ICAgile
Advanced Docker (Kubernetes)
ICP – K8S

Agile Brains Consulting, Inc.

ICP-IDO

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Introduction !!

- Who you are
- Your role in the team
- Experience with Docker and Kubernetes

Agenda

Chapter 1 – Docker Refresher

Chapter 2 – Kubernetes Foundation

Chapter 3 – Kubernetes Installation and Architecture

Chapter 4 – Kubernetes API overview and resources

Chapter 5 – Kubernetes for CI

Chapter 6 – Kubernetes Monitoring, Logging and health checks

Chapter 1: Docker – Refresher

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Lab: Setting up the machine

- Install docker, Kubernetes in the provided AWS machine
- Configure Kubernetes master
- Verify installation

*** Master node need to have at least 2 CPUs*

https://github.com/shekhar2010us/kubernetes_teach_git/blob/master/kubernetes_single_node_cluster_installation.md

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Docker Basics

Docker Image

- The basis of a Docker container

Docker Container

- The standard unit in which the application service resides

Docker Engine

- Creates, ships and runs Docker containers deployable on physical or virtual host locally, in a datacenter or cloud service provider

Docker Registry

- On-premises registry for image storing and collaboration

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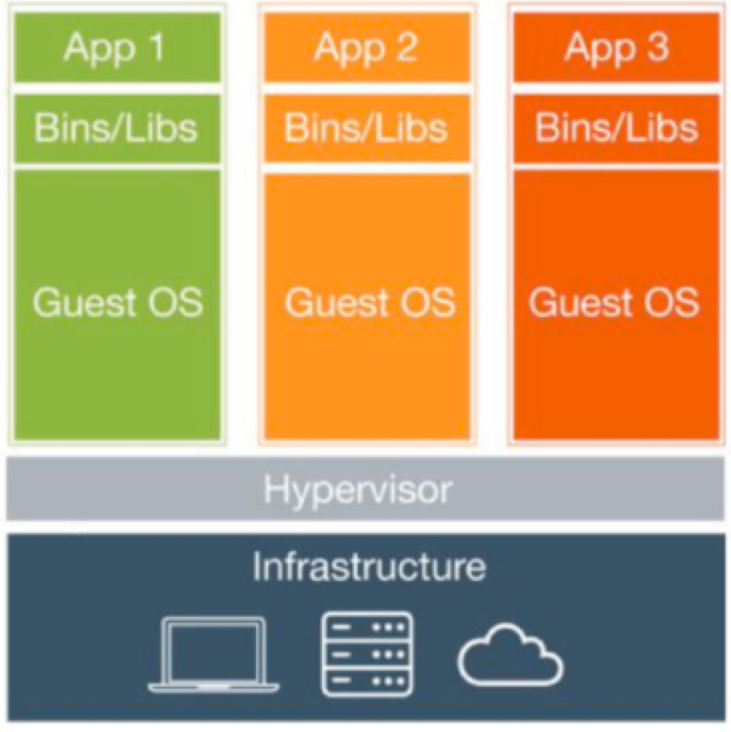
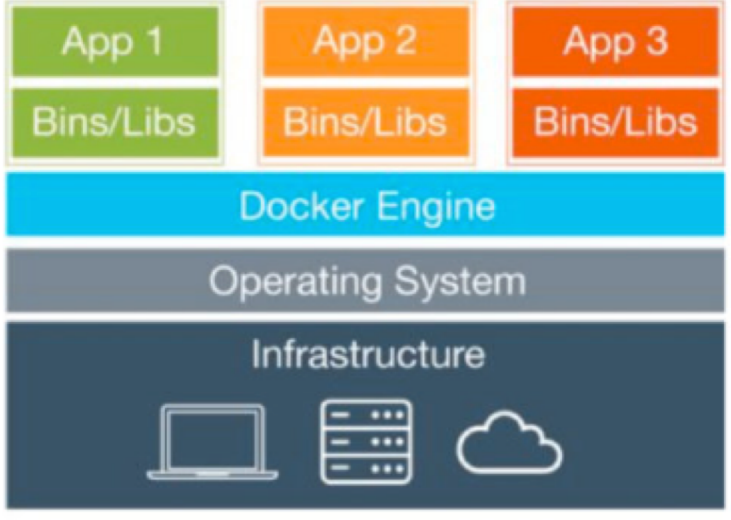
VMs vs Containers



Virtual Machines



Containers

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Containers as a Solution

Container

- Packages up software binaries and dependencies
- Isolates software from each other
- Container is a standard format
- Easily portable across environment
- Allows ecosystem to develop around its standard

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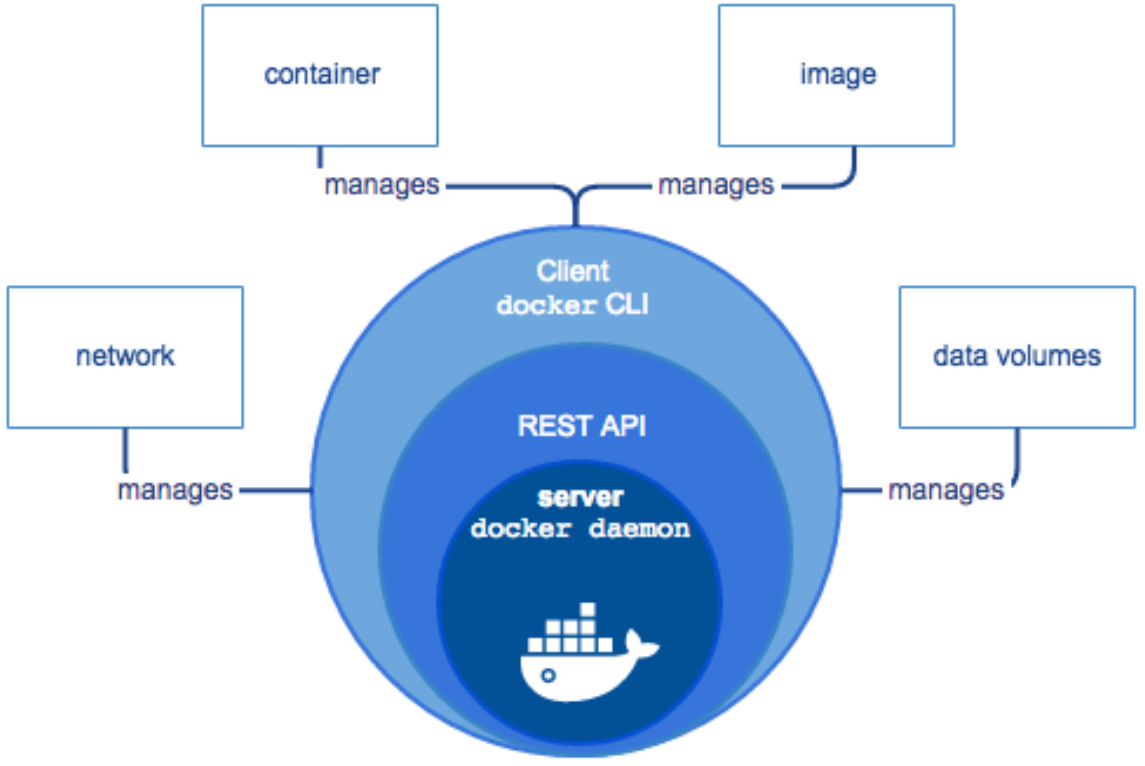
Components of Docker



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Components of Docker

- The Docker daemon (***dockerd***) is a service runs on the host OS. It listens for Docker API requests and manages Docker objects such as images, containers, networks, and volumes.

- The Docker client (***docker***) is the primary way that many Docker users interact with Docker. When you use commands such as docker run, the client sends these commands to dockerd, which carries them out. The docker command uses the Docker API.

- A Docker **registry** stores Docker images. Docker Hub and Docker Cloud are public registries that anyone can use, and Docker is configured to look for images on Docker Hub by default. You can even run your own private registry.

Connect Client to remote dockerd

Server: Create CA private and public keys on server, create CSR, and generate signed certificate

Client: Create client key and make the key suitable for authentication

Connection: docker --tlsverify --tlscacert=ca.pem --tlscert=cert.pem --tlskey=key.pem \ -H=$HOST:2376 version

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Installing Docker on Linux

- There is a Docker-maintained community script that will install the latest release on your Linux machine (most popular flavors) available at https://get.docker.com/
- Run ‘curl -sSL https://get.docker.com/ | sh’ in your terminal
- The script will also install a Union File System driver and verify Docker engine functionality

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Check Docker Installation

$ sudo docker version

```
cludwig — student@docker-proto: ~ — ssh student@...
student@docker-proto:~$ sudo docker version
Client:
 Version:      17.03.1-ce
 API version:  1.27
 Go version:   go1.7.5
 Git commit:   c6d412e
 Built:        Mon Mar 27 17:14:09 2017
 OS/Arch:      linux/amd64

Server:
 Version:      17.03.1-ce
 API version:  1.27 (minimum version 1.12)
 Go version:   go1.7.5
 Git commit:   c6d412e
 Built:        Mon Mar 27 17:14:09 2017
 OS/Arch:      linux/amd64
 Experimental: false
student@docker-proto:~$
```

$ sudo service docker status

```
ubuntu@ubuntu-xenial:~/docker$ sudo service docker status
● docker.service - Docker Application Container Engine
   Loaded: loaded (/lib/systemd/system/docker.service; enabled; vendor preset: enabled)
   Active: active (running) since Tue 2016-11-29 14:12:54 UTC; 2h 47min ago
     Docs: https://docs.docker.com
 Main PID: 1204 (dockerd)
    Tasks: 22
   Memory: 82.9M
      CPU: 1min 31.242s
   CGroup: /system.slice/docker.service
           ├─1204 /usr/bin/dockerd -H fd://
           └─1212 docker-containerd -l unix:///var/run/docker/libcontainerd/docker-containerd.sock --shim docker-containerd-shim --metrics-interval=0 --start-ti

Nov 29 16:29:33 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:29:33.147992827Z" level=info msg="Layer sha256:6fc2e4ad81348c14fd2d7e3880b5db2bbc2f699a5cdcf18b
Nov 29 16:29:36 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:29:36.424426912Z" level=info msg="Layer sha256:a21398f45083710727f6f382cf232d5d50d4dcd9589d6ff5
Nov 29 16:30:09 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:30:09.788820380Z" level=info msg="Layer sha256:9359188bd45e8c8b98fcd0f0297ba87b4f5ed64e9dc8fba7
Nov 29 16:30:09 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:30:09.913582571Z" level=info msg="Layer sha256:9359188bd45e8c8b98fcd0f0297ba87b4f5ed64e9dc8fba7
Nov 29 16:30:28 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:30:28.557526233Z" level=info msg="Layer sha256:be3b076c597ddebb0e264d732927a160c2e91c78516c84a1
Nov 29 16:30:50 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:30:50.018714100Z" level=info msg="Layer sha256:47e85df6c4115d2974ab00ef823c215917dae0a9011f4262
Nov 29 16:30:56 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:30:56.620202459Z" level=info msg="Layer sha256:ce06475a45c5830b905647755ce0324b8c313502bf66ea0c
Nov 29 16:31:14 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:31:14.829527550Z" level=info msg="Layer sha256:2b9628b0eba7b5a870fd354986be4d15e605d51c8f9f7f2a
Nov 29 16:31:15 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:31:15.102270791Z" level=info msg="Layer sha256:c8f15147c2663dc3d68f177fffc0934bb2c04e25eddc6007
Nov 29 16:32:33 ubuntu-xenial dockerd[1204]: time="2016-11-29T16:32:33.801824138Z" level=info msg="Layer sha256:72deb7ae364e53981d0d1befdf7d9c5b15208f93cd8e169b
lines 1-22/22 (END)
```


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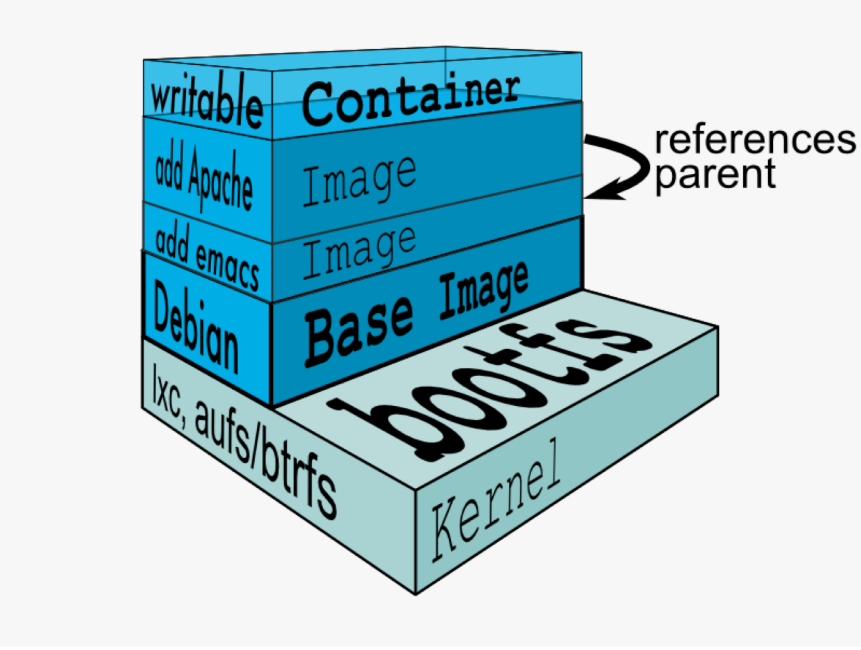
Docker Union File System

AuFS (**AnotherUnionFS**) is a multi-layered filesystem that implements union mount

- Allows several filesystems or directories to be simultaneously mounted and visible through a single mount point
- Appears to be one filesystem to the end user



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Example Docker Layers

Docker Layer – Each Docker image is composed of a series of layers. Docker uses Union File Systems to combine these into a single image. The combination of these layers gives the illusion of a traditional file system. Only the top layer is writeable.

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Docker Hub

Docker's first-party cloud-based registry

- Hosts a broad repository of Docker images
- Contains nearly any popular open source technology
- Contains 'Official images' from vendors such as Canonical, Oracle, Red Hat, etc
- Provides **one free private Docker repo**, more for a paid subscription

hub.docker.com

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Docker Private Registry

- The Registry is a stateless, highly scalable server side application that stores and lets you distribute Docker images.
- Private registries are registries that are hosted and managed by third party or the organization itself (not by Docker).

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Running a Private Docker Registry

- docker run -d -p5000:5000 registry

```
ubuntu@instance-41:~/app$ sudo docker pull registry
Using default tag: latest
latest: Pulling from library/registry
3690ec4760f9: Already exists
930045f1e8fb: Pull complete
feeaa90cbdbc: Pull complete
61f85310d350: Pull complete
b6082c239858: Pull complete
Digest: sha256:1152291c7f93a4ea2ddc95e46d142c31e743b6dd70e194af9e6ebe530f782c17
Status: Downloaded newer image for registry:latest
ubuntu@instance-41:~/app$ sudo docker run -d -p5000:5000 registry
64730d7011f71d463d480982a765624b4f353e2f2c7003779281cf453c8b2178
```

- docker push localhost:5000/<id>

```
ubuntu@instance-41:~/app$ sudo docker push localhost:5000/plamar
The push refers to a repository [localhost:5000/plamar]
88c7ceeb5d69: Pushed
fa69d2e74ebd: Pushed
4b80ed184035: Pushed
90b244cdf6f8: Pushed
e8c1de3c7027: Pushed
011b303988d2: Pushed
latest: digest: sha256:4dd3b61159aeeda583f480c542da468a68c63633d7e8a51e5645609701814e72 size: 1572
```

https://github.com/docker/docker.github.io/blob/master/registry/deploying.md

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Docker Registry Search

- Search Registry
  - **https://docs.docker.com/registry/spec/api/#listing-repositories**

```
ubuntu@instance-41:~/app$ curl -X GET http://localhost:5000/v2/_catalog
{"repositories":["plamar"]}
```

- List Image Tags
  - **https://docs.docker.com/registry/spec/api/#listing-image-tags**

```
ubuntu@instance-41:~/app$ curl -X GET http://localhost:5000/v2/plamar/tags/list
{"name":"plamar","tags":["latest"]}
```


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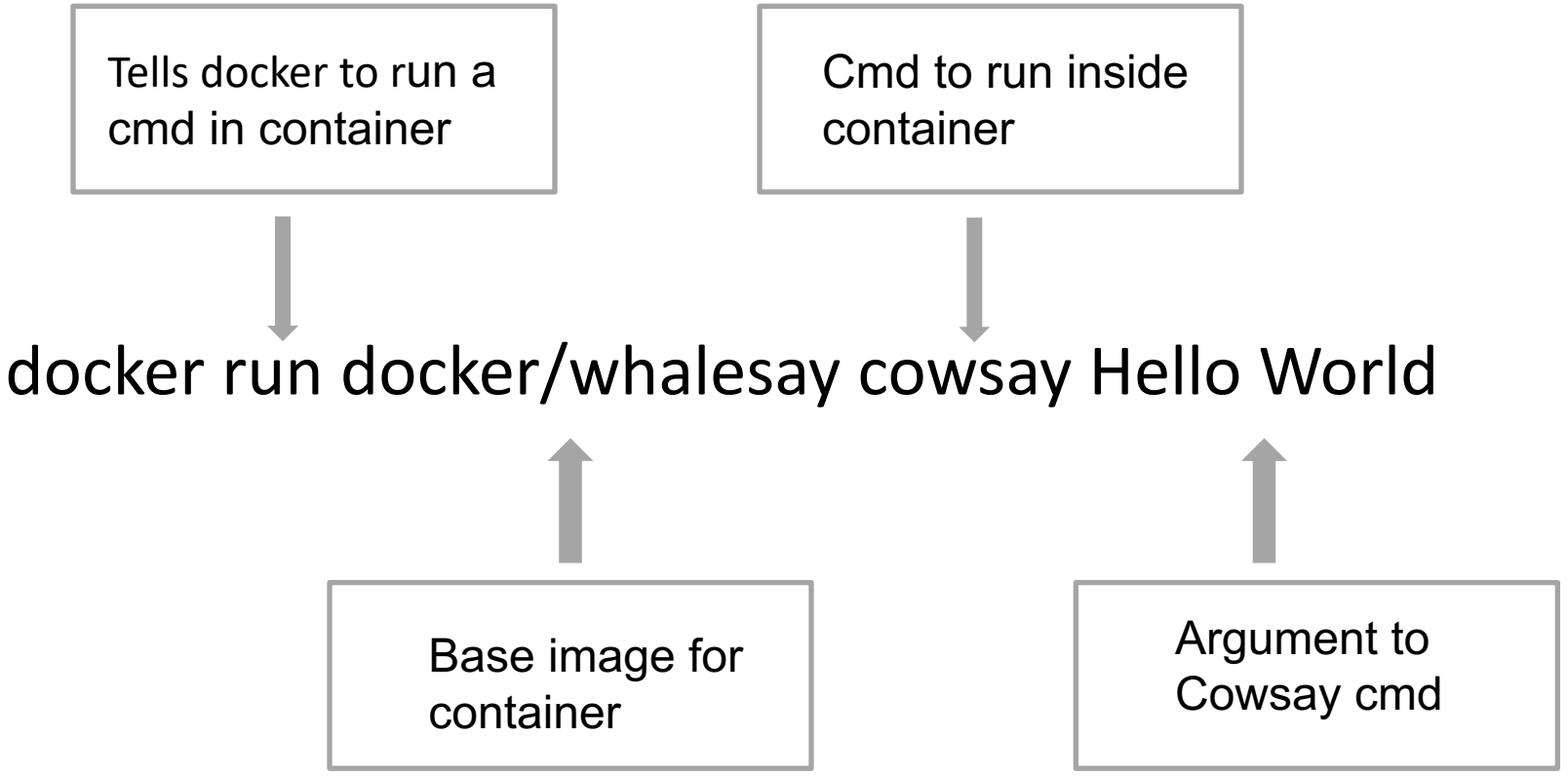
Docker – Run Containers



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Docker – Other useful commands

- docker run -i -t <image> # interactive mode
- docker attach <container> # attach a process id to a container
- docker exec -it <container> /bin/bash # execute a cmd in container from host
- docker ps # list running containers
- docker ps -a # list all containers
- docker images # list all image
- docker stats # provide cpu, memory, etc. for containers
- docker pull # pull image from a repo
- docker inspect <container>|<image> # inspect an image or a container
- docker history <image> # check layers of an image
- docker container|image prune -f # remove unused containers or images

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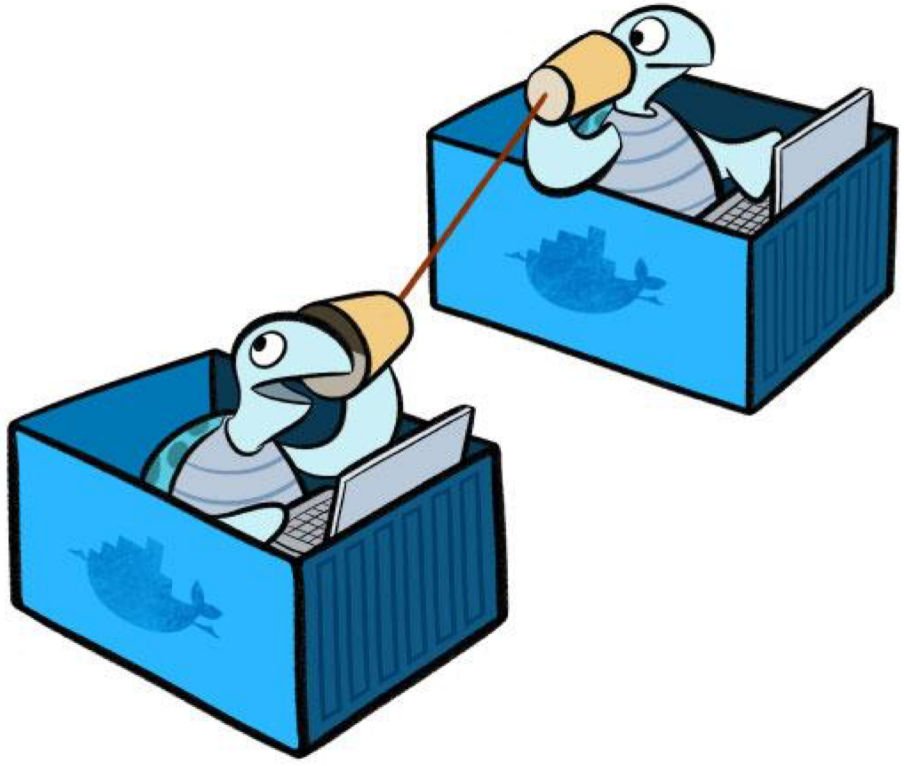
Docker Networking



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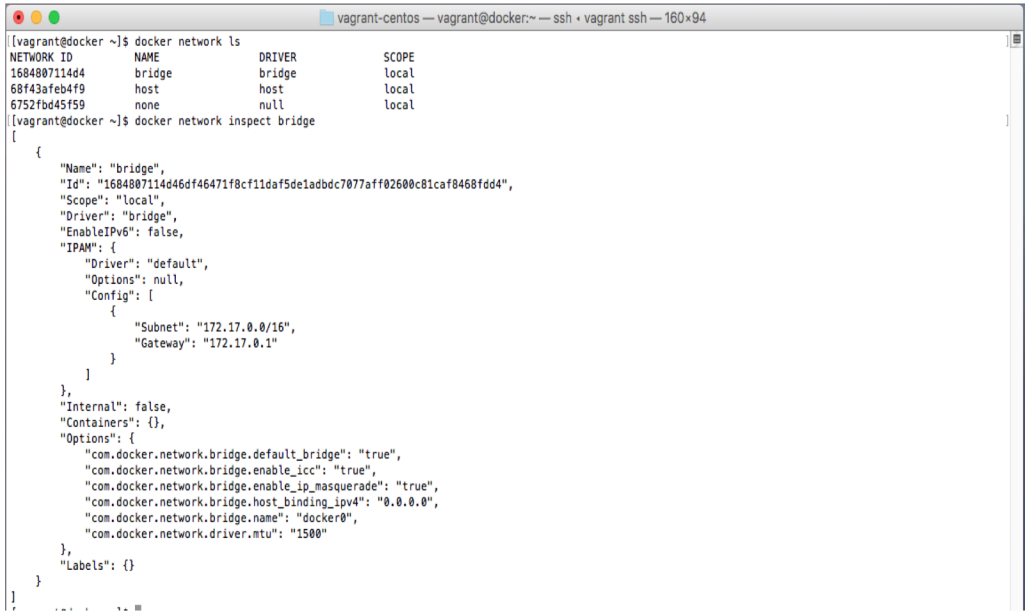
Docker Networking Defaults

- Three networks are created by default (bridge, host & none)
  - ➢ **docker network ls**
- We can easily inspect the bridge network
  - ➢ **docker network inspect bridge**
- We see that a 172.17.0.0/16 address space is allocated. Created Containers are given an IP in this space by default.



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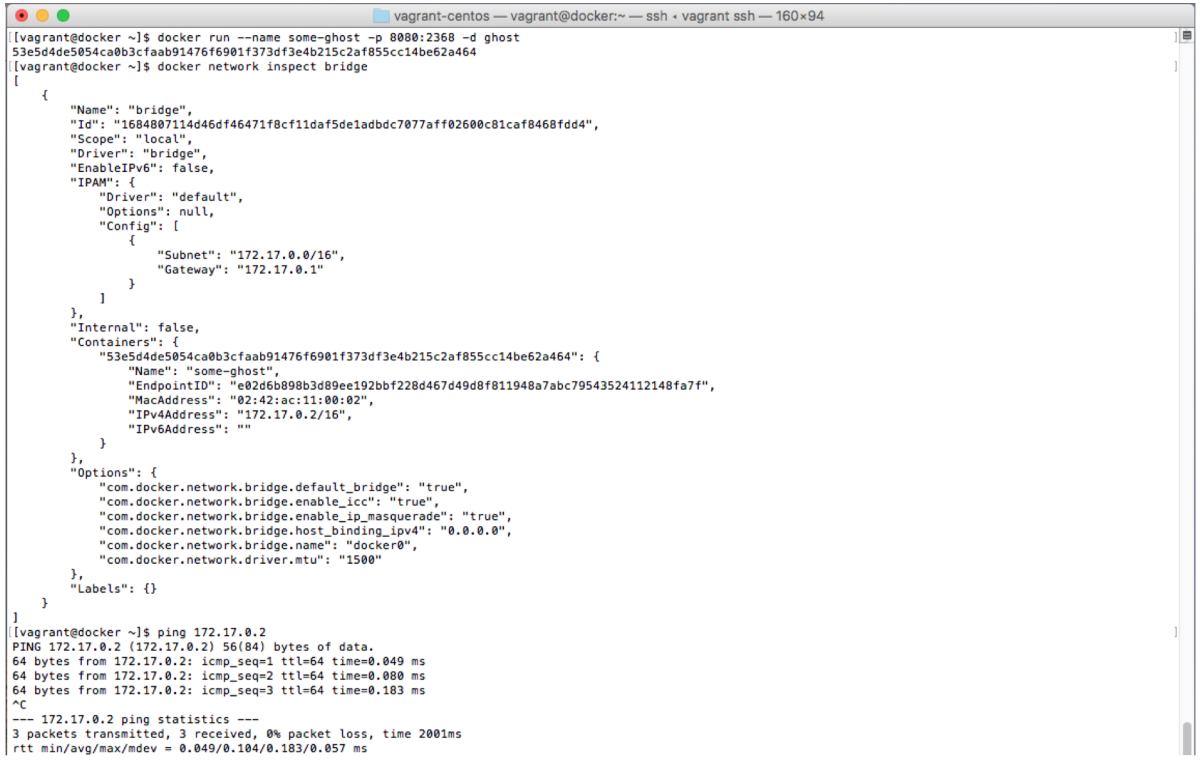
Docker Networking Defaults



- Created container is attached to bridge network by default
  - ➢ Can be attached to user created networks as well with **--network** flag
- Container is assigned 172.17.0.2 ip in the bridge network and appears in the docker inspect command
- The container can then be pinged at 172.17.0.2

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Docker Networking Commands

Command	Description
docker network create	**Create a network**
docker network ls	**List networks**
docker network inspect	**Detailed information on network**
docker network rm	**Remove network**
docker network disconnect	**Disconnect container from network**
docker network connect	**Connect container to network**

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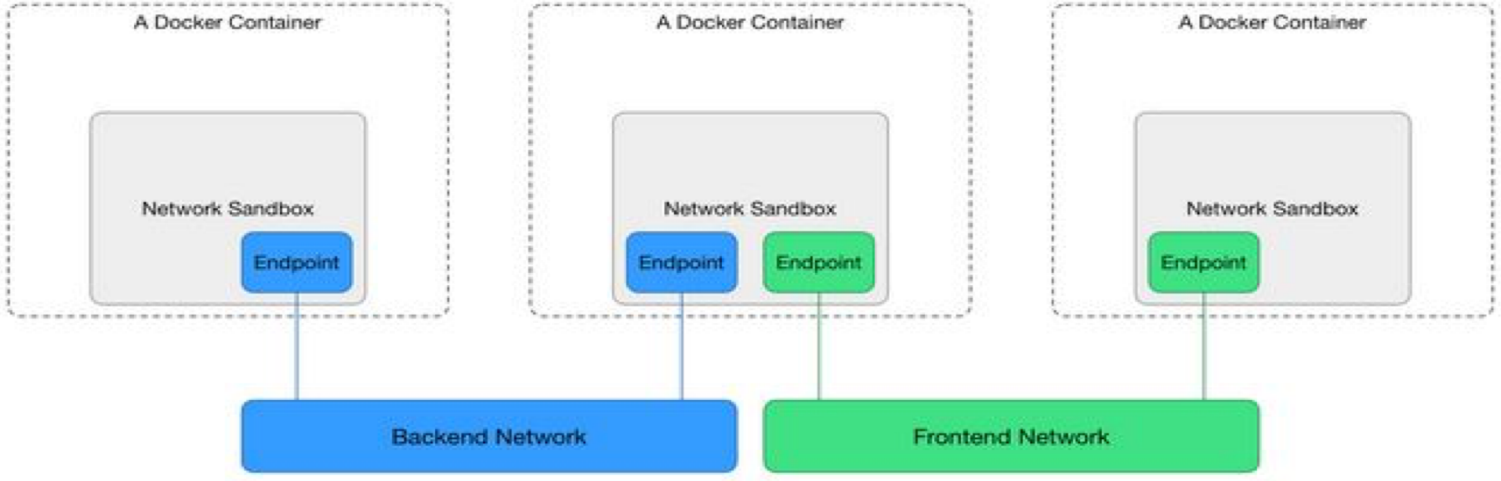
Isolated User Networks

- The bridge network is useful in a development environment
- Production environments usually require more security and isolated or more customized networking solutions.



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Docker Networking – Lab

https://github.com/shekhar2010us/kubernetes_teach_git/blob/master/docker_networking/docker_networking_lab.md

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docker0 bridge

- Docker0 bridge is the bridge network named *bridge* created automatically when you install Docker.
- Options.{com.docker.network.bridge.name}
- By default, the Docker server creates and configures the host system's docker0 a network interface called docker0, which is an ethernet bridge device. If you don't specify a different network when starting a container, the container is connected to the bridge and all traffic coming from and going to the container flows over the bridge to the Docker daemon, which handles routing on behalf of the container.

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Customize docker0 bridge

- You can configure the default bridge network's settings using flags to the **dockerd** command. However, the recommended way to configure the Docker daemon is to use the daemon.json file, which is located in /etc/docker/ on Linux
- Restart Docker after making changes to the daemon.json file

```
{
  "bip": "192.168.1.5/24",
  "fixed-cidr": "192.168.1.5/25",
  "fixed-cidr-v6": "2001:db8::/64",
  "mtu": 1500,
  "default-gateway": "10.20.1.1",
  "default-gateway-v6": "2001:db8:abcd::89",
  "dns": ["10.20.1.2","10.20.1.3"]
}
```

- *--bip=CIDR*: supply a specific IP address and netmask for the docker0 bridge, using standard CIDR notation.
- *--fixed-cidr=CIDR* and *--fixed-cidr-v6=CIDRv6*: restrict the IP range from the docker0 subnet, using standard CIDR notation.
- *--mtu=BYTES*: override the maximum packet length on docker0.
- *--default-gateway=Container default Gateway IPV4 address* and *--default-gateway-v6=Container default gateway IPV6 address*: designates the default gateway for containers connected to the docker0 bridge, which controls where they route traffic by default.
- *--dns=[]*: The DNS servers to use

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Docker Interaction with iptables

- **iptables** is a command line firewall utility that uses policy chains to allow or block traffic.
- When a connection tries to establish itself, iptables looks for a rule in its list to match it to.
- **Docker** manipulates iptables rules to provide network isolation

Usage

- To restrict connection to Docker daemon
- By default, all external source IPs are allowed to connect to the Docker daemon.
- To allow only a specific IP or network to access the containers, insert a negated rule at the top of the DOCKER filter chain.

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Docker Interaction with IPTables

Best Practice

- All of Docker's iptables rules are added to the DOCKER chain. Do not manipulate this table manually. If you need to add rules which load before Docker's rules, add them to the DOCKER-USER chain. These rules are loaded before any rules Docker creates automatically

- IPTable rule chains

Input, Forward, Output

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Control Docker with IPTables

- To restrict access to all external IPs except a single IP:
  - *iptables -I DOCKER-USER -i ext_if ! -s 192.168.1.1 -j DROP*

- To only allow access to connection from a subnet:
  - *iptables -I DOCKER-USER -i ext_if ! -s 192.168.1.0/24 -j DROP*

- To specify a range of IP addresses to accept:
  - *iptables -I DOCKER-USER -m iprange -i ext_if ! --src-range 192.168.1.1-192.168.1.3 -j DROP*

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Docker Volumes

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Volume Persistence

{docker -v} flag can mount the volume to a specific directory

Volumes can be mounted using absolute path or specified “Docker Volumes” which resides in /var/lib/docker/…

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Docker Volume Commands

Command	Description
docker volume create	Create a volume
docker volume ls	List volumes
docker volume inspect	Detailed information on volume
docker volume rm	Remove volume

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Working with Volumes

```
ubuntu@instance-41:~$ docker volume create --name myvolume
myvolume
ubuntu@instance-41:~$ docker volume ls
DRIVER              VOLUME NAME
local               030f652ad7ea6766f3d17a421233896b78296cf89d9bc816c69e6084df1aa24d
local               94ed6b916617b932638619fcbdbfc77d843175a57c520d02d3162f5750916409
local               myvolume
ubuntu@instance-41:~$ docker volume inspect myvolume
[
    {
        "Name": "myvolume",
        "Driver": "local",
        "Mountpoint": "/var/lib/docker/volumes/myvolume/_data",
        "Labels": {},
        "Scope": "local"
    }
]
ubuntu@instance-41:~$ docker volume rm myvolume
myvolume
```


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Dangling Volumes

- If container is deleted with a volume attached, the volume remains. Sometimes removing all such ‘dangling’ volumes is desired

  $ docker volume prune

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Docker Daemon Logging

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Docker Daemon Logging

- Docker includes multiple logging mechanisms to help you get information from running containers and services. These mechanisms are called logging drivers.
- Each Docker daemon has a default logging driver, which each container uses unless you configure it to use a different logging driver.
- To configure the Docker daemon to default to a specific logging driver, set the value of log-driver to the name of the logging driver in the *daemon.json* file, which is located in */etc/docker/* on Linux hosts

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Docker Daemon Logging

- The daemon logs may help you diagnose problems. The logs may be saved in one of a few locations:

Operating System	Location
RHEL, Oracle Linux	/var/log/messages
Debian	/var/log/daemon.log
Ubuntu 16.04+, CentOS	Use the command **journalctl -u docker.service**
Ubuntu 14.10-	/var/log/upstart/docker.log
macOS (Docker 18.01+)	~/Library/Containers/com.docker.docker/Data/vms/0/console-ring
macOS (Docker <18.01)	~/Library/Containers/com.docker.docker/Data/com.docker.driver.amd64-linux/console-ring
Windows	AppData\Local

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Docker Daemon Logging

- To enable debugging, the recommended approach is to set the **debug** key to true in the *daemon.json* file, which is usually located in /etc/docker/
- On macOS or Windows, do not edit the file directly. Instead, go to **Preferences** / **Daemon** / **Advanced**.

Change log driver to syslog

```
{ "log-driver": "json-file",  or syslog
   "log-opts": {
      "max-size": "10m",
      "max-file": "3",
      "labels": "production_status",
      "env": "os,customer”
   }
}
```


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Container Logging

- To find the current default logging driver for the Docker daemon:

```
docker info --format '{{.LoggingDriver}}'
```

- When you start a container, you can configure it to use a different logging driver than the Docker daemon's default:
  - *docker run -it --log-driver <driver> <image> <params>*

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Container Logging – Lab

https://github.com/shekhar2010us/kubernetes_teach_git/tree/master/docker_logging

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