Docker

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About me

Lev Epshtein

Technology enthusiast with 10 years of industry experience in DevOps and IT. Industry experience with back-end architecture.

Solutions architect with experience in big scale systems hosted on AWS/GCP, end-to-end DevOps automation process.

DevOps, and Big Data instructor at NAYA.

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Docker Basics

Objectives

- By the end of this module
  - You'll be familiar with Docker concepts & Base command
  - Configure Dockers using Dockerfile and Passing Properties To it
  - Run standalone Jar in docker
  - Operate docker registry (docker hub)
  - Build docker images with Maven
  - Docker Network, Docker compose

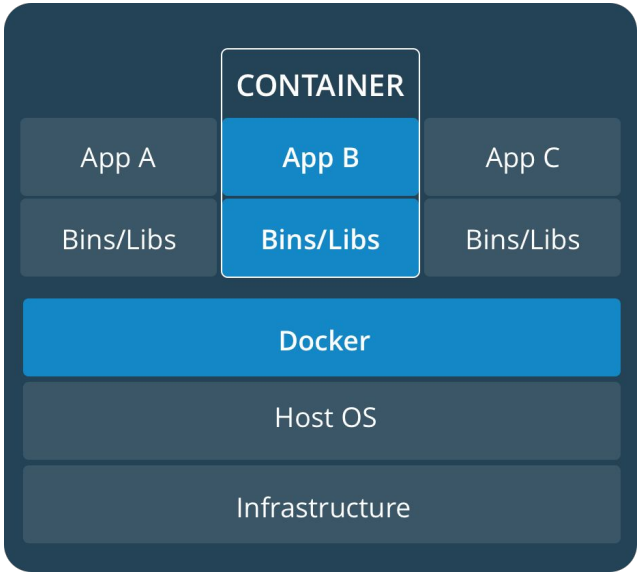
Questions for you…

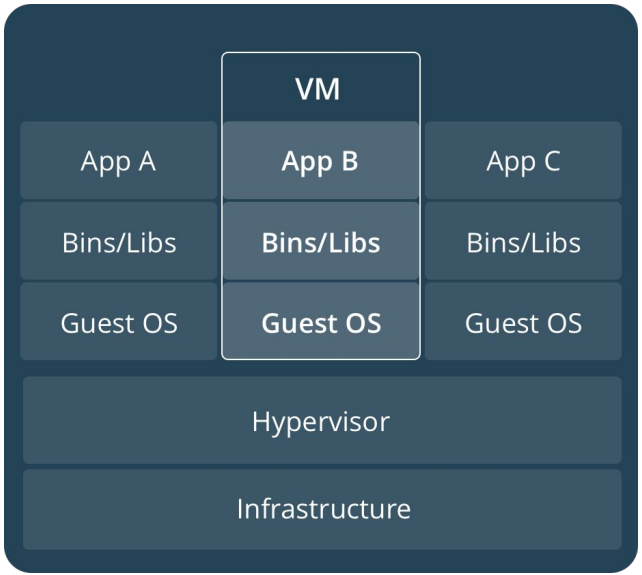
- What do you know about Docker?
- Who use docker for Development/QA/STG/PROD?
- Who tried and failed implementing Docker?

What is Docker?

- Docker is a platform for developers and sysadmins to **build, share, and run** applications with containers.
- The use of containers to deploy applications is called *containerization*.
  - Flexible
  - Lightweight
  - Portable
  - Loosely coupled
  - Scalable
  - Secure

Containers and virtual machines

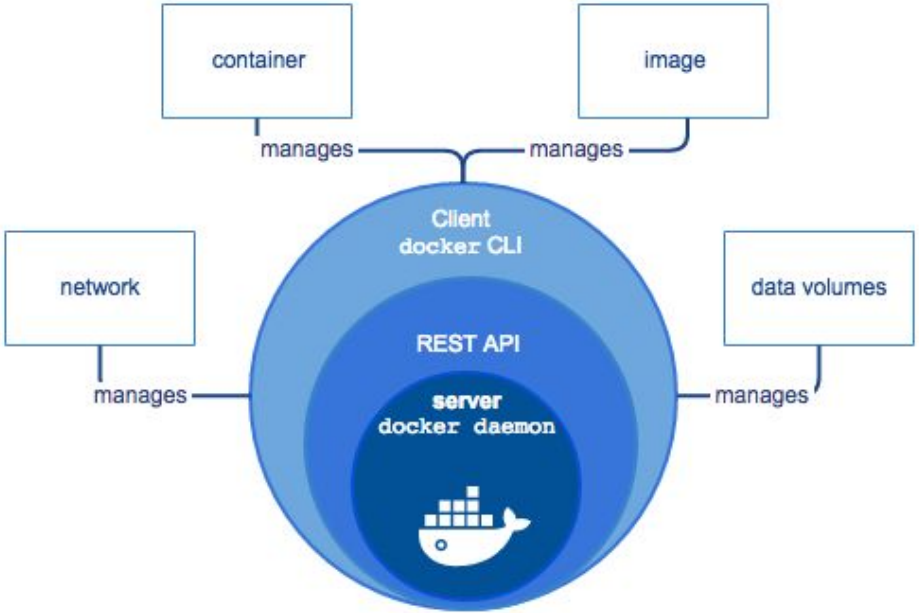




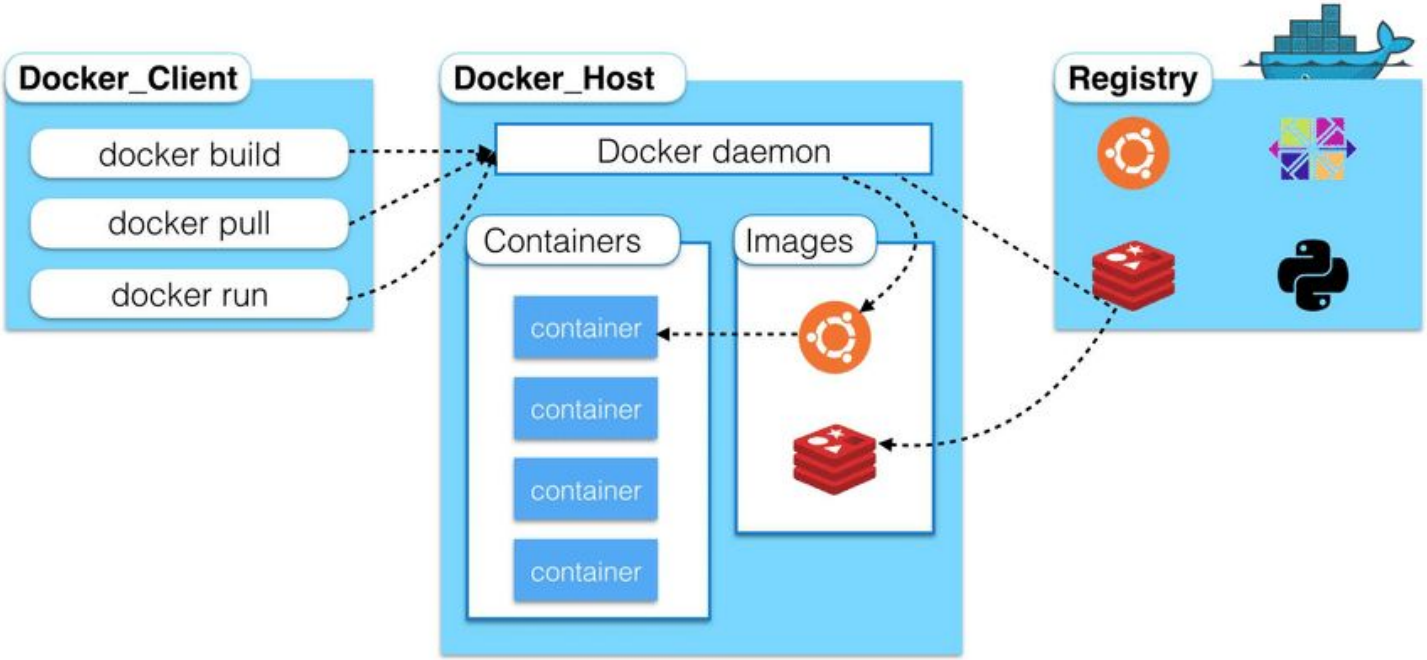
Common Use Case for Docker

- Microservices / Multi-Tier application (Front End, Mid Tier, Data Tier)
- CI/CD
- Sandboxed environment
- Local Environment

Docker Engine



The Docker Architecture



The underlying technology

Written in Go and takes advantage of several of the Linux kernel features:

- Namespaces
- Control groups

Let’s Start

git clone https://github.com/levep/docker-course-bezeq.git

Hello World

docker run alpine echo "Hello World"

docker run -i -t alpine ash

/ # echo "Hello from container"

/ # cat /etc/os-release

/ # exit

Docker Basic Commands

> ***docker run -i -t -d --name nicedocker -p 8080:80 alpine ash***

- docker run will run the container
  - -i - Interactive mode
  - -t - Allocate pseudo TTY - or not Terminal will be available
  - -d - Run in background (Daemon style)
  - --name - Give the container a name or let Docker to name it
  - -p [local port]:[container [port] - Forward local to the container port

Docker Basic Commands

> docker run -h MyDocker -i -t --rm debian /bin/bash

- docker run will run the container
  - -h - Container host name
  - --rm - Automatically remove the container when it exits
- docker exec/atatch

  > docker exec -it <CONTAINER> ash

  > docker attach <CONTAINER> ,.. (Ctrl P + Ctr Q to quit)

Common Docker commands

// General info
man docker // man docker-run
docker help // docker help run
docker info
docker version
docker network ls
docker volumes ls

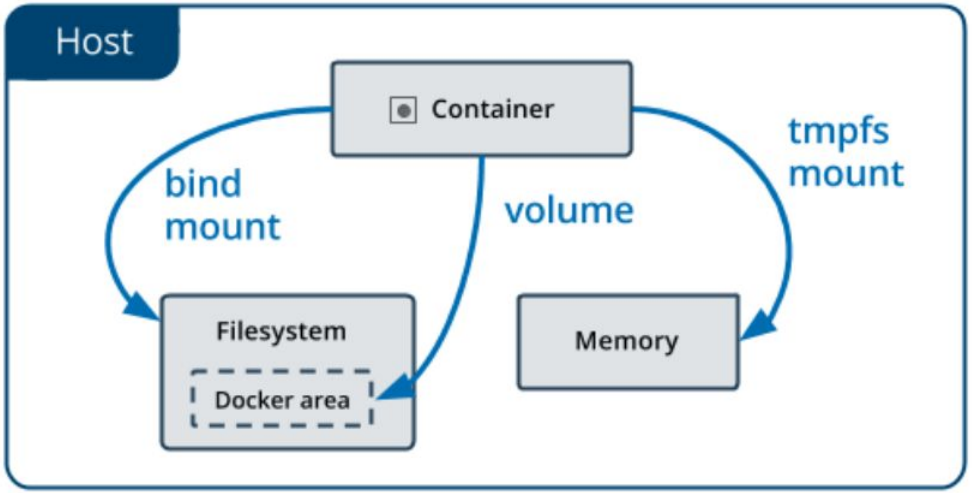
// Images
docker images // docker [IMAGE_NAME]
docker pull [IMAGE] // docker push [IMAGE]

// Containers
docker run
docker ps // docker ps -a, docker ps -l
docker stop/start/restart [CONTAINER]
docker stats [CONTAINER]
docker top [CONTAINER]
docker port [CONTAINER]
docker inspect [CONTAINER]
docker inspect -f "{{ .State.StartedAt }}" [CONTAINER]
docker rm [CONTAINER]

Docker Volumes

Manage Data in Docker

An easy way to visualize the difference among volumes, bind mounts, and tmpfs mounts is to think about where the data lives on the Docker host.



Volumes - Demo

> docker run -dti --name alpine1 --mount target=/app alpine ash

> docker inspect alpine1

> docker stop alpine1 && docker rm alpine1

Volumes - Demo

Creating a VOLUME managed by docker FS and share it with multiple containers

> ***docker volume create fs_shared***

> ***docker volume ls***

> ***docker run --rm -tdi --name alpine1 --mount source=fs_shared,target=/app alpine ash***

> ***docker run --rm -tdi --name alpine2 --mount source=fs_shared,target=/app alpine ash***

> ***docker run --rm -tdi --name alpine3 --mount source=fs_shared,target=/app alpine ash***

Volumes - Lab

Attach to running containers, create files and verify files gets updated on all containers

TIPS:

- Use previous slides to create volume and container that running with mount to that volume.
- Disconnect sequence: **Ctrl+p+Ctrl+q**

BIND mounts

> docker run --rm -tdi -v `pwd`/source:/app alpine ash

> docker run --rm -tdi --mount type=bind,source=`pwd`/source,target=/app alpine ash

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BIND mounts using -V or --MOUNT?

Both will provide the same outcome but as -v /--volume exists since day 1 in docker and --mount was introduced since docker 17.06 it became normal and easier to use --mount.

BIND MOUNTS - Lab

- **Create and manage bind mount:**
  - Create new host local project folder called “nice_docker” and cd into it
    - Create 2 alpine containers and share new local folder called source1 using --mount
    - Create 2 alpine containers and share new local folder called source2 using -v
    - What happened when you tried creating a shared host folder with --mount without first creating the folder manually ? and what happened when you were using -v
  - Inspect the new volumes and containers
  - Validate shared folder by creating files and make sure the exists on both containers
  - Stop all docker containers and Make sure containers got deleted

Running BootStrap app in a container - Lab

- **Hook SpringBoot Jar into a container:**
  - Cd into your “nice_docker” folder
    - Copy from your cloned git the demo artifact to ./source

      from docker-course-bezeq/Docker/spring-boot-music/artifacts/spring-music.jar
  - Run **1 new container**
    - Name: web_api
    - Mount Using -v or --mount
      - <>\docker-course-bezeq\Docker\spring-boot-music\artifacts:
      - Target: /app
    - Image: **levep79/alpine-oraclejre8**
    - CMD: `java -jar -Dspring.profiles.active  /app/spring-music.jar`

Running BootStrap app in a container - Lab

Validate your work:

docker ps, docker log, docker attach

Try Browsing from your host browser: http://<machine ip>:8080

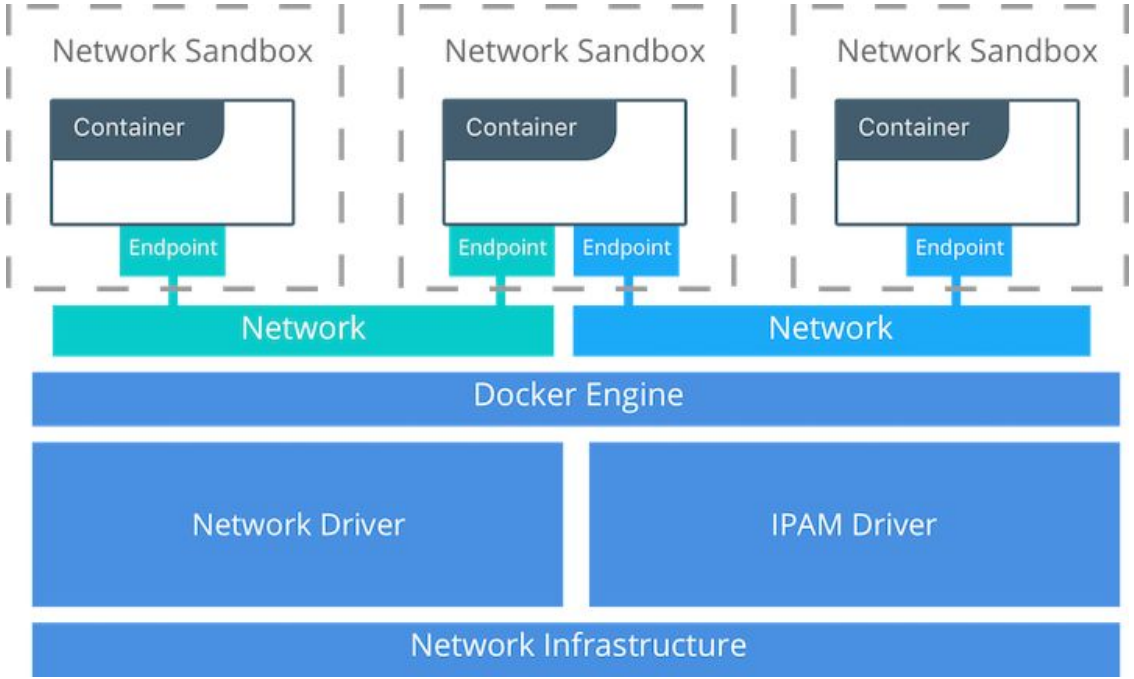
Did it worked?

What do you need to do to forward request to port 8080 and 8080 to your docker web_api?

Docker Networking

https://docs.docker.com/network/

The Container Networking Model - CNM



Network Native Network Driver

Host - With the **host** driver, a container uses the network stack of the host. There is no namespace separation, and all interfaces on the host can be used directly by the container.

Bridge - The basic and default driver which is used for standalone containers setup that need to communicate.

Overlay - Connect multiple docker daemons together and enable swarm (cluster) services to communicate with each other. This can be used to facilitate communication between swarm and standalone container or between two standalone containers on different docker daemons.

Network Native Network Driver

MACVLAN - Allow us to assign a MAC address to a container for making it appear as physical device on our network. Best when you are migrating from a VM setup or need your containers to look like physical hosts on your network, each with a unique MAC address. Macvlan usually to be used with legacy or HW required product that must have a MAC and being directly connected to the physical network to operate.

None - The none driver gives a container its own networking stack and network namespace but does not configure interfaces inside the container. Without additional configuration, the container is completely isolated from the host networking stack.

Networking - Lab

> docker network ls

> docker run --rm -tdi --name alpine1 alpine ash

> docker run --rm -tdi --name alpine2 alpine ash

1. Check that the containers are actually running
2. Inspect the network and see what containers are connected to it using

   docker network inspect bridge
3. Connect to one of the Alpine containers using **docker attach or exec** and ping the other container with IP and than with it’s name. What happened ?

Networking - Lab

> docker network create dmz

> docker network inspect dmz

> docker run -tdi --rm --name network_test --network dmz alpine ash

> docker inspect network_test

Networking - Lab

1. Delete the previous containers (stop and then remove)
2. Create a newly user Defined network bridge named “**alpine-net”** and verify creation with **network ls** and than **Inspect** the network to see that no containers are connected
3. Create 4 new alpine containers with -dit and --network to the following network configuration
    a. First two to: alpine-net
    b. 3rd one to the **default bridge**
    c. 4th one to **alpine-net &** to the **bridge** network **(trickey…)**

    Tip: *network connect*...
4. Inspect Network bridge and user defined network

Networking - Lab

5. Connect to alpine1 and try pinging to alpine1,2,3,4 with IP and DNS - What happened ?
6. Connect to alpine4 and try pinging to alpine1,2,3,4 with IP and DNS - What happened ?
7. Why?
8. Stop all containers , Remove them and delete the user defined network you created

Docker Images

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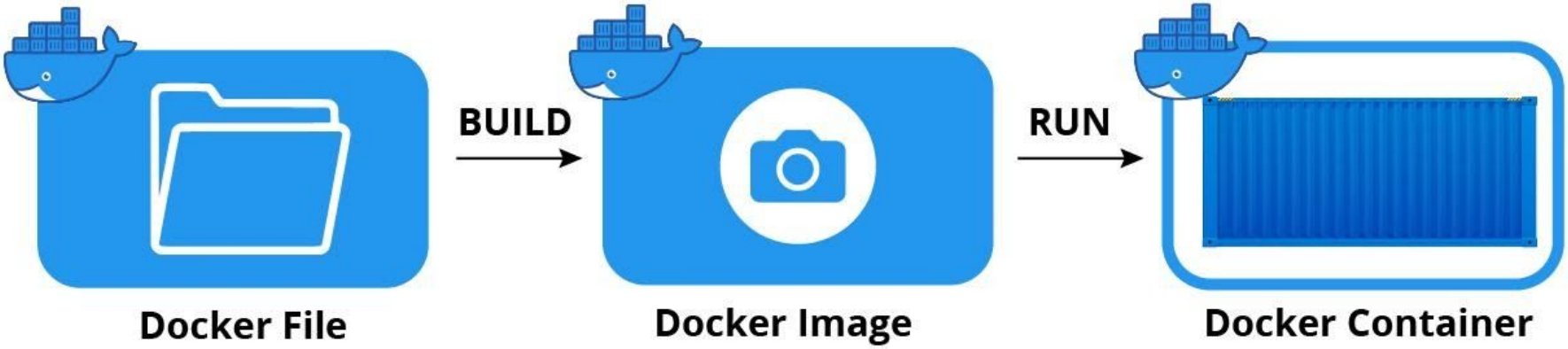
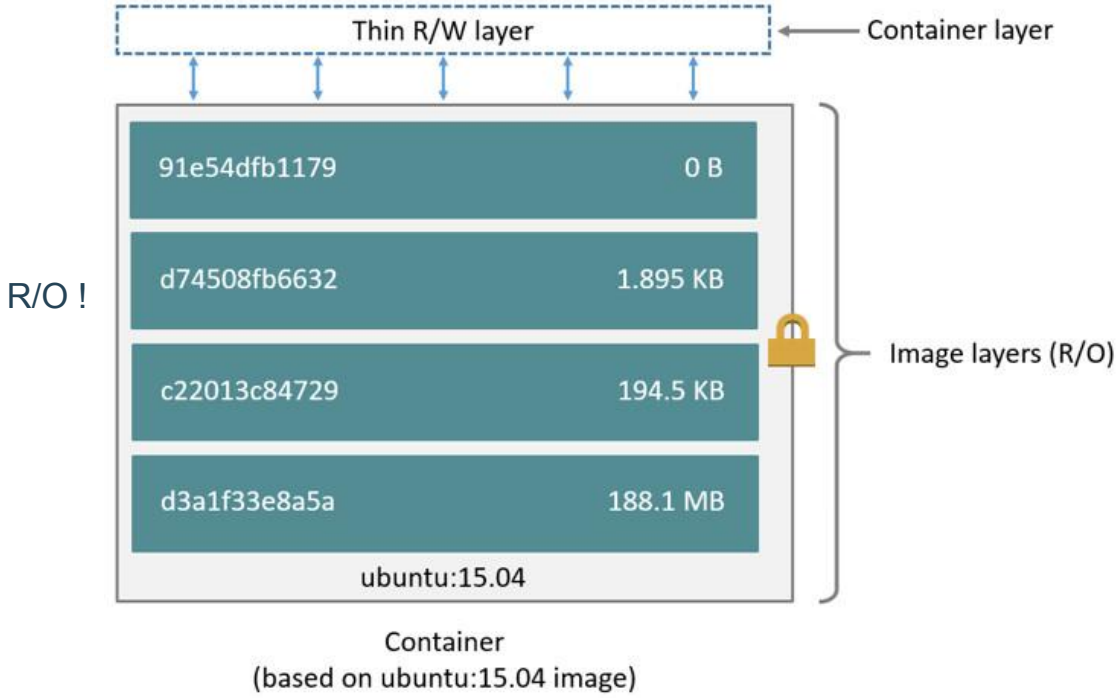
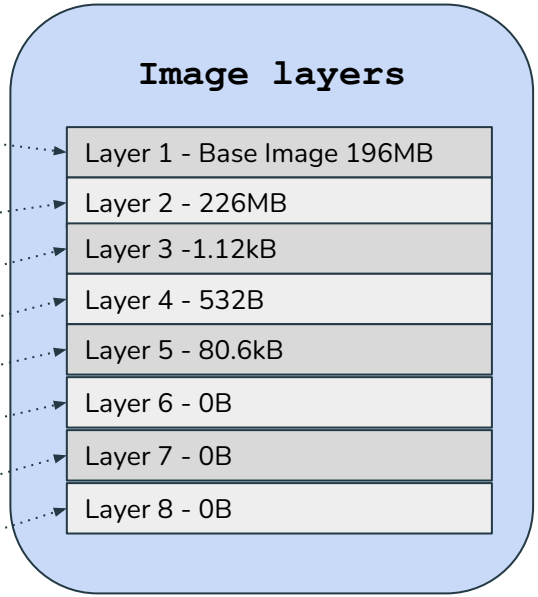


Layered FS


Thin R/W layer
Container layer
91e54dfb1179
0 B
d74508fb6632
1.895 KB
c22013c84729
194.5 KB
d3a1f33e8a5a
188.1 MB
ubuntu:15.04
Image layers (R/O)
R/O !
Container
(based on ubuntu:15.04 image)

```
#
# Ubuntu Dockerfile
#
# https://github.com/dockerfile/ubuntu
#

# Pull base image.
FROM ubuntu:14.04

# Install.
RUN \
  sed -i 's/# \(.*multiverse$\)/\1/g' /etc/apt/sources.list && \
  apt-get update && \
  apt-get -y upgrade && \
  apt-get install -y build-essential && \
  apt-get install -y software-properties-common && \
  apt-get install -y byobu curl git htop man unzip vim wget && \
  rm -rf /var/lib/apt/lists/*

# Add files.
ADD root/.bashrc /root/.bashrc
ADD root/.gitconfig /root/.gitconfig
ADD root/.scripts /root/.scripts

# Set environment variables.
ENV HOME /root

# Define working directory.
WORKDIR /root

# Define default command.
CMD ["bash"]
```



Command	Overview
FROM	Specify base image
RUN	Execute specified command
ENTRYPOINT	Specify the command to execute the container
CMD	Specify the command at the time of container execution (can be overwritten)
COPY	Simple copy of files / directories from host machine to container image
ADD	COPY + unzip / download from URL (**not recommended**)
ENV	Add environment variables
EXPOSE	Open designated port
WORKDIR	Change current directory
MAINTAINER	**deprecated**
	now `LABEL maintainer="maintainer@example.com"`should be specified as

https://docs.docker.com/engine/reference/builder/

CMD and ENTRYPOINT

- **CMD** sets default command and/or parameters, which can be overwritten from command line when docker container runs.

- **ENTRYPOINT** configures a container that will run as an executable.

Shell form

```
CMD echo "Hello world"
```

```
ENTRYPOINT echo "Hello world"
```

Exec form

```
CMD ["/bin/echo", "Hello world"]
```

```
ENTRYPOINT ["/bin/echo", "Hello world"]
```

how **CMD** and **ENTRYPOINT** interact

- Dockerfile should specify at least one of **CMD** or **ENTRYPOINT** commands.
- **ENTRYPOINT** should be defined when using the container as an executable.
- **CMD** should be used as a way of defining default arguments for an **ENTRYPOINT** command or for executing an ad-hoc command in a container.
- **CMD** will be overridden when running the container with alternative arguments.

ADD and COPY

- COPY will work for most of the cases.

- ADD has all capabilities of COPY and has the following additional features:

  Allows tar file auto-extraction in the image, for example,

  ```
  ADD app.tar.gz /opt/var/myapp
  ```

  Allows files to be downloaded from a remote URL.

ENV

Environment variables (declared with the **ENV** statement) can also be used in certain instructions as variables to be interpreted by the Dockerfile.

```
FROM busybox

ENV FOO=/bar

WORKDIR ${FOO}   # WORKDIR /bar

ADD . $FOO       # ADD . /bar

COPY \$FOO /quux # COPY $FOO /quux
```

USER

If a service can run without privileges, use **USER** to change to a non-root user. Start by creating the user and group in the Dockerfile with something like

```
RUN groupadd -r postgres && useradd --no-log-init -r -g postgres postgres
```

Avoid installing or using **sudo** as it has unpredictable TTY and signal-forwarding behavior that can cause problems. If you absolutely need functionality similar to **sudo**, such as **initializing the daemon as root but running it as non-root**, consider using “**gosu**”.

BuildKit

Docker Build enhancements for 18.09 release introduces a much-needed overhaul of the build architecture. By integrating **BuildKit**, users should see an improvement on **performance**, **storage management**, **feature functionality**, and **security**.

https://docs.docker.com/develop/develop-images/build_enhancements/

Import and export images

Docker images can be saved using image save command to a .tar file:

> ***docker image save helloworld > helloworld.tar***

These tar files can then be imported using load command:

> ***docker image load -i helloworld.tar***

Dockerfile best practices

https://docs.docker.com/develop/develop-images/dockerfile_best-practices/

Develop with Docker

https://docs.docker.com/develop/

Docker Compose

https://docs.docker.com/compose/

Docker-compose

Compose is a tool for defining and running **multi-container Docker applications.**

With Compose, you use a **YAML** file to configure your application's **services**:

```yaml
version: "3.9"  # optional since v1.27.0
services:
  web:
    build: .
    ports:
      - "5000:5000"
    volumes:
      - .:/code
      - logvolume01:/var/log
    links:
      - redis
  redis:
    image: redis
volumes:
  logvolume01: {}
```

With a single command, you create and start all the services from your configuration.

```
$ docker-compose up
```

or daemon mode:

```
$ docker-compose up -d
```

Using Compose is basically three-step

1. Define your app's environment with a Dockerfile so it can be reproduced anywhere.

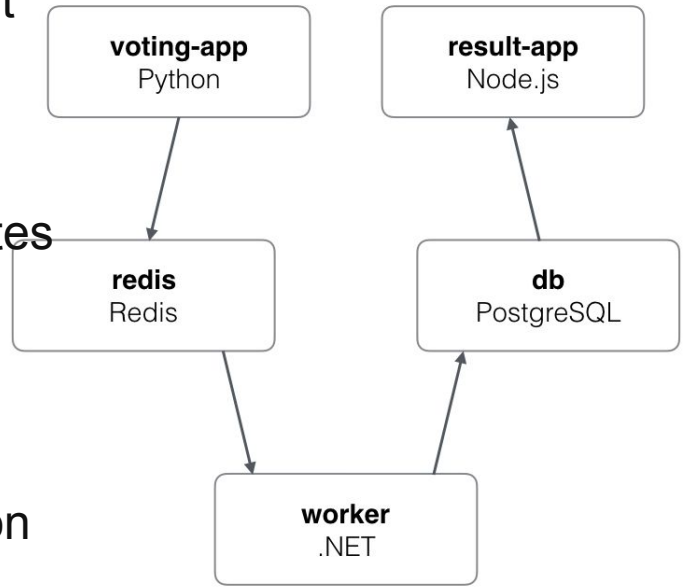
2. Define the services that make up your app in docker-compose.yml so they can be run together in an isolated environment.

3. Run docker-compose up and Compose starts and runs your entire app.

Demo 1

Demo 2 - The Voting App

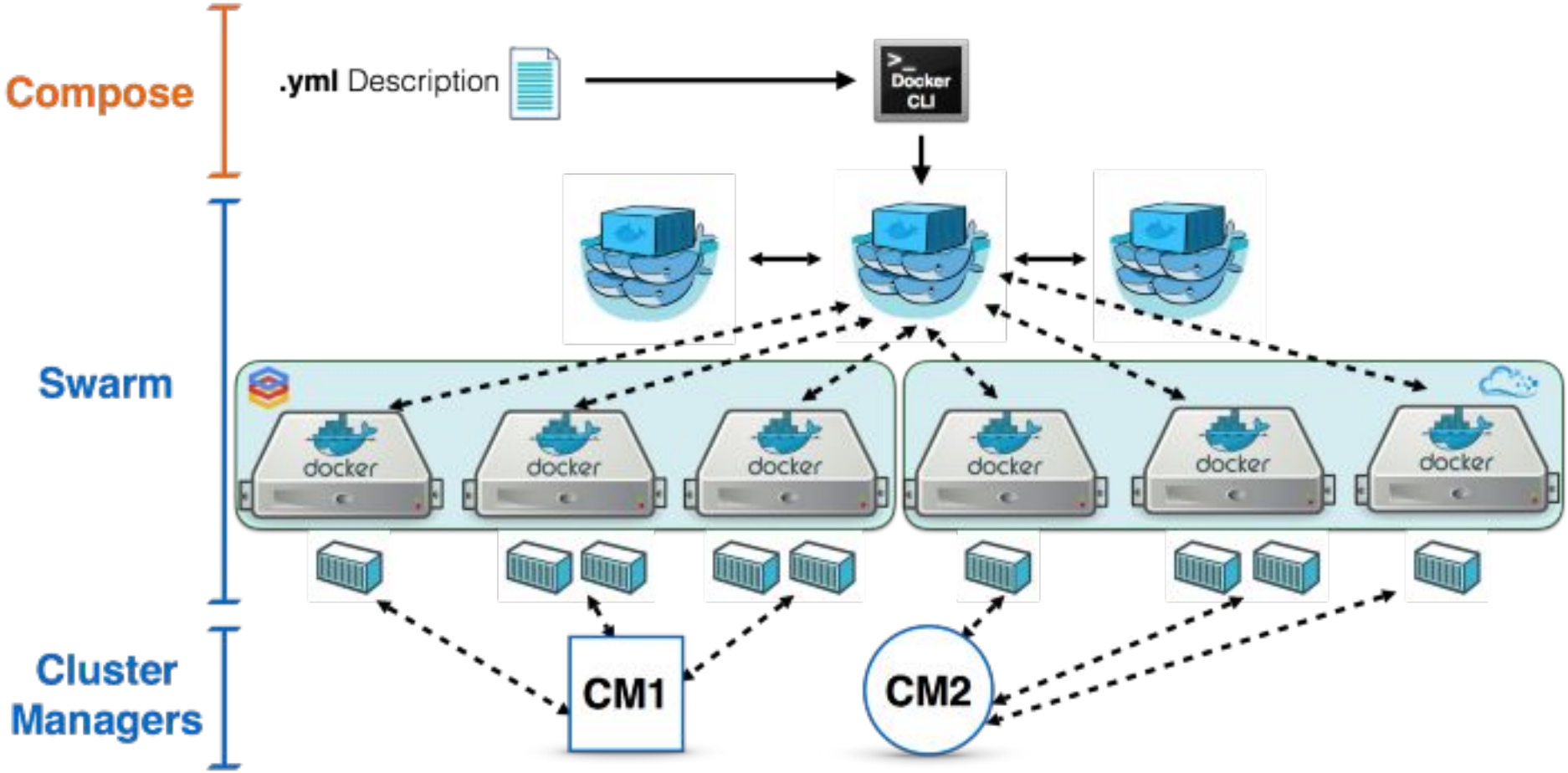
1. **Voting-App**: Frontend of the application written in Python, used by users to cast their votes.
2. **Redis**: In-memory database, used as intermediate storage.
3. **Worker**: .Net service, used to fetch votes from Redis and store in Postres database.
4. **DB**: PostgreSQL database, used as database.
5. **Result-App**: Frontend of the application written in Node.js, displays the voting results.



Demo 2 - The Voting App

```
$ docker-compose up

$ docker ps -a --format="table {{.Names}}\t{{.Image}}\t{{.Ports}}"

$ docker-compose up -d
$ docker-compose down
$ docker-compose start
$ docker-compose stop
$ docker-compose build
$ docker-compose logs -f db
$ docker-compose scale db=4
$ docker-compose events
$ docker-compose exec db bash
```

Docker Swarm


Compose
.yml Description
Docker CLI
Swarm
docker
docker
docker
docker
docker
docker
Cluster Managers
CM1
CM2

Cluster creation

Requirements:
VirtualBox, Vagrant

https://github.com/levep/vagrant-swarm-cluster.git

Or we can turn docker stand alone to single manager:

docker swarm init