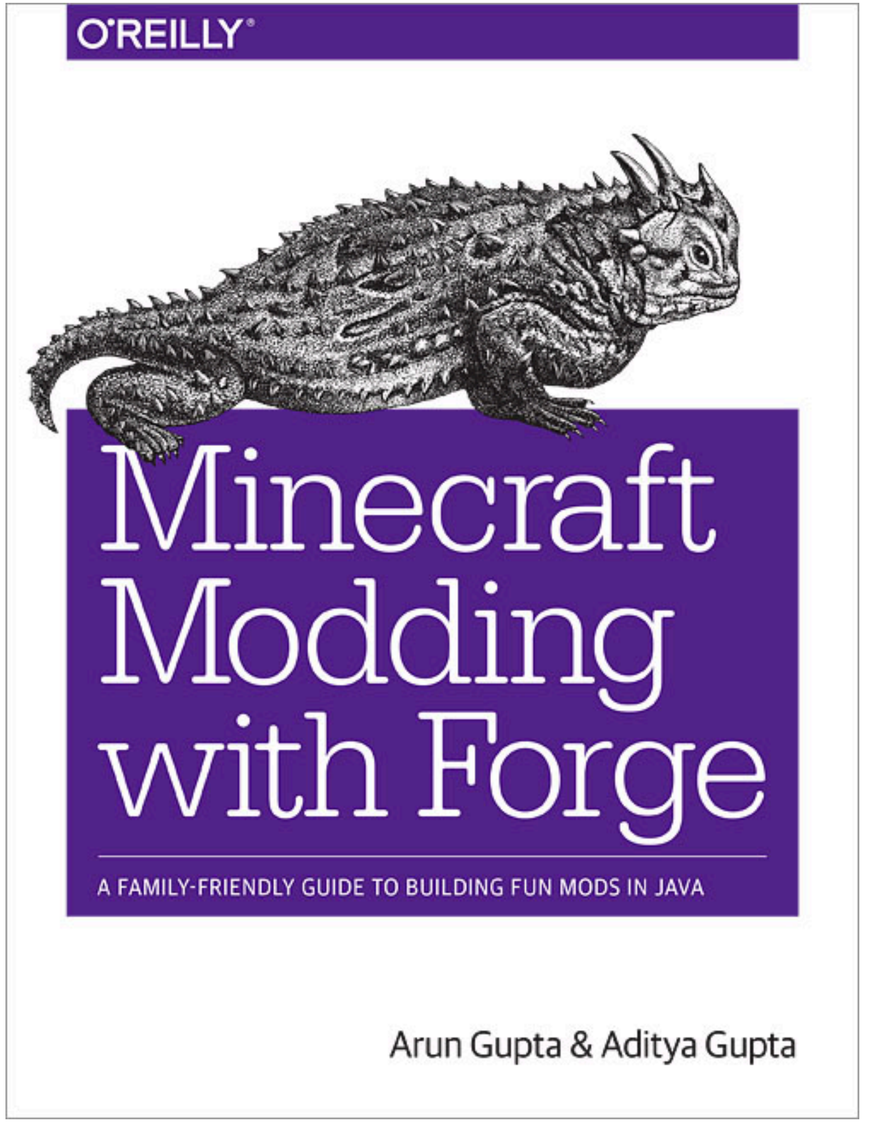
Getting Started with Docker

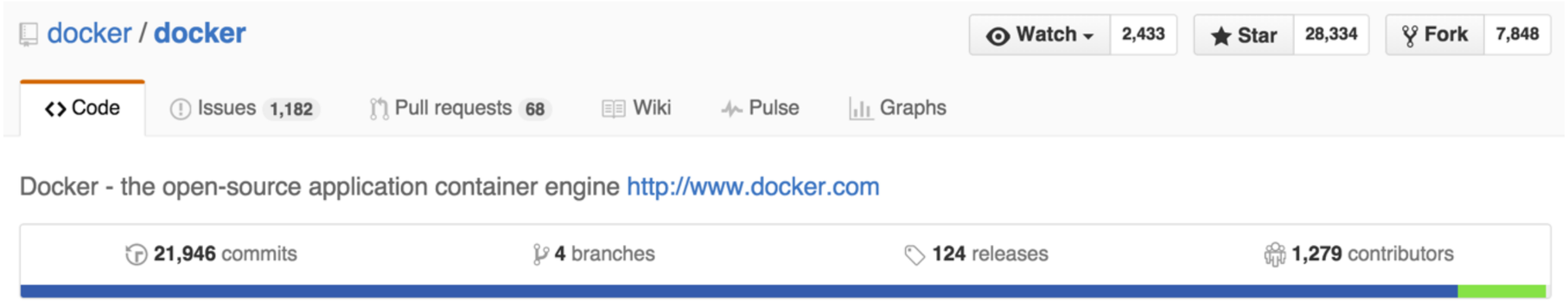
Arun Gupta, @arungupta
VP Developer Advocacy, Couchbase

DEVOXX™ 4KIDS USA

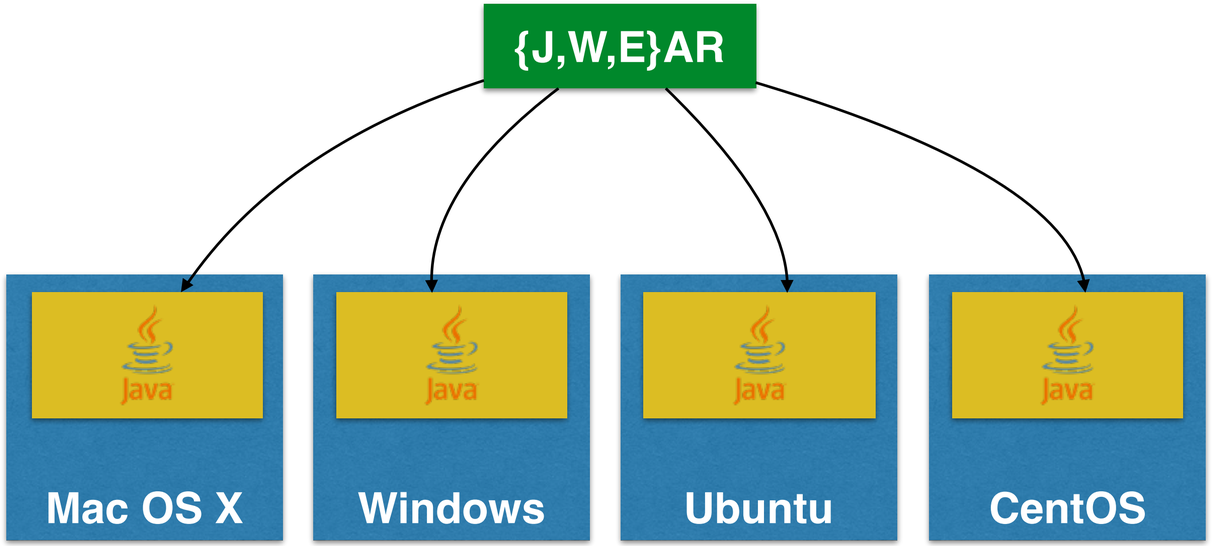


What is Docker?

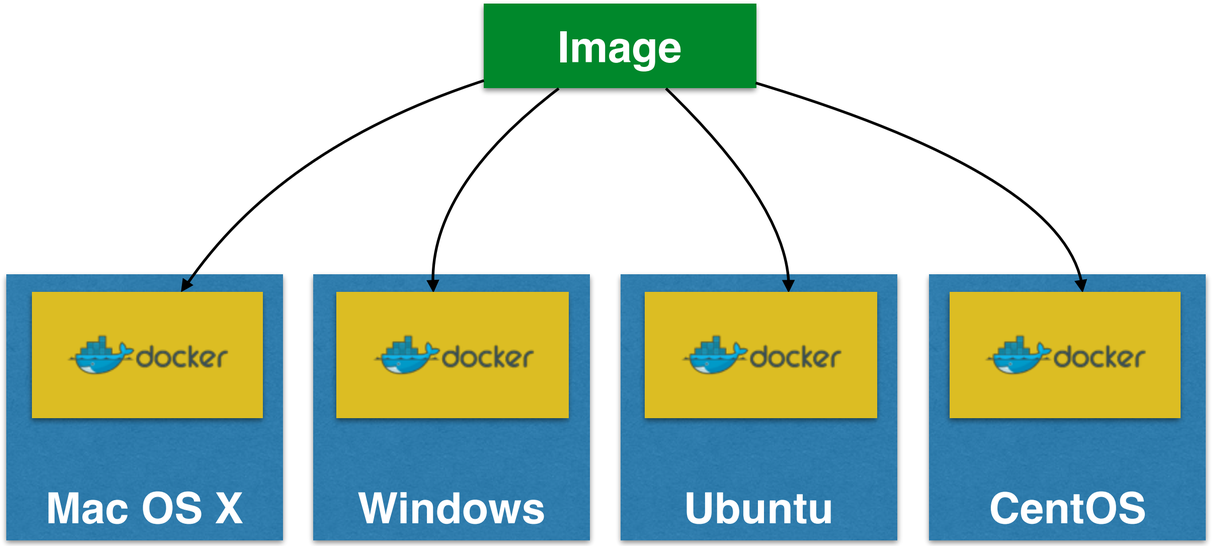
- Open source project and company



- Used to create containers for software applications
- Package Once Deploy Anywhere (PODA)

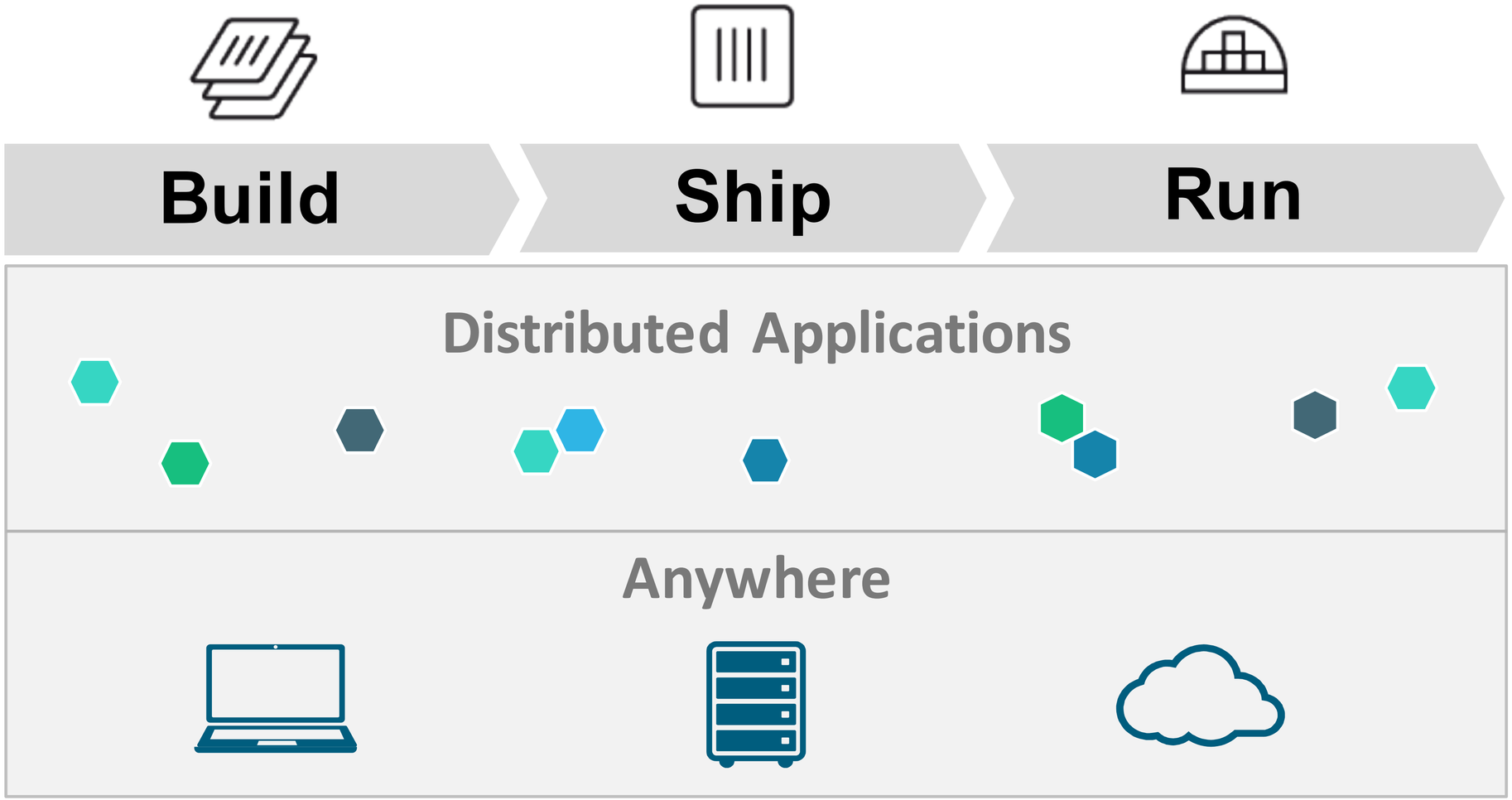


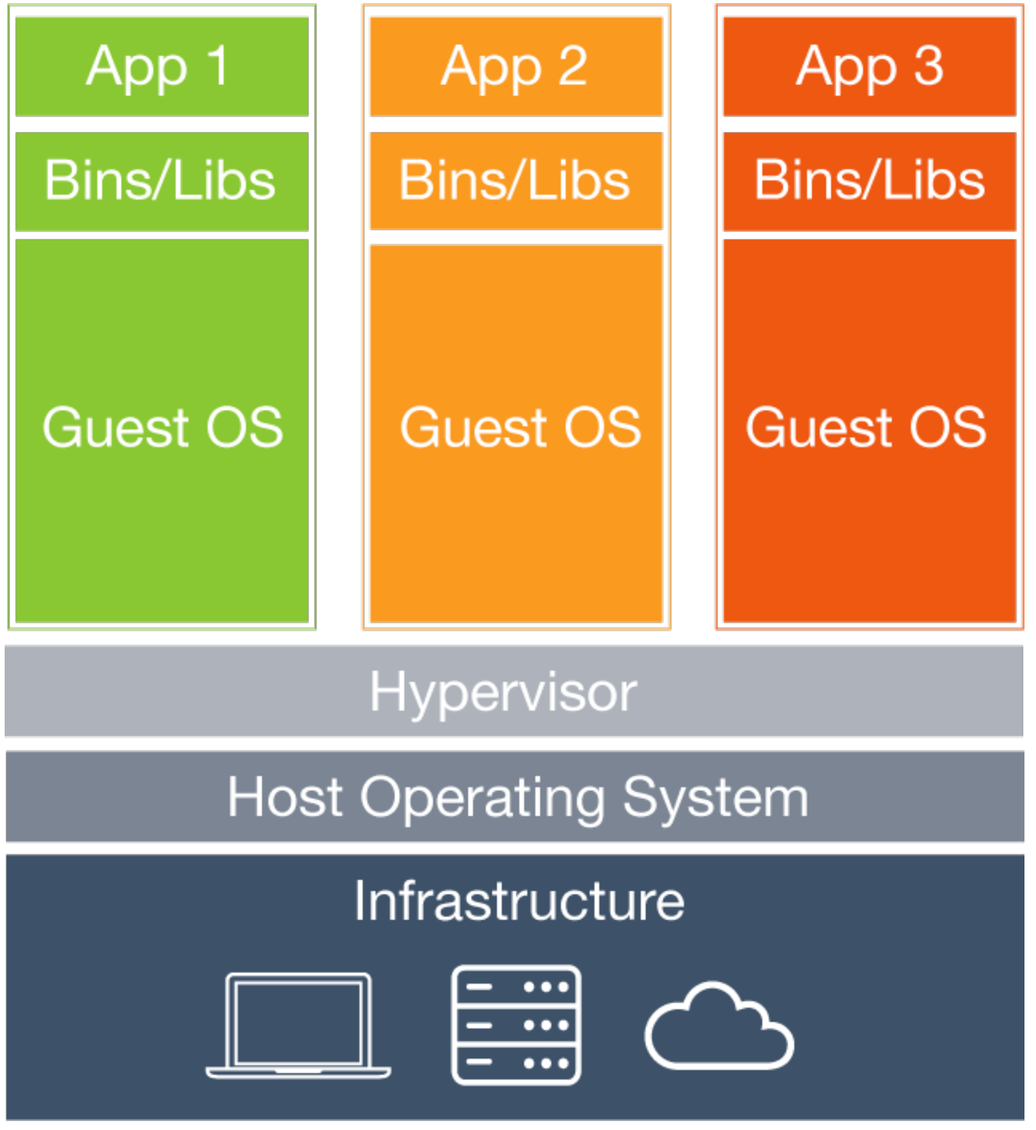
WORA = Write Once Run Anywhere

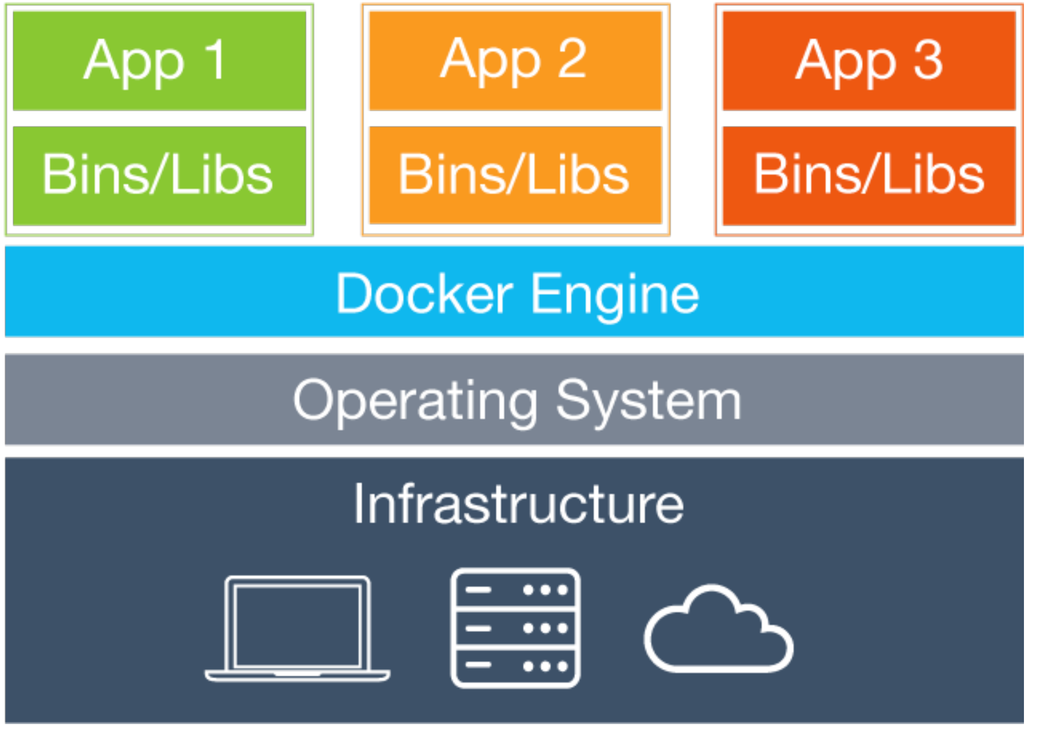


PODA = Package Once Deploy Anywhere

Docker Mission







Build

Develop an app using Docker containers with any language and any toolchain.

```
FROM ubuntu

CMD echo “Hello world”
```

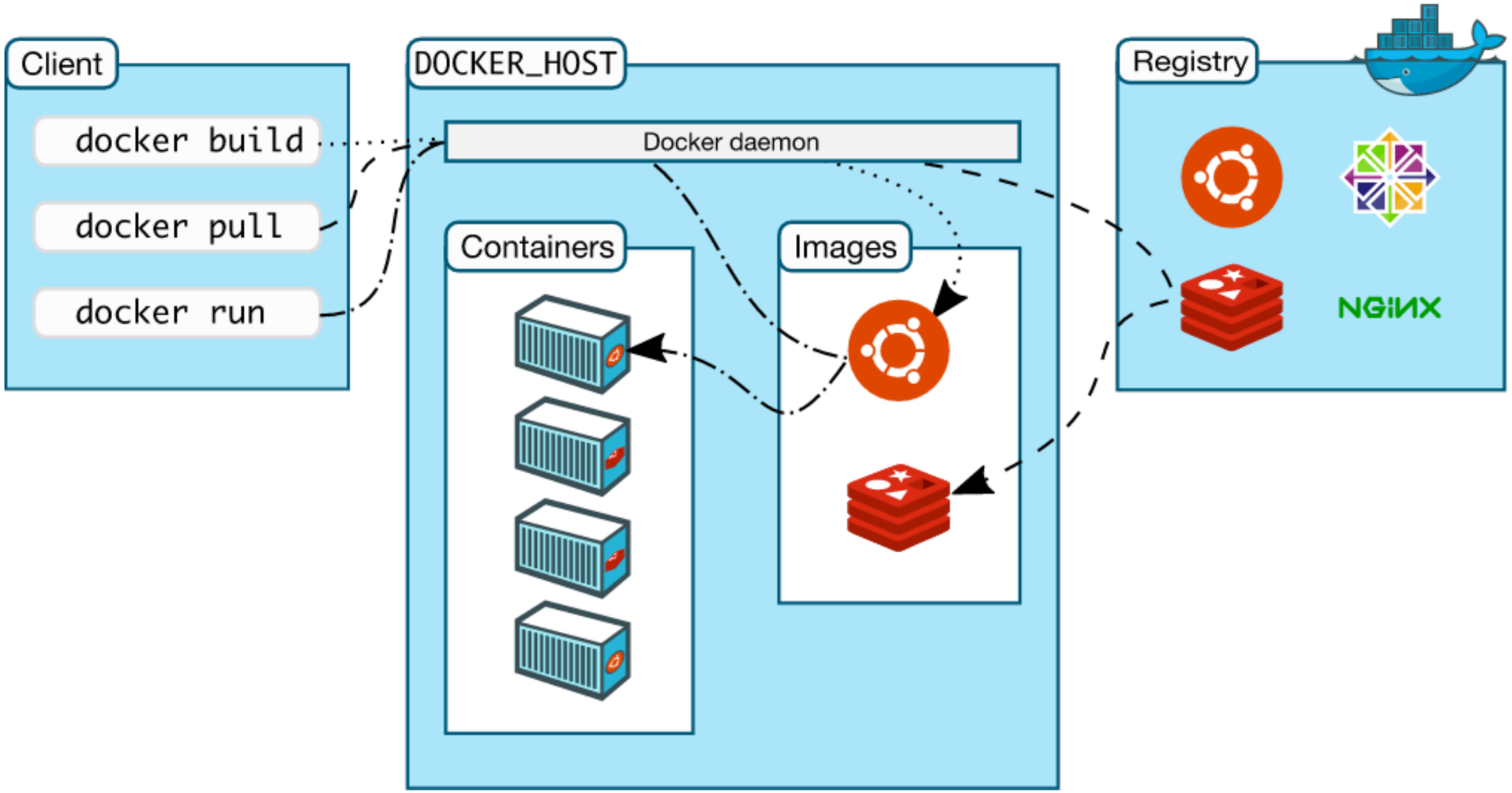
```
FROM jboss/wildfly

RUN curl -L https://github.com/javaee-
samples/javaee7-hol/raw/master/solution/
movieplex7-1.0-SNAPSHOT.war -o /opt/jboss/
wildfly/standalone/deployments/
movieplex7-1.0-SNAPSHOT.war
```

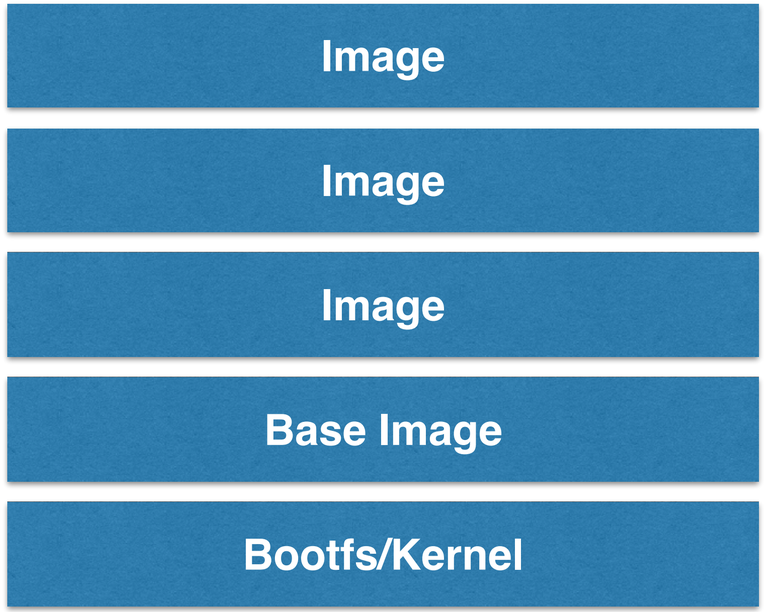
- Dockerfile reference
  - Usage
  - Format
    - Environment replacement
    - .dockerignore file
  - FROM
  - MAINTAINER
  - RUN
    - Known issues (RUN)
  - CMD
  - LABEL
  - EXPOSE
  - ENV
  - ADD
  - COPY
  - ENTRYPOINT
    - Exec form ENTRYPOINT example
    - Shell form ENTRYPOINT example
  - VOLUME
  - USER
  - WORKDIR
  - ARG
  - ONBUILD
  - STOPSIGNAL
  - Dockerfile examples

http://docs.docker.com/engine/reference/builder/

Docker Workflow



Union File System



jboss/wildfly

jboss/base-jdk:8

jboss/base

centos:7

Image Layers - Couchbase

```
~ > docker images couchbase
REPOSITORY          TAG                 IMAGE ID            CREATED             VIRTUAL SIZE
couchbase           latest              45abdd57689a        3 weeks ago         372 MB
~ > docker history couchbase
IMAGE               CREATED             CREATED BY                                      SIZE
COMMENT
45abdd57689a        3 weeks ago         /bin/sh -c #(nop) VOLUME [/opt/couchbase/var]   0 B
dd8c5611343d        3 weeks ago         /bin/sh -c #(nop) EXPOSE 11207/tcp 11210/tcp    0 B
30852bbad62b        3 weeks ago         /bin/sh -c #(nop) CMD ["couchbase-server"]      0 B
5537747ea12f        3 weeks ago         /bin/sh -c #(nop) ENTRYPOINT &{["/entrypoint.   0 B
e8a83a5448df        3 weeks ago         /bin/sh -c #(nop) COPY file:cbb44c9c65b64a9dc   182 B
18165b90fefa        3 weeks ago         /bin/sh -c #(nop) COPY file:34e32c52f0895191f   389 B
5f37b8bdc5a6        3 weeks ago         /bin/sh -c wget -N $CB_RELEASE_URL/$CB_VERSIO   212.1 MB
1a8da511d01b        3 weeks ago         /bin/sh -c groupadd -g 1000 couchbase && user   328.7 kB
d9b2222c39b4        3 weeks ago         /bin/sh -c #(nop) ENV CB_VERSION=4.0.0 CB_REL   0 B
815f08b3c781        3 weeks ago         /bin/sh -c apt-get update &&     apt-get inst   23.57 MB
fc38f156c0ea        3 weeks ago         /bin/sh -c #(nop) MAINTAINER Couchbase Docker   0 B
2a7a952931ec        3 weeks ago         /bin/sh -c #(nop) CMD ["/bin/bash"]             0 B
10f1b5844a9c        3 weeks ago         /bin/sh -c sed -i 's/^#\s*\(deb.*universe\)$/   1.911 kB
23c388b926b6        3 weeks ago         /bin/sh -c echo '#!/bin/sh' > /usr/sbin/polic   156.2 kB
b45376f323f5        3 weeks ago         /bin/sh -c #(nop) ADD file:4a9e089e81d6581a54   135.9 MB
```

Image Layers - WildFly

```
~ > docker images jboss/wildfly
REPOSITORY          TAG                 IMAGE ID            CREATED             VIRTUAL SIZE
jboss/wildfly       latest              be97bf33ad55        2 weeks ago         584.5 MB
~ > docker history jboss/wildfly
IMAGE               CREATED             CREATED BY                                      SIZE                COMMENT
be97bf33ad55        2 weeks ago         /bin/sh -c #(nop) CMD ["/opt/jboss/wildfly/bi   0 B
fd24a9f17c67        2 weeks ago         /bin/sh -c #(nop) EXPOSE 8080/tcp               0 B
f5dea43156ba        2 weeks ago         /bin/sh -c #(nop) ENV LAUNCH_JBOSS_IN_BACKGRO   0 B
b17d8182afad        2 weeks ago         /bin/sh -c cd $HOME     && curl -O https://do   159.1 MB
00429dab510a        2 weeks ago         /bin/sh -c #(nop) ENV JBOSS_HOME=/opt/jboss/w   0 B
ca2596a51c35        2 weeks ago         /bin/sh -c #(nop) ENV WILDFLY_SHA1=75738379f7   0 B
62de294133f4        2 weeks ago         /bin/sh -c #(nop) ENV WILDFLY_VERSION=9.0.2.F   0 B
52940fa06773        3 months ago        /bin/sh -c #(nop) ENV JAVA_HOME=/usr/lib/jvm/   0 B
bda081e220a9        3 months ago        /bin/sh -c #(nop) USER [jboss]                  0 B
1681ffdbbe50        3 months ago        /bin/sh -c yum -y install java-1.8.0-openjdk-   195.3 MB
3b4e1d18fb41        3 months ago        /bin/sh -c #(nop) USER [root]                   0 B
481c174e3d0d        3 months ago        /bin/sh -c #(nop) MAINTAINER Marek Goldmann <   0 B
722c8bdf4d33        5 months ago        /bin/sh -c #(nop) USER [jboss]                  0 B
88389be452f6        5 months ago        /bin/sh -c #(nop) WORKDIR /opt/jboss            0 B
e5351df2706d        5 months ago        /bin/sh -c groupadd -r jboss -g 1000 && usera   294.8 kB
e3ff94cddd8b        5 months ago        /bin/sh -c yum update -y && yum -y install xm   57.58 MB
92009d6c8aff        5 months ago        /bin/sh -c #(nop) MAINTAINER Marek Goldmann <   0 B
7ed0005a64f9        5 months ago        /bin/sh -c #(nop) CMD ["/bin/bash"]             0 B
4d1ec7e2b1dd        5 months ago        /bin/sh -c #(nop) ADD file:82835f82606420c764   172.2 MB
a2c33fe967de        7 months ago        /bin/sh -c #(nop) MAINTAINER The CentOS Proje   0 B
```

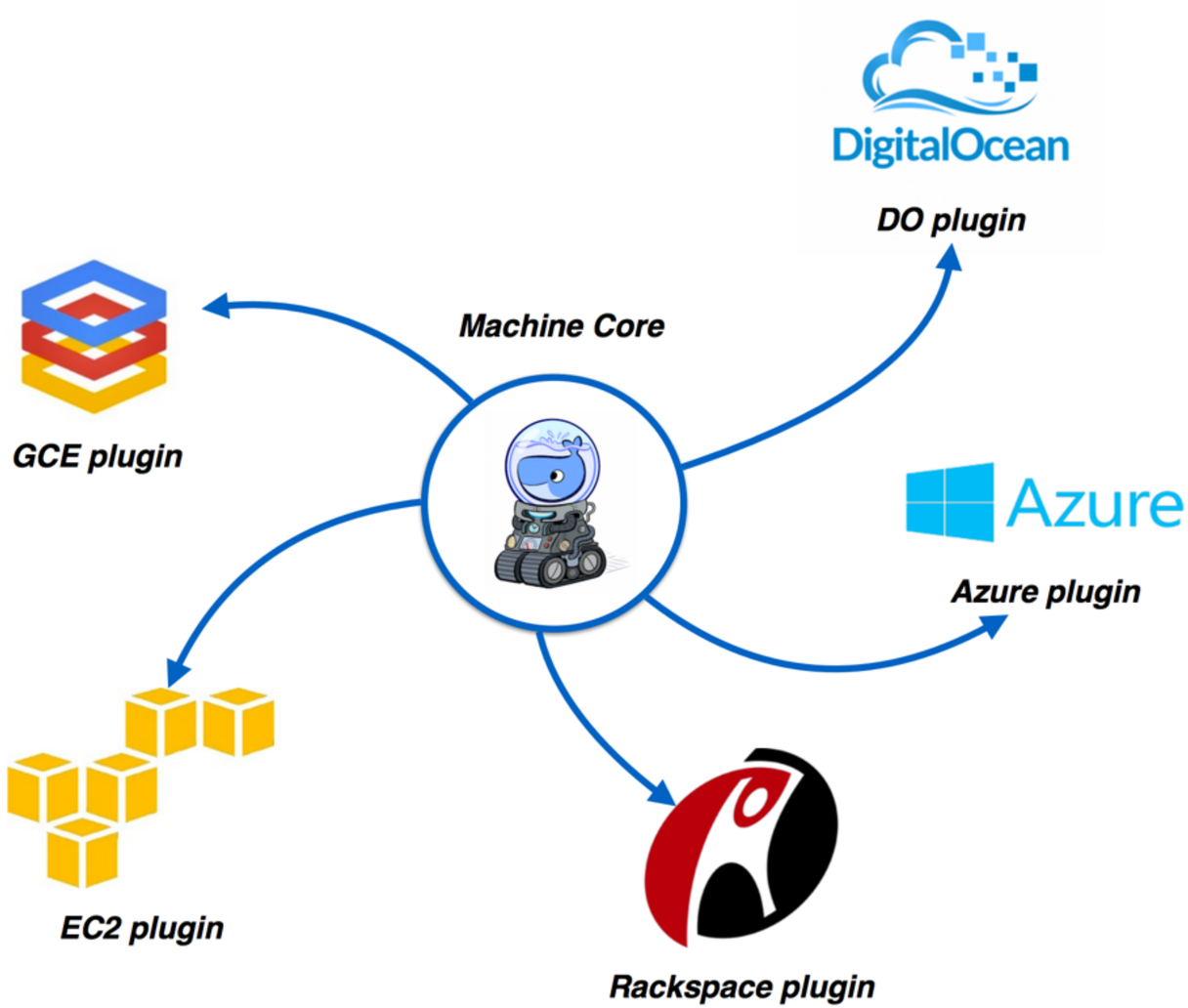
Docker Machine

- Create Docker Host on computer or cloud provider

```
docker-machine create --driver=virtualbox myhost
```

  - Configure Docker client to talk to host
  - Create and pull images
  - Start, stop, restart containers
  - Upgrade Docker
- Not recommended for production yet

Docker Machine Providers



boot2docker

- Migrate to Docker Machine

```
docker-machine
create -d virtualbox
--virtualbox-import-boot2docker-vm
boot2docker-vm docker-vm
```

`boot2docker`	`docker-machine`	`docker-machine` **description**
init	create	Creates a new docker host.
up	start	Starts a stopped machine.
ssh	ssh	Runs a command or interactive ssh session on the machine.
save	-	Not applicable.
down	stop	Stops a running machine.
poweroff	stop	Stops a running machine.
reset	restart	Restarts a running machine.
config	inspect	Prints machine configuration details.
status	ls	Lists all machines and their status.
info	inspect	Displays a machine's details.
ip	ip	Displays the machine's ip address.
shellinit	env	Displays shell commands needed to configure your shell to interact with a machine
delete	rm	Removes a machine.
download	-	Not applicable.
upgrade	upgrade	Upgrades a machine's Docker client to the latest stable release.

https://docs.docker.com/machine/migrate-to-machine/

Docker Toolbox

- Docker Client 1.9.0
- Docker Machine 0.5.0
- Docker Compose 1.5.0 ~~(Mac only)~~
- Docker Kitematic 0.9.3
- Boot2Docker ISO 1.9.0
- Virtualbox 5.0.8

https://www.docker.com/toolbox

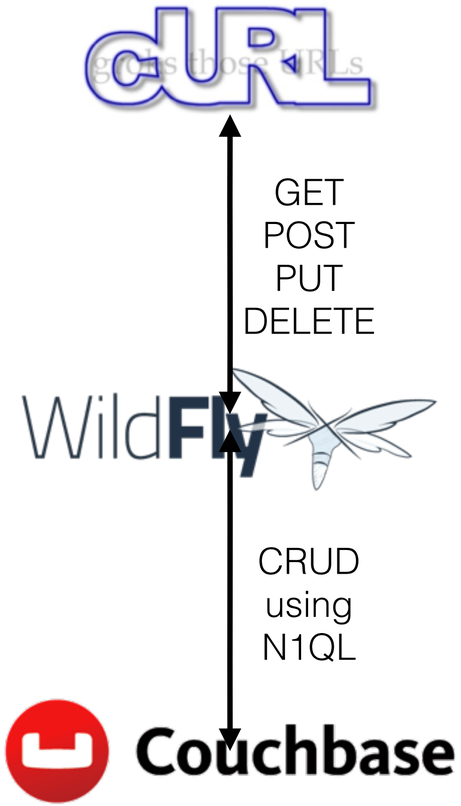
Docker Compose - One Service

```
mycouchbase:
  name: mycouchbase
  image: couchbase/server
  volumes:
    - ~/couchbase:/opt/couchbase/var
  ports:
    - 8091:8091
    - 8092:8092
    - 8093:8093
    - 11210:11210
```

```
docker run
--name couchbase
-p 8091:8091
-p 8093:8093
-p 11210:11210
-v ~/couchbase:/opt/couchbase/var
-d
couchbase
```

```
docker run
--name mywildfly
--link mycoucbbase:cb
-p 8080:8080
-d
arungupta/wildfly-admin
```

Docker Compose - Two Services

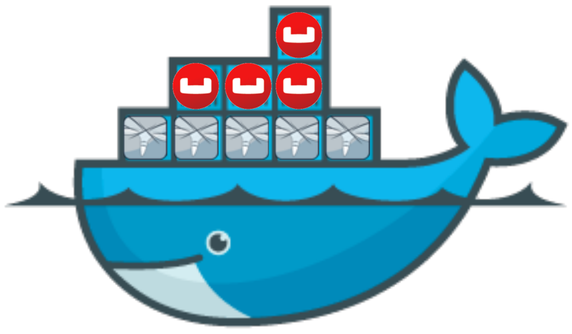


Docker Compose

- Defining and running multi-container applications
- Configuration defined in one or more files
  - `docker-compose.yml` (default)
  - `docker-compose.override.yml` (default)
  - Multiple files specified using `-f`
  - All paths relative to base configuration file
- Great for dev, staging, and CI

Docker Compose - Two Services

```
mycouchbase:
  image: couchbase/server
  ports:
    - 8091:8091
    - 8092:8092
    - 8093:8093
    - 11210:11210
mywildfly:
  image: arungupta/wildfly-admin
  links:
    - mycouchbase:cb
  ports:
    - 8080:8080
    - 9990:9990
```



docker

Docker Compose - Links

```
CouchbaseCluster.create(System.getenv("DB_PORT_8091_TCP_ADDR"));
```

Docker Compose - Couchbase Cluster

```
couchbase1:
  image: couchbase/server
  volumes:
    - ~/couchbase/node1:/opt/couchbase/var
couchbase2:
  image: couchbase/server
  volumes:
    - ~/couchbase/node2:/opt/couchbase/var
couchbase3:
  image: couchbase/server
  volumes:
    - ~/couchbase/node3:/opt/couchbase/var
  ports:
    - 8091:8091
    - 8092:8092
    - 8093:8093
    - 11210:11210
```

Overriding Services in Docker Compose

```
mywildfly:
  image: jboss/wildfly
  ports:
    - 8080:8080
```

docker-compose.yml

```
mywildfly:
  ports:
    - 9080:8080
```

docker-compose.override.yml

```
docker-compose up -d
```

Dev/Prod with Compose

```
mycouchbase:
  container_name: "db-dev"
  image: couchbase/server
  ports:
    - . . .
mywildfly:
  image: arungupta/wildfly-couchbase-javaee7
  environment:
    - COUCHBASE_URI=db-dev:8093
  ports:
    - 8080:8080
```

docker-compose.yml

```
docker-compose up -d
```

```
mywildfly:
 environment:
    - COUCHBASE_URI=db-prod:8093
  ports:
    - 80:8080
mycouchbase:
  container_name: "db-prod"
```

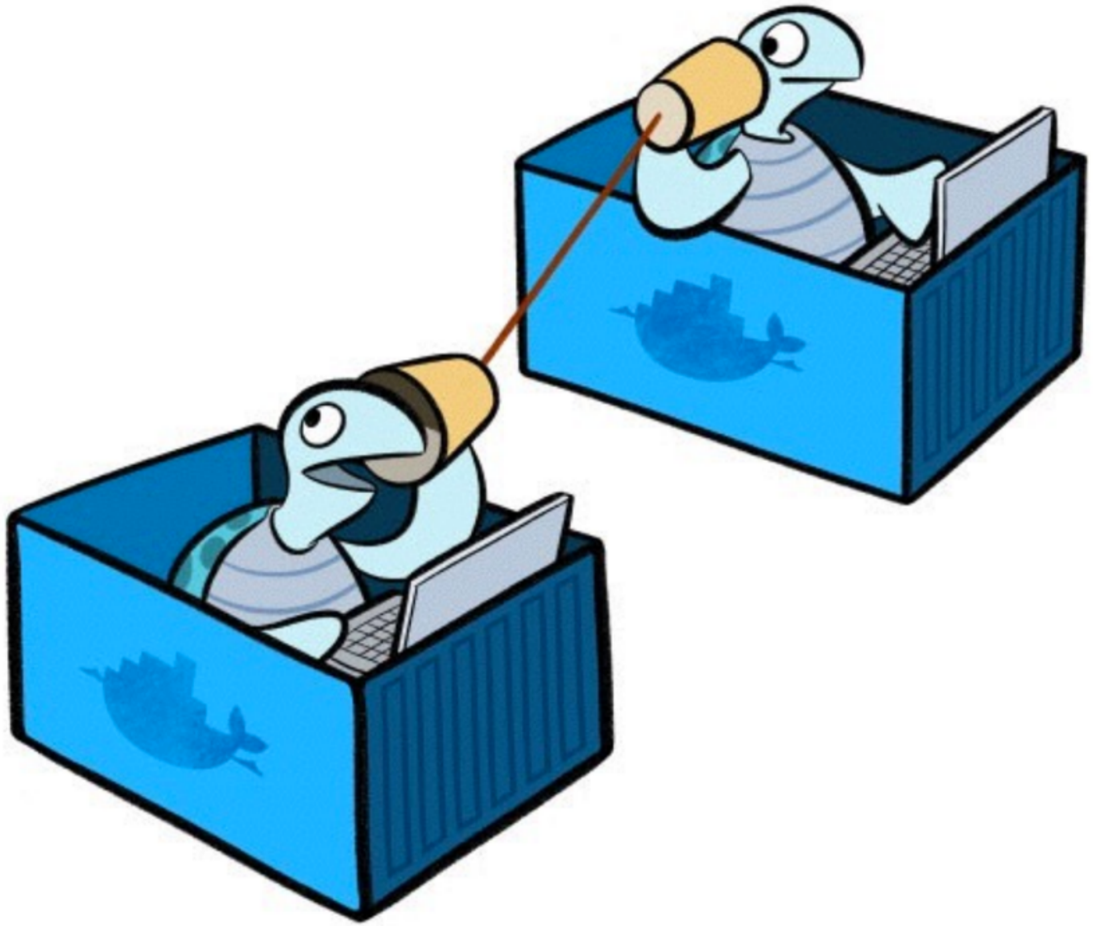
production.yml

```
docker-compose up
-f docker-compose.yml
-f production.yml
-d
```

Compose in Production

- Primarily aimed at development and testing environments
- May be for smaller deployments
- Not suitable for larger deployments

Multi Host Networking



Default Networks

```
docker network ls
NETWORK ID          NAME                DRIVER
8cf651cafbef        bridge              bridge
14e63204639e        none                null
96901337c96f        host                host
```

Network Name	Purpose
`bridge`	Default network that containers connect to
`none`	Container-specific networking stack
`host`	Adds container on hosts networking stack

Multi-host Networking

- Create virtual networks and attach containers
- **`Bridge`** network span single host
- **`Overlay`** network spans multiple hosts
  - Uses **`libnetwork`** (built-in VXLAN-based overlay network driver) and Docker's **`libkv`**
- Works with Swarm and Compose
  - Experimental in Compose
- Pluggable: Calico, Cisco, Weave, . . .

Networking vs Links

- Connect containers to each other across different physical or virtual hosts
- Containers can be easily stopped, started and restarted w/o disrupting connection to other containers
- Can be created in any order

```
mycouchbase:
  image: couchbase/server
  ports:
    - 8091:8091
    - 8092:8092
    - 8093:8093
    - 11210:11210
mywildfly:
  image: arungupta/wildfly-admin
  links:
    - mycouchbase:cb
  ports:
    - 8080:8080
    - 9990:9990
```

Links

```
mycouchbase:
  container_name: "db"
  image: couchbase/server
  ports:
    - 8091:8091
    - 8092:8092
    - 8093:8093
    - 11210:11210
mywildfly:
  image: arungupta/wildfly-admin
  environment:
    - COUCHBASE_URI=db
  ports:
    - 8080:8080
    - 9990:9990
```

Networking

Networking - Application Code

```
CouchbaseCluster.create(System.getenv("DB_PORT_8091_TCP_ADDR"));
```

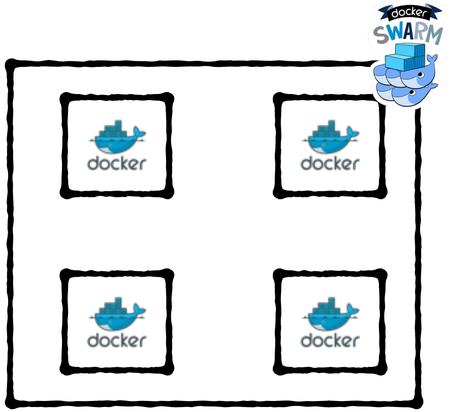
Links

```
CouchbaseCluster.create(System.getenv("COUCHBASE_URI"));
```

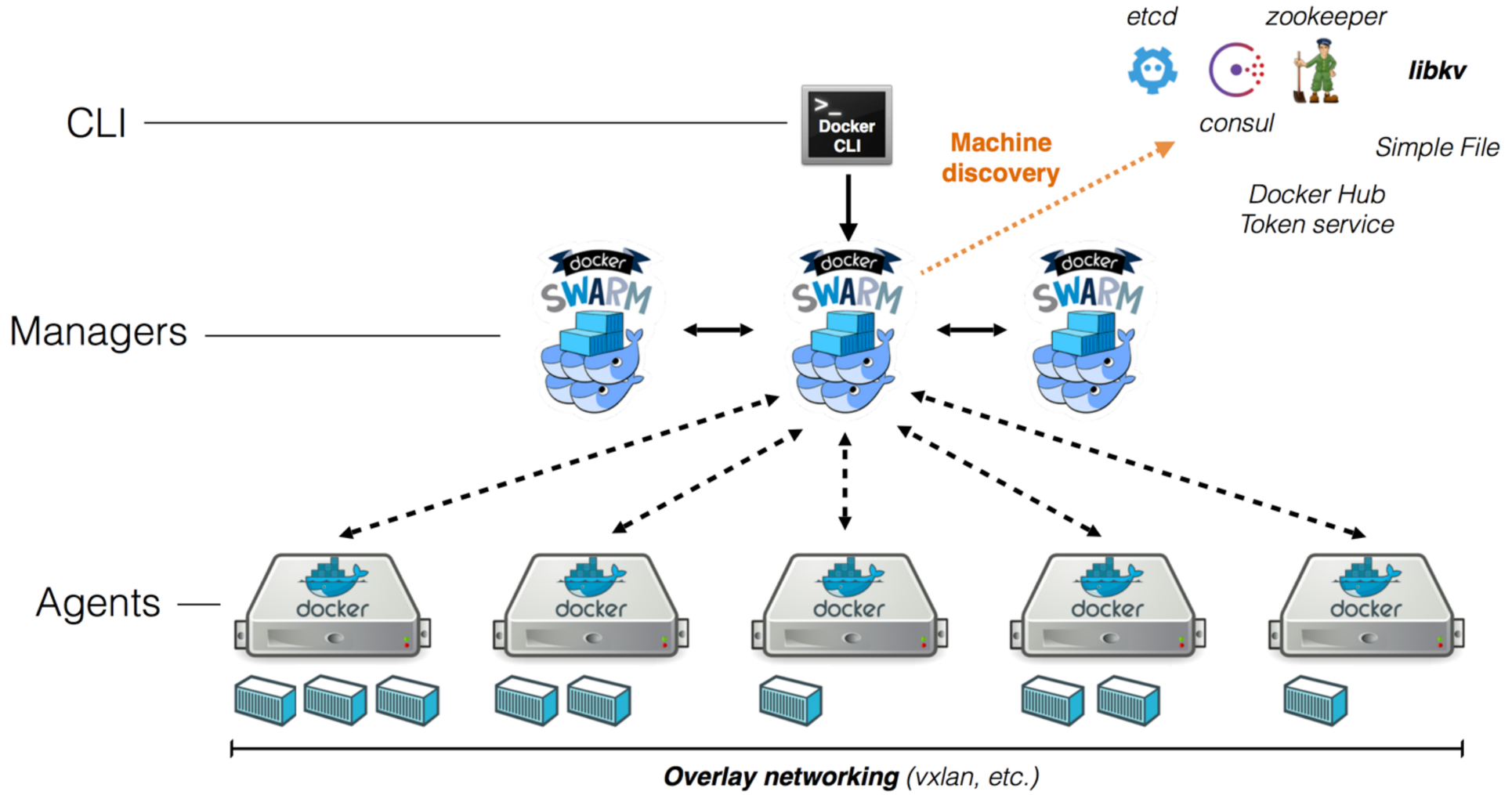
Networking

Docker Swarm

- Native clustering for Docker
- Provides a unified interface to a pool of Docker hosts
- Fully integrated with Machine and Compose
- Serves the standard Docker API
- 1.0.1 - Ready for production?



Stress tested on 1000 EC2 nodes, ~30k containers



Node Discovery

```
docker-machine create
--engine-opt --cluster-advertise=<value>
--engine-opt --cluster-store=<value>
--engine-opt -cluster-store-opt=<value>
-d=virtualbox
myMachine
```

Master High Availability

- Handle the failover of a manager instance
- **Primary** manager, multiple **replica** instances
- Requests to replica are proxied to primary
- **`docker run swarm manage`**
  - **`--replication`**: Enable Swarm manager replication
  - **`--replication-ttl “30s”`**: Leader lock release time on failure
  - **`--advertise`**, **`--addr`**: Address of the swarm manager joining the cluster

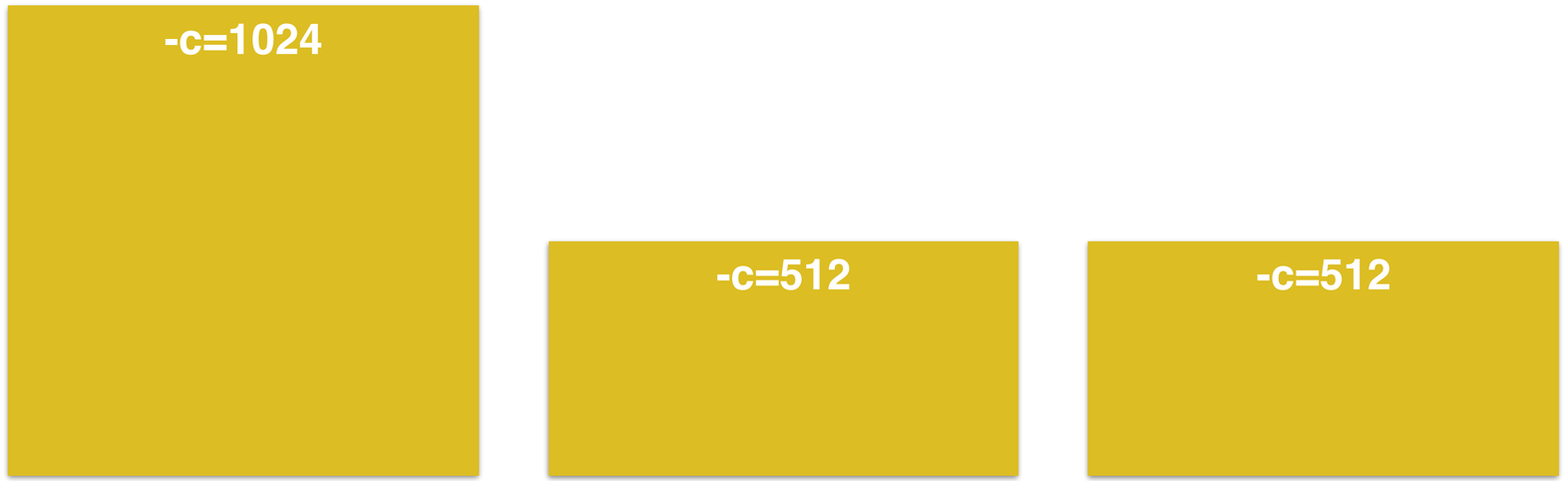
https://docs.docker.com/swarm/multi-manager-setup/

Scheduling Backends

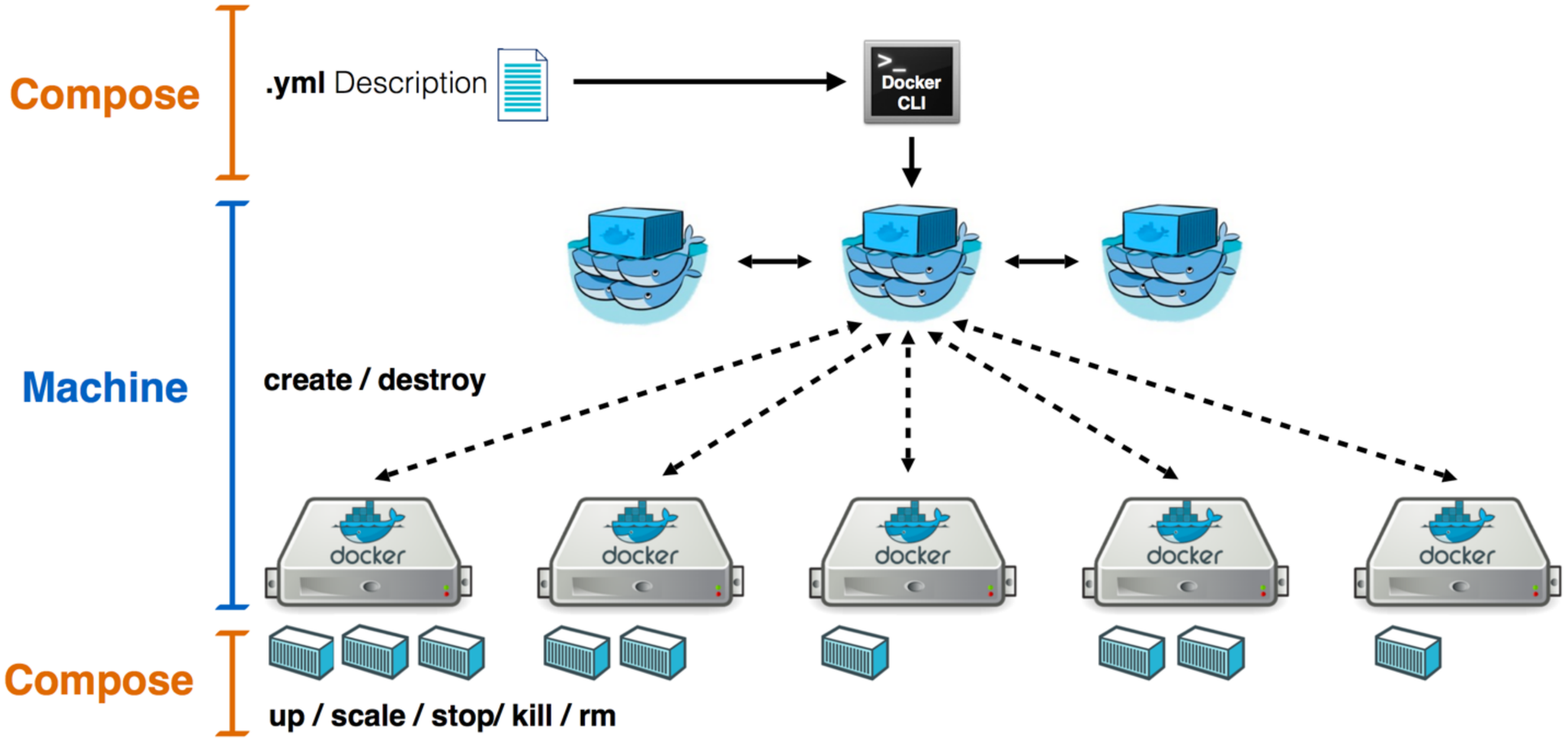
- Based on CPU (`-c`), RAM (`-m`), number of containers
- `docker machine create –strategy <value>`
  - `spread` (default): node with least number of running containers
  - `binpack`: node with most number of running containers
  - `random`: mostly for debugging
- API for pluggable backends (e.g. Mesos) coming

Limiting CPU resources

```
docker run --help | grep cpu
  --cpu-shares=0                 CPU shares (relative weight)
  --cpu-period=0                 Limit CPU CFS (Completely Fair Scheduler) period
  --cpu-quota=0                  Limit CPU CFS (Completely Fair Scheduler) quota
  --cpuset-cpus=                 CPUs in which to allow execution (0-3, 0,1)
  --cpuset-mems=                 MEMs in which to allow execution (0-3, 0,1)
```



Machine + Swarm + Compose



Persistent Storage

- Data volumes - used to persist data independent of container's lifecycle
- Multiple plugins: Flocker, Ceph, . . .

```
docker volume --help

Usage: docker volume [OPTIONS] [COMMAND]

Manage Docker volumes

Commands:
  create                  Create a volume
  inspect                 Return low-level information on a volume
  ls                      List volumes
  rm                      Remove a volume
```

Persistent Storage

Create a volume

```
docker volume create –name=data data
```

Run a container with the volume

```
docker run -it -v data:/opt/couchbase/
var couchbase/server
```

docker network

```
docker network --help

Usage: docker network [OPTIONS] COMMAND [OPTIONS]

Commands:
  disconnect                  Disconnect container from a network
  inspect                     Display detailed network information
  ls                          List all networks
  rm                          Remove a network
  create                      Create a network
  connect                     Connect container to a network
```

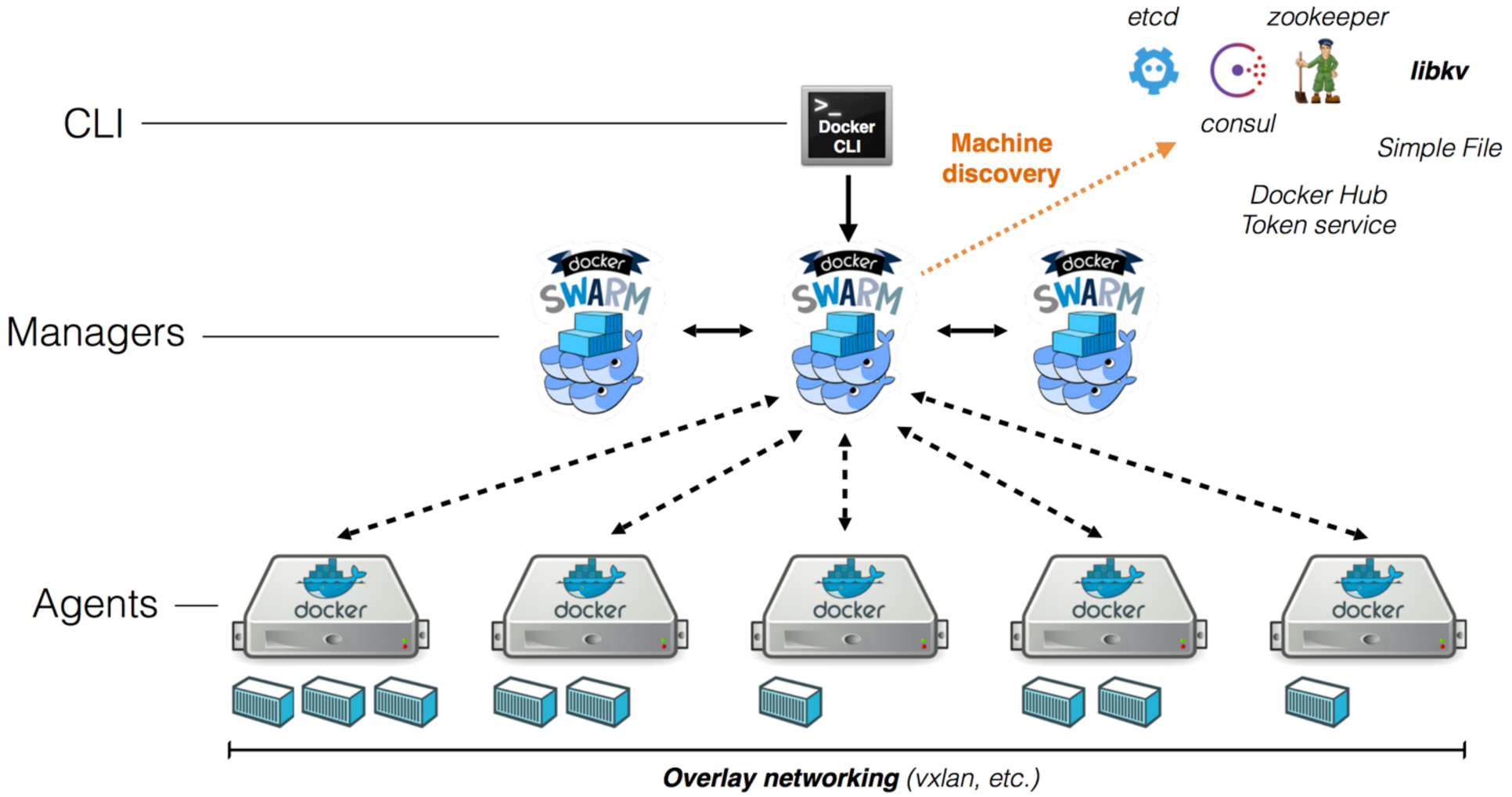
Docker Compose and Networking

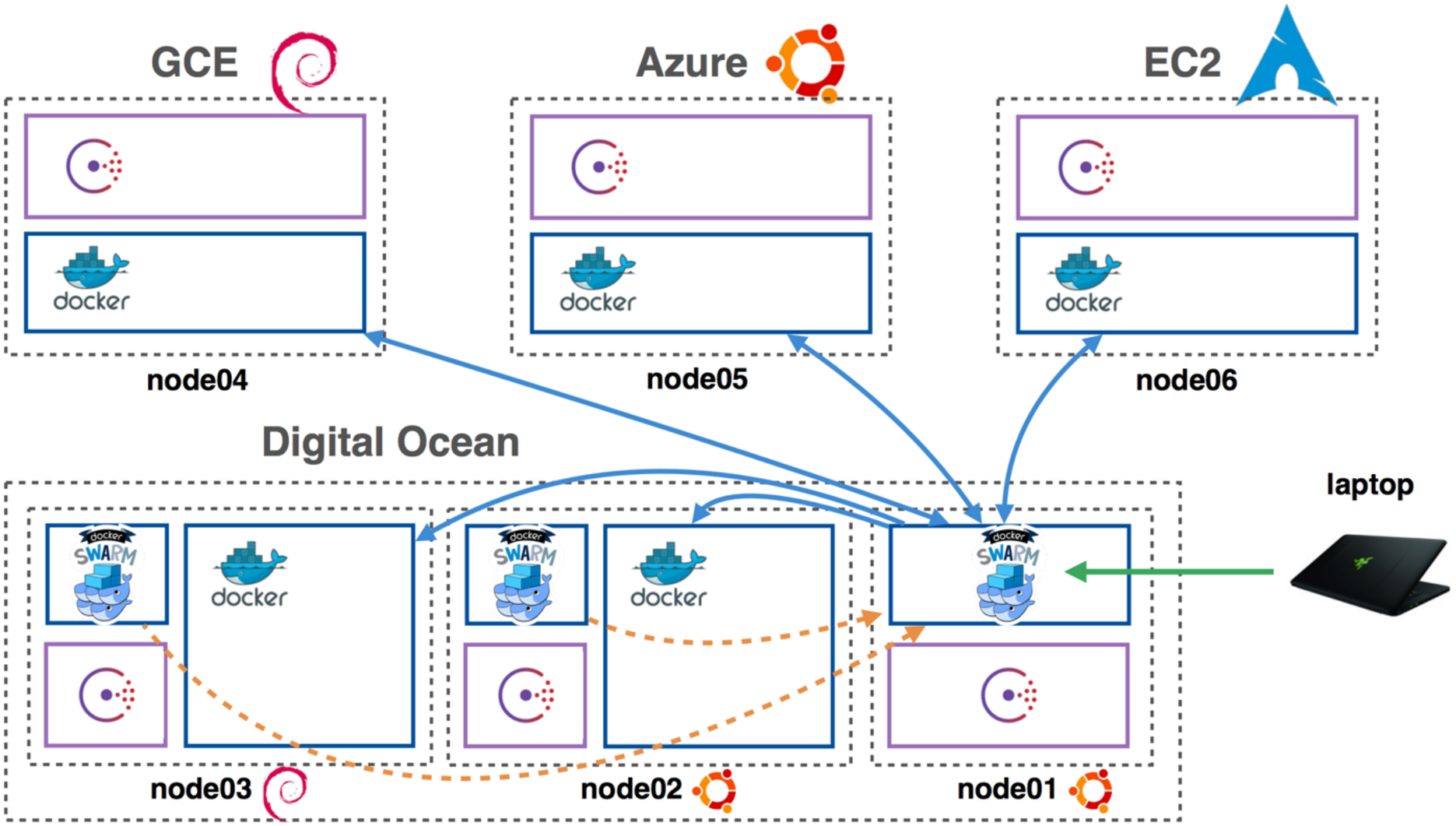
- `docker network ls`

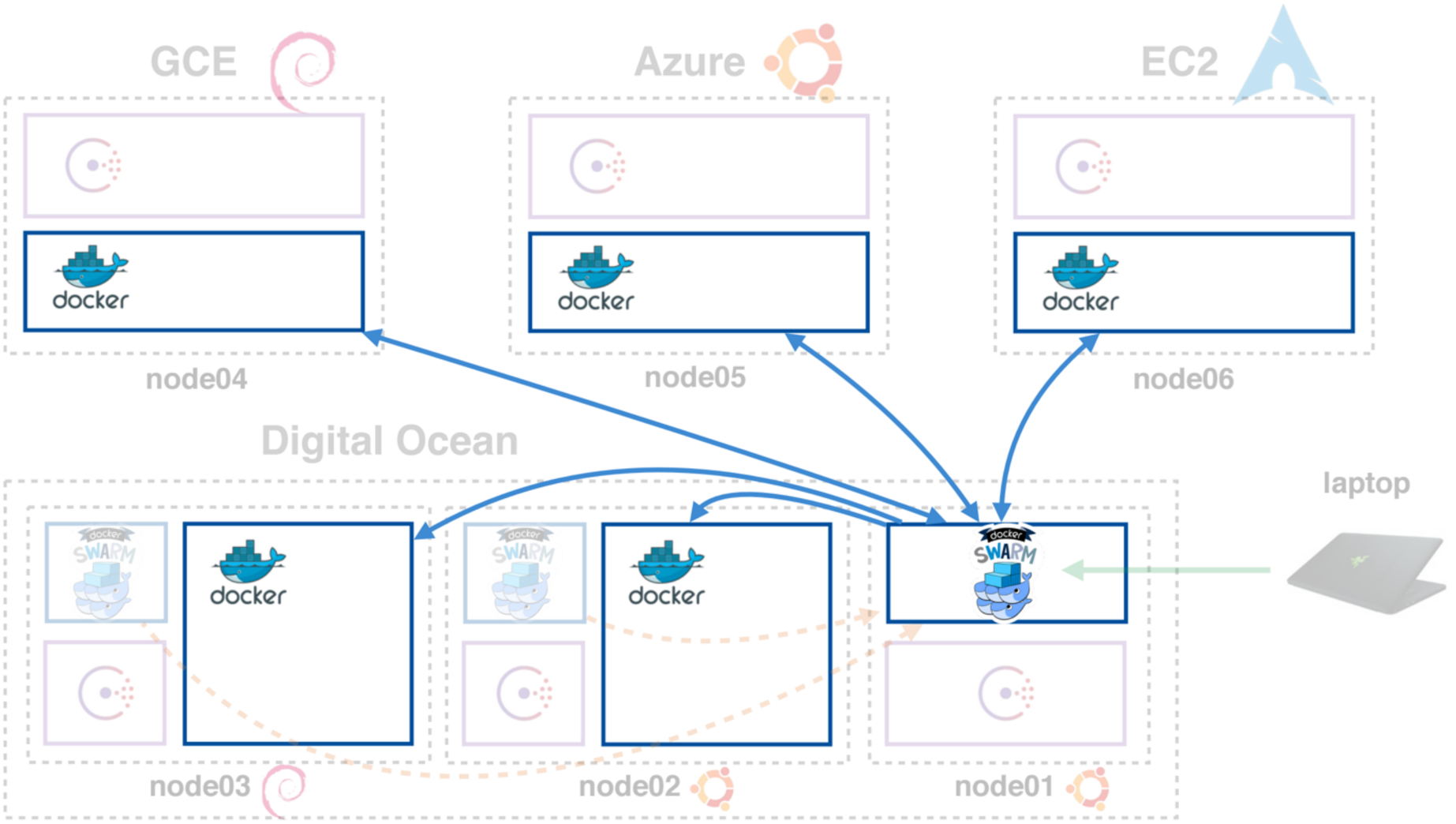
```
NETWORK ID          NAME                DRIVER
1d4d4152b99a        bridge              bridge
8396171e6bbc        none                null
8b50dda5fe61        host                host
```

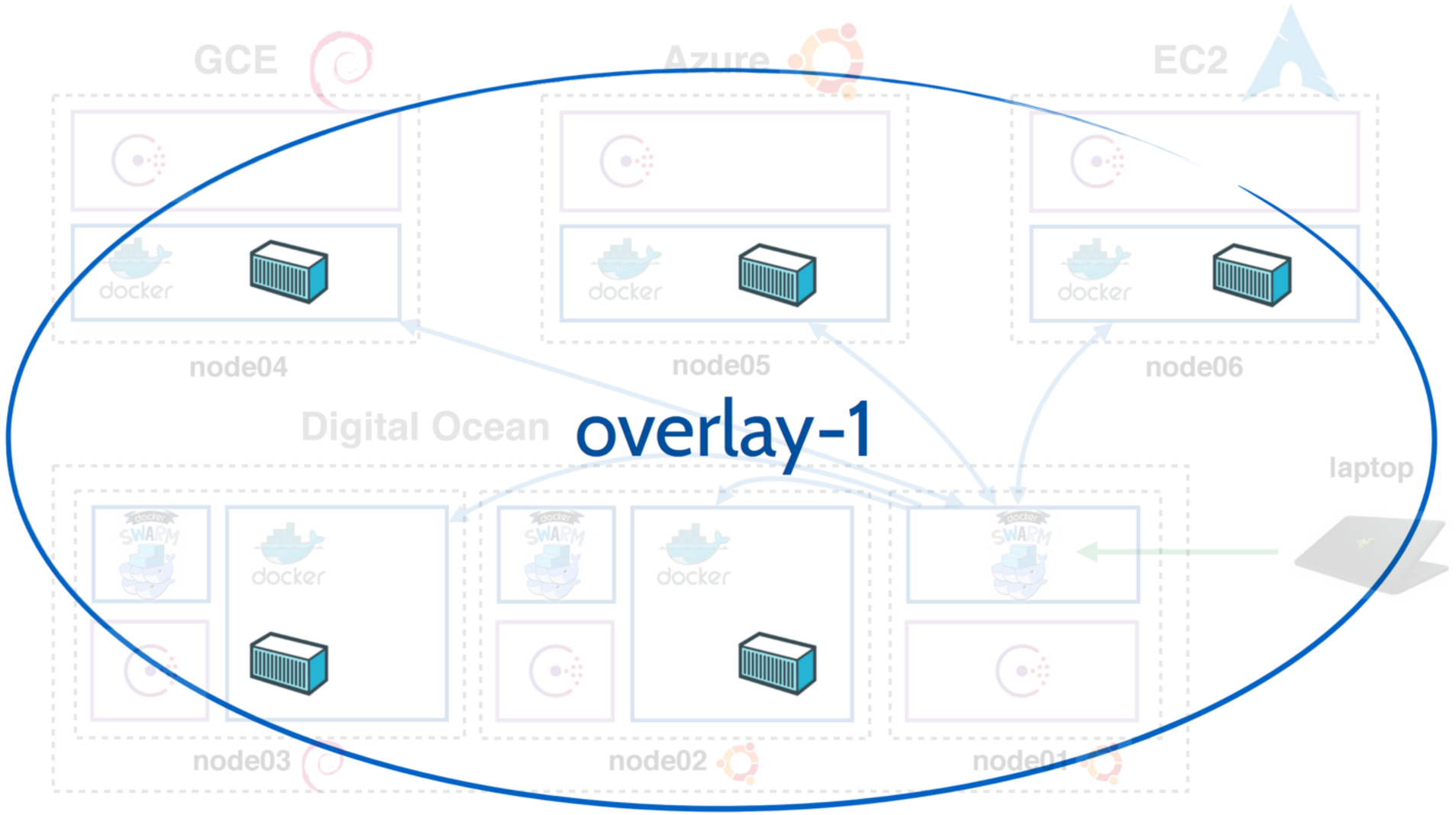
- `docker-compose --x-networking up -d`
- `docker network ls`

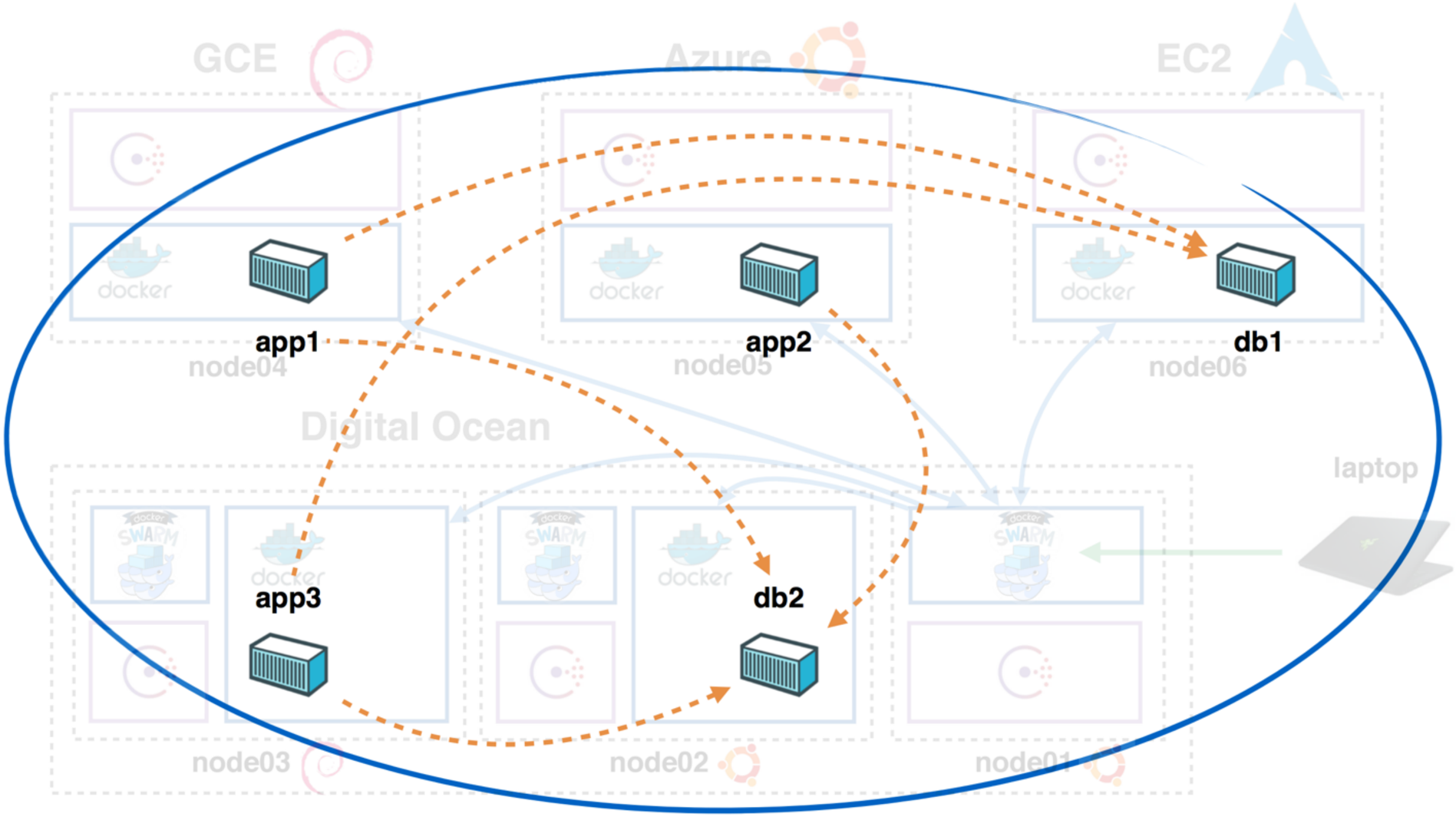
```
NETWORK ID          NAME                          DRIVER
1d4d4152b99a        bridge                        bridge
8396171e6bbc        none                          null
8b50dda5fe61        host                          host
b1770955e5aa        wildflycouchbasejavaee7       bridge
```

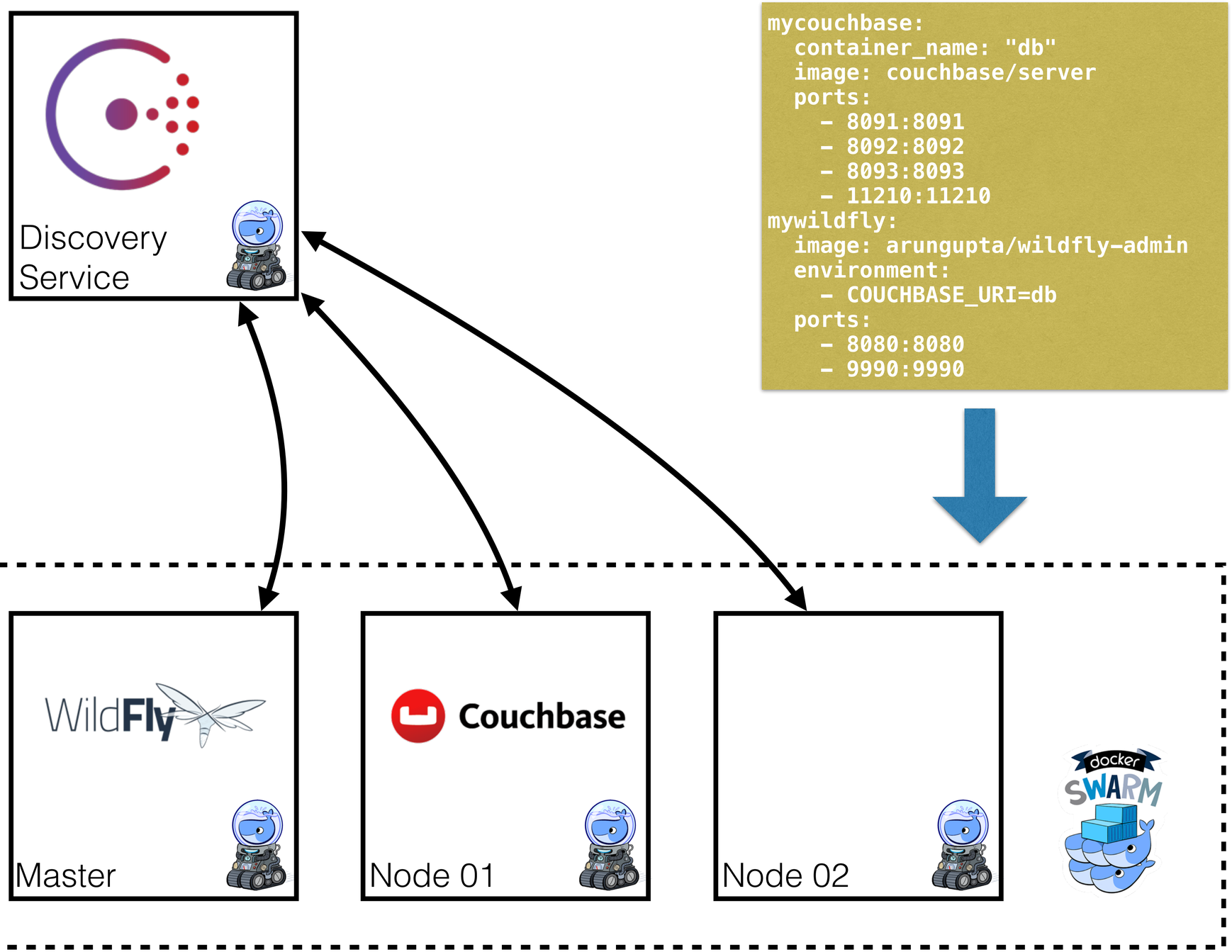












Docker Tutum

- SaaS
- Build
- Deploy and manage across different clouds
  - Amazon, Digital Ocean, Microsoft, Azure, IBM SoftLayer
  - BYON

Docker Tutum

Build

Containerize your applications and accelerate development.

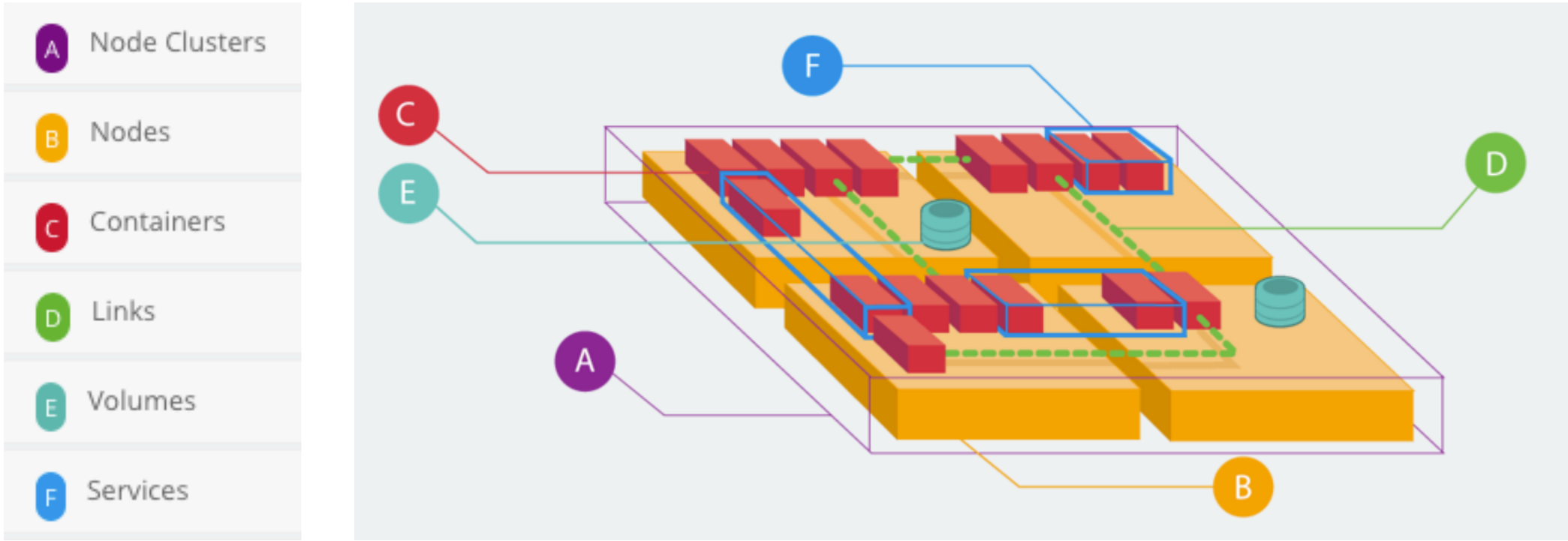
Deploy

All frameworks and technologies welcomed. Scale with ease on any Cloud.

Manage

Simplify operations, focus on your code, and forget about managing servers.

Docker Tutum Architecture

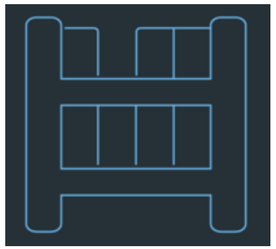


https://www.tutum.co/how/

Docker Universal Control Plane

- On-premise management solution for Docker
- Swarm: clustering and orchestration
- More details coming

Docker Trusted Registry



- Registry to store and manage images on-premise
  - securely within your firewall
  - Maintain control over Docker images
  - Meet security or regulatory compliance

DTR Primary Usage Scenario

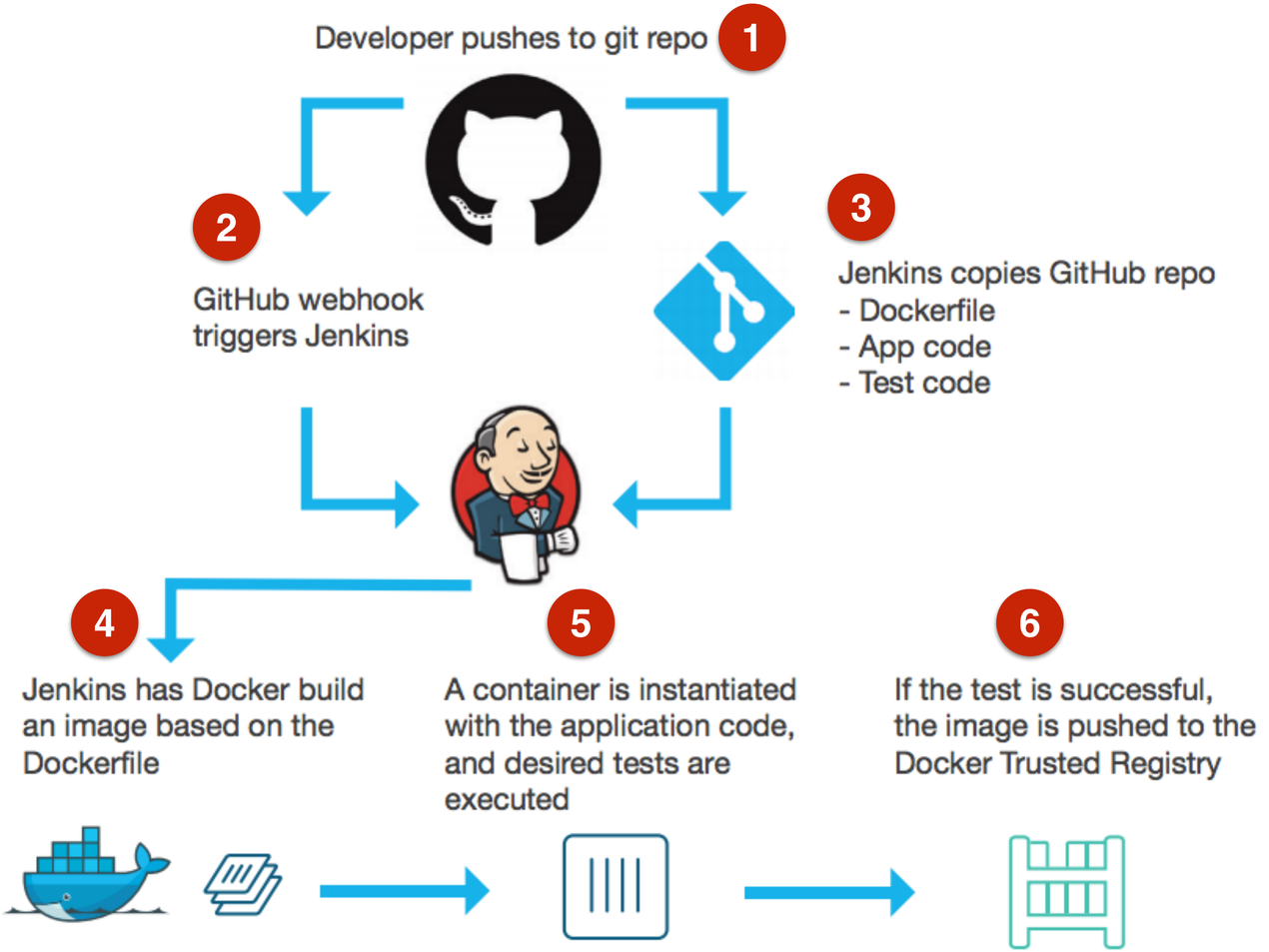
- CI/CD with Docker
  - Centrally located base images
  - Store individual build images
  - Pull tested images to production

DTR Features

- **Deployment flexibility**: can be installed on infrastructure of your choice
- **Integrates into your infrastructure**: storage backends, AD/LDAP user authentication
- **Delete** old images
- **Configure garbage collection** to optimize storage allocation
- RBAC

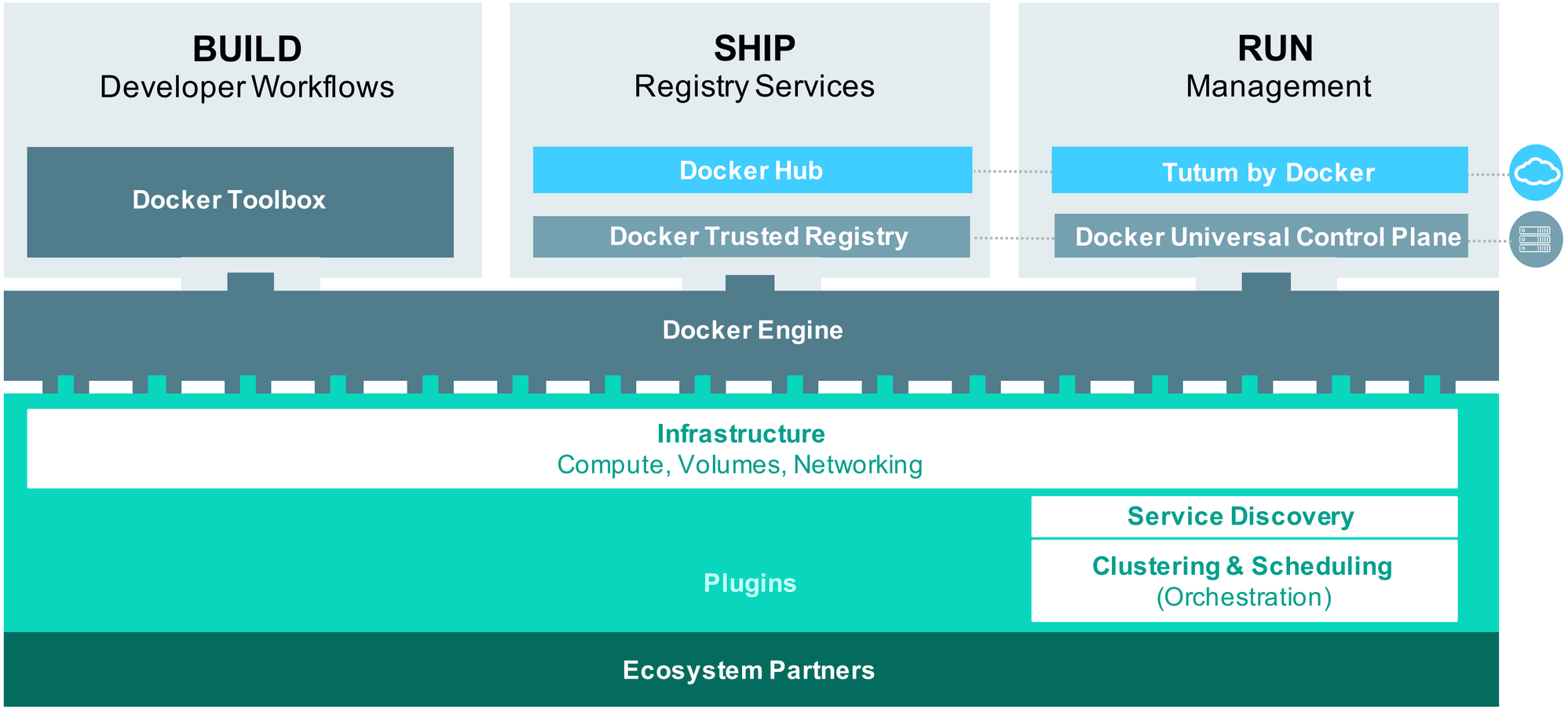
CI/CD with Docker + Jenkins

1. Push a commit to GitHub
2. GitHub webhook
3. Jenkins copies artifacts
4. Jenkins builds Docker image
5. Runs test on Docker container
6. Pushes to DTR



https://www.docker.com/sites/default/files/UseCase/RA_CI%20with%20Docker_08.25.2015.pdf

Docker Mission



References

- github.com/javaee-samples/docker-java
- docs.docker.com