**DOCKER**

**Introduction:**

Before going to the concept of Docker, let’s discuss about containerization.

**What is Containerization?**

Containerization also called Container. Containerization is a lightweight virtualization technology alternative to hypervisor virtualization. Any application can be bundled in a container can run without any worries about dependencies, libraries and binaries. Because container creates the isolated environment with all the required dependencies, libraries and binaries to run your application without any issue. Hence we can build the packages, ship the application to any environment and run it.r



So Containers are designed to run on physical servers, virtual machines and any cloud instances.

**Why do we need containerization (Container)?**

Containers are a solution to the problem of how to run the applications efficiently when moved from one environment to another environment. This is what the biggest problem we had before containerization.  
  
Let’s say, a developer has developed the Application code in his own machine, and it was working fine in his machine. But when he moved the same code to development server, application will not work properly. Because, His own machine and development environment server configuration and versions are not similar. He developed the application code in python 2 and Development server has python 3. So again he need to work on the application code to make it work based on development server version i.e. Python 3. Now he fixed the issue and its working now on development server.  
  
This time, He is moving the application code to testing or production environment. But still not working because of some libraries are missing to run the application.



**Difference of containerization and Virtualization:**

Virtualization technology that allow us to have multiple operating systems to share a single hardware processor.  
  
It is mainly used to utilize the maximum hardware resources efficiently by deploying the application into “virtual machines” (VMs) with their own operating systems, so an application can run independently on top of a server’s operating system which is a dedicated virtual machine for an application. Operation system / Guest OS lies on top of the hypervisor software’s. That might be VMware esx, Microsoft Hyper V, Kvm, Xen and so on.  
  
But Container runs on a single operating system i.e. host os, and each container shares the Host operating system kernel with the other containers. Here you would have only one operating system, on top of it you will have applications within container, so it doesn’t require an additional operating system for each application as we have in virtualization technology.  
  
So I would say Containerization is an application-specific virtualization, because it provides application with dedicated environments in the form of container to run on, which can be deployed and run anywhere without a dedicated virtual machine with Operating system for each application.  
  
Also Container was designed to solve modern problems and application management issues. So it’s not a replacement for virtualization, but it’s complementary to it.



**Advantages of Container**  
  
Containers are **isolated**, doesn’t require operating system and it shares a host kernel. So containers run on the same server and use the same resources, they do not interact with each other because it’s isolated. If one application crashes, other containers with the same application will keep running without any issues.  
  
It’s a **Portable** and **light weight** operating system and it contains only the required binaries, dependencies and libraries to run the application. So it can be move anywhere easily and can run without worrying about compatibility, dependencies kind of issues.  
  
**Faster** and **Resource Efficiency**, It’s very fast to boot, because containers are lightweight and start in less than a second since they do not require an operating system boot.  
  
Resource efficiency since containers do not require a separate operating system, they use less resources.  
  
Improves **Scalability** and **lowers costs** - By allowing more containers in the environment without the need for more servers, containerization increases scalability anywhere from 10 to 100 times that of traditional VM environments.

**What is Docker?**

Docker is an open source platform tool designed to manage the containers, which allow us to build the application in a container with required libraries, binaries, dependencies to run the application, ship the container and run anywhere.

**Why do we use Docker?**  
1. *Portability*: An applications can be bundled in to a single unit and same unit can be deployed to various environments such as dev server, testing server and production server without making any changes to the container.  
2. *Light Weight*: Docker containers are pretty lightweight so it provides a smaller footprint of the operating system via containers.  
3. *Fast Delivery* and *Scalable*: Since Docker containers are pretty lightweight, so they can be deployed faster and they are very easily scalable.

4. Docker used for *Continuous Deployment* and *Testing*. So With the help of containers, it becomes easier for teams across different units, such as development, QA and Operations to work seamlessly across applications.  
5. Docker also provides you, ability to run multiple *isolated* OS on single host.  
6. *Resource Optimization:* Docker enable you to utilize the maximum resources and reduce the resource wastages of your hardware.

**What is Docker on container?**  
Docker is a tool designed to manage the containers. Using Docker you can create, deploy, and run the applications containers.

**Docker Architecture and Docker Components**

The below image shows you the Docker Architecture with Docker Components where you have docker client, docker host, docker hub, docker images, docker containers.  
  
So Docker Architecture depends on three main components: which are  
  
1. Docker Client  
2. Docker Host (Docker Engine)  
3. Docker Registry  
  
Also we have other components  
4. Docker Images  
5. Docker Containers  
6. Docker Network  
7. Docker Storages



**Docker Client**  
Docker client is used to manage the docker components such as containers, images, networks, storage volumes by giving the specific instructions to perform some operations like build, pull, create, run, delete, stop, restart,.  
  
So Docker client interacts with the docker host where docker daemon (dockerd) is installed, i.e. Docker Host.  
  
It’s not necessary that Docker Client must be available at the Docker host, it can also be used from the remote machine to manage your docker host. The Docker client and Docker daemon can be communicated each other using a REST API, over UNIX sockets or a network interfaces.

**Docker Host (Docker Engine)**  
Docker host is the server where the Docker Daemon is running and it manages the docker containers and other resources. It listens and accepts the requests from Docker Client.  
  
**Docker Registry - Docker Hub**Docker registry or Docker Hub is a repository to manage the Docker images. So this will allow us to push or pull the Docker images which means you can download or upload the images..  
  
There are two types of docker registry available,   
1. Docker hub - It is available in internet, Maintaining by Docker Company in cloud. We can download (pull) the publicly available images or also we can upload (push) the images to Docker Hub online. We have two services available with docker hub i.e. public and private. If you want your images to available to everyone, set it to public. If you want your images only to you, set it to private.

2. Local Docker Hub - Its available locally within the organization. By default if we pull the images, it checks the local docker hub regsitry. If not finds the requested images locally, then it goes to download from online docker hub.  
  
**Docker Images**  
Docker Images are a just templates, it is very similar to snapshot image.  
Docker images can be used to create the containers. It is a read only layer.  
Docker Images can be created from the container once you have done the changes on the container or you can create the Docker Images using a Docker file with specific instructions. So these Docker Images are very lightweight, small, and fast to deploy the containers.  
  
**Docker Containers**Docker Containers are actually a executable run-time light weight operating system.  
Docker Container is a read/write layer of a Docker Images.  
Docker containers can be created using a docker images also we can create a docker images from a docker container once the required modification is done.

**Docker Network**  
Docker network enables the network to communicate with other containers. By default, we have three networks created when you have installed docker.  
  
1*. Bridge*: This is the default network driver attached to the container during the container creation if you didnt specify other network. So any containers on the same network can be communicated with other containers.  
2. *Host*: It allows a container to directly attached to the docker host network. It can be used to have a standalone container, so this will not have isolate the network between docker host and docker containers.  
3. *None*: This can be used to disable the networking for the containers. So containers will not have ip address when you have used this network.  
  
Also we have other network drivers can be used for other features.  
  
4. *Overlay:* also ingress network, it can be used to connect different containers hosted on different docker host or many. Mostly this network automatically used in the docker swarm clustering environment.  
5. *Macvlan*: This network driver used to assign a MAC address to the container, so the container attached with a Macvlan network driver will looks like physical network attched to it. Because there are some application would work only on physical network not on virtual network. On that cases, we can use this network driver.

**Docker Storages**  
Any data written to the docker container will not be available when docker container is removed. So we must use a docker storage to have the data permanently if need.

There are three types of storage available with docker.

1. **Volumes** are stored in a part of the host filesystem which is managed by Docker (/var/lib/docker/volumes/ on Linux). Non-Docker processes should not modify this part of the filesystem. Volumes are the best way to persist data in Docker.
2. **Bind mounts** may be stored anywhere on the host system. They may even be important system files or directories. Non-Docker processes on the Docker host or a Docker container can modify them at any time.
3. **tmpfs mounts**are stored in the host system’s memory only, and are never written to the host system’s filesystem.

**How to install Docker on Cent OS:**

1. Docker binaries are incorporated into RHEL/CentOS 7 extras repositories, the installation process being pretty simple. Install Docker package by issuing the following command with root privileges:

Install Docker on CentOS 7:

**#** **yum install docker**



Install Docker on CentOS 6:

To install Docker, the [Epel repositories](https://www.tecmint.com/how-to-enable-epel-repository-for-rhel-centos-6-5/) must be enabled on your system by issuing the following command:

# yum install epel-release

# yum install docker-io



2. After, Docker package has been installed, start the daemon, check its status and enable it system wide using the below commands:

On CentOS 7:

# **systemctl start docker**

# **systemctl status docker**

# **systemctl enable docker**



On CentOS 6:

# service docker start

# service docker status

# chkconfig docker on



3.  Finally, run a container test image to verify if Docker works properly, by issuing the following command:

# **docker run hello-world**

If you can see the below message, then everything is in the right place.

**Hello from Docker!**

**This message shows that your installation appears to be working correctly.**

4. Now, you can run a few basic Docker commands to get some info about Docker:

For system-wide information on docker:

# **docker info**



For Docker version:

Use below docker command with "-v" option to know the docker package version with build release information.

[root@localhost /]# **docker -v**

Docker version 1.13.1, build dded712/1.13.1

Also use "version" argument along with docker command to know the relevant information about the docker package.

[root@localhost /]# **docker -version**



5. To get list of all available docker commands on the console:

# **docker**



**What is a snapshot image?**

A snapshot image is a logical, read-only copy of volume content, captured at a particular point in time. You can use snapshots to protect against data loss.

Snapshot images also are useful for test environments. By creating a virtual copy of data, you can test data using the snapshot without altering the actual volume itself. In addition, hosts do not have write access to snapshot images, so your snapshots are always a secure backup resource.

(The Volumes page is where you create the storage containers for your applications, databases, and file systems. A volume is the logical component created for the host to access storage on the array.)

**What is a docker image?**

Docker images are just a templates of a Docker Containers and it is very similar to snapshot image with smaller in size. Singe Docker Image can be used to create multiple containers for different environment like development, UAT and Production.

Docker Images are very lightweight, small, and fast to deploy the containers.



Docker Images are consists of many layers with unique Image ID (e.g. : e34fs4553) from Base Images. Each Layers may have some changes committed on top of a existing layers.  
  
Docker Images are read only layer of Docker Containers and Docker Containers are read write layer of Docker Images.

**Images:**

The file system and configuration of our application which are used to create containers.

**Containers:**

Running instances of Docker images - containers run the actual applications.

A container includes an application and all of its dependencies.

It shares the kernel with other containers, and runs as an isolated process in user space on the host OS.

**Docker daemon:**

The background service running on the host that manages building, running and distributing Docker containers.

**Docker client:**

The command line tool that allows the user to interact with the Docker daemon.

**Docker Store:**

Store is, among other things, a registry of Docker images. You can think of the registry as a directory of all available Docker images.

For example,

Image is like a file. Image usually contains software like os, MySQL, notepad , jdk etc and data like .Java, .class, .txt etc . By using image we create container which is a place/box where we can perform action (run Java code, maintain database, ui code) by making use softwares, data present in the image.

**How to Create or Customize a Docker Images?**  
Docker Images can be created from the Container itself, when some changes are done on the container or you can create the [Docker Images using a Dockerfile with specific instructions](http://www.learnitguide.net/2018/06/write-dockerfile-to-build-own-images.html). But remember, we must need an existing docker images for both the cases, either to create a container or to customize a new docker images. Let’s see how to get these docker existing base images.

**How to get Docker Images?**  
Docker Images are available in Docker Registry hub (<https://hub.docker.com/>) over the internet, it is a repository to manage the docker images. So Docker Images can be pulled (download) and pushed (Upload) to the repository at any time.  
  
But Account registration is required for uploading your Docker images not for downloading. Account Registration is free and pretty straight forward.

**How to pull / download docker images?**  
Docker is the tool used to manage the entire docker environment.

Let’s take an example that, I want "Hello-world"

We must know the exact repository name to pull corresponding docker images. So use "docker search" command to find the correct repository name to download the particular docker images.

For Hello-World:

[root@docker-host ~]# docker search hello-world

Above commands will give the list of available docker images from docker hub registry with name, description, number of stars awarded, whether the image is official, and whether it is automated as shown in the below image.



Get repository path from the name column to download the particular docker images. Similarly you can try for other docker images too.  
  
For example,  
Hello-World has "docker.io/hello-world"  
centos has "docker.io/centos"

Use "docker pull" command to download the particular docker images. By default, it will check the local docker hub regsitry. If it didnt find the requested images locally, then it goes to download from online docker hub as below. This will download each layer of docker images.

For Hello-World Docker Image:

[root@docker-host ~]# docker pull docker.io/hello-world  
Using default tag: latest  
Trying to pull repository docker.io/library/hello-world ...  
latest: Pulling from docker.io/library/hello-world  
Digest: sha256:f5233545e43561214ca4891fd1157e1c3c563316ed8e237750d59bde73361e77  
Status: Image is up to date for docker.io/hello-world:latest  
[root@docker-host ~]#

**How to list available docker images?**  
Use "docker images" command to know the list of docker images available in your local docker host.

[root@docker-host ~]# docker images  
REPOSITORY              TAG                 IMAGE ID            CREATED             SIZE  
docker.io/centos        latest              49f7960eb7e4        2 weeks ago         200 MB  
docker.io/hello-world    latest              e38bc07ac18e        2 months ago        1.85 kB  
[root@docker-host ~]#

Above "docker images" command displays the list of docker images with following information.  
  
Repository - Name of the Repository  
Tag - Version of the Docker Images  
Image ID - Unique Docker Images ID to manage the Docker Images  
Created - When Docker Images is created  
Size - Size of the Docker Images

[root@localhost /]# **docker images**

REPOSITORY TAG IMAGE ID CREATED SIZE

docker.io/hello-world latest 2cb0d9787c4d 7 weeks ago

**How to know detailed information about a Docker Images?**  
Use "docker inspect" command to know detailed information about a Docker Images available locally using Docker Image ID.  
This will give lot of information about Docker Images as below.

[root@localhost /]# **docker inspect 2cb0d9787c4d**

[

{

"Id": "sha256:2cb0d9787c4dd17ef9eb03e512923bc4db10add190d3f84af63b744e353a9b34",

"RepoTags": [

"docker.io/hello-world:latest"

],

"RepoDigests": [

"docker.io/hello-world@sha256:4b8ff392a12ed9ea17784bd3c9a8b1fa3299cac44aca35a85c90c5e3c7afacdc"

],

"Parent": "",

"Comment": "",

"Created": "2018-07-11T00:32:08.432822465Z",

"Container": "6b6326f6afc81f7850b74670aad2bf550c7f2f07cd63282160e5eb564876087f",

"ContainerConfig": {

"Hostname": "6b6326f6afc8",

"Domainname": "",

"User": "",

"AttachStdin": false,

"AttachStdout": false,

"AttachStderr": false,

"Tty": false,

"OpenStdin": false,

"StdinOnce": false,

"Env": [

"PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin"

],

"Cmd": [

"/bin/sh",

"-c",

"#(nop) ",

"CMD [\"/hello\"]"

],

"ArgsEscaped": true,

"Image": "sha256:6bc48d210ad4c6bbb74e02e6196a9133b57107033c09e92cac12616cad30ebcf",

"Volumes": null,

"WorkingDir": "",

"Entrypoint": null,

"OnBuild": null,

"Labels": {}

},

"DockerVersion": "17.06.2-ce",

"Author": "",

"Config": {

"Hostname": "",

"Domainname": "",

"User": "",

"AttachStdin": false,

"AttachStdout": false,

"AttachStderr": false,

"Tty": false,

"OpenStdin": false,

"StdinOnce": false,

"Env": [

"PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin"

],

"Cmd": [

"/hello"

],

"ArgsEscaped": true,

"Image": "sha256:6bc48d210ad4c6bbb74e02e6196a9133b57107033c09e92cac12616cad30ebcf",

"Volumes": null,

"WorkingDir": "",

"Entrypoint": null,

"OnBuild": null,

"Labels": null

},

"Architecture": "amd64",

"Os": "linux",

"Size": 1848,

"VirtualSize": 1848,

"GraphDriver": {

"Name": "devicemapper",

"Data": {

"DeviceId": "2",

"DeviceName": "docker-8:3-269536477-3d406d917b8bbaee1799f1af0481f735306151438a12dc2dd127ceed8545746f",

"DeviceSize": "10737418240"

}

},

"RootFS": {

"Type": "layers",

"Layers": [

"sha256:ee83fc5847cb872324b8a1f5dbfd754255367f4280122b4e2d5aee17818e31f5"

]

}

}

]

**How to get history of a Docker Images?**  
Use "docker history" command along with Docker Image ID to get a history of a Docker Images.

[root@localhost /]# **docker history 2cb0d9787c4d**

**IMAGE CREATED CREATED BY SIZE COMMENT**

2cb0d9787c4d 7 weeks ago /bin/sh -c #(nop) CMD ["/hello"] 0 B

<missing> 7 weeks ago /bin/sh -c #(nop) COPY file:3c3ca82dfdb40d... 1.85 kB

where **2cb0d9787c4d** is the docker id of “hello-world” docker image.

**How to Save or Backup a Docker Image?**  
Use "docker save" command along with Docker Image ID to save or backup Docker Images in archive format. It can be used to restore the Docker Images in any Docker Host, when it is required.

[root@localhost /]# **docker save 2cb0d9787c4d > backup\_hello-world.tar**

List the folder to confirm the docker Image ID is saved or not.

[root@localhost /]# **ll**

total 72

-rw-r--r--. 1 root root 11776 Aug 29 06:08 backup\_hello-world.tar

lrwxrwxrwx. 1 root root 7 Dec 12 2017 bin -> usr/bin

dr-xr-xr-x. 4 root root 4096 Mar 5 02:54 boot

drwxr-xr-x. 2 manasa manasa 6 Mar 26 05:57 data

drwxr-xr-x. 19 root root 3280 Aug 29 06:08 dev

Or can check in this way,

[root@localhost /]# **ll backup\_hello-world.tar**

-rw-r--r--. 1 root root 11776 Aug 29 06:08 backup\_hello-world.tar

**How to remove or delete Docker Images?**  
Use "docker images" to find the Docker Image ID or Image Name and use "docker rmi" command to remove or delete docker images.

Removed the docker image “hello-world”





To remove multiple docker images, mention the docker images ID separated by spaces as below.

[root@localhost /]# docker rmi 49f7960eb7e4 47fjay738290 987tr78rt5g5

Once removed image can be restored if backup is taken,



To remove all docker images in a single command,

[root@localhost /]# docker rmi $(docker images -a -q)

**Pulled an iib image from docker hub:**

<https://hub.docker.com/r/ibmcom/iib/>

# docker pull ibmcom/iib



