anywhere

Connect using MobaxTerm
Downloading Mobaxterm
https://mobaxterm.mobatek.net/download-home-edition.html

https://get.docker.com/

Go to Root Account
$ sudo su -
# curl -fsSL https://get.docker.com -o get-docker.sh
(this will download shell script in the machine)

sh get-docker.sh (This will execute the shell script, which will install docker)

How to check the docker is installed or not

docker --version

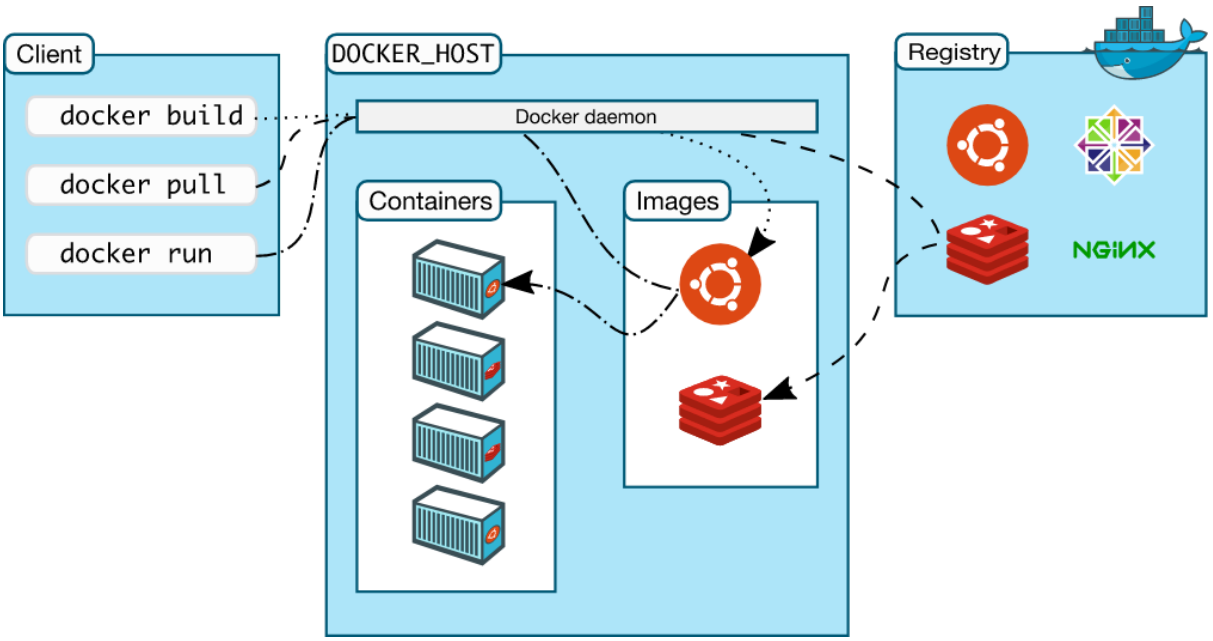
Terminalogy:
1) Docker Images
Combinations of binaries / libraries which are necessary for one software application.

2) Docker Containers
When image is executed comes into running condition, it is called container.

3) Docker Host
Machine on which docker is installed, is called as Docker host.

4) Docker Client
Terminal used to run docker run commands (Git bash)

On linux machine, git bash will work like docker client.



Docker Commands

Working on Images

1 To download a docker image
docker pull image_name

2 To see the list of docker images
docker image ls
(or)
docker images

3 To delete a docker image from docker host
docker rmi image_name/image_id

4) To upload a docker image into docker hub
docker push image_name

5) To tag an image
docker tag image_name ipaddress_of_local_registry:5000/image_name

6) To build an image from a customised container
docker commit container_name/container_id new_image_name

7) To create an image from docker file
docker build -t new_image_name

8) To search for a docker image
docker search image_name

9) To delete all images that are not attached to containers
docker system prune -a

Working on containers

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10) To see the list of all running continers
docker container ls

11) To see the list of running and stopped containers
docker ps -a

12) To start a container
docker start container_name/container_id

13) To stop a running container
docker stop container_name/container_id

14) To restart a running container
dock restart container_name/container_id
To restart after 10 seconds
docker restart -t 10 container_name/container_id

15) To delete a stopped container
docker rm container_name/container_id

16) To delete a running container
docker rm -f container_name/container id

17) To stop all running containers
docker stop $(docker ps -aq)
(q will give image ids)
18) To restart all containers
docker restart $(docker ps -aq)

19) To remove all stopped containers

docker rm $(docker ps -aq)

20) To remove all contianers(running and stopped)
docker rm -f $(docker ps -aq)

21) To see the logs generated by a container
docker logs container_name/container_id

22) To see the ports used by a container
docker port container_name/container_id

23) To get detailed info about a container
docker inspect container_name/container_id

24) To go into the shell of a running contianer which is moved into background
docker attach container_name/container id

25) To execute anycommand in a container
docker exec -it container_name/container_id command
Eg: To launch the bash shell in a contianer
docker exec -it container_name/container_id bash
26) To create a container from a docker image (imp)
docker run image_name

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Run command options

-it for opening an interactive terminal in a container

--name Used for giving a name to a container

-d Used for running the container in detached mode as a background process

-e Used for passing environment variables to the container

-p Used for port mapping between port of container with the docker host port.

-P Used for automatic port mapping i.e., it will map the internal port of the container with some port on the host machine.

This host port will be some number greater than 30000

-v Used for attaching a volume to the container

--volume-from Used for sharing volume between containers

--network Used to run the contianer on a specific network
--link Used for linking the container for creating a multi container architecture

--memory Used to specify the maximum amount of ram that the container can use

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docker images (There are no images)

To download tomcat image

docker pull tomee

docker images

docker pull ubuntu

If you do not specify the version, by default, we get latest version

I want to download jenkins
docker pull jenkins

To create a container from an image

docker run --name mytomcat -p 7070:8080 tomee

docker run --name c1 -p 7070:8080 tomee

docker exec -it mytomcat bash
To check the tomcat is running or not
http://13.126.59.69:7070

(7070 is port number mapped in docker host)

Lets remove the container (Open another gitbash terminal)

docker stop c1

docker rm -f c1

docker run --name   mytomcat -p 7070:8080   -d   tomee

(The above command runs tomcat in detached mode , so we get out # prompt back)

docker container ls

TO start jenkins
docker run --name myjenkins -p 9090:8080   -d   jenkins/jenkins

To check for jenkins (Open browser)
 http://13.126.59.69:9090
To create ubuntu container
docker run --name myubuntu -it   ubuntu

Observation: You have automatically entered into ubuntu
ls (To see the list of files in ubuntu)
exit (To comeout of container back to host or us ctrl + p + q)

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Scenario:
Start tomcat as a container and name it as "webserver". Perform port mapping and run this container in detached mode

docker run --name webserver -p 7070:8080 -d tomee

To access homepage of the tomcat container
Launch any browser
public_ip_of_dockerhost:7070

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Scenario:
Start jenkins as a container in detached mode , name is as "devserver", perform port mapping

docker run -d --name devserver -p 9090:8080 jenkins/jenkins

To access home page of jenkins (In browser)
public_ip_of_dockerhost:9090

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Scenario : Start nginx as a container and name as "appserver", run this in detached mode , perform automatic port mapping

Generally we pull the image and run the image

Instead of pulling, i directly

docker run --name appserver -P -d nginx
(if image is not available, it perform pull operation automatically)
(Capital P , will perform automatic port mapping)

How to check nginx is running or not? (we do not know the port number)

To know the port that is reserved for nginx)
docker port appserver
80/tcp -> 0.0.0.0:32768

80 is nginx port
32768 is dockerhost port

or

docker container ls   (to see the port of nginz and docker host)

To check nginx on browser
13.126.59.69:49153

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To start centos as container

docker run --name mycentos -it centos
exit (To come back to dockerhost)

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To start mysql as container, open interactive terminal in it, create a sample table.

docker run --name mydb -d -e MYSQL_ROOT_PASSWORD=laxman mysql:5

docker container ls

I want to open bash terminal of mysql
docker exec -it mydb bash

To connect to mysql database
mysql -u root -p

enter the password, we get mysql prompt

TO see list of databases
> show databases;

TO switch to a databse
> use db_name
> use mysql

> exit
exit
exit

Multi container architecture using docker

This can be done in 2 ways
1) --link / network
2) docker-compose

1) --link option

Use case:

Start two busybox containers and create link between them

(**BusyBox** combines tiny versions of many common UNIX utilities into a single small executable)

Create 1st busy box container
docker run --name busybox1 -it busybox

/ #

How to come out of the container without exit
(ctrl + p + q)

Create 2nd busy box container and establish link to c1 container
docker run --name busybox2 --link busybox1:busybox1-alias -it busybox (busybox1-alias is alias name)

/ #

How to check link is established for not?

/ # ping c10

Ctrl +c (to come out from ping)

(ctrl + p + q)
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Ex : Creating development environment using docker

Start mysql as container and link it with wordpress container.

Developer should be able to create wordpress website

1) TO start mysql as container

docker run --name mydb -d -e MYSQL_ROOT_PASSWORD=laxman mysql:5

(if container is already in use , remove it
docker rm -f mydb)

Check whether the container is running or not
docker container ls

2) TO start wordpress container
docker run --name mysite -d -p 5050:80 --link mydb:mysql wordpress

13.232.183.233:5050

Check wordpress installed or not
Open browser
public_ip:5050
18.138.58.3:5050

Lets delete all the container
docker rm -f $(docker ps -aq)

To start jenkins as a container
docker run --name devserver -d -p 7070:8080 jenkins/jenkins

to check jenkins is running or not?
Open browser
public_ip:7070
http://18.138.58.3:7070

We need two tomcat containers (qa server and prod server)
docker run --name qaserver -d -p 8080:8080 --link devserver:jenkins tomee

to check the tomcat   use public_ip but port number will be 8080
http://18.138.58.3:8080

docker run --name prodserver -d -p 9090:8080 --link devserver:jenkins tomee
to check the tomcat of prodserver
http://18.138.58.3:9090

All the commands we learnt till date are adhoc commands.

In the previous usecase we have installed two containers (chrome and firefox)
Lets say you need 80 containers?
Do we need to run 80 commands?

Instead of 80 commands, we can use docker compose which we will see in coming sections.
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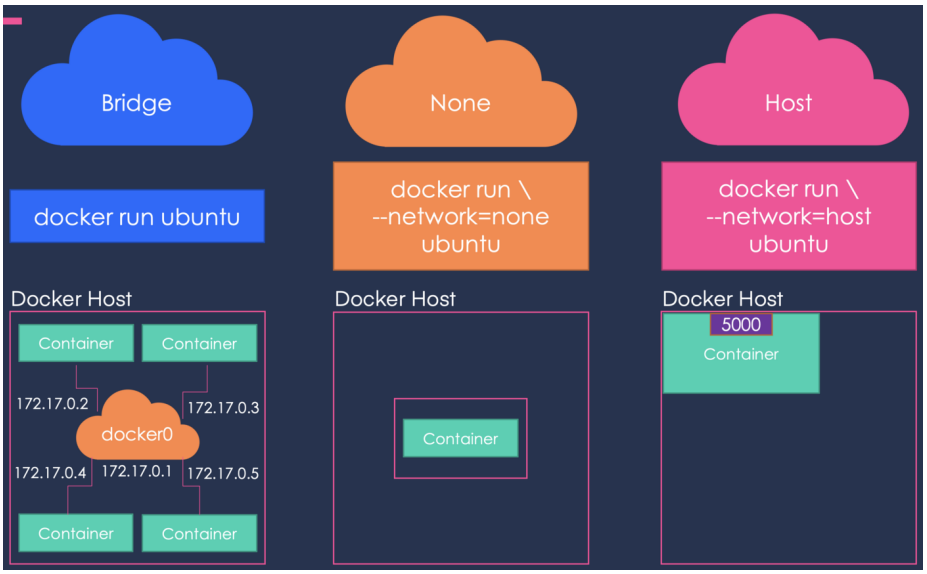
Docker Networking



One of the reasons Docker containers and services are so powerful is that you can connect them together.

Network Drivers

Docker supports networking for its containers via network drivers.
In this article, we will be discussing how to connect your containers with suitable network drivers. The network drivers used in Docker are below:

- Bridge
- Host
- None
- Overlay
- Macvlan

Bridge

It is a private default network created on the host
Containers linked to this network have an internal IP address through which they communicate with each other easily
The Docker server (daemon) creates a virtual ethernet bridge docker0 that operates automatically, by delivering packets among various network interfaces
These are widely used when applications are executed in a standalone container

Host

It is a public network
It utilizes the host's IP address and TCP port space to display the services running inside the container
It effectively disables network isolation between the docker host and the docker containers.

None
In this network driver, the Docker containers will neither have any access to external networks nor will it be able to communicate with other containers
This option is used when a user wants to disable the networking access to a container
In simple terms, None is called a loopback interface, which means it has no external network interfaces

Overlay
This is utilized for creating an internal private network to the Docker nodes in the Docker swarm cluster
Note: Docker Swarm is a service for containers which facilitates developer teams to build and manage a cluster of swarm nodes within the Docker platform
It is an important network driver in Docker networking. It helps in providing the interaction between the stand-alone container and the Docker swarm service

Macvlan
It simplifies the communication process between containers
This network assigns a MAC address to the Docker container. With this Mac address, the Docker server (daemon) routes the network traffic to a router
Note: Docker Daemon is a server which interacts with the operating system and performs all kind of services
It is suitable when a user wants to directly connect the container to the physical network rather than the Docker host

When you start Docker, a default bridge network (also called bridge) is created automatically, and newly-started containers connect to it unless otherwise specified. You can also create user-defined custom bridge networks. User-defined bridge networks are superior to the default bridge network.

Containers on the default bridge network can only access each other by IP addresses, unless you use the --link option, which is considered legacy. On a user-defined bridge network, containers can resolve each other by name or alias.

To list the networks
docker network ls

docker run --name nginx -d -p 8080:80 nginx
It will automatically attached to default bridge network
Access using hostip
docker inspect nginx

docker network ls
docker network create --driver bridge my-network
If we don’t specify the driver, by default it takes bridge driver only.

docker network ls

Running nginx and connecting it to my-network
docker run --name nginx2 -d --network my-network -p 7070:80 nginx

docker inspect nginx2
docker inspect my-network

docker run -it --name ubuntu1 ubuntu

docker network inspect bridge

docker run -it --name ubuntu2 ubuntu

docker network inspect bridge

docker exec -it ubuntu1 bash

ping <internal-ip-of-ubuntu2>

and also try to ping using container name that is
ping ubuntu2

To install ping in the docker container
apt-get update
apt-get install iputils-ping

docker network ls
docker inspect my-network
docker run -it --name ubuntu1 --network my-network ubuntu
docker inspect my-network

docker run -it --name ubuntu2 --network my-network ubuntu
docker inspect my-network

Try to ping one container from other with their ip addresses and DNS names(container names)

To install ping in the docker container
apt-get update
apt-get install iputils-ping
To connect a running container to a network:

docker network connect <network-name> <container-name>
docker network disconnect <network-name> <container-name>

To delete the network
docker network rm my-network
docker network ls

Networking using the host network

To start a nginx container which binds directly to port 80 on the Docker host. From a networking point of view, this is the same level of isolation as if the nginx process were running directly on the Docker host and not in a container. However, in all other ways, such as storage, process namespace, and user namespace, the nginx process is isolated from the host.
Attaching a container to host network:

docker run --name nginx --network host -d nginx
Observe, here we are not performing port mapping.
Access the application using docker-host-ip

Docker volumes

Docker containers are ephemeral (temporary)
Where as the data processed by the container should be permanent.

Generally, when a container is deleted all its data will be lost.
To preserve the data, even after deleting the container, we use volumes.

Volumes are of two types
1) Simple docker volumes
2) Sharable volumes

Simple docker volumes

These volumes are used only when we want to access the data,
even after the container is deleted.

But this data cannot be shared with other containers.

Docker has 3 options for containers to store files in the host machine, so that the files are persisted even after the container stops:

docker volume types:

1. anonymous volumes
2. named volumes
3. host volume or bind volumes

Anonymous Volumes

Create a container with an anonymous volume which is mounted as /data01 on container. in this case we mention container directory name. On host system it maps to a random-hash directory under /var/lib/docker directory.

```
docker run -it --name webuat01 -v /data01 nginx /bin/bash
```

On Host to verify volume

```
docker volume ls
docker inspect <volume_name>
```

watch -n 1 ls /var/lib/docker/volumes/_data

Named Volumes

Create a container with a named volume name which is mounted as `/data01` on container. You can see volume name as `vtwebuat02_data01_val`

```
docker run -it --name webuat02 -v webuat02_data01_val:/data01 nginx /bin/bash
```

Create a named volume then attach volume to a container

```
docker volume create uatweb03_data01_vol
docker run -it --name uatweb03 -v uatweb02_data01_vol:/data01 nginx /bin/bash
```

Host Volumes

Create a host volume

```
mkdir /opt/data02
docker run -it --name webuat03 -v /opt/data02:/data02 nginx bash
```

Use case
---
1) Create a directory called /data ,
start centos as container and mount /data as volume.
Create files in mounted volume in centos container,
exit from the container and delete the container. Check if the files are still available.

Lets create a folder with the name
mkdir /data

docker run --name c1 -it -v /data centos (v option is used to attach volume)

ls (Now, we can see the data folder also in the container)

cd data
touch file1 file2
ls
exit (To come out of the container)
docker inspect c1

We can see under mounts "data" folder it located in the host machine.
Copy the path

/var/lib/docker/volumes/c5c85f87fdc3b46b57bb15f2473786fe7d49250227d1e9dc537bc594db001fc6/_data

Now, lets delete te container
docker rm -f c1

After deleting the container, lets go to the location of the data folder

cd
/var/lib/docker/volumes/d867766f70722eaf8cba651bc1d64c60e9f49c5b1f1ebb9e781260f777f3c7e8/_data

ls (we can see file1 file2)

(Observe , the container is deleted but still the data is persistant)

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Sharable Volumes

These are also known as reusable volume.
The volume used by one container can be shared with other containers.
Even if all the containers are deleted, data will still be available on the docker host.

Ex:

sudo su -

Lets create a directory /data
mkdir /data

Lets Start centos as container
docker run --name c1 -it -v /data:/data centos
ls (we can see the list of files and dir in centos)

cd data
ls (currently we have no files)

Lets create some files
touch file1 file2 (These two files are available in c1 container)

Comeout of the container without exit
Ctrl +p +q (container will still runs in background)

Lets Start another centos as container (c2 container should use the same volume as c1)
docker run --name c2 -it --volumes-from c1 centos

cd data
ls (we can see the files created by c1)

Lets create some more files
touch file3 file4
ls (we see 4 files)

Comeout of the container without exit
Ctrl +p Ctrl +q (container will still runs in background)

Lets Start another centos as container
docker run --name c3 -it --volumes-from c2 centos

cd data
ls (we can see 4 files)
touch file5 file6
ls

Comeout of the container without exit
Ctrl +p Ctrl +q (container will still runs in background)

Now, lets connect to any container which is running in the background
docker attach c1
ls (you can see all the files)
exit

Identify the mount location
$ docker inspect c1
(search for the mount section)

Take a note of the source path

/var/lib/docker/volumes/e22a9b39372615727b964151b6c8108d6c02b13114a3fcce255df0cee7609e15/_data

Lets remove all the container
docker rm -f c1 c2 c3

Lets go to the source path

cd
/var/lib/docker/volumes/e22a9b39372615727b964151b6c8108d6c02b13114a3fcce255df0cee7609e15/_data

ls (we can see all the files)