Dockers and Containers

Virtualization:

Virtualization is the ability to run multiple operating systems on a single physical system and share the underlying hardware resources.

It is the process by which one server hosts the appearance of many computers.

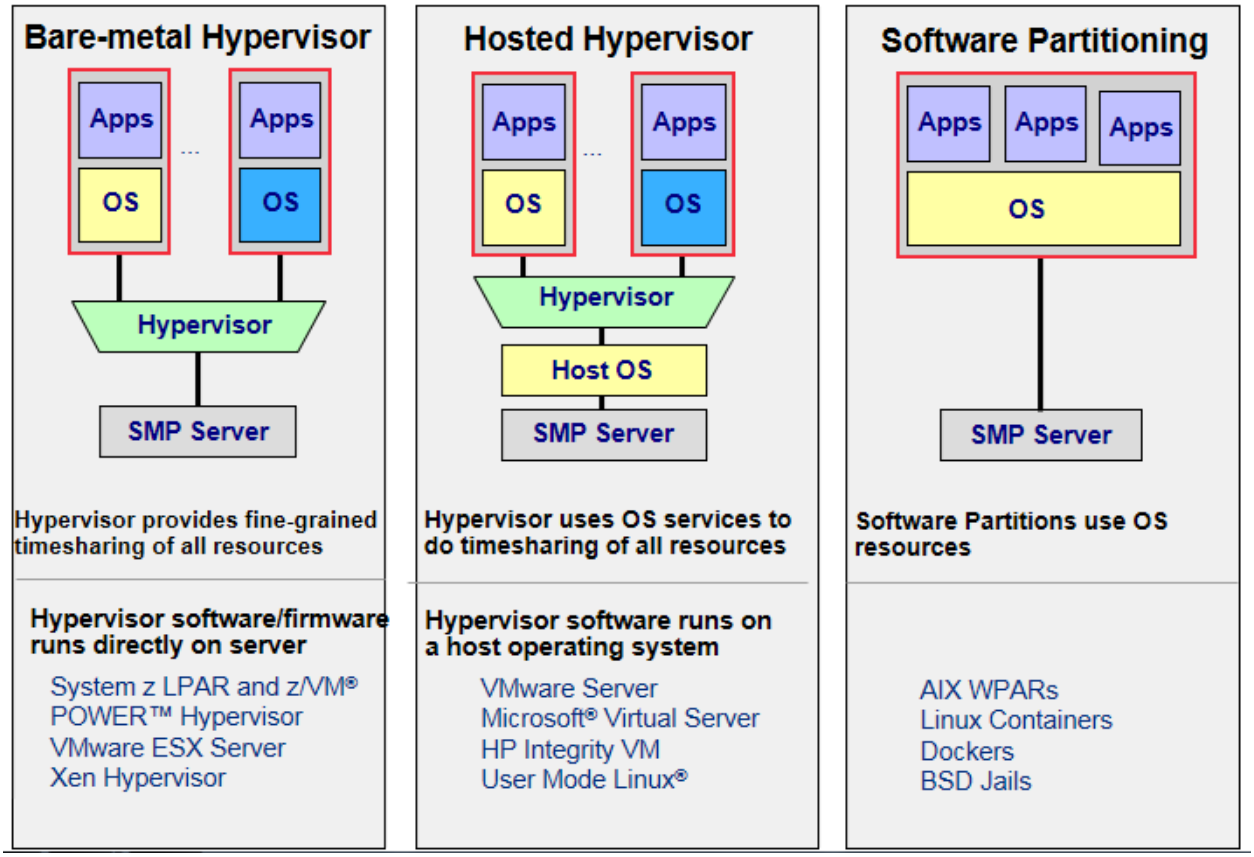
Virtualization is used to improve IT throughput and costs by using physical resources as a pool from which virtual resources can be allocated.

Different types of virtualizations:

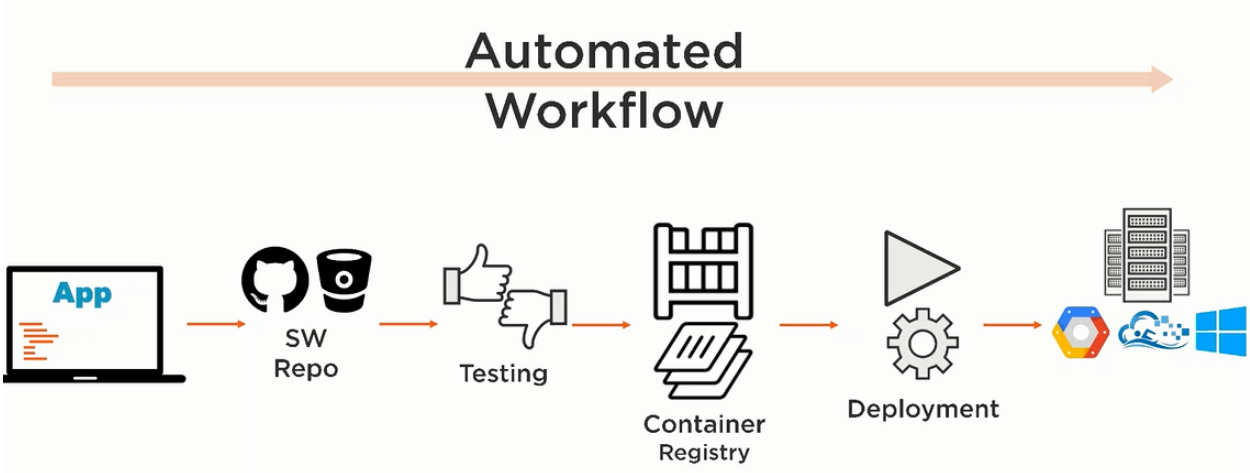
Bare metal hypervisor ex: Vmware ESX, IBM PowerVM, Xen

Hosted Hypervisor ex: KVM

Software partitioning: Dockers, WPARs



SMP – Symmetric multi processing



LXC (Linux Containers) is an operating-system-level virtualization method for running multiple isolated Linux systems (containers) on a control host using a single Linux kernel

Uses kernel features calls cgroups (Linux Kernel control groups)– that allows limitation and prioritization of resources like CPU/memory, /i/o, network

Namespace isolation – that allows complete isolation of an application view of Operating system environment including process trees. networking ,user ids and mounted file system

LXC combines kernel's cgroups and support for isolated namespaces to provide an isolated environment for applications

Note: LXC is a Linux technology. It does not work on Windows or Mac.

Dockers are useful in:

To avoid having too much software on the machine

To try deploying a web app

To try provisioning scripts on fake machine first them try on actual machine

Dockers leverage LXC – Lightweight alternative to full virtualization such as provided by traditional hypervisors like KVM VMware Xen or ESXi

Installing docker:

Steps for RHEL:

1. Execute below command on the node

sudo yum-config-manager --add-repo https://docs.docker.com/engine/installation/linux/repo_files/centos/docker.repo

sudo yum -y install docker-engine

sudo systemctl start docker

service docker status

Ensure the below file is created in /etc/yum.repos.d

cat /etc/yum.repos.d/docker.repo

root@reviewb ~]# cd /etc/yum.repos.d/

```
[root@reviewb yum.repos.d]# ls
iso.repo
[root@reviewb yum.repos.d]# cat /docker
cat: /docker: Is a directory
[root@reviewb yum.repos.d]# cat /docker.repo
[docker-main]
name=Docker Repository
baseurl=https://yum.dockerproject.org/repo/main/centos/7/
enabled=1
gpgcheck=1
gpgkey=https://yum.dockerproject.org/gpg

[docker-testing]
name=Docker Repository
baseurl=https://yum.dockerproject.org/repo/testing/centos/$releasever/
enabled=0
gpgcheck=1
gpgkey=https://yum.dockerproject.org/gpg

[docker-beta]
name=Docker Repository
baseurl=https://yum.dockerproject.org/repo/beta/centos/7/
enabled=0
gpgcheck=1
gpgkey=https://yum.dockerproject.org/gpg
```

[docker-nightly]

name=Docker Repository

baseurl=https://yum.dockerproject.org/repo/nightly/centos/7/

enabled=0

gpgcheck=1

gpgkey=https://yum.dockerproject.org/gpg

docker --help

```
 --config=~/.docker            Location of client config files
 -D, --debug                   Enable debug mode
 -H, --host=[]                 Daemon socket(s) to connect to
 -h, --help                    Print usage
 -l, --log-level=info          Set the logging level
 --tls                         Use TLS; implied by --tlsverify
 --tlscacert=~/.docker/ca.pem  Trust certs signed only by this CA
 --tlscert=~/.docker/cert.pem  Path to TLS certificate file
 --tlskey=~/.docker/key.pem    Path to TLS key file
 --tlsverify                   Use TLS and verify the remote
 -v, --version                 Print version information and quit
```

Commands:

```
   attach    Attach to a running container
   build     Build an image from a Dockerfile
```

commit Create a new image from a container's changes

cp Copy files/folders between a container and the local filesystem

create Create a new container

diff Inspect changes on a container's filesystem

events Get real time events from the server

exec Run a command in a running container

export Export a container's filesystem as a tar archive

history Show the history of an image

images List images

import Import the contents from a tarball to create a filesystem image

info Display system-wide information

inspect Return low-level information on a container, image or task

kill Kill one or more running container

load Load an image from a tar archive or STDIN

login Log in to a Docker registry.

logout Log out from a Docker registry.

logs Fetch the logs of a container

network Manage Docker networks

node Manage Docker Swarm nodes

pause Pause all processes within one or more containers

port List port mappings or a specific mapping for the container

ps List containers

pull Pull an image or a repository from a registry

push Push an image or a repository to a registry

rename Rename a container

restart Restart a container

rm Remove one or more containers

rmi Remove one or more images

run Run a command in a new container

save Save one or more images to a tar archive (streamed to STDOUT by default)

search Search the Docker Hub for images

service Manage Docker services

start Start one or more stopped containers

stats Display a live stream of container(s) resource usage statistics

stop Stop one or more running containers

swarm Manage Docker Swarm

tag Tag an image into a repository

top Display the running processes of a container

unpause Unpause all processes within one or more containers

update Update configuration of one or more containers

version Show the Docker version information

volume Manage Docker volumes

wait Block until a container stops, then print its exit code

Run 'docker COMMAND --help' for more information on a command.

Steps:

1. Install docker using yum

yum install docker

2. download the image using docker pull

docker pull ubuntu

docker pull rhel6

3. List dockers available

docker ps → to list running containers

docker ps -a → lists all containers including killed ones

4. start a docker using

docker run -t -i ubuntu

5. To stop a docker

docker stop <container_id>

6. to start a docker

docker start <container_id>

7.to login

docker attach <>

Commands:

Docker pull is to pull images

Docker ps to display running containers

Docker ps -a to display all running containers including the dead ones

Docker inspect is to show all values

Docker stop/start – is to stop or start a container

Docker attach/detach is to attach or detach to a container

Docker run is to run the container, if image is not available docker pulls from docker hub repository

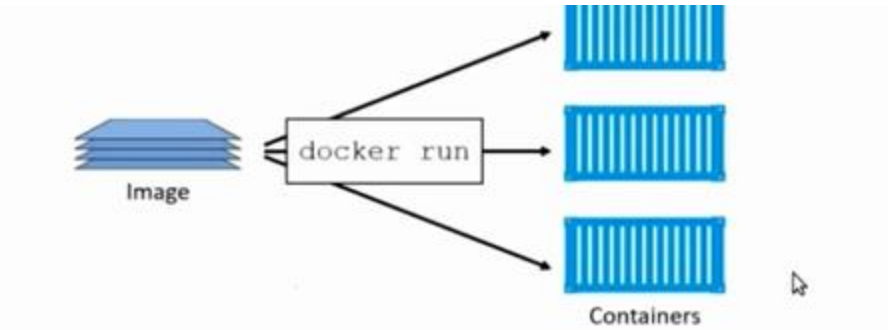


Figure 6.1

Examples:

[root@rscthydnet1 ~]# docker images

REPOSITORY TAG IMAGE ID CREATED SIZE

ubuntu latest 1967d889e07f 2 weeks ago 167.9 MB

➔ ***sudo docker run -t -i ubuntu:latest*** ➔ downloads Ubuntu docker

checks local machine first, it not available downloads the image from net

[root@rscthydnet1 LINUX]# ***sudo docker run -t -i ubuntu***

Unable to find image 'ubuntu:latest' locally

latest: Pulling from ubuntu

0847857e6401: Pull complete

f8c18c152457: Pull complete

8643975d001d: Pull complete

d5802da4b3a0: Pull complete

fe172ed92137: Pull complete

Digest: sha256:5349f00594c719455f2c8e6f011b32758dcd326d8e225c737a55c15cf3d6948c

Status: Downloaded newer image for ubuntu:latest

```
root@d47c9e2cbf15:/#
```

it will login to docker

```
root@d47c9e2cbf15:/# id
uid=0(root) gid=0(root) groups=0(root)
root@d47c9e2cbf15:/# cat /etc/*release
DISTRIB_ID=Ubuntu
DISTRIB_RELEASE=16.04
DISTRIB_CODENAME=xenial
DISTRIB_DESCRIPTION="Ubuntu 16.04.1 LTS"
NAME="Ubuntu"
VERSION="16.04.1 LTS (Xenial Xerus)"
ID=ubuntu
ID_LIKE=debian
PRETTY_NAME="Ubuntu 16.04.1 LTS"
VERSION_ID="16.04"
HOME_URL="http://www.ubuntu.com/"
SUPPORT_URL="http://help.ubuntu.com/"
BUG_REPORT_URL="http://bugs.launchpad.netubuntu/"
VERSION_CODENAME=xenial
UBUNTU_CODENAME=xenial
root@d47c9e2cbf15:/#
```

We can download the docker and load it

docker load -i centos_docker_image.tar

run apt-get update to work with apt-get

root@d47c9e2cbf15:/# **apt-get update**

Get:1 http://ports.ubuntu.comubuntu-ports xenial InRelease [247 kB]

Get:2 http://ports.ubuntu.comubuntu-ports xenial-updates InRelease [95.7 kB]

Get:3 http://ports.ubuntu.comubuntu-ports xenial-security InRelease [94.5 kB]

Get:4 http://ports.ubuntu.comubuntu-ports xenial/main Sources [1103 kB]

Get:5 http://ports.ubuntu.comubuntu-ports xenial/restricted Sources [5179 B]

Get:6 http://ports.ubuntu.comubuntu-ports xenial/universe Sources [9802 kB]

Get:7 http://ports.ubuntu.comubuntu-ports xenial/main x86_64el Packages [1470 kB]

Get:8 http://ports.ubuntu.comubuntu-ports xenial/universe x86_64el Packages [9485 kB]

Get:9 http://ports.ubuntu.comubuntu-ports xenial-updates/main Sources [256 kB]

Get:10 http://ports.ubuntu.comubuntu-ports xenial-updates/restricted Sources [1872 B]

Get:11 http://ports.ubuntu.comubuntu-ports xenial-updates/universe Sources [136 kB]

Get:12 http://ports.ubuntu.comubuntu-ports xenial-updates/main x86_64el Packages [487 kB]

Get:13 http://ports.ubuntu.comubuntu-ports xenial-updates/universe x86_64el Packages [395 kB]

Get:14 http://ports.ubuntu.comubuntu-ports xenial-security/main Sources [54.7 kB]

Get:15 http://ports.ubuntu.comubuntu-ports xenial-security/restricted Sources [1872 B]

Get:16 http://ports.ubuntu.comubuntu-ports xenial-security/universe Sources [13.8 kB]

Get:17 http://ports.ubuntu.comubuntu-ports xenial-security/main x86_64el Packages [171 kB]

Get:18 http://ports.ubuntu.comubuntu-ports xenial-security/universe x86_64el Packages [55.7 kB]

Fetched 23.9 MB in 1min 2s (382 kB/s)

Reading package lists... Done

Install packages

apt-get install vim

apt-get install openssh

apt-get install vim

apt-get install iputils-ping

apt-get install net-tools

apt-get install ksh

to come out of docker without stopping it control+pq

docker run – every time it creates a new container.

to get the container id

root@rscthydnet1 ~]# docker ps -a

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

docker stop container_ID

docker start container_ID

docker run -d --name ubuntu-docker1 ubuntu

[root@rscthydnet1 ~]# docker ps

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

20354b3035a3 ubuntu "/bin/bash" 6 seconds ago Up 3 seconds romantic_booth

docker attach 20354b3035a3

[root@rscthydnet1 ~]# docker ps

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

20354b3035a3 ubuntu "/bin/bash" 8 minutes ago Up 18 seconds romantic_booth

[root@rscthydnet1 ~]# docker stop 20354b3035a3

20354b3035a3

[root@rscthydnet1 ~]# docker start 20354b3035a3

20354b3035a3

[root@rscthydnet1 ~]# docker ps -a

CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES

20354b3035a3 ubuntu "/bin/bash" 9 minutes ago Up 57 seconds romantic_booth

5f3e16925382 ubuntu "/bin/bash" 9 minutes ago Exited (127) 9 minutes ago admiring_montalcini

24eedbddd026 ubuntu "/bin/bash" 11 minutes ago Exited (0) 11 minutes ago ubuntu-docker1

d47c9e2cbf15 ubuntu "/bin/bash" 3 hours ago Exited (127) 11 minutes ago sleepy_elion

```
[root@rscthydnet1 ~]#



[root@rscthydnet1 ~]# docker attach d47c9e2cbf15
You cannot attach to a stopped container, start it first
[root@rscthydnet1 ~]# docker start d47c9e2cbf15

d47c9e2cbf15
[root@rscthydnet1 ~]#
[root@rscthydnet1 ~]# docker attach d47c9e2cbf15
root@d47c9e2cbf15:/#
root@d47c9e2cbf15:/#
root@d47c9e2cbf15:/#
root@d47c9e2cbf15:/# ls -lrt
total 828
drwxr-xr-x.   2 root root      6 Apr 12  2016 home
drwxr-xr-x.   2 root root      6 Apr 12  2016 boot
drwxr-xr-x.  10 root root     97 Nov  1 08:20 usr
drwxr-xr-x.   2 root root      6 Nov  1 08:20 srv
drwxr-xr-x.   2 root root      6 Nov  1 08:20 opt
drwxr-xr-x.   2 root root      6 Nov  1 08:20 mnt
drwxr-xr-x.   2 root root      6 Nov  1 08:20 media
drwxr-xr-x.   2 root root     22 Nov  1 08:21 lib64
drwxr-xr-x.  11 root root   4096 Nov  1 08:21 var
dr-xr-xr-x.  12 root root      0 Nov 14 04:07 sys
```

drwxr-xr-x. 2 root root   6 Nov 16 08:25 rsctfvt

drwxr-xr-x. 9 root root   4096 Nov 16 08:31 lib

-rw-r-----. 1 root root 809234 Nov 16 08:34 sg3_utils-1.41-3.fc24.x86_64.rpm

drwxrwxrwx. 2 root root   8192 Nov 16 08:36 _linux_2

drwxr-xr-x. 5 root root   74 Nov 16 08:38 run

drwxr-xr-x. 2 root root   4096 Nov 16 08:40 bin

drwxr-xr-x. 2 root root   4096 Nov 16 08:40 sbin

drwxr-xr-x. 72 root root   4096 Nov 16 08:45 etc

drwxrwxrwt. 2 root root   6 Nov 16 08:45 tmp

drwx------. 4 root root   94 Nov 16 10:32 root

dr-xr-xr-x. 583 root root   0 Nov 16 10:44 proc

drwxr-xr-x. 5 root root   380 Nov 16 10:44 dev

root@d47c9e2cbf15:/#

root@d47c9e2cbf15:/#

root@d47c9e2cbf15:/#

to make container running always

docker run -d <docker name> sh /script.sh

this script,sh should be a never ending loop

something like:

while true

do

sleep 1

done

Port forwarding:

Start a container from host

And we can map the host and container's ports

Container 's app can be accessed from host machine using port forwarding concept

Example:

Create a docker and do a mapping between host port 8080 to container 8080

docker run -p 8080:8080 jenkins:latest

docker run -d -p 8080:8080 jenkins:latest -> to run in the background

docker rm <name of the container> to remove the container, first stop the container and remove.

Detaching/attaching – we can do on a running container

Attaching/detaching a shell

Stop/start – stoping a service .

Docker rmi – to remove image

Docker pull xyz:latest

Docker run -it xyz /bin/bash

Install software

Apt-get update

Apt-get install <>

Customize the image

Exit the container

To create the image to push it to Docker Hub:

docker commit -m “customized image name” -a “authorname” <containerid> <nameofaccount>/<nameof the image>:tag

docker commit -m "ubuntupython" -a "santosh" f56be454c884 santoshdevops/ubuntupython:v1

sha256:7f093647f35a39965d101859c269da63884fef22bc574829786408513efbe7b8

docker commit -m "jenkinscustomzed3" -a "santosh" fd4e1be10bd2 santoshdevops/jenkinscustomzed3:v200

docker login

Note:

We need to create a login in docker hub, and use the same for pushing images

Give account name and password

Docker push nameofdockerimage

docker push santoshdevopsubuntupython

then try to delete the image from local machine

and try to pull same image

Docker File:

To automate the image creation

Create docker file

touch Dockerfile

Add the instructions to file

Command	**Description**
ADD	Copies a file from the host system onto the container
CMD	The command that runs when the container starts
ENTRYPOINT	
ENV	Sets an environment variable in the new container
EXPOSE	Opens a port for linked containers
FROM	The base image to use in the build. This is mandatory and must be the first command in the file.
MAINTAINER	An optional value for the maintainer of the script
ONBUILD	A command that is triggered when the image in the Docker file is used as a base for another image
RUN	Executes a command and save the result as a new layer
USER	Sets the default user within the container
VOLUME	Creates a shared volume that can be shared among containers or by the host machine
WORKDIR	Set the default working directory for the container

cat Dockefile

FROM ubuntu:latest

MAINTAINER Visualpath

RUN apt-get update && apt-get install -y ruby

Docker build -t newdockerimage:v3 .

Creates image

Do all the stuff

Create a new container

Remove the old container

ADD

CMD similar to run,

Run gets executed while building

CMD gets executed while running the container

USER to set user id

VOLUME – attach a directory from a host machine

WORKDIR – launch into default dir

Docker bridge ip 172.17.0.1 – advanced switch

This is the gateway for containers

Example of building image from Dockerfile:

docker build -t myimage_t .

docker run --name my_first_instance -t myimage_t

To stop all the docker containers

docker stop $(docker ps -a -q)

to remove all the docker images

docker rm $(docker ps -a -q)

Docker images are stored in - /var/lib/docker/devicemapper/

(based on the device used, here device used is devicemapper)

Can we directly copy the image from one machine to other?

Yes:

save the docker image as a tar file:

docker save -o <save image to path> <image name>

Then copy your image to a new system with regular file transfer tools such as cp or scp. After that you will have to load the image into docker:docker load -i <path to image tar file>

docker load -i <path to image tar file>

Can we control the cpu /memory running for a container?

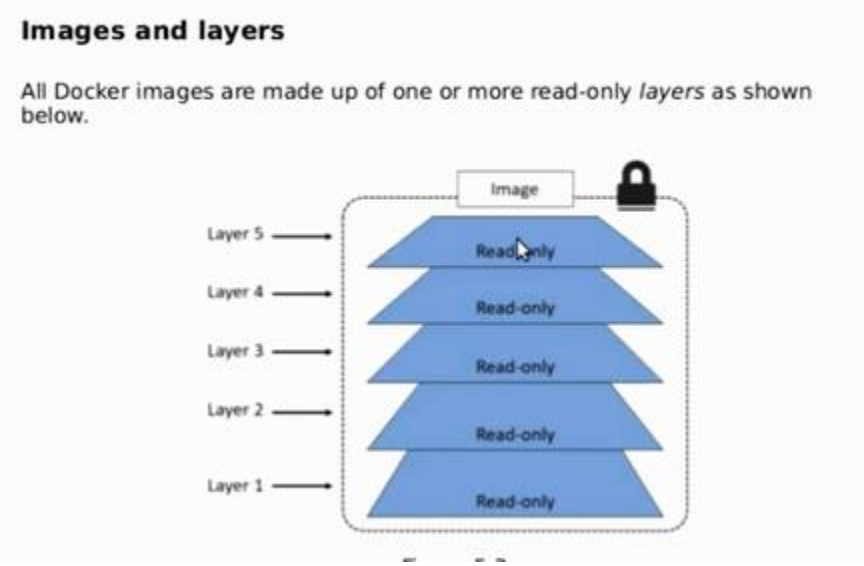
Yes:

If we have 2 containers, one for the database and one more for the web server

sudo docker run -c 614 -dit --name db postgres /postgres.sh

sudo docker run -c 410 -dit --name web nginx /nginx.sh

Will give 60% to the db container (614 is 60% of 1024) and 40% to the web container.



Docker image has layers

If any data is added, after a container is created on top of image it will create a new layer.

Every layer will have id.

Docker inspect is command to give info about docker.

To share volumes between 2 containers:

[root@reviewb ~]# cd /vol2

[root@reviewb vol2]# ls -lrt

total 4

-rw-r--r--. 1 root root 92 Mar 4 10:10 Dockerfile

[root@reviewb vol2]# cat Dockerfile

FROM ubuntu:latest

RUN mkdir /myvol

RUN echo "hello world" > /myvol/greeting

VOLUME /myvol

docker build -t vol2 . → build the image with directory /myvol

docker run -it vol2 /bin/bash → creates container1

docker run -it --volumes-from <1st container id> ubuntu:latest bash → creates container2 with shared directory /myvol

file /myvol will be shared across 2 dockers

Sharing file between Host and Container:

on host:

docker volume create --name DataVolume1 --> creates a docker volume

docker run -ti --rm -v DataVolume1:/datavolume1 ubuntu --> creates container, upon exit docker will be deleted

on docker:

echo "Example1" > /datavolume1/Example1.txt

on host:

docker volume inspect DataVolume1

output


```
[
    {
        "Name": "DataVolume1",
        "Driver": "local",
        "Mountpoint": "/var/lib/docker/volumes/datavolume1/_data",
        "Labels": null,
        "Scope": "local"
    }
]
```


we can start a new docker with same data volume

docker run --rm -ti -v DataVolume1:/datavolume1 ubuntu

to create volume that persists when container is removed.

docker run -ti --name=Container2 -v DataVolume2:/datavolume2 ubuntu

Docker logs:

On RHEL

cat /var/log/messages | grep docker

or

journalctl -u docker.service

Docker logs based on OS:

Ubuntu (old using upstart) - /var/log/upstart/docker.log

Ubuntu (new using systemd) - journalctl -u docker.service

Boot2Docker - /var/log/docker.log

Debian GNU/Linux - /var/log/daemon.log

CentOS - /var/log/daemon.log | grep docker

CoreOS - journalctl -u docker.service

Fedora - journalctl -u docker.service

Red Hat Enterprise Linux Server - /var/log/messages | grep docker

OpenSuSE - journalctl -u docker.service

OSX - ~/Library/Containers/com.docker.docker/Data/com.docker.driver.amd64-linux/log/docker.log

Database Use case:

docker run --name db -d -e MYSQL_ROOT_PASSWORD=123 -p 3306:3306 mysql:latest

docker ps

docker exec -it db /bin/bash

mysql -uroot -p123

show databases;

exit

steps to build image:

1. docker pull ubuntu ==> downloads image

2. docker run -it ubuntu => creates container, logs into container

3. do customization, apt-get update, apt-get install python

4. exit from the container using exit

5. docker commit

6. docker login (need to sign up with docker hub first)

7. docker push

this can be automated using dockerfile

docker build -t <image name> .

Create nginx container using docker image:

docker run --name mynginx-P -d nginx

creates a container with name mynginx and runs in the detached mode

container will be running until it is stopped.

Nginx exposes the ports 80 and 443 in the container

-P tells dockers to map those ports to ports in the docker host.

Nginx (pronounced as engine-x) is open source software for web serving, caching load balancing.

Its designed for max performance and stability

Apache webserver is slow, developed in 1995, there are some issues with respect to multi tasking

Nginx was developed in 2004.

FROM nginx

RUN rm /etc/nginx/conf.d/default.conf

RUN rm /etc/nginx/conf.d/examplessl.conf

COPY content /usr/share/nginx/html

COPY conf /etc/nginx

Create the image by running

docker build -t mynginximage1 .

nginx content will be from

/usr/share/nginx/html

Dockerfile to create image with customized code:

FROM nginx

RUN rm /usr/share/nginx/html/index.html

COPY content /usr/share/nginx/html

Docker Swarm:

docker swarm is cluster of machines running docker which provides scalable and reliable platform to run many containers.

Manages all the containers.

Single faced manager where user can interact with.

Docker swarm is for

load balancing: load is balanced across the containers/machines

high availability/fail-over: Webserver will be up, even if one of the node goes down

reliability: load will be shared even if the node goes down.

How to convert 4 machines to docker swarm machines:

Pre-req:

Machines are running with Docker version 1.12

Machines are in the same subnet

With ports 2377,4789 7946 open.

Login to 1st machine and make it manager:

docker swarm init --listen-addr 192.168.0.104:2377 --advertise-addr 192.168.0.104

docker node ls → to check nodes in the swarm.

Login to 2nd, 3rd , 4th nodes and make them workers

docker swarm join --token SWMTKN-1-0fywejkjqfpvnmivezc5biirlqe1dkaxqbdiuv3642v4jsdkbs-0lamc59edwsqzdmqkh1gtnrwj 192.168.0.104:2377

docker node ls → will show 4 nodes

Running service on swarm:

Swarm manages individual containers, we work at higher level

Service is abstract created on top of the containers.

Service is independent function/task/application running inside the container.

Create a service with nginx server:

docker service create --name website --publish 80:80 sixeyed/docker-swarm-walkthrough

make it more scalable:

scale up to 10 instances:

docker service inspect website --pretty

docker service update --replicas 20 website

containers can run on manager or workers

docker service list

even without running the container, using second node we can access website.

Reliability:

If the node goes down, manager knows, node list shows node as down.

The containers will be moved to another node.

Dockerfile example:

```
#select the base image

FROM ubuntu

#author name

MAINTAINER ubuntu

#copies the contents from docker host to docker container

ADD /host /var/www/html

# execute a command

RUN apt-get update

RUN apt-get install -y python

# define environment variable

ENV var 1

# expose a port

EXPOSE 80

#mount

VOLUME ["/host1"]
```

Example2:

```
FROM ubuntu

ENTRYPOINT ["/bin/ping"]

CMD ["localhost"]
```

docker run -i -t test ➔pings local host

docker run -i -t test google ➔pings google

The ENTRYPOINT specifies a command that will always be executed when the container starts.

The CMD specifies arguments that will be fed to the ENTRYPOINT.

To mount a directory from host to container

docker run -i -t -v /host1:/mnt new:v1 "bin/bash"