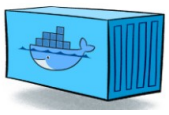
Containerization using Dockers (CA21B403)



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Syllabus

COURSE CODE	CONTAINERIZATION USING DOCKERS	Total Lecture : 60 Theory : 45 Practical : 15
CA21B403	(LTP =3 – 0 – 2 = 4)	

Course Objectives:

- To learn the introduction to dockers.
- To identify the different docker images and repositories.
- To recognize the importance of containerized applications.
- To gain the knowledge on docker networking and APIs.
- To exploreabout docker orchestration and service discovery.

UNIT	CONTENTS	HOURS
I	**Getting Started with Docker:** Introduction to Dockers, Containers vs Virtual Machines, Docker Architecture, Docker Components, Installing Docker, Working with Docker Containers, Introduction to Swarm mode and Micro services.	9
II	**Docker Images and Repositories:** Docker Image Layers, Listing Docker Images, Pulling Images, Searching Images, Building Docker Images – Using Commands, Using Docker File, working with Docker file, pushing image to the Docker Hub, Deleting an Image, Running Docker Registry.	9
III	**Containerized Applications:** Docker to build and test a web application, Docker for Continuous Integration, Managing Multiconfiguration job, building services with Docker – Application, Application Server and Multicontainer application stack, managing containers without SSH.	9
IV	**Docker Networking and Docker APIs:** Introduction to Docker Networking, None Network, Bridge Network, Host Network, Overlay Network, Container Networks with Docker Compose. The Docker APIs, Engine API, managing images and containers with API, Authenticating the Docker Engine API.	9
V	**Docker Orchestration and Service Discovery:** Docker Compose, Consul, Service Discovery and Docker, Docker Swarm, Orchestration alternatives and components – Fleet andetcd, Kubernetes, Apache Mesos, Helios, Centurion.	9

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO1	**Discuss**[2] the introduction to dockers
CO2	**Know**[2] about different docker images and repositories
CO3	**Describe**[2] the importance of containerized applications
CO4	**Intrepret**[3] on docker networking and APIs
CO5	**Demonstrate**[4] the process of docker orchestration and service discovery
Text Books	• The Docker Book: Containerization is the new virtualization, James Turnbull; 2nd edition • The Docker Handbook, Farhan Hasin Chowdhury, 2021 edition.
Reference Books	• Using Docker, by Adrian Mouat, Released December 2015, O'Reilly Media, Inc., ISBN: 9781491915769

Reference: https://docs.docker.com/

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How to work with Docker?

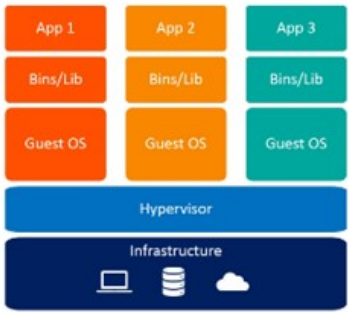
1. Docker Desktop
2. Play with Docker (https://labs.play-with-docker.com/)
3. AWS ECS
4. Azure Container Apps

Topics to be covered (Unit-1)

- ✓ Introduction to Dockers
- ✓ Containers vs Virtual Machines
- ✓ Docker Architecture
- ✓ Installing Docker
- ✓ Working with Docker Containers
- ✓ Introduction to Swarm mode and Micro services

Virtualization

Virtualization uses software to mimic the functions of physical hardware. This allows IT organizations to run more than one virtual system, multiple operating systems, and applications on a single serve.

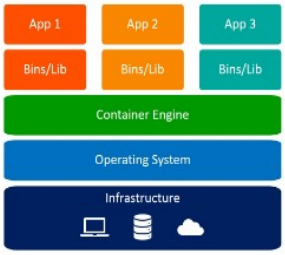


Virtual Machines

Why Containerization?

- Dependencies
- Libraries and versions
- Framework
- OS Level features
- Microservices

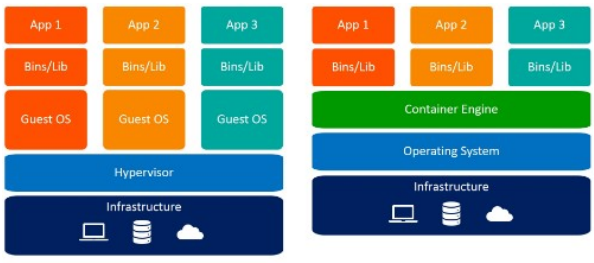
Containerization



Containers

- Containerization is a standardized way to package the application with its dependencies and deploy it on any environment.
- Docker is a tool used to create, deploy, and run applications using containers.
- It makes it easy to deploy and run applications in a repeatable and secure.
- Docker allows applications to run on separate machines with the same operating system kernel.
- Docker allows developers to create applications that can be quickly and easily shipped to different machines with different configuration.

Containers Vs Virtual Machines



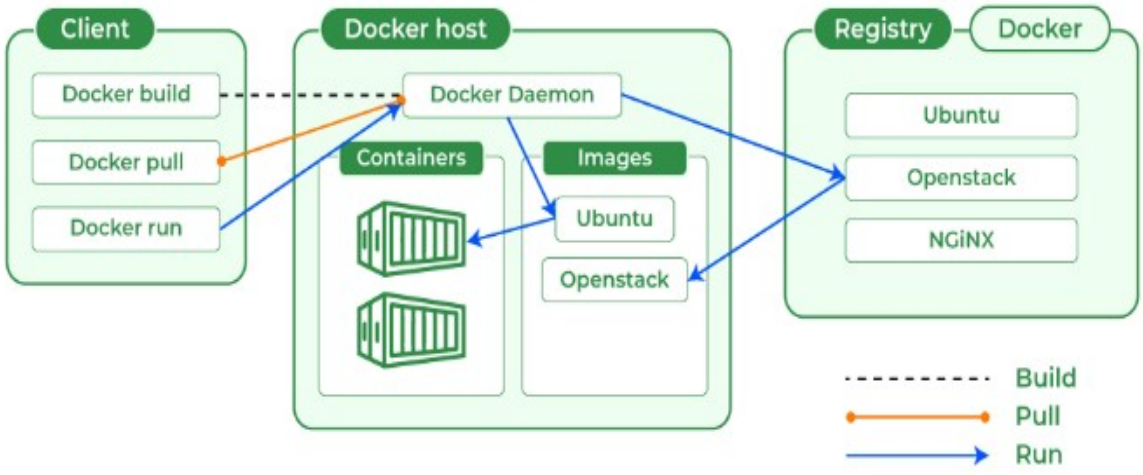
Virtual Machines Containers

Virtual machine	Docker container
1)occupies lot of memory space	1)occupies less memory space
2)Bootup time is long	2)Bootup time is less
3)Multiple running Virtual Machine leads to unstable	3)Multiple diff host OS containers run efficiently
4)Difficult to scale up	4)Easy to scale up
5)Low efficiency	5)High efficiency

Advantages of docker

- Low system requirements
- Quick application portability
- Local development environment
- Continous integration and deployment
- Code isolation
- Increased efficiency

Docker Architecture



Docker Architecture

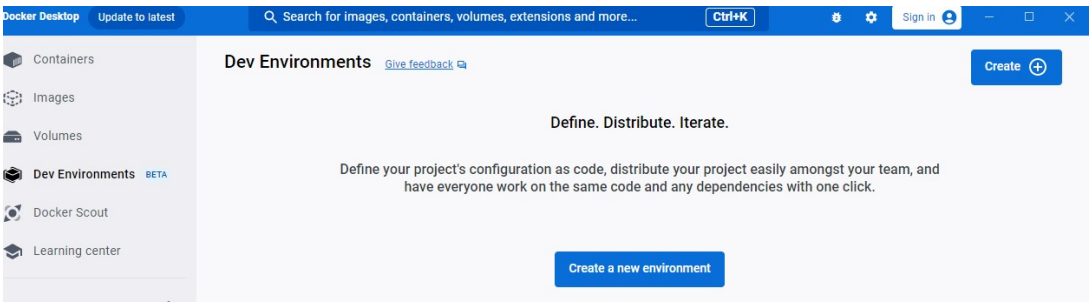
- **Docker Daemon:** It runs on host OS & responsible for running containers to manage docker service,
  - It communicating with other daemons
  - It offers various docker objects such images, containers, networking & volume.
- **Docker Client:** It is a command line interface tool that allows user to interact with Docker Daemon. It send commands to Docker Daemon & receives response
- **Docker Host:** It provides environment to execute and run the application
  - It contains docker daemon,images,containers,networks & storage
- **Docker Registry:** It manages and stores the Docker images
  - Two types of Docker Registry are
    1) Public Registry: Docker hub
    2) Private Registry: Images share within enterprise

Docker Architecture

- **Docker Network:** Docker provides build in network infrastructure that allows containers to communicate with each other & with the host machine.
- **Docker Image:** It is a read only template that contain set of instructions for creating docker container.
- **Docker Container:** It is a run time environment to images with updating all its dependencies to run applications.
- **Docker volume:** It is a persistent data storage mechanism that can be used to store data outside of a container's file system.

Installation of Docker Desktop

1. Check System Requirements
2. Download Docker Toolbox
3. Install Docker Toolbox
4. Launch Docker Toolbox
5. Test Docker Installation



Working with Docker Containers

$ docker version : To check detailed docker version

$ docker –v : To check short-info docker version

$ docker search imagename : To search image name (e.g. docker search ubuntu)

$ docker pull imagename: To pull image from dockerhub (e.g. docker pull ubuntu)

$ docker images: To list images

$ docker run –it - -name newcontainer imagename: To enter inside container (e.g. docker run –it - -name mycont ubuntu)

ctrl+p+ctrl+q : exit container without stopping

$ docker ps : To check runnung container

$ docker run –it imagename: To go inside container with its random container name

Working with Docker Containers

$ docker ps –a : To list Running and stopped container

$ docker stop containername: To stop running container

$ docker kill containername :- To stop container suddenly

$ docker rm containername: To delete stopped container

$ docker start containername: To start container

$ docker rmi imagename: To delete image name

$ docker run –i –d - -name newcontainername imagename

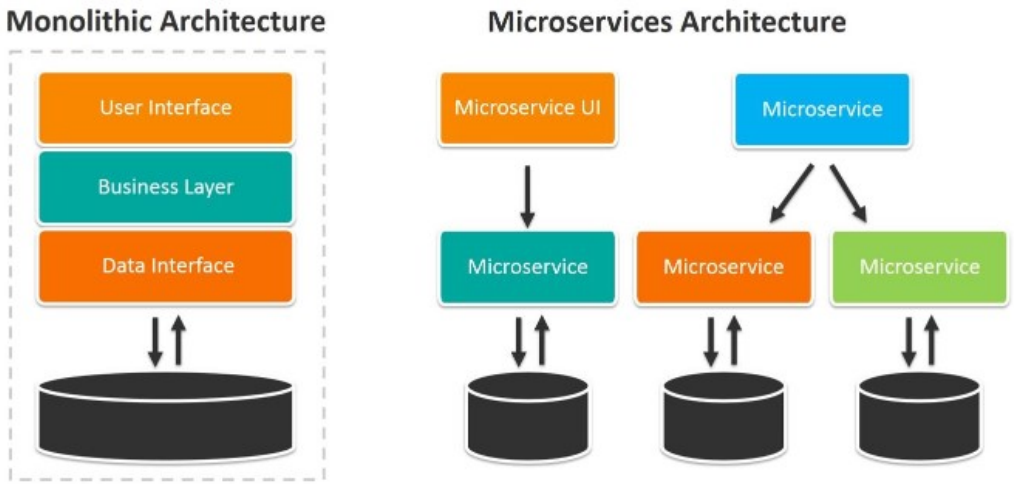
$ docker exec –it containername /bin/bash

$ docker diff containername : To see any updates or logs in the image

Output shows: C-changed, A-appended(add), D-Deleted

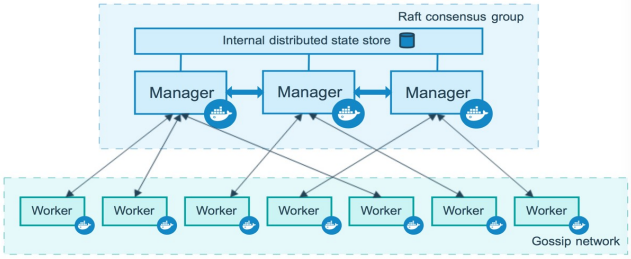
$ docker commit runcontainername newimagename: To create new image from running container

Monolithic Vs Microservices Architecture



Docker Swarm

- A Docker Swarm is a container orchestration/management tool running the Docker application.
- It has been configured to join together in a cluster. The activities of the cluster are controlled by a swarm manager, and machines that have joined the cluster are referred to as nodes.
- A swarm consists of multiple Docker hosts which run in Swarm mode and act as managers, to manage membership and delegation, and workers, which run swarm services. A given Docker host can be a manager, a worker, or perform both roles.



Docker Swarm Advantages

- **Easy to use:** Docker Swarm is relatively easy to set up and use, even for those who are new to container orchestration.
- **Scalability:** Docker Swarm can scale to manage a large number of Docker hosts.
- **High availability:** Docker Swarm can provide high availability for your applications by automatically restarting failed containers.
- **Load balancing:** Docker Swarm can automatically distribute traffic across your containers.
- **Rolling updates:** Docker Swarm can perform rolling updates of your applications, which means that you can update your applications without any downtime.
- **Security:** Docker Swarm provides a number of security features, such as encryption and role-based access control.
- **Monitoring:** Docker Swarm provides a number of monitoring features, which can help you to track the performance of your applications.

Docker Swarm Disadvantages

- **Limited functionality:** Docker Swarm is a simpler tool than Kubernetes, and as a result, it has fewer features.
- **Limited scalability:** Docker Swarm is not as scalable as Kubernetes. It can be difficult to manage large swarms, and they can be more prone to failure.
- **Limited third-party support:** There are fewer third-party tools and resources available for Docker Swarm than for Kubernetes.
- **Steeper learning curve:** Docker Swarm is a more complex tool than Docker Compose, and it can take some time to learn how to use it effectively.
- **Limited fault tolerance**: If a manager node fails, the swarm can become unavailable.
- **Smaller community:** Docker Swarm has a smaller community than Kubernetes. This means that there are fewer resources available to help you learn and use Swarm.
- **Less mature:** Docker Swarm is a newer tool than Kubernetes. It is still under development, and some features may not be as polished as they are in Kubernetes.

MCQs 1

What is primary use of Docker?

A) Virtualization

B) Containerization

C) Microservices

D) Continuous Integration

Answer: B) Containerization

MCQs 2

What is the main advantage of using Docker containers?

A) They consume less memory.

B) They are isolated from the host.

C) They are slower to start.

D) They run a complete OS.

Answer: A) They consume less memory.

References

1. Docker Docs (https://docs.docker.com/)
2. The Docker Book: Containerization is the new virtualization, James Turnbull; 2nd edition.
3. Using Docker, by Adrian Mouat, Released December 2015, O'Reilly Media, Inc., ISBN: 9781491915769.

Thank You!!!