

Docker Reference Material

Please feel free to reach me for any consulting/training requirements

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Few key points to keep in mind about Docker

- is a Linux Technology that supports Application Virtualization
- is a Client/Server Technology
- is developed in Go Programming Language by Docker Inc organization
- is not a replacement for Virtual Machines as Containers are Application Process while Virtual Machines are a complete Operating System.
- As Containers are assigned with Private IPs, they appear like a VM, however they don't even have their own Kernel.
- All Docker containers run on the Host machine Kernel space just like how other application processes.
- is a way to ship your pre-installed applications along with its dependencies
- can be used with legacy applications as well by modern applications that follow microservice architecture.
- comes in two flavours
 - Community Edition (CE) - Open Source
 - Enterprise Edition (EE) - Commercial Use
- Depends on Linux Kernel Feature
 - Namespace - For isolation, Network namespace, Port namespace etc.
 - CGroups (Control Groups) - For quota restricts like CPU usage, memory and storage utilization, etc
- When Docker is installed on Mac - OSX or Windows it installs a thin-linux layer. Hence to support Linux containers, Docker containers are still created on top of Linux Layer on Windows/Mac OS.
- On Windows 10 & Later, Docker supports windows containers with the help of Hyper-V tiny virtual machines to simulate containers similar to Linux containers.

Docker Images

- a specification of docker container
- a blueprint of a docker container
- similar to ISO OS images or VMWARE images
- Open sources images can be downloaded from Docker Hub (hub.docker.com)
- Custom Docker images may be created using Dockerfile

Docker Containers

- is an instance of Docker Image
- every containers get an unique docker id assigned by Docker Engine (Server)
- every container get's its own Private IP by default
- are light-weight as they don't get their own dedicated CPU cores, RAM and Storage unlike Virtual Machines.
- every container can be assigned an user-defined container name and hostname optionally
- In case, no container name is allotted by the user, Docker Engine assigns a random name.
- In case, no hostname is allotted by the user, Docker Engine assigns container id as the hostname
- containers typically has one single application along with its dependencies
- In case, more than one application is installed inside a container, Docker uses supervisord to monitor the additional processes created to run each of those applications. Hence generally container images must restrict one application per container.
- has its own Port range 0 to 65535
- the ports used internally by the Docker containers won't conflict with host machine ports or other containers unless the Container uses Host Network.

Some most commonly used Docker commands

Listing images

`docker images`

Inspect Docker Image to find more details about the image

`docker image inspect ubuntu:16.04`

Listing only currently running containers

`docker ps`

Listing all containers irrespective of their running status

`docker ps -a`

To download a docker image from Docker Hub(hub.docker.com)

`docker pull hello-world:latest`

To create a docker container in foreground mode(interactive)

```
docker run hello-world
```

```
docker run -it --name ubuntu1 --hostname ubuntu1 ubuntu:16.04 /bin/bash
```

In the above command

- it stands for interactive terminal

- ubuntu1 - is the docker container name

- ubuntu1 - is the hostname of the container

- ubuntu:16.04 - is the image name with version 16.04

- /bin/bash - blocking application that will be launched inside container

Stopping a running container

```
docker stop ubuntu1
```

Starting a exited container

```
docker start ubuntu1
```

Opening a second shell inside a running container

```
docker exec -it ubuntu1 /bin/bash
```

Finding IP address of a running container

```
docker inspect ubuntu1 | grep IPA
```

```
docker inspect -f "{{ .NetworkSettings.IPAddress }}" ubuntu1
```

Finding IP address of a container from within container shell

```
hostname -i
```

Finding Hostname of a container from within container shell

```
hostname
```

In order to provide internet access to your containers, make sure the below configuration is done on CentOS Lab machine

```
vim /etc/sysctl.conf and add the below line
```

```
net.bridge.bridge-nf-call-iptables=1
```

The above line shall be added for machines that support IPV4, in case your machine also uses IPV6, you may also add the below line

```
net.bridge.bridge-nf-call-ip6tables=1
```

Make sure the below services are restarted after the above changes are made

```
systemctl daemon-reload
```

```
systemctl restart network
```

```
systemctl restart docker
```

You may start the container that originally had trouble connecting to internet as shown below

```
docker start ubuntu1
```

Get inside the ubuntu1 container using below command

```
docker exec -it ubuntu1 bash
```

Trying installing some tools to verify if Internet works

```
apt update && apt install -y vim
```

Creating MYSQL Docker container

```
docker run --name mysql-server --hostname mysql-server -e MYSQL_ROOT_PASSWORD=root -d mysql:5.6
```

Get inside the mysql-server container with the below command

```
docker exec -it mysql-server /bin/bash
```

```
mysql -u root -p
```

You need to type root as the password to login to mysql prompt. On successful login, you will see a prompt as shown below

```
mysql >
```

In the mysql prompt, you may type the below command to display all the existing databases

```
mysql > SHOW DATABASES;
```

In case you would like to create a database

```
mysql > CREATE DATABASE tektutor;
```

Before you can create a table, you need to select a database first,

```
mysql > USE tektutor;
```

You may now create a table inside tektutor database as shown below

```
mysql > CREATE TABLE Training(id integer NOT NULL UNIQUE, name varchar(25), duration varchar(10));
```

You may now insert a record as shown below

```
INSERT INTO Training VALUES ( 1, 'DevOps', '5 days' );
```

You may now see the records in the table as shown below

```
SELECT * FROM Training;
```

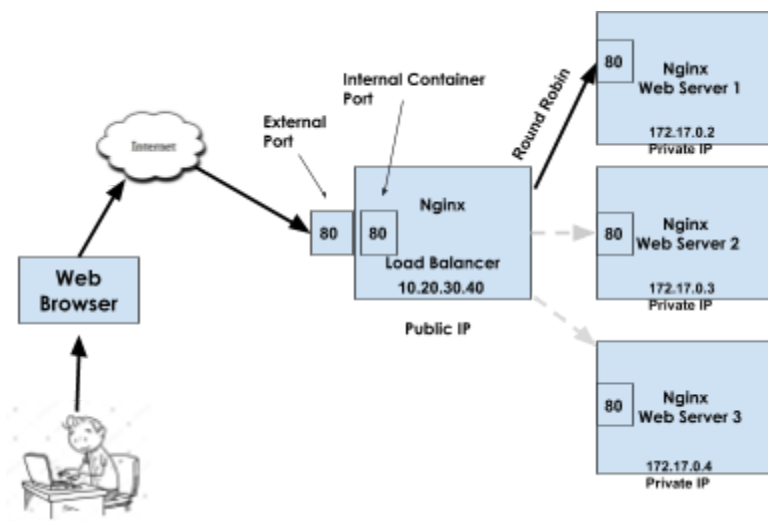
Volume Mounting

In order to persist the application data, application logs, etc it is recommended to mount an external storage volume inside the container. Otherwise, whenever the container gets deleted the data stored inside the container also gets deleted.

```
docker run --name mysql-server --hostname mysql-server -e  
MYSQL_ROOT_PASSWORD=root -d -v /home/jegan/tmp:/var/lib/mysql mysql:5.6
```

The above command is a single line command, as it is a very lengthy command it is word wrapped.

Setting up Nginx as a Load Balancer with Docker Containers



You need to create 3 nginx web server as shown below

```
docker run -d --name nginx1 --hostname nginx1 nginx:1.16
```

```
docker run -d --name nginx2 --hostname nginx2 nginx:1.16
```

```
docker run -d --name nginx3 --hostname nginx3 nginx:1.16
```

You need to create a nginx load balancer container as shown below

```
docker run -d --name lb --hostname lb -p 80:80 nginx:1.16
```

In order to configure the lb container to work as a load balancer

we need to first copy the nginx.conf from the container to the local machine

```
docker cp lb:/etc/nginx/nginx.conf .
```

You need to edit **nginx.conf** on the centos lab machine with any text editor.

vim **nginx.conf** and make sure the file looks as below

```
user nginx;

worker_processes 1;

error_log /var/log/nginx/error.log warn;

pid /var/run/nginx.pid;

events {
    worker_connections 1024;
}

http {
    upstream backend {
        server 172.17.0.2:80;
        server 172.17.0.3:80;
        server 172.17.0.4:80;
    }

    server {
        location / {
            proxy_pass http://backend;
        }
    }
}
```

In the above file,

172.17.0.2 is the ip address of nginx1 container

172.17.0.3 is the ip address of nginx2 container

172.17.0.4 is the ip address of nginx3 container

You may need to replace the ip addresses of your containers.

In order to apply the configuration changes in the load balancer container

`docker restart lb`

Make sure the lb container is actually running after the config changes

```
docker ps
```

Once you have made sure the lb container is running, then you may find the IP Address of your CentOS Lab machine as shown below.

```
ifconfig ens33
```

You may customize the web pages on nginx1, nginx2 and nginx3 respectively as shown below

```
echo "Server 1" > index.html
```

```
docker cp index.html nginx1:/usr/share/nginx/html/index.html
```

```
echo "Server 2" > index.html
```

```
docker cp index.html nginx2:/usr/share/nginx/html/index.html
```

```
echo "Server 3" > index.html
```

```
docker cp index.html nginx3:/usr/share/nginx/html/index.html
```

In my system IP Address of my CentOS machine happens to be 172.16.124.251

From the Alchemy Windows Cloud machine, open the browser with the URL as shown below

<http://172.16.124.251>

Each time you refresh the web page on the above URL, you may see the output as

Server 1

Server 2

Server 3 in a round robin fashion.

Building Custom Docker Images

IN order to build a custom ubuntu docker image, you may get my latest Dockerfile from my GitHub repository as shown below

On the terminal, login as root user

```
sudo su -
```

To build custom ansible ubuntu image

```
git clone https://github.com/tektutor/ubuntu-ansible.git
```

```
cd ubuntu-ansible
```

You may now create public/private key pair as shown below
`ssh-keygen`

Accept all default values by hitting enter while generating public/private key pairs.

Assuming, you generated the keys as the root user. You may copy the public key (id_rsa.pub) from /root/.ssh/id_rsa.pub as shown below
`cp /root/.ssh/id_rsa.pub authorized_keys`

You may now build your custom ubuntu images as shown below
`docker build -t tektutor/ansible-ubuntu .`

If you would like to create docker

To build custom ansible centos image

git clone <https://github.com/tektutor/centos-sshd-passwordless.git>

```
cd centos-sshd-passwordless
cp /root/.ssh/id_rsa.pub authorized_keys
```

You may now build your custom centos image as shown below
`docker build -t tektutor/ansible-centos .`

You may now list the newly build images as shown below
`docker images | grep tektutor`

In order to test if the ansible node images are working as expected, let us create couple of containers from these newly build images as demonstrated below
`docker run -d --name ubuntu1 --hostname ubuntu1 -p 2001:22 -p 8001:80 tektutor/ansible-ubuntu`
`docker run -d --name centos1 --hostname centos1 -p 2002:22 -p 8002:80 tektutor/ansible-centos`

You may check if the containers are in running state as shown below
`docker ps`

Let's try to login of these containers as demonstrated below
`ssh -p 2001 root@localhost`

You may need to accept yes when it prompts to confirm adding the container fingerprints to known_hosts file.

However, it is important to observe that the login happens without prompting for a password as we have set up the custom docker images to perform key based login authentication.

Docker Networking

Docker supports

- bridge network (default)
- host network (container will not get it own ip address)
- none (containers that don't need network access shall be connected to this network type)

In case you wish to create your own custom bridge network in Dockers, you may try the below command

```
docker network create my-net-work-1
```

You may inspect the my-net-work-1 interface to identify the subnet (ip cidr block)
`docker network inspect my-net-work-1`

You may create another custom bridge network with name 'my-net-work-2' as shown below

```
docker network create my-net-work-2 --subnet 172.20.0.0/16
```

Let's create a container c1 and connect c1 to network my-network-1, and create a container c2 and connect c2 to network my-network-2

```
docker run -dit --name c1 --hostname c1 --network=my-net-1 ubuntu:16.04 /bin/bash  
docker run -dit --name c2 --hostname c2 --network=my-net-2 ubuntu:16.04 /bin/bash
```

You may login to container c1 and try to ping the c2 container

```
docker exec -it c1 bash  
ping 172.20.0.2
```

You may now observe that container c1 couldn't reach container c2 as they belong to different networks. On the similar note, container c2 couldn't reach container c1 for the same reason.

In case you wish c1 to communicate with c2 and vice versa, you may connect c1 to my-net-2 network in addition to already connected my-net-1.

```
docker network connect my-net-2 c1
```

After the above step, c1 should be able to ping c2 and c2 in turn should be able to ping c1.

