Docker 101 Workshop

DockerCon EU October 2017

dockercon17 EU

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Agenda

Part 1

- Running Containers
- Images
- Dockerfiles
- Bind Mounts
- Port Mapping

Part 2

- Understanding the Docker Filesystem
- Understanding Volumes

Part 3

- Docker Networking
- Docker Swarm Intro

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Part 1

Running containers, Dockerfiles, Bind mounts

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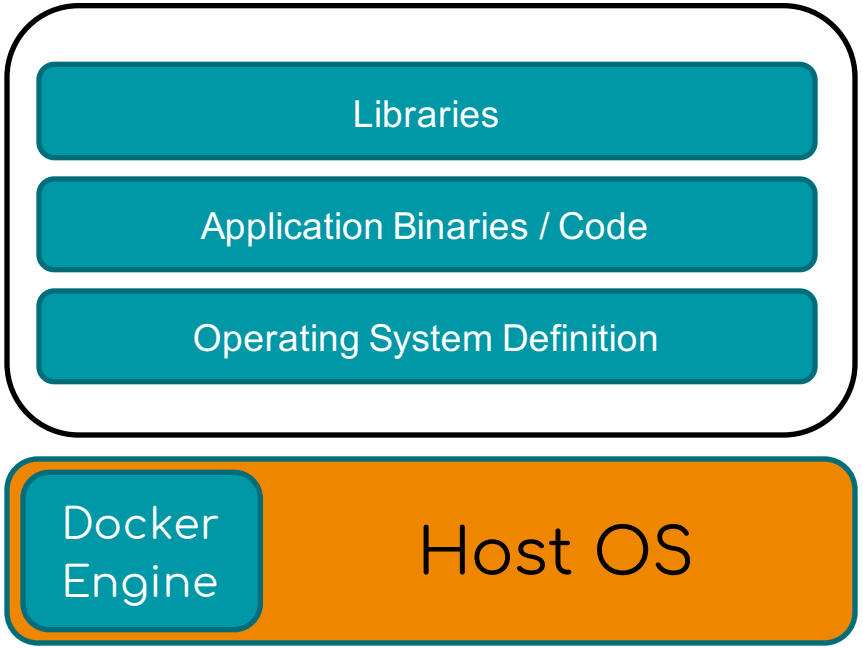
Containers are Not VMs?

VMs

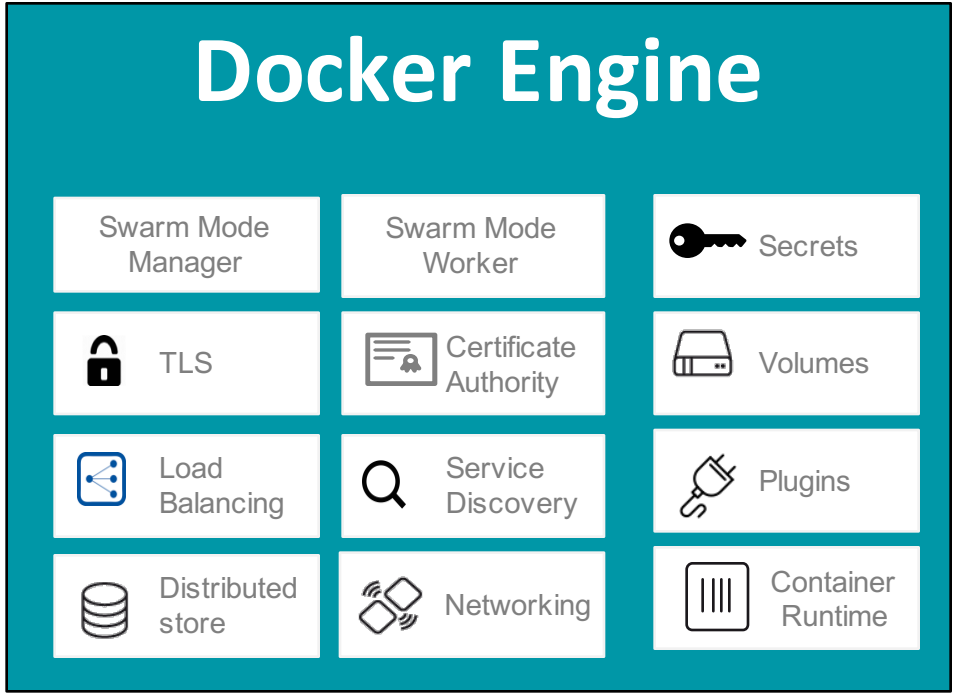
Containers

What is a Container?



- Isolated Operating System Process
- Includes Everything The App Needs to Run
- Shares Underlying OS Kernel
- Inherently Portable
- Managed by Docker Engine

Docker Engine



- Powerful yet simple, built in orchestration
- Declarative app services
- Built in container centric networking
- Built in default security
- Extensible with plugins, drivers and open APIs

Build, Ship, Run

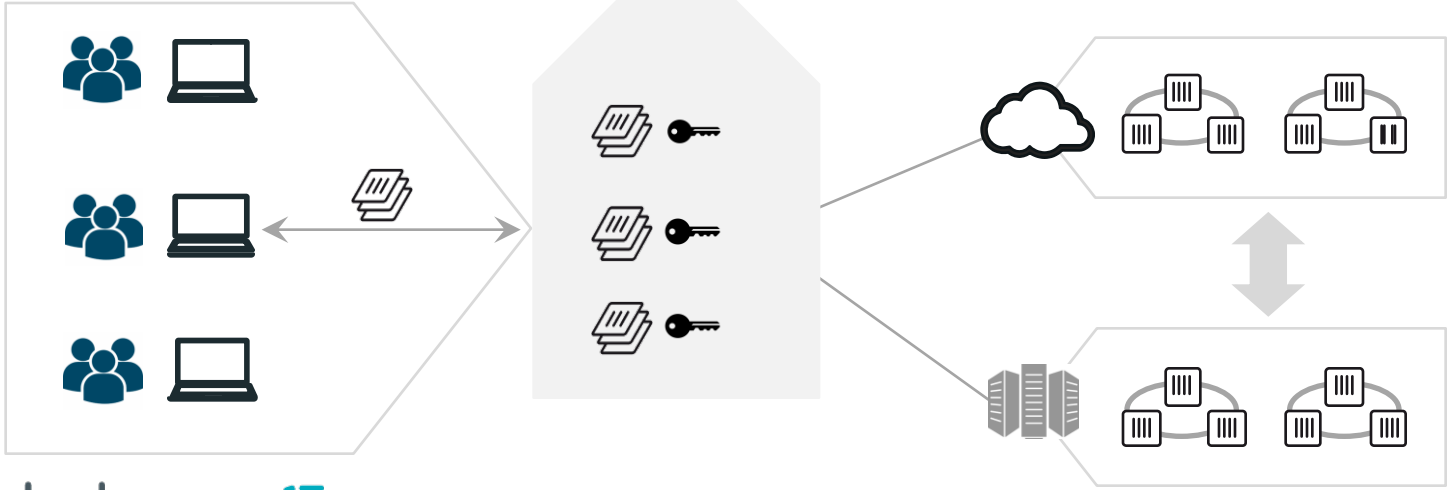
Developers

IT Operations

BUILD
Development Environments

SHIP
Create & Store Images

RUN
Deploy, Manage, Scale



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Docker Images

- Read only
- Build-time artifact
- Basis for running containers
- Built using Dockerfile
- Stored on a registry

Managing Images

- Images are pushed and pulled from registries
- Registries can be SaaS / public or on-prem
- Tags can be applied to images to denote versions
- Effective Dockerfiles are extremely important

Dockerfile Example

```
# our base image
FROM alpine:latest

# Install python and pip
RUN apk add --update py-pip

# upgrade pip
RUN pip install --upgrade pip

# install Python modules needed by the Python app
COPY requirements.txt /usr/src/app/
RUN pip install --no-cache-dir -r /usr/src/app/requirements.txt

# copy files required for the app to run
COPY app.py /usr/src/app/
COPY templates/index.html /usr/src/app/templates/

# tell the port number the container should expose
EXPOSE 5000

# run the application
CMD ["python", "/usr/src/app/app.py"]
```

- Instructions on how to build a Docker image
- Looks very similar to “native” commands
- Important to optimize your Dockerfile

Types of Running Containers

Single task:

```
$ docker container run alpine hostname
```

Background:

```
$ docker container run --detach alpine top
```

Interactive:

```
$ docker container run –interactive –tty alpine bash
```

Bind Mounts

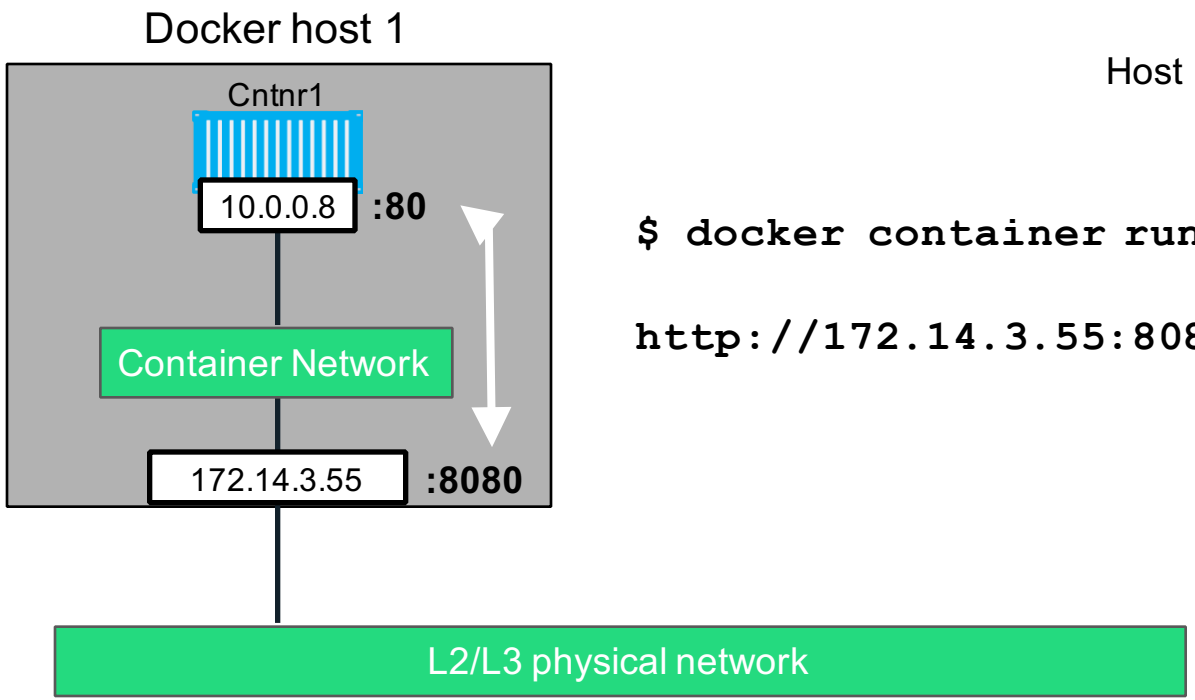
- Mount a directory on the host into the running container
- Good for source code
- Changes can be immediately reflected
- Not a volume

```
$ docker container run -v $(pwd):/usr/src/app webfrontend
```

Exposing Ports

- A host can only expose a given port once
- Some uses cases require the same port multiple times
- Docker uses port mapping to achieve this

Port Mapping



Host port

Container port

```
$ docker container run -p 8080:80 ...

http://172.14.3.55:8080
```

Lab: Part 1

https://github.com/mikegcoleman/docker101-linux

Part 2

Docker filesystem, Volumes,

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Let's Go Back to Our Dockerfile

```
# our base image
FROM alpine:latest

# Install python and pip
RUN apk add --update py-pip

# upgrade pip
RUN pip install --upgrade pip

# install Python modules needed by the Python app
COPY requirements.txt /usr/src/app/
RUN pip install --no-cache-dir -r /usr/src/app/requirements.txt

# copy files required for the app to run
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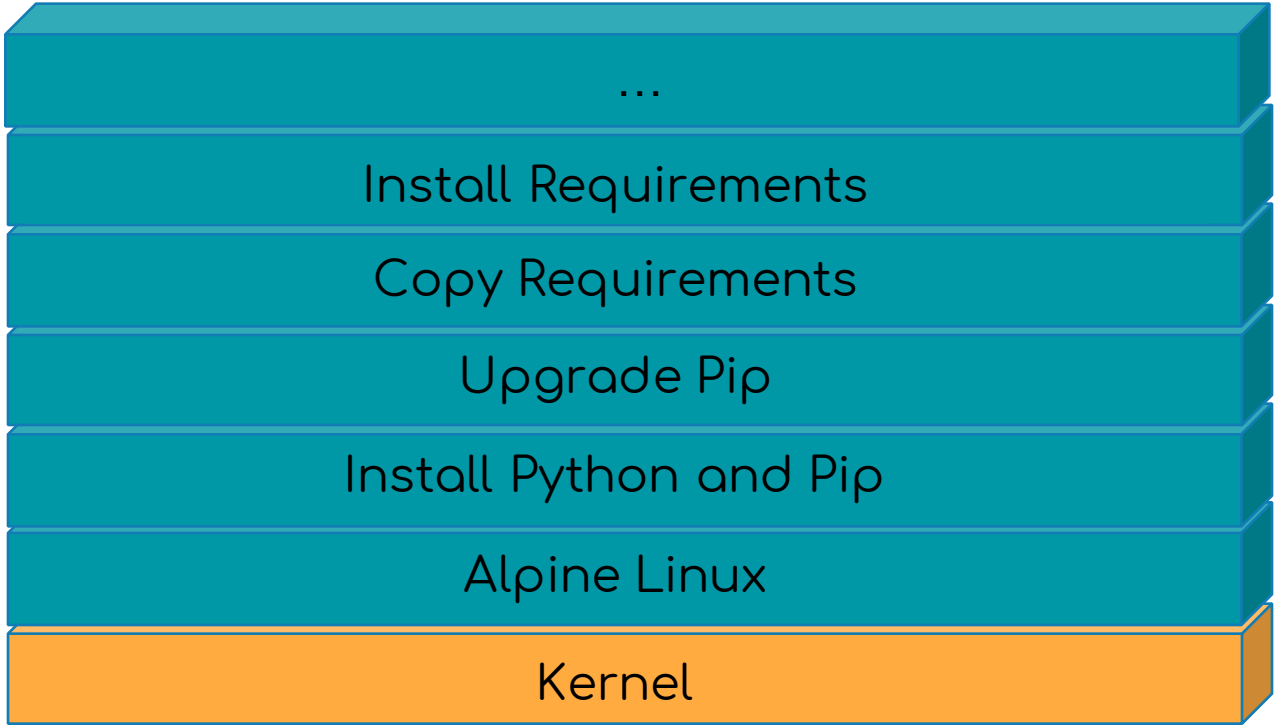
EXPOSE 5000

# run the application
CMD ["python", "/usr/src/app/app.py"]
```

Each Dockerfile Command Creates a Layer



Docker Image Pull: Pulls Layers

```
docker@catweb:~$ docker pull mikegcoleman/catweb
Using default tag: latest
latest: Pulling from mikegcoleman/catweb
e110a4a17941: Pull complete
a7e93a478b87: Pull complete
e0e87116a98c: Pull complete
dddf428a10bc: Pull complete
9a375cf861ff: Pull complete
268b9bc10aaf: Pull complete
1a51b806ff97: Pull complete
Digest: sha256:45707f150180754eb00e1181d0406240f943a95ec6069ca9c60703870ce48068
Status: Downloaded newer image for mikegcoleman/catweb:latest
docker@catweb:~$
```

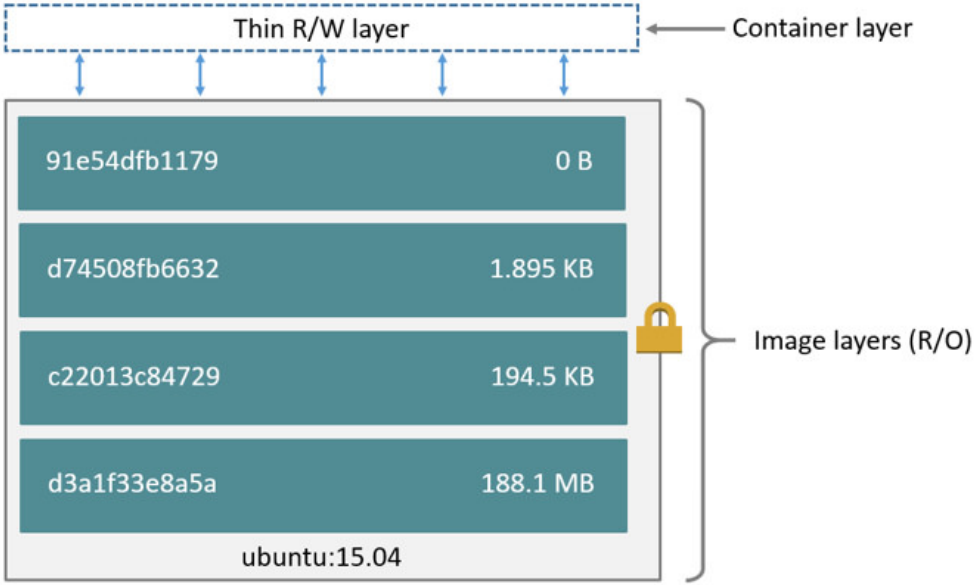
Docker Storage Drivers

- Union file system (UFS)
- Aggregates multiple FS primitives into a single logical FS in the image
- Several different drivers available

Copy on Write

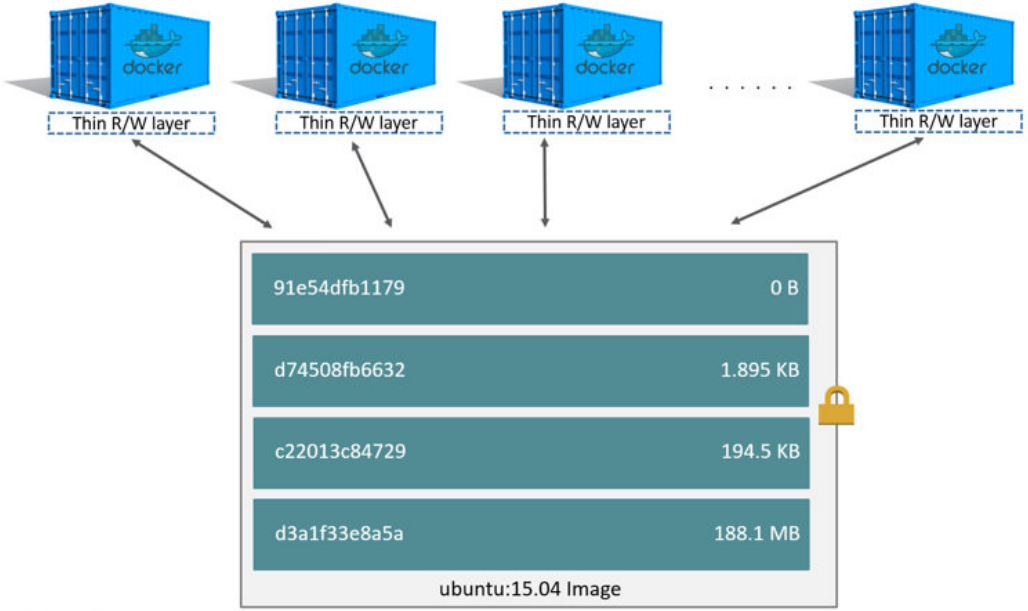
- Super efficient:
  - Sub second instantiation times for containers
  - New container can take <1 Mb of space
- Containers appears to be a copy of the original image
- But, it is really just a link to the original shared image
- If someone writes a change to the file system, a copy of the affected file/directory is “copied up”

Containers vs. Images



Container
(based on ubuntu:15.04 image)

Efficient Storage Utilization



Docker Volumes

- Volumes mount a directory on the host file system into the container at a specific location
- Volume directory structure is not managed by the Docker storage drive
- Can be created in via a Dockerfile, Docker Compose or CLI
- Named vs. Anonymous
- Use cases
  - Persistence
  - Performance

Lab: Part 2

https://github.com/mikegcoleman/docker101-linux

https://hybrid.play-with-docker.com

Part 3

Networking and Swarm

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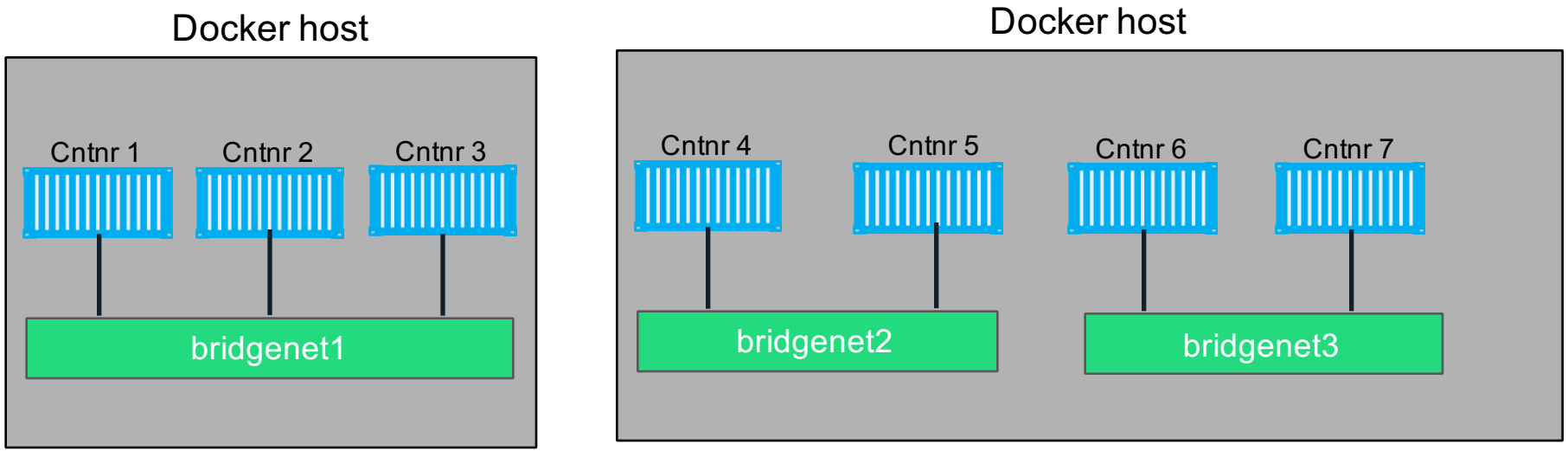
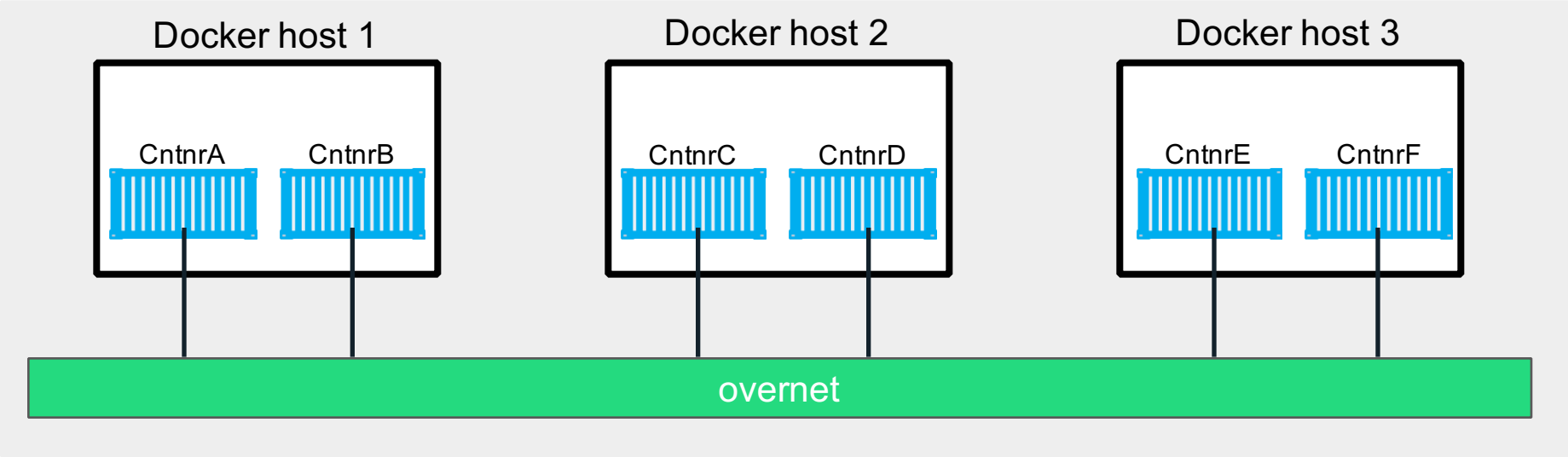
What is Docker Bridge Networking




```
docker network create -d bridge --name bridgenet1
```

What is Docker Overlay Networking

The **overlay** driver enables simple and secure **multi-host** networking



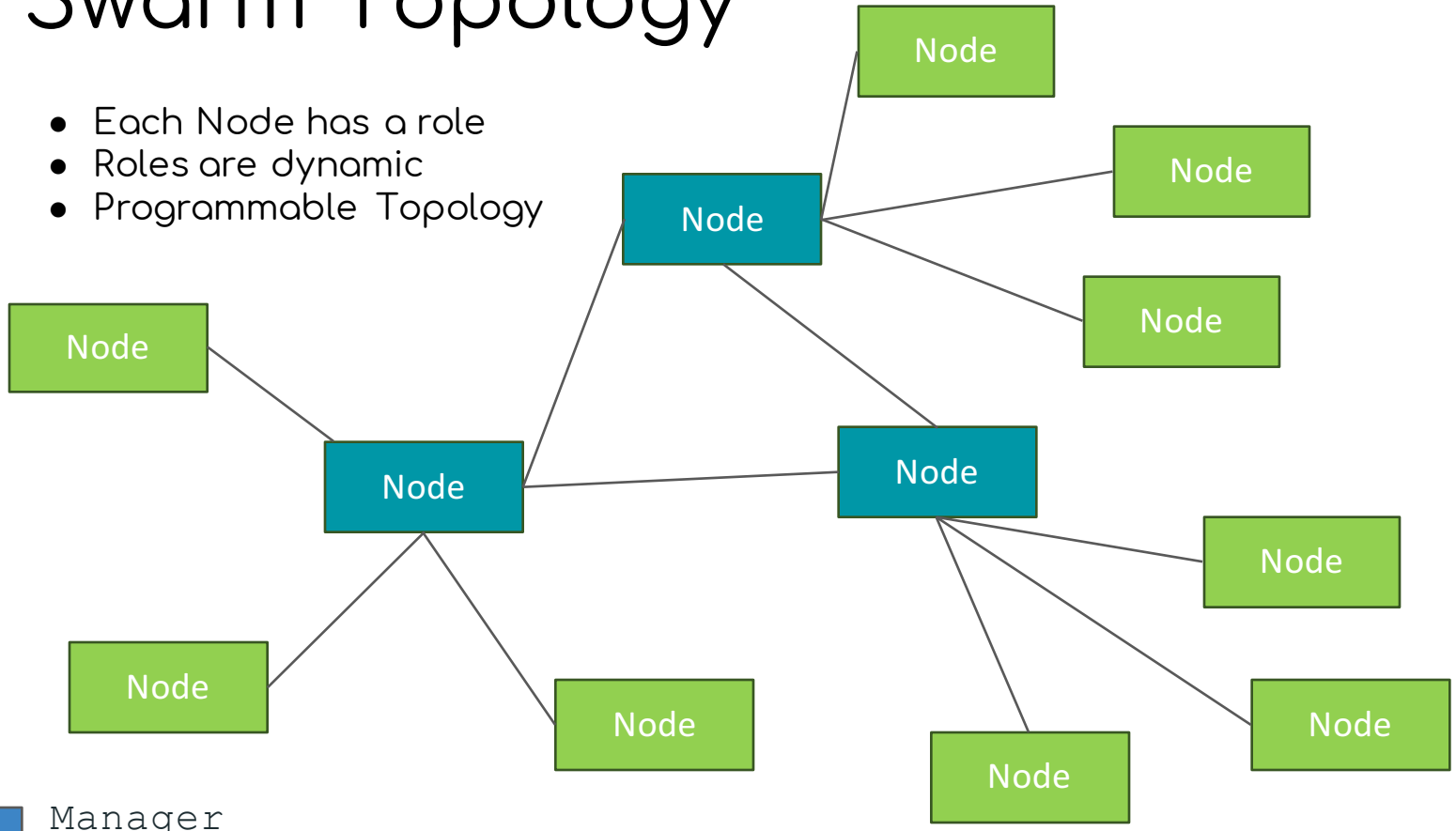

```
docker network create -d overlay --name overnet
```

Docker Swarm

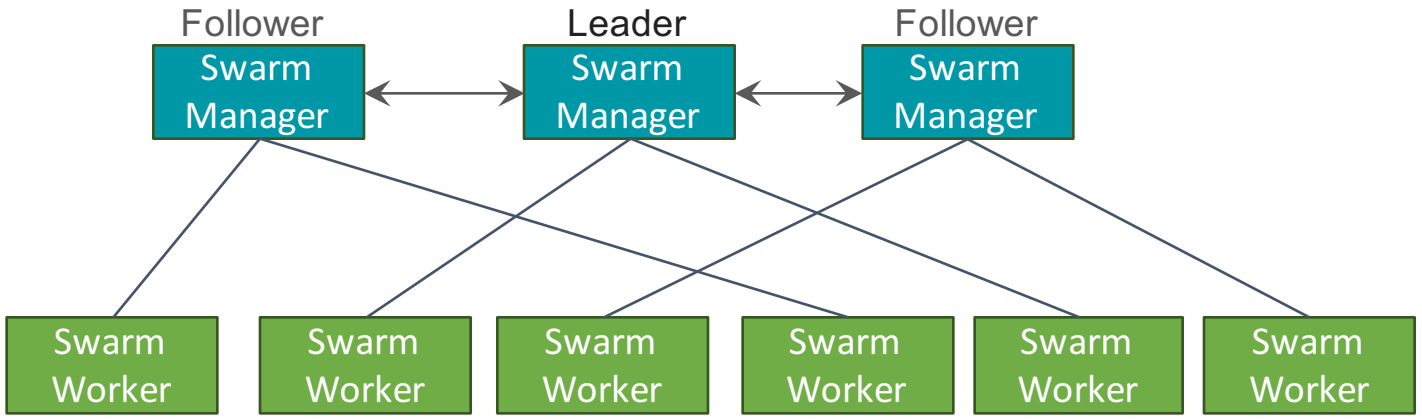
- Orchestration built into Docker engine
- Provides
  - Clustering
  - Scheduling
  - Load Balancing

Swarm Topology

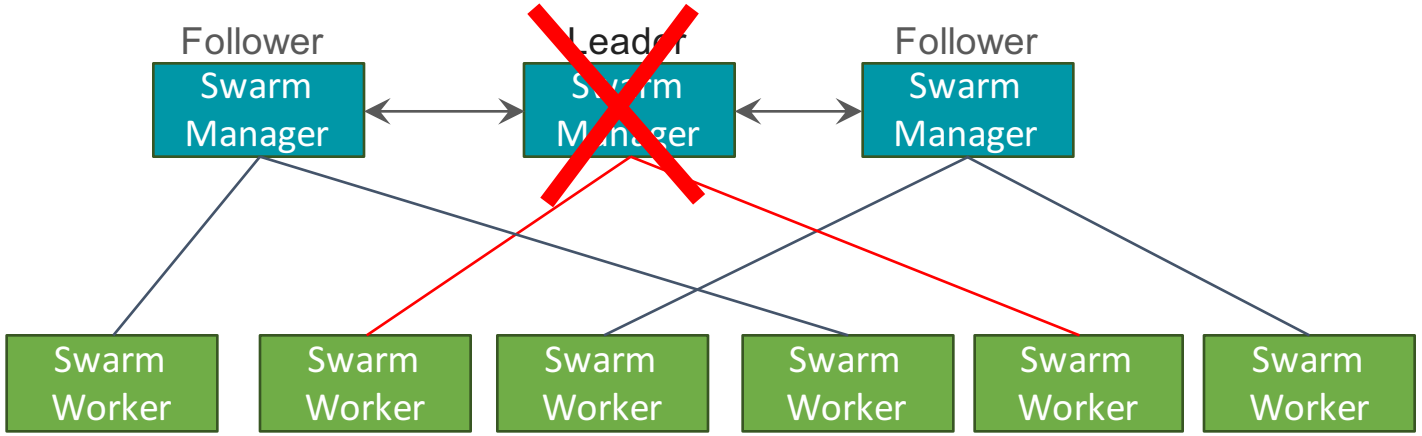
- Each Node has a role
- Roles are dynamic
- Programmable Topology



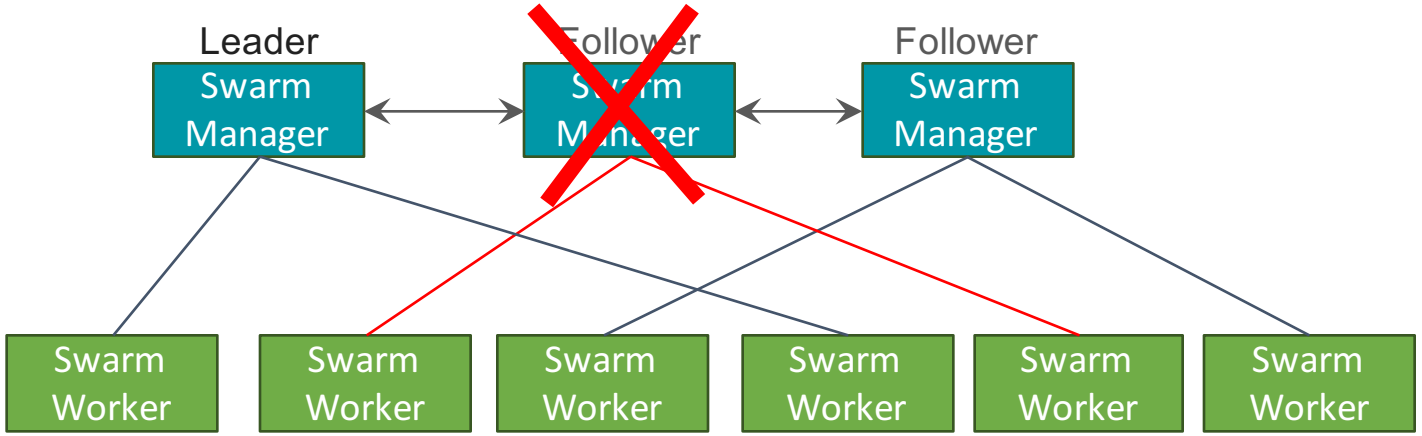
Swarm Topology: High Availability



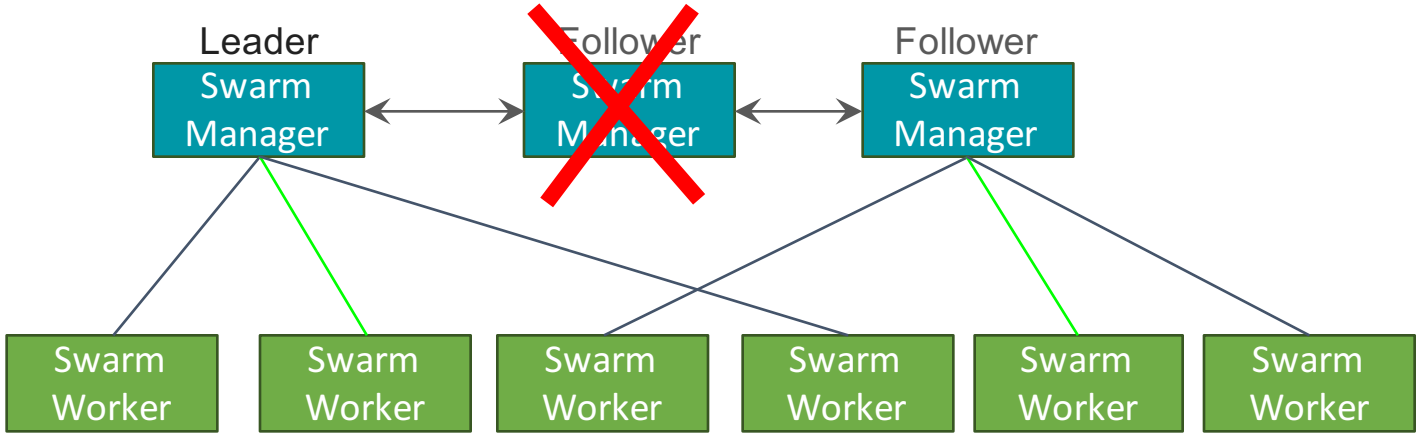
Swarm Topology: High Availability



Swarm Topology: High Availability



Swarm Topology: High Availability



Services

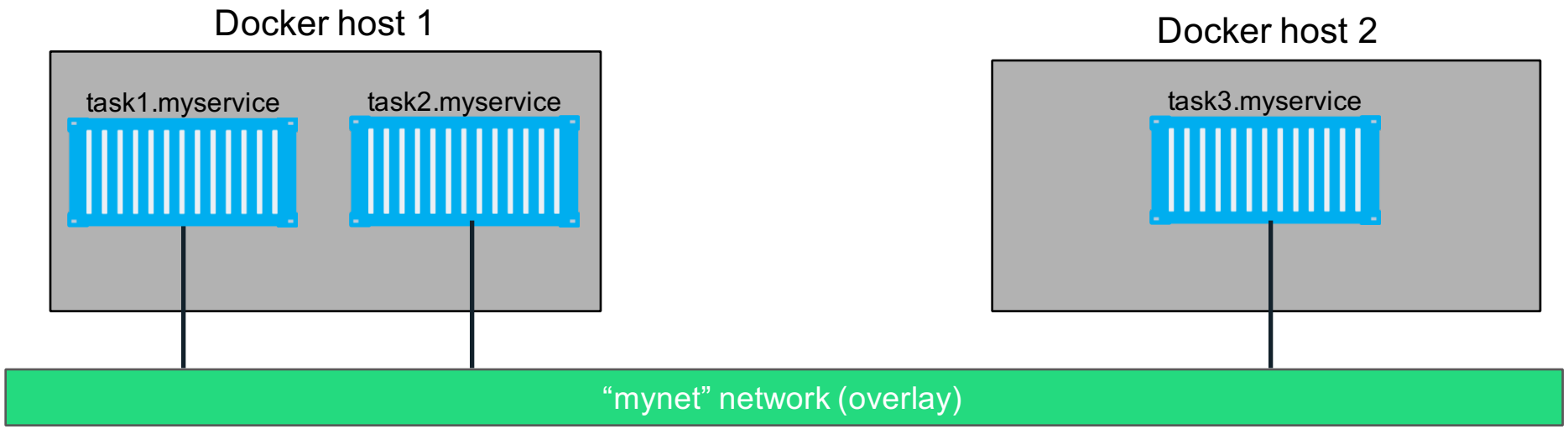
- Provide an abstraction for some component of work
- Based on a single Docker Image
- Comprised of tasks (single container)
- Provides service discovery, load balancing, routing, state reconciliation . . .

What is Service Discovery

The ability to discover services within a Swarm

- Every **service** registers its name with the Swarm
- Clients (other app components) can lookup service **names**
- Service discovery uses the DNS resolver embedded inside each container and the DNS server inside of each Docker Engine

Service Discovery




```
task1.myservice      10.0.1.19
task2.myservice      10.0.1.20
task3.myservice      10.0.1.21
myservice
            10.0.1.18
```

Swarm DNS (service discovery)

Service Virtual IP (VIP) Load Balancing

- Every **service** gets a **VIP** when it's created
  - This stays with the service for its entire life
- Lookups against the VIP get load-balanced across all **healthy tasks** in the service
- Behind the scenes it uses Linux kernel **IPVS** to perform transport layer load balancing
- `docker service inspect <service>` (shows the service VIP)

Service VIP

Load balance group

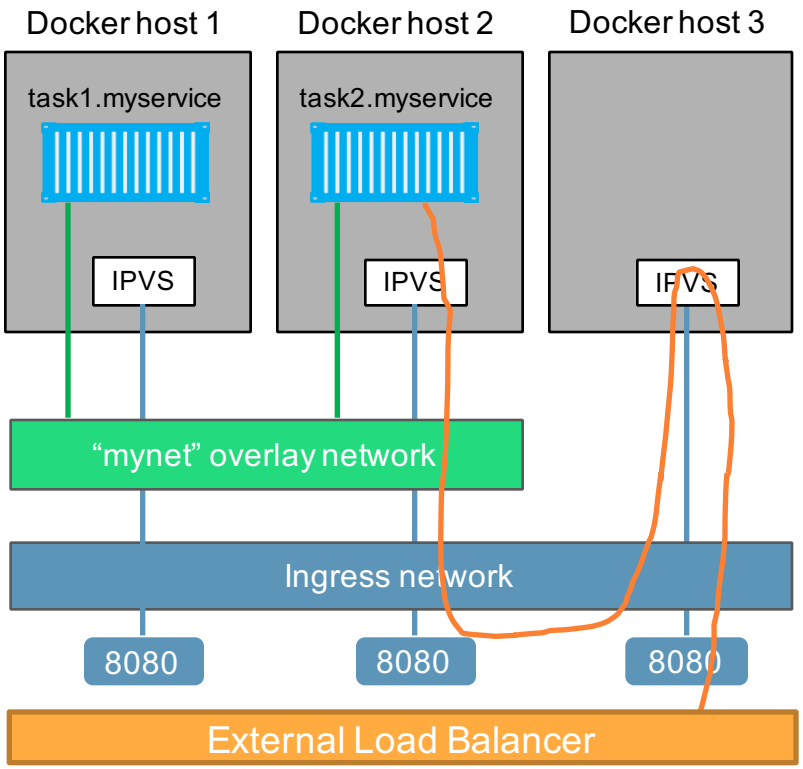
```
NAME                    HEALTHY                 IP
myservice                                       10.0.1.18
task1.myservice         Y                       10.0.1.19
task2.myservice         Y                       10.0.1.20
task3.myservice         Y                       10.0.1.21
task4.myservice         Y                       10.0.1.22
task5.myservice         Y                       10.0.1.23
```

What is the Routing Mesh

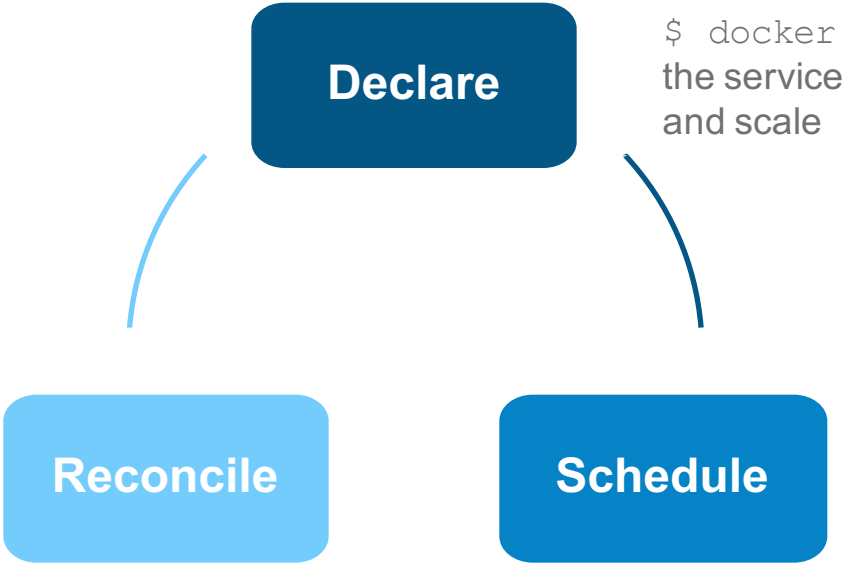
Native load balancing of requests coming from an external source

- Services get published on a single port across the entire Swarm
- Incoming traffic to the published port can be handled by all Swarm nodes
- A special overlay network called “Ingress” is used to forward the requests to a task in the service
- Traffic is internally load balanced as per normal service VIP load balancing

Routing Mesh Example



How service reconciliation works



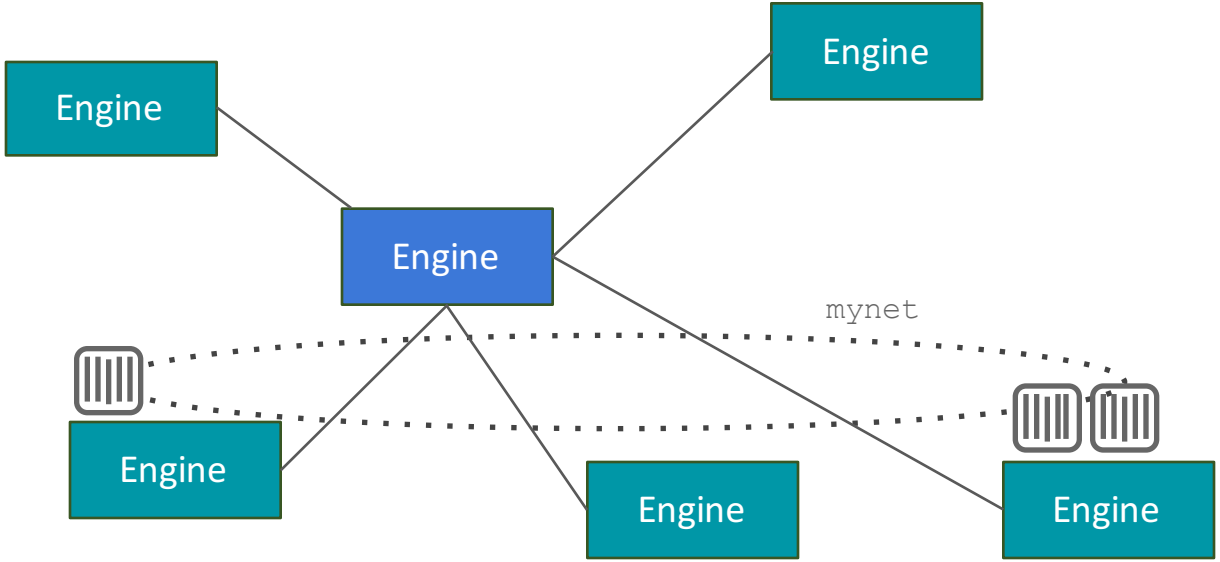
`$ docker service create` declares the service name, network, image:tag and scale

Managers break down service into tasks, schedules them and workers execute tasks

Engines check to see what is running and compared to what was declared to “true up” the environment

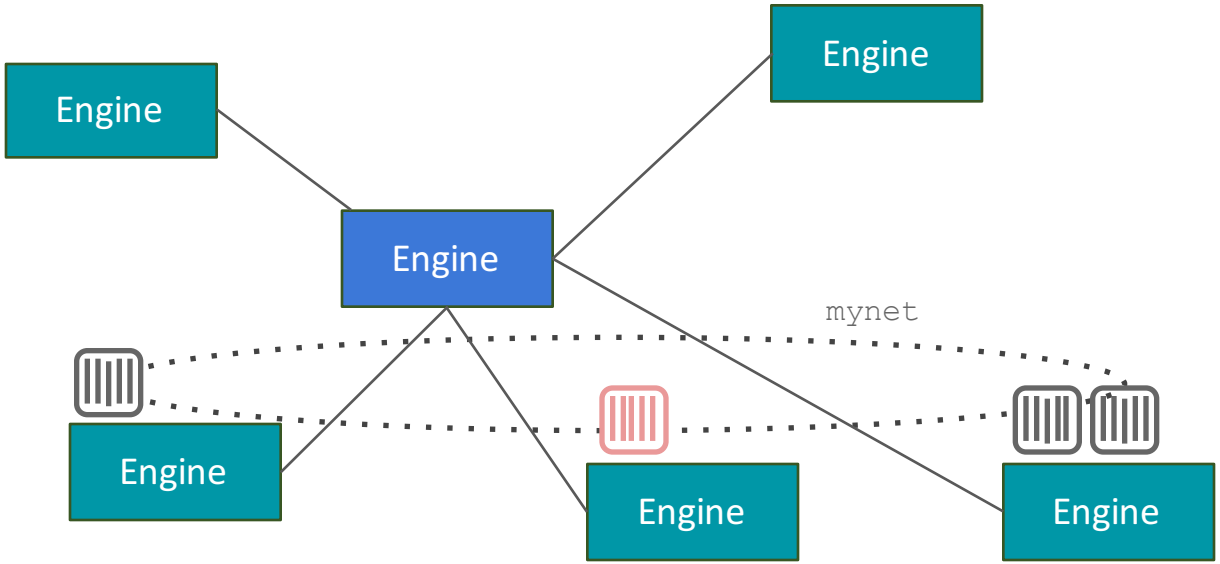
docker

Service Deployment




```
$ docker service create --replicas 3 --name frontend --network mynet
 --publish 80:80/tcp frontend_image:latest
```

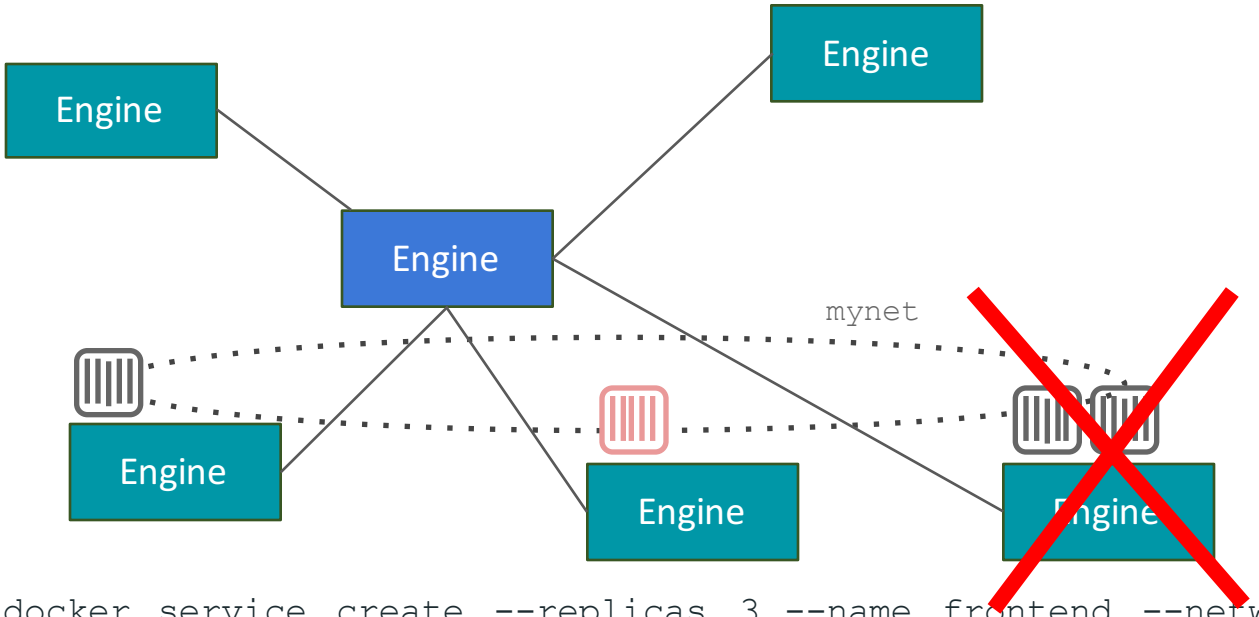
Service Deployment




```
$ docker service create --replicas 3 --name frontend --network mynet
 --publish 80:80/tcp frontend_image:latest
```

```
$ docker service create --name redis --network mynet redis:latest
```

Node Failure




```
$ docker service create --replicas 3 --name frontend --network mynet
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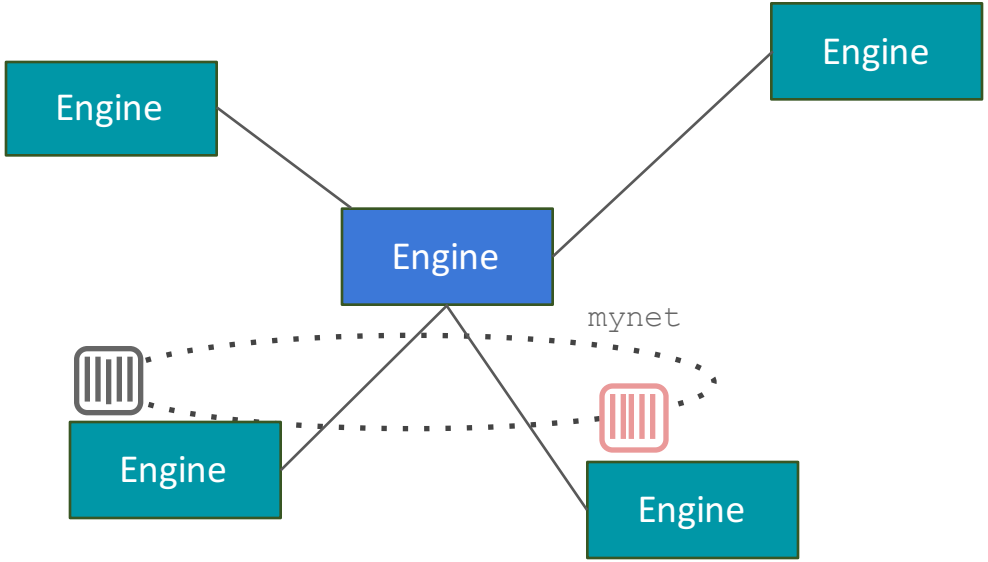
```

```
$ docker service create --name redis --network mynet redis:latest
```

Desired State ≠ Actual State

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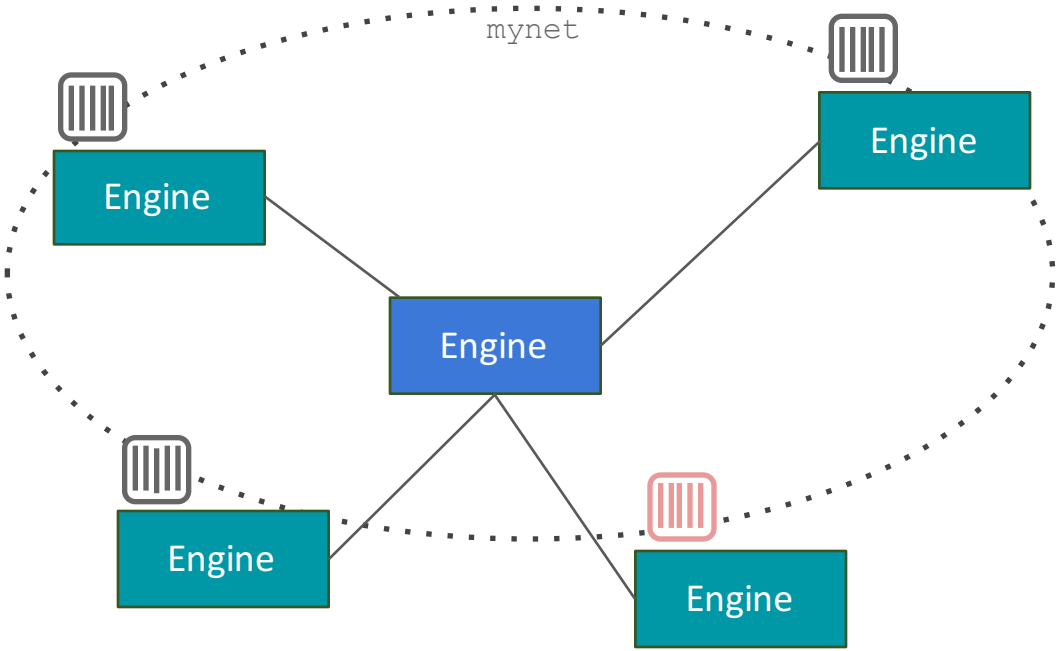
```

```
$ docker service create --name redis --network mynet redis:latest
```

Converge Back to Desired State

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```
$ docker service create --name redis --network mynet redis:latest
```

Lab: Part 3

https://github.com/mikegcoleman/docker101-linux

https://dockercon.play-with-docker.com

Please Complete the Survey

https://bit.ly/docker101survey