Containerization and Docker Fundamentals

.NET

Docker provides the ability to run one or more applications, in an isolated environment called a Container, without a hypervisor, on a single computer.

HTTPS://DOCS.DOCKER.COM/ENGINE/DOCKER-OVERVIEW/

What is Containerization?

https://hackernoon.com/what-is-containerization-83ae53a709a6

Containerization involves bundling an application together with all the configuration files, libraries, and dependencies required for it to run efficiently and bug-free across different computing environments.

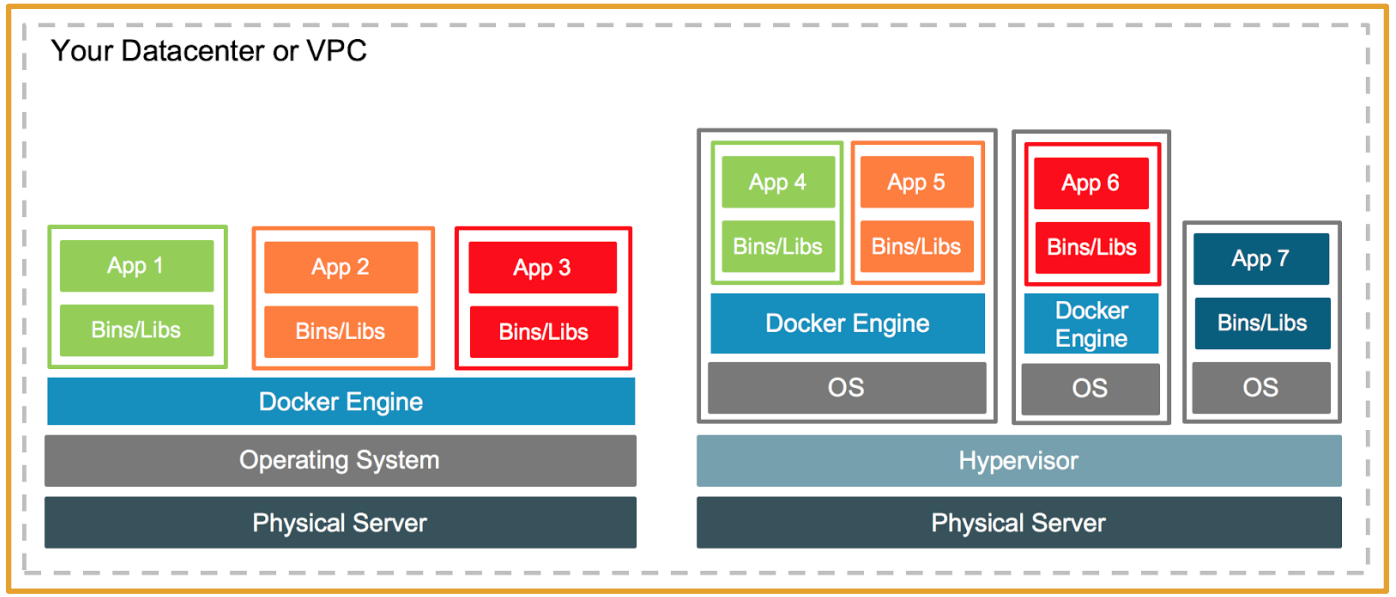
The most popular ***containerization*** ecosystems are ***Docker*** and ***Kubernetes***.

What is Virtualization?

https://en.wikipedia.org/wiki/Virtualization#Hardware_virtualization
https://www.docker.com/blog/containers-and-vms-together/

Hardware or platform ***virtualization*** refers to the creation of a Virtual Machine (an application) that simulates a real computer within an existing operating system.

Software executed on a Virtual Machine is isolated from the underlying hardware resources.



Examples of Virtualization Software.

https://en.wikipedia.org/wiki/Virtualization

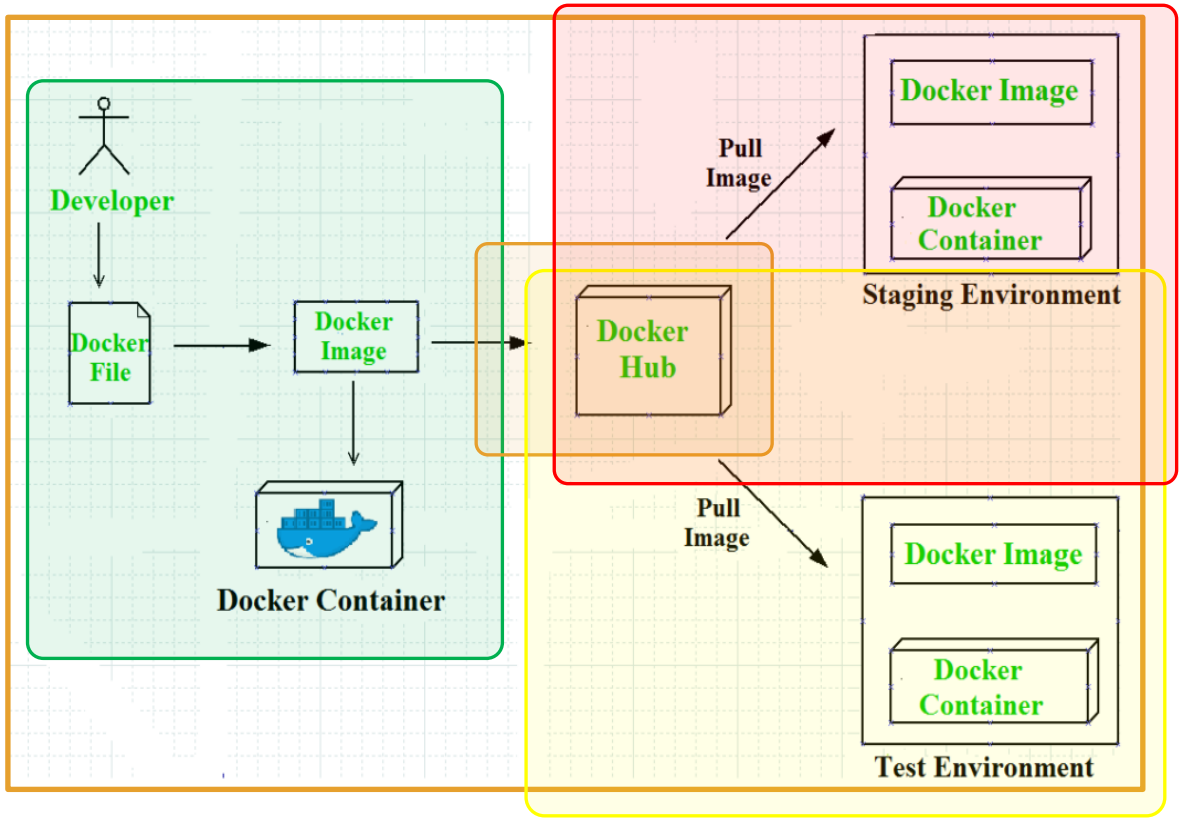
V · T · E	Virtualization software		[hide]
Comparison of platform virtualization software			
Hardware virtualization (hypervisors)	**Native**	Adeos · CP/CMS · Hyper-V · KVM (Red Hat Enterprise Virtualization) · LDoms / Oracle VM Server for SPARC · Logical Partition (LPAR) · LynxSecure · PikeOS · Proxmox VE · SIMMON · VMware ESXi (VMware vSphere · vCloud) · VMware Infrastructure · Xen (Oracle VM Server for x86 · XenServer) · XtratuM · z/VM	
	Hosted	**Specialized**	Basilisk II · bhyve · Bochs · Cooperative Linux · DOSBox · DOSEMU · PCem · PikeOS · SheepShaver · SIMH · Windows on Windows (Virtual DOS machine) · Win4Lin
		Independent	Microsoft Virtual Server · Parallels Workstation · Parallels Desktop for Mac · Parallels Server for Mac · PearPC · QEMU · VirtualBox · Virtual Iron · VMware Fusion · VMware Server · VMware Workstation (Player) · Windows Virtual PC
	Tools		Ganeti · oVirt · System Center Virtual Machine Manager · Virtual Machine Manager
OS-level virtualization	**OS containers**		FreeBSD jail · iCore Virtual Accounts · Linux-VServer · LXC · OpenVZ · Solaris Containers · Virtuozzo · Workload Partitions
	Application containers		Docker · lmctfy · rkt
	Virtual kernel architectures		User-mode Linux · vkernel
	Related kernel features		BrandZ · cgroups · chroot · namespaces · seccomp
	Orchestration		Amazon ECS · Kubernetes · OpenShift
Desktop virtualization	Citrix XenApp · Citrix XenDesktop · Remote Desktop Services · VMware Horizon View · Ulteo Open Virtual Desktop		
Application virtualization	Ceedo · Citrix XenApp · Dalvik · InstallFree · Microsoft App-V · Remote Desktop Services · Symantec Workspace Virtualization · Turbo · VMware ThinApp · ZeroVM		
Network virtualization	Distributed Overlay Virtual Ethernet (DOVE) · Ethernet VPN (EVPN) · NVGRE · Open vSwitch · Virtual security switch · Virtual Extensible LAN (VXLAN)		
See also: List of emulators			

Docker – Purpose

https://docs.docker.com/engine/docker-overview/#what-can-i-use-docker-for

Docker allows developers to continue working in standardized environments while using *Containers*. *Containers* provide everything needed to run applications and services. *Containers* are perfect for *CI/CD* workflows.

1. Developers write code locally in a ***development environment*** and share their work using ***Docker containers***.
2. They can use Docker to push their applications into a test environment to execute automated and manual tests.
3. Bugs can be fixed in the ***development environment*** and redeployed to the ***test environment*** for re-testing and validation.
4. When testing is complete, developers push the updated image to the ***production environment***.



Docker – Benefits

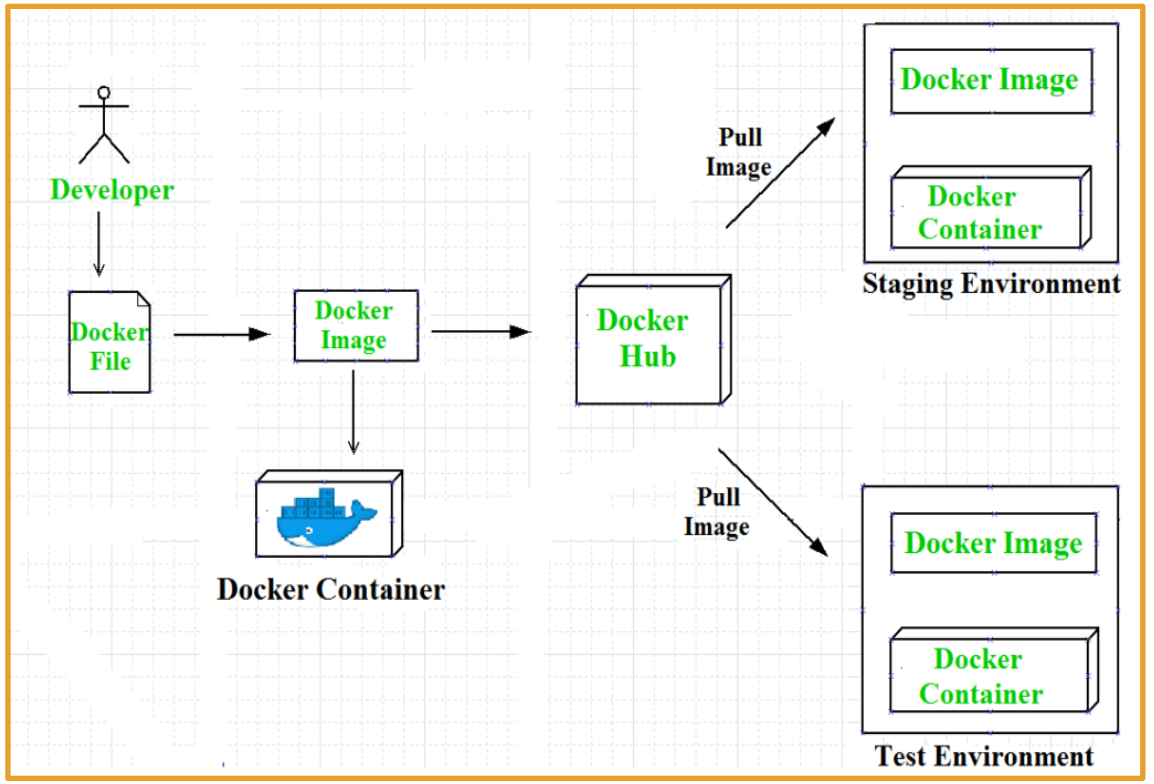
https://docs.docker.com/engine/docker-overview/#what-can-i-use-docker-for

Responsive deployment and scaling:

- *Docker Images* are portable. They can run on a local laptop, on physical and virtual machines, in a data center, or on cloud providers.
- You can scale up or tear down applications (and services) as needed.

Run more workloads on the same hardware:

- Docker is lightweight and fast.
- Docker is NOT a Virtual Machine.
  - a *virtual machine* (VM) runs a full-blown "guest" operating system with *virtual* access to host resources through a hypervisor. VMs incur a lot of overhead.

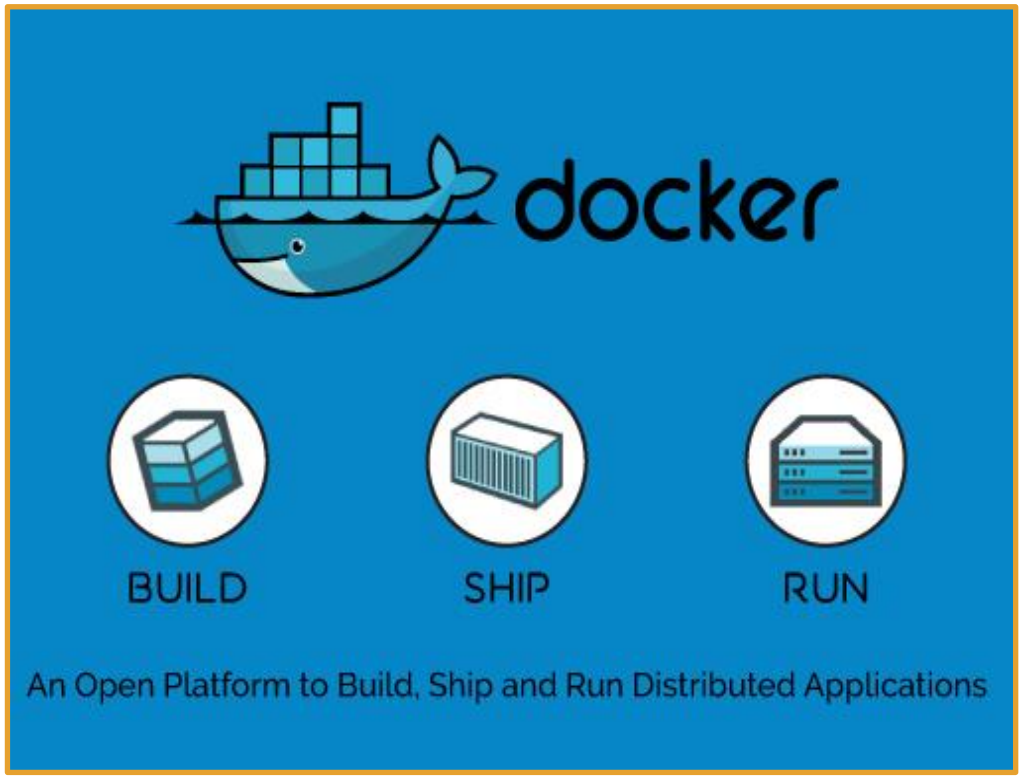


The Docker Platform

https://www.docker.com/resources/what-container

Docker provides a platform to manage the entire lifecycle of your ***containers***:

1. You develop an application and its supporting components using a ***Container***.
2. The ***Container*** becomes the unit for distributing and testing your application.
3. Deploy your application into your production environment as a ***Container***.
4. This process is identical for all production environments:
   - in a local data center,
   - a cloud provider,
   - or a hybrid.



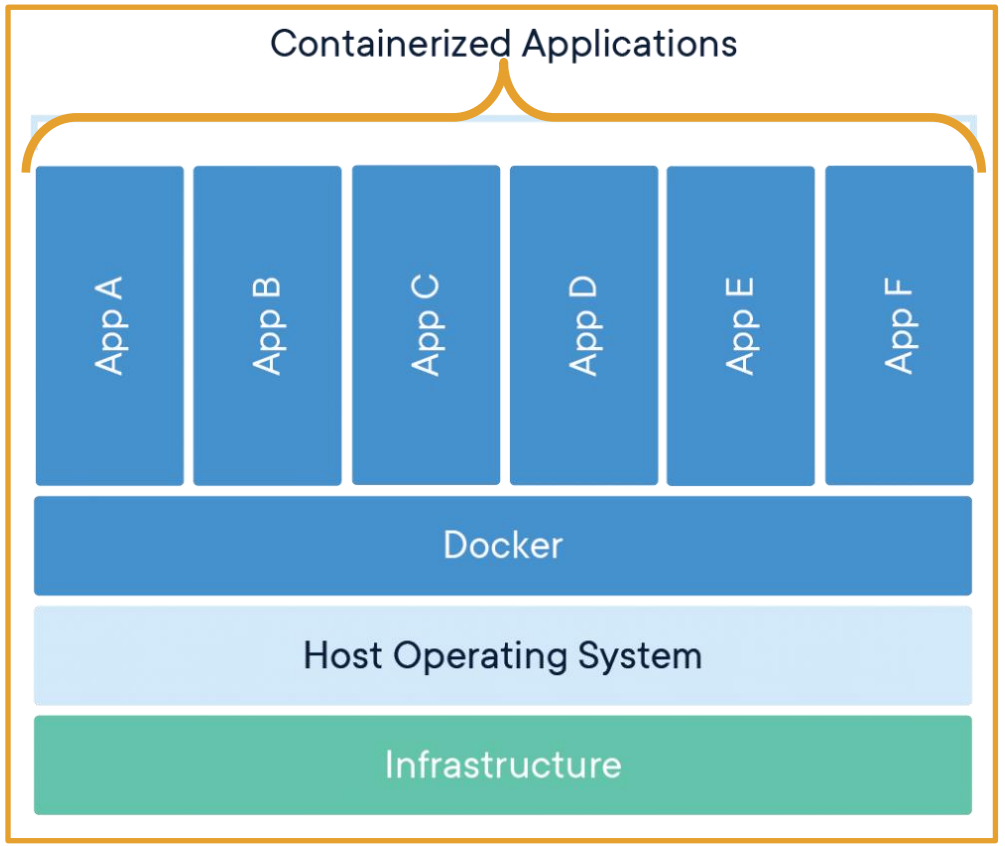
Docker Container

https://www.docker.com/resources/what-container
https://docs.docker.com/get-started/

A ***Docker Image*** is a standalone executable package that includes everything needed to run an application: code, runtime, system tools and libraries, and settings.

A ***Docker Container*** is created from a ***Docker Image*** at runtime when run on the ***Docker Engine***. ***Containers*** run identically on Linux or PC machines.

A ***Container*** is a running process with encapsulation features applied to it to keep it isolated from the host. A ***Container*** even interacts with its own private filesystem.

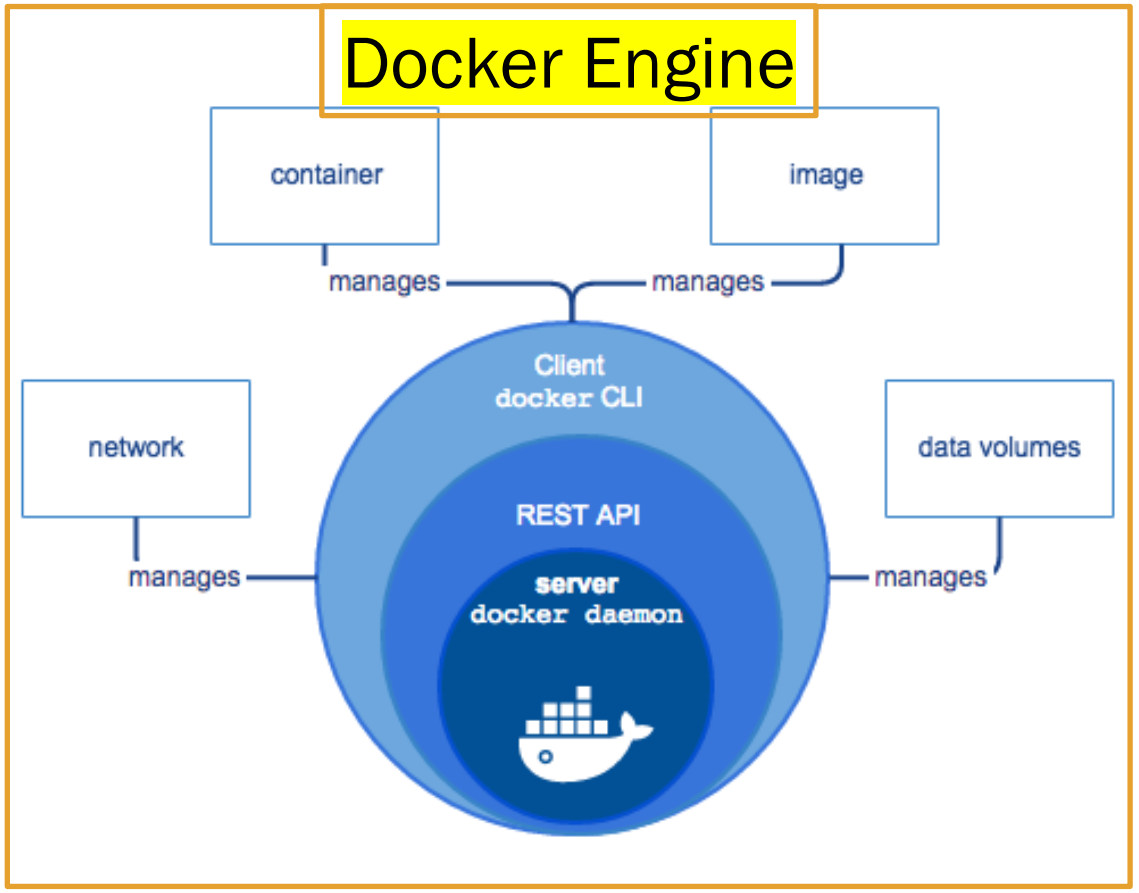


Docker Engine

https://docs.docker.com/engine/docker-overview/#docker-engine

Docker Engine is a client-server application with three major components:

1. A server, which is a long-running program called a ***daemon***.
2. A ***REST API*** which specifies interfaces used to talk to the daemon and instruct it what to do. You interact with the ***daemon*** with the dockerd command.
3. A command line interface (***CLI***) client (*docker* <command>).

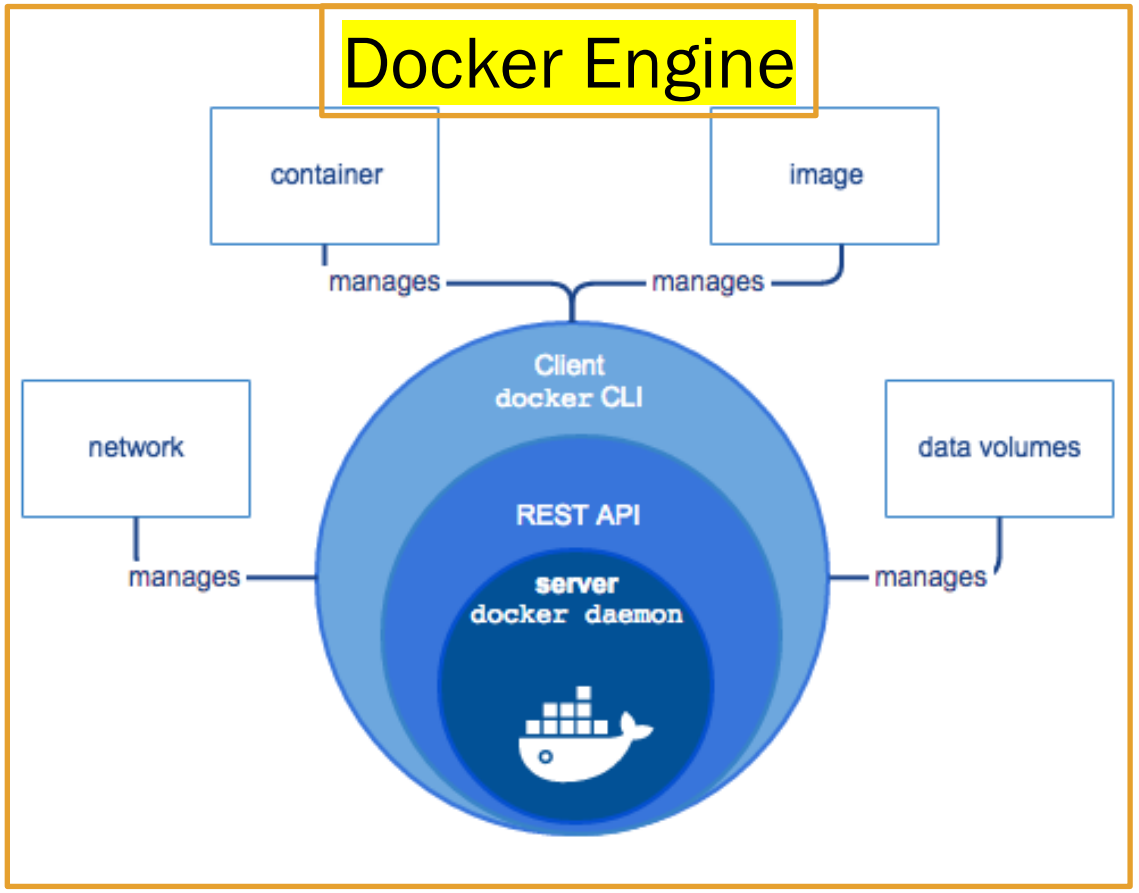


Docker Engine

https://docs.docker.com/engine/docker-overview/#docker-engine

The Docker ***CLI*** uses the ***Docker REST API*** to interact with the ***Docker daemon*** through scripting and/or ***CLI*** commands. Many ***Docker*** applications use the underlying ***API*** and ***CLI***.

The ***daemon*** creates and manages Docker objects, such as ***images***, ***Containers***, networks, and ***volumes***.



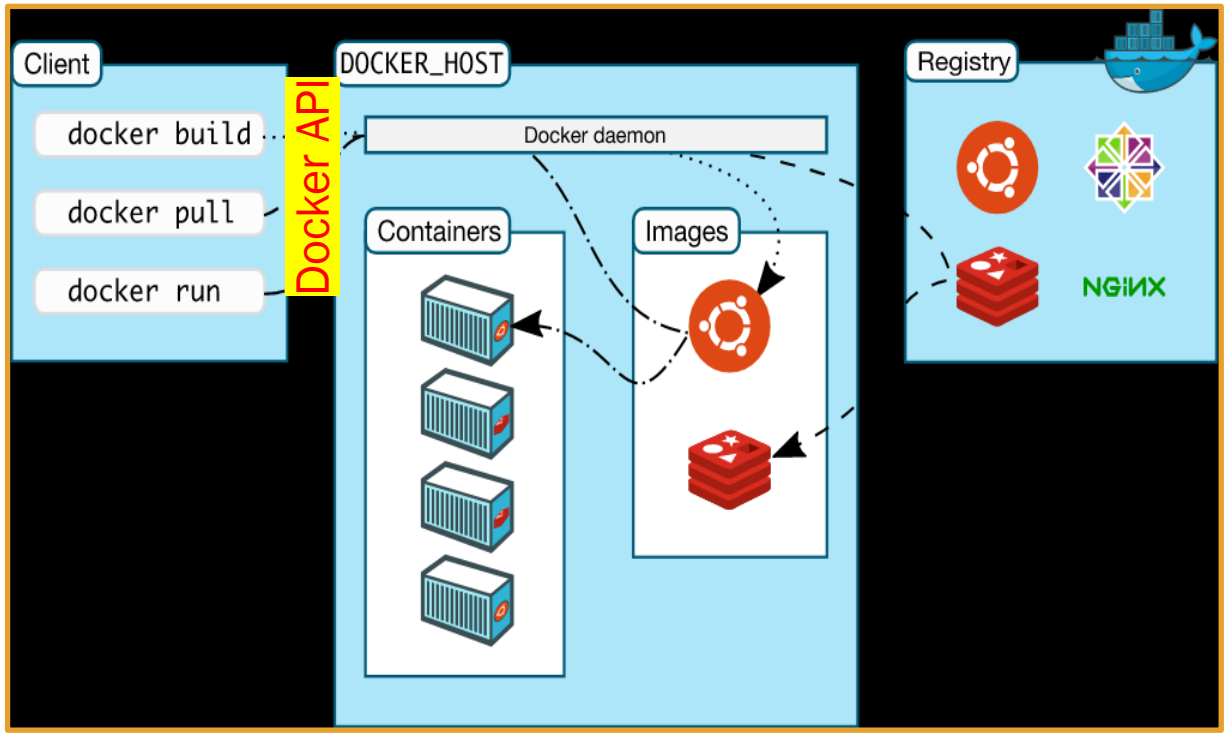
Docker Architecture

https://docs.docker.com/engine/docker-overview/#docker-architecture

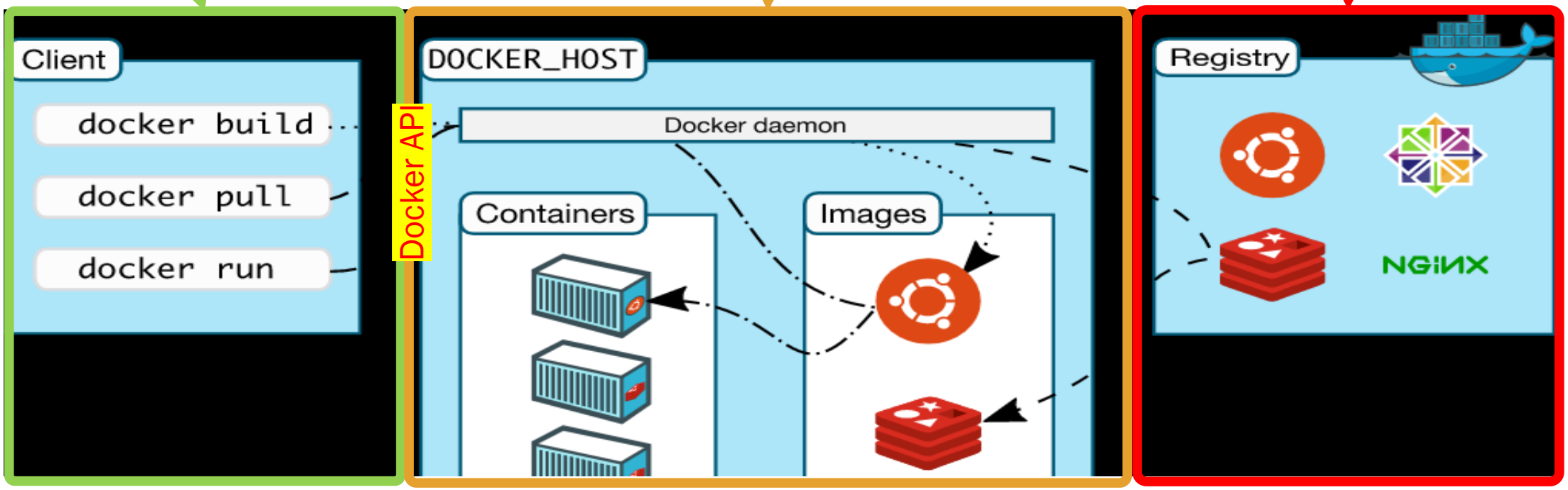
Docker uses a ***client-server architecture***. The ***Docker client*** talks to the ***Docker daemon (server)***, which builds, runs, and distributes ***Docker containers***.

The ***Docker client*** and ***daemon*** can run on the same system, or you can connect a ***Docker client*** to a remote ***Docker daemon***.

The ***Docker client*** and ***daemon*** communicate using a ***REST API***.



Docker Client	Docker daemon	Docker registries
The ***Docker client*** is the primary way that most Docker users interact with Docker. With docker run, the client sends commands to ***dockerd***, which carries them out. The ***docker*** keyword specifies the ***Docker API***.	The ***Docker daemon*** *(*dockerd*)* listens for ***Docker API*** requests and manages Docker objects such as ***images***, ***networks,*** ***containers***, and ***volumes***.	A **Docker registry** stores **Docker images**. hub.docker.com is a public registry. With the **docker pull** or **docker run** commands, images can be pulled from the configured registry. When you use the **docker push** command, the **image** is pushed to the configured registry.



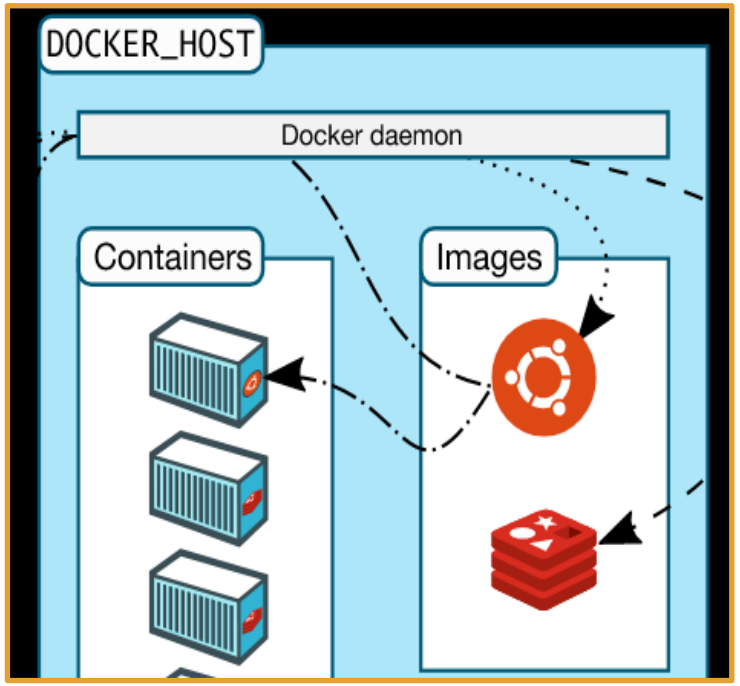
Docker Container and Docker Image

https://docs.docker.com/engine/docker-overview/#docker-architecture

A *container* is a runnable instance of an ***image***. You can create, start, stop, move, or delete a ***Container*** using the ***Docker API*** or ***CLI***.

A ***Container*** is defined by an ***image*** as well as any configuration options you provide to it when you create or start it.

You can connect a ***Container*** to one or more networks, attach storage to it, or even create a new ***image*** based on its current state.



An *image* is a read-only template with instructions for creating a ***Docker container***.

An ***image*** often is based on another ***image***. An ***image*** could be based on one ***image***, then install a different web server, then install an application and the configuration details needed to make the application run.

To build an ***image***, create a ***Dockerfile*** which defines the steps to create an ***image*** and run it.

When you change a ***Dockerfile*** and rebuild the ***image***, only those layers which have changed are rebuilt.

List of Basic Docker commands

Command	Purpose
docker start <containername>	Start a container.
docker stop <containername>	Stop a running container
docker container <command>	Manage containers
docker image ls	list the images on your machine.
docker ps –a	Lists all containers, running or stopped
docker ps	Lists the running containers
docker run <containername>	Re-run a container
docker build –t myimage .	Build an image to be called myimage) from a Dockerfile at '.' (in the same directory).
docker rm <containername>	Delete a stopped container
docker push username/reponame:<tagname>	Push an image to a repo in the Docker Registry
docker create myimage	Create a Container from an image, but don't start it.
docker attach <containername>	Connect to a running container

Docker – Setup and Test a Container

https://docs.docker.com/get-started/

- 1. Download Docker Desktop.
- 2. Go to Docker.com and create an account
- 3. Run docker –version in the Command Line to see what Docker version you have.
- 4. Run docker run hello-world to test that docker is running correctly. You don't have this image so it will get downloaded automatically and run.
- 5. Run docker image ls to list the downloaded hello-world image on your machine.
- 6. Run docker ps -a to see the container created from the hello-world ***image***.
- 7. Do the Docker tutorial here.
- 8. Then complete the Getting Started Walk-through for Developers tutorial.

Docker in action

The following command runs an ubuntu container, attaches interactively to your local command-line session, and runs the /bin/bash script.

$ docker run -i -t ubuntu /bin/bash

The following happens (assuming default registry configuration):

1. If you do not have the ***ubuntu*** image locally, Docker pulls it from your configured registry, as though you had run ***docker pull ubuntu*** manually.
2. Docker creates a new container, as though you had run a ***docker container create*** command manually.
3. Docker allocates a read-write filesystem to the container, as its final layer.
   - This allows a running container to create or modify files and directories in its local filesystem.
4. Docker creates a network interface to connect the container to the default network,
   - because you did not specify any networking options.
   - This includes assigning an IP address to the container.
   - By default, containers can connect to external networks using the host machine's network connection.
5. Docker starts the container and executes ***/bin/bash***.
   - Because the container is running interactively and attached to your terminal (due to the ***-i*** and ***-t*** flags), you can provide input using your keyboard while the output is logged to your terminal.
6. When you type ***exit*** to terminate the ***/bin/bash*** command, the container stops but is not removed.
   - You can start it again or remove it.

Assignment 2

The assignment for after finishing the tutorials is to redo this tutorial with modifications. The modifications are:

- you will run it on your local machine and
- make the necessary changes to get it to work.

You don't have the .html and .png files that are ***COPY***'d into the container in the Dockerfile. There are certainly other things missing and it is your task to find out what must be changed and change them.

The first person who finishes and presents to the class tomorrow morning will get 5 points added to their quiz on Monday.

You must be the first to contact me with a working site and explanation of exactly what had to be changed.