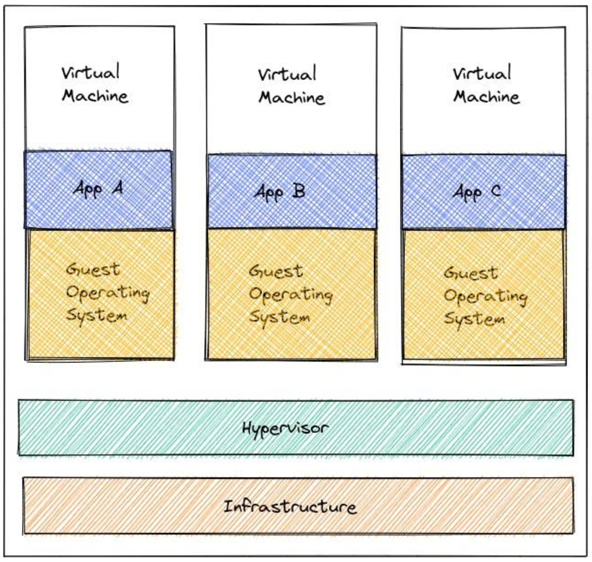
Docker

Virtual Machines

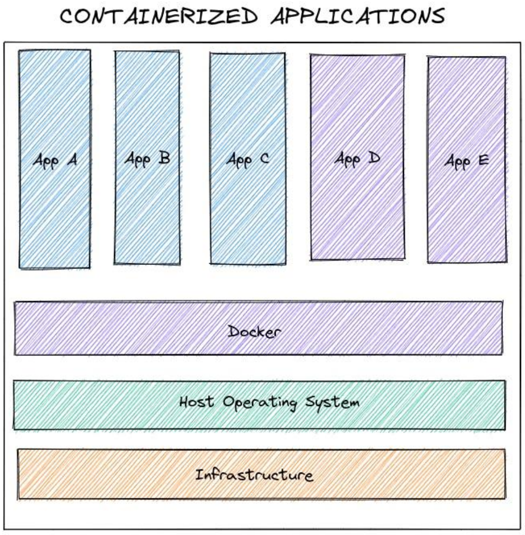
As the name suggest, A virtual machine lets you run multiple operating system on your local machine on the top of hypervisor.



A hypervisor creates a layer between an existing operating system and an environment to run virtual machines. Examples of hypervisors are VmWare and Hyper-V.

Containers

Containers are lightweight virtual VM, that virtualizes the operating system. A container creates an isolated environment/sandbox (Just like the above image, think of each container as an isolated environment that docker provides) for your operating system, so you can run multiple operating systems isolated with each other. It is like working on virtual machines without the need of it and some added advantage.



Containers consume less space and starts instantly. They are ephemeral in nature, meaning when they die data inside the container are not accessible. One of the examples of container platform is Docker.

Docker tries to solve the problem by containerizing and shipping the whole application with all the package, dependencies, libraries included. This way you don't need to worry about anything, just fetch the application using docker container image, and you are good to go. It is almost guaranteed that if an app is running on one machine when Dockerised and shipped will run on any machine.

Building Block of Docker

Docker underlying principle is originated from Linux Kernel. Containers are nothing but isolated Linux processes with all the necessities included to run the process in isolation. It is a combination of Kernel namespace, Cgroups and union filesystem. Let’s understand each of them:

Kernel Namespace

Kernel namespace is a feature by which one set of processes see one set of resources and another set of resources see another/different set of resources. Kernel namespace allows these services to be created in isolation:

- Process trees (PID Namespace)
- Mounts (MNT namespace)
- Network (Network namespace)
- Users / UIDs (User Namespace)
- Hostnames (UTS Namespace)
- Inter Process Communication (IPC Namespace)

Cgroups

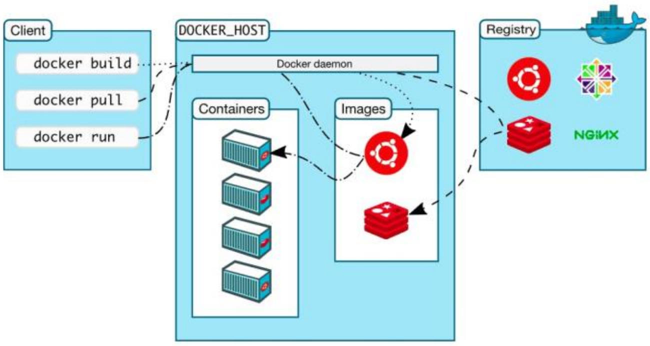
Cgroups accounts for the resources used by processes. It allocates, limits, isolates the resource usage like CPU, Memory, Network etc.

Union File System

Docker uses the Union file system for building containers to create layers, making them fast and lightweight.

Docker Images

Docker images are predefined template with instructions of packed application, including its dependencies of what processes will run when launched. There are thousands of images in the **dockerhub** publicly available. You can fetch and run containers with just few clicks.



We interact with Docker daemon via Docker CLI. We send a request to built, pull or run the image. If its locally available Docker Daemon will build a container out of it, if not it will look into its online registry(Dockerhub), fetch it.

Nginx

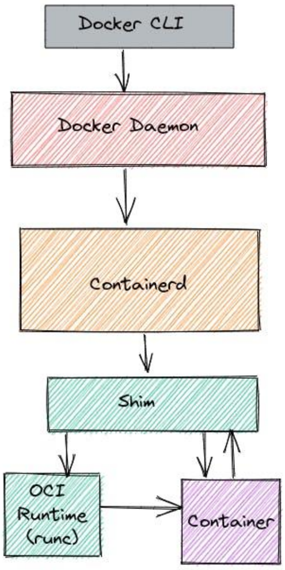
- docker pull nginx
- docker run nginx

docker ps -This will show up the running processes, In our case, you will see a nginx process running.

Now you can stop the container by typing

- docker stop container-ID

How Docker works internally?



We interact with Docker via Docker CLI. Docker CLI has a bunch of command to interact with Docker Daemon.

Docker Daemon is referred to as the brain of Docker. It performs the command that the client issues like managing images, network, containers and volumes.

Containerd is the high level container runtime, that manages network's namespace. It helps in building the images.

Shim is responsible for all the interaction logic we give to the containers, also it redirects stdin, stdout, stderr to logs. Shim will be present till the state of the container is active, and reports its state to containerd. It detaches the container lifecycle with containerd, in case if you want to update the containerd version it will not affect the running containers.

Before understanding Runc let’s understand OCI (open container initiative). An OCI initiative is a governance structure and a collaborative project by different companies with a goal to establish common and open standards for containers.

Runc is a low level container runtime and is OCI compatible, meaning it will run containers that are OCI compliant. It starts up the container process and then exit.

When we post a request to fetch images, mostly it fetches from **DockerHub**. Dockerhub is the repository by Docker team for finding, uploading and downloading container images.

There are already some prebuilt image by Docker community and by individual community members, you can also build and push your own Docker image to Dockerhub.

Building an image with Dockerfile

Dockerfile is the list of instructions listed in a file to assemble and create a Docker image. Lets built a Dockerfile. In the Dockerfile, we will be installing Python on the top of Ubuntu image.

- mkdir docker
- cd docker

Open up nano editor and create dockerfile nano Dockerfile

After this

```
FROM ubuntu:16.04 RUN apt-get update RUN apt-get install -y python3 LABEL maintainer="Your name "

docker build .

docker image ls

docker inspect image-id
```

Docker Volume

As we talked earlier, Docker containers are ephemeral, meaning data is not persistent. When the container die, the data can't be accessed.

To solve this problem, we need to make the data persistent and mount it, so it can be accessible anytime. This way, we don't need to rebuild our docker image whenever we do changes in our container.

Docker Volumes is a folder which exist outside the container but in the host machine and can be accessible by container. There are three categories of Docker Volume, let's explore each of them:

Volumes

Volumes are Docker way of assigning the data in the host machine. It will create a path, assign and manage the data itself. With this method, we can't edit the file from outside the container. To use the volume type, the below command

- docker run -v volume-name:path-in-container IMAGE_ID

You can use any name and the path of the container you want to link.

Bind Mounts

Bind mount is the same except the fact that you determine the location of the host machine where you want to store the data. Using this method, we can also edit the files from outside the container. To use Bind Mount type: docker run -v our-machine-path:path-in-container IMAGE_ID

Tmps Mount

These mounts are stored in the system memory and are temporary. As soon as the container die, the data within it will be wiped out. This type of mount is used by the container during the lifecycle to store not so critical data.

If you have a lot of Data i.e. containers, images, caches which is of no use, type this command and free up some space docker system prune

Docker Compose

Remember, we built a Dockerfile earlier in this blog. Dockerfile is used to built up a container by assembling layers of image into a file. What if we want to create multiple container, the usual solution would be to create Dockerfile for each of them and when needed, all of them should be started one by one.

Guess what! We have a better solution. We can run multiple containers as a single service using Docker compose.

Using WordPress in an isolated environment and a MySQL database connected to it with mount volume. In case, if we shut down the container, it will start back again with data in place. Create a new directory and head over to it.

- mkdir wordpress
- cd wordpress

create a docker compose file by using

nano docker-compose.yaml version: "3.3"

services: db: image: mysql:5.7 volumes:

- db_data:/var/lib/mysql restart: always environment: MYSQL_ROOT_PASSWORD: somewordpress MYSQL_DATABASE: wordpress MYSQL_USER: wordpress MYSQL_PASSWORD: wordpress

wordpress: depends_on:

- db image: wordpress:latest volumes:
- wordpress_data:/var/www/html ports:
- "8000:80" restart: always environment: WORDPRESS_DB_HOST: db WORDPRESS_DB_USER: wordpress WORDPRESS_DB_PASSWORD: wordpress WORDPRESS_DB_NAME: wordpress volumes: db_data: {} wordpress_data: {} Save and exit the file.

Now, run the docker compose command

- docker-compose up -d
- http://localhost:8000

To remove the container type

- docker-compose down