Learning Containerization

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What are containers?

They have been around for longer than you think.

- A way to package your application and environments.
- A way to ship your application with ease.
- A way to isolate resources in a shared system.

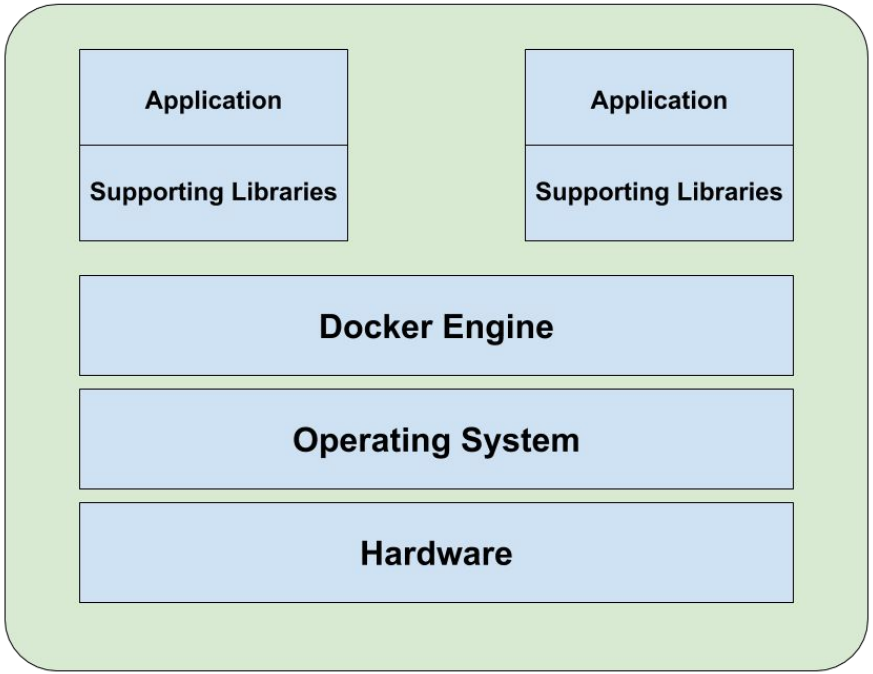
What is Docker?

Package your application into a standardized unit for software development.

Docker containers wrap a piece of software in a complete filesystem that contains everything needed to run: code, runtime, system tools, system libraries – anything that can be installed on a server. This guarantees that the software will always run the same, regardless of its environment.

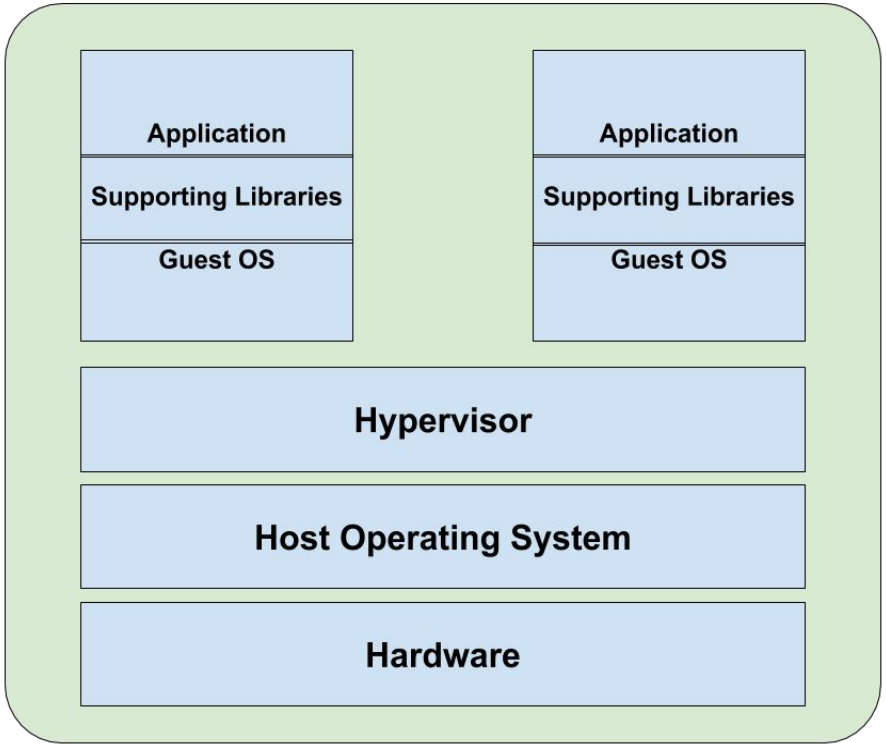
How Docker Works?

- Docker runs on host operating system.
- The kernel is shared among all the containers but the resources are in appropriate namespaces and cgroups.
- Typical container consists of operating system libraries and the application code, much of which is shared.
- No emulation of hardware.



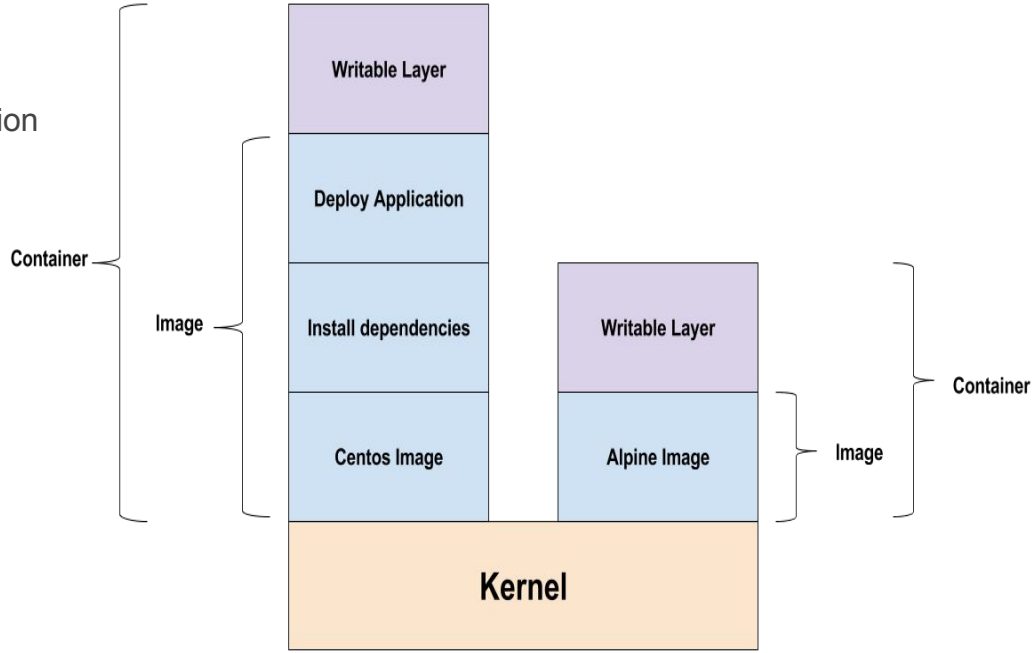
How is Docker different from Virtual Machines?

- Additional hypervisor layer.
- Each guest OS comes with its own Kernel and libraries.
- Hardware is emulated.
- Much more resource intensive.
- Difficult to share a virtual machine.



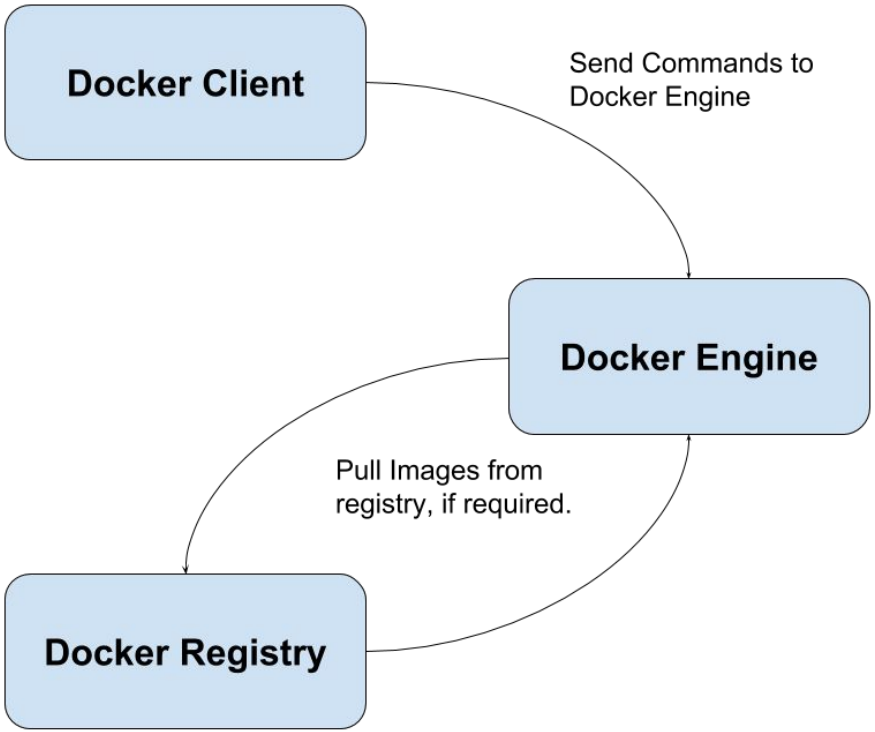
Basic Components and Terminologies

- Docker Image
  a. Read-only
  b. May consist of bare OS libs or application
- Docker Container
  a. Stateful instance of image
  b. Image with a writable layer
- Docker Registry
  a. Repository of Docker images
- Docker Hub
  a. A public registry hosted by Docker Inc.



Docker Workflow

1. Docker client passes a command like *docker run* to Docker Engine.
2. Docker Engine checks whether it needs to pull any image from a Docker registry.
3. If required, the image is pulled.
4. If the image is present locally, the run command is executed.
5. The container would run on Docker Engine.
6. Docker Engine and Docker Client can be on the same machine or they can be separated on the network.



Installing Docker Engine

1. Install from default operating system repositories
    a. Very convenient.
    b. Can be an outdated version.
2. Install from Docker's official repositories
    a. Usually up-to-date.
    b. Need to configure the repository.
3. Use binaries from Github
    a. Download binaries from Github and put in a location on $PATH variable.
    b. Makes auditing slightly difficult since it skips dpkg and rpm list commands.

Let us install Docker

docker run hello-world

$ sudo docker run hello-world
Unable to find image 'hello-world:latest' locally
latest: Pulling from library/hello-world

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Common Commands: docker ps

$ sudo docker ps

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

$ sudo docker ps -a

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

33fd08c23918 hello-world "/hello" 5 minutes ago Exited (0) 5 minutes ago tiny_stonebraker

Common Commands: docker images

$ sudo docker images

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
hello-world	latest	c54a2cc56cbb	6 weeks ago	1.848 kB

Common Commands: docker pull

$ sudo docker pull alpine
Using default tag: latest
latest: Pulling from library/alpine
e110a4a17941: Pull complete
Digest: sha256:3dcdb92d7432d56604d4545cbd324b14e647b313626d99b889d0626de158f73a
Status: Downloaded newer image for alpine:latest

$ sudo docker images

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
hello-world	latest	c54a2cc56cbb	6 weeks ago	1.848 kB
alpine	latest	4e38e38c8ce0	7 weeks ago	4.795 MB

Common Commands: docker run

$ sudo docker run -i -t alpine /bin/sh
/ #

Common Commands: docker logs

$ sudo docker ps -a

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

8cc5470146f4 alpine "/bin/sh" About a minute ago Exited (0) 4 seconds ago pensive_lumiere

$ sudo docker logs 8cc5470146f4

/ # ls /

bin dev etc home lib linuxrc media mnt proc root run sbin srv sys tmp usr var

/ # echo hello

hello

/ # exit

Common Commands: docker stop

$ sudo docker ps

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

1ff3ca902cdf alpine "sleep 100" 11 seconds ago Up 2 seconds pensive_mestorf

$ sudo docker stop 1ff3ca902cdf

1ff3ca902cdf

Common Commands: docker rm

$ sudo docker ps

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

1ff3ca902cdf alpine "sleep 100" 11 seconds ago Up 2 seconds pensive_mestorf

$ sudo docker rm 1ff3ca902cdf

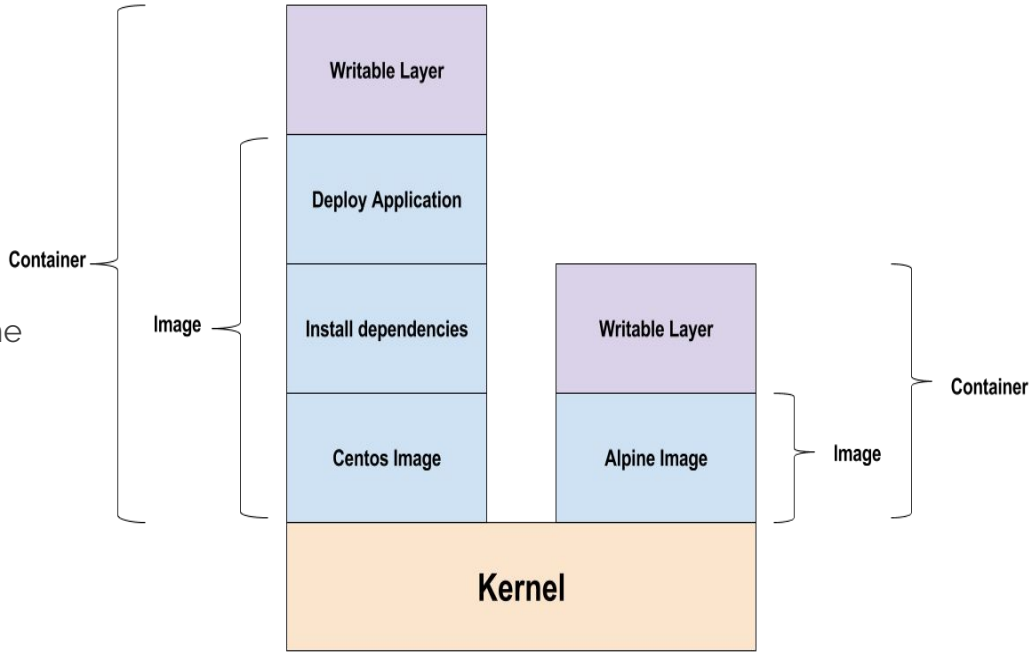
1ff3ca902cdf

Common Commands: docker rmi

$ sudo docker rmi hello-world
Untagged: hello-world:latest
Untagged:
hello-world@sha256:0256e8a36e2070f7bf2d0b0763dbabdd67798512411de4cdcf9431a1feb60fd9Del
eted: sha256:c54a2cc56cbb2f04003c1cd4507e118af7c0d340fe7e2720f70976c4b75237dc
Deleted: sha256:a02596fdd012f22b03af6ad7d11fa590c57507558357b079c3e8cebceb4262d7

Docker Images

- Docker images are the read-only templates from which a container is created.
- An image consist of one or more read-only layers.
- These layers are overlaid to form a single coherent file system.
- Any change to an image forms a new layer which is overlaid on the older layers.
- When an image is pulled or pushed, only the differential layers travel over the network, saving time and bandwidth.



Building Docker Images: Commit Method

1. Create and run a container from an existing Docker images.
2. Make required changes to the container.
3. Use docker commit to create the image out of the container.

$ sudo docker commit <container_id> <optional_tag>

Building Docker Images: Dockerfile Method

1. Choose a base image.
2. Define set of changes in a description file.
3. Use docker build to create an image.

$ sudo docker build -f <path_of_dockerfile> .

Building Docker Images: Example Dockerfile

```
FROM centos
MAINTAINER Aditya Patawari <aditya@adityapatawari.com>
RUN yum -y update && yum clean all
RUN yum -y install httpd
EXPOSE 80
CMD ["/usr/sbin/httpd", "-D", "FOREGROUND"]
```

Building Docker Images: Understanding Dockerfile

- Some common terminologies for Dockerfile used in previous example
  a. FROM: This defines the base image for the image that would be created
  b. MAINTAINER: This defines the name and contact of the person that has created the image.
  c. RUN: This will run the command inside the container.
  d. EXPOSE: This informs that the specified port is to be bind inside the container.
  e. CMD: Command to be executed when the container starts.
- Each statement creates a new layer, which is why sometimes we club commands using “&&”.
- For a full set of supported statements, check out Dockerfile reference
  https://docs.docker.com/engine/reference/builder/

Dockerfile vs Commit

Dockerfile

- Repeatable method
- Self documenting
- Easy to audit and validate
- Great for building CI pipelines
- Better and prefered method

Commit

- Easier
- Non-repeatable
- Difficult to audit
- Usually for one-off testing
- Avoid for production grade usage

Introduction to Docker Compose

- Docker Compose is a way to define specifications of a multi-container application.
- It can consist of Dockerfiles, images, environment variables, volumes and many other parameters which are required to run a container based application
- The specification is written in YAML format
- A full reference can be obtained from https://docs.docker.com/compose/compose-file/

Installing Docker Compose

- Docker Compose is distributed as a binary.
- Latest release of the same can be downloaded from Github.
  # curl -L
  https://github.com/docker/compose/releases/download/1.8.0/docker-compose
  - `uname -s `- `uname -m ` > /usr/local/bin/docker-compose
- After downloading Docker Compose, we need to set the correct permissions to make is executable
  # chmod +x /usr/local/bin/docker-compose

Basic Compose Spec

```
owncloud9:
  image: adimania/owncloud9-centos7
  ports:
    - 80:80
  links:
    - mysql
mysql:
  image: mysql
  environment:
    - MYSQL_ROOT_PASSWORD=my-secret-pw
    - MYSQL_DATABASE=owncloud

# docker-compose -f docker-compose.yml up
```