Docker Advanced Concepts

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Agenda

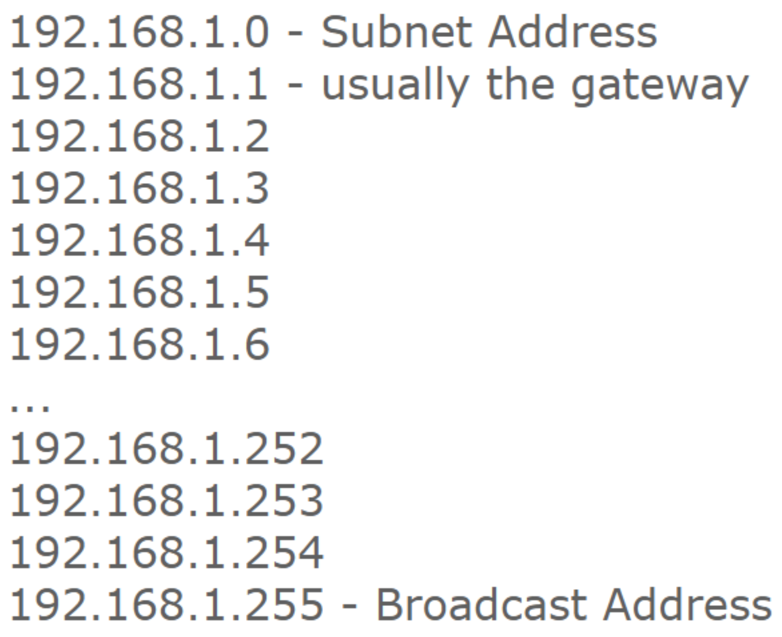
- Networking Basics
- IP Address
- Subnet
- Docker Networking
- Container Orchestration
- Docker Swarm
- Docker Service
- Docker Compose

IP Address

- IP address is a series of four numbers separated by periods. Generally it looks like 147.181.183.86.
- Each number will range from 0 to 255. So 255 would be the largest number in an ip address and 0 would be the smallest number.
- Each number is an eight bit number and looks like:
  - 10010011.10110101.10110111.01010110 = 147.181.183.86

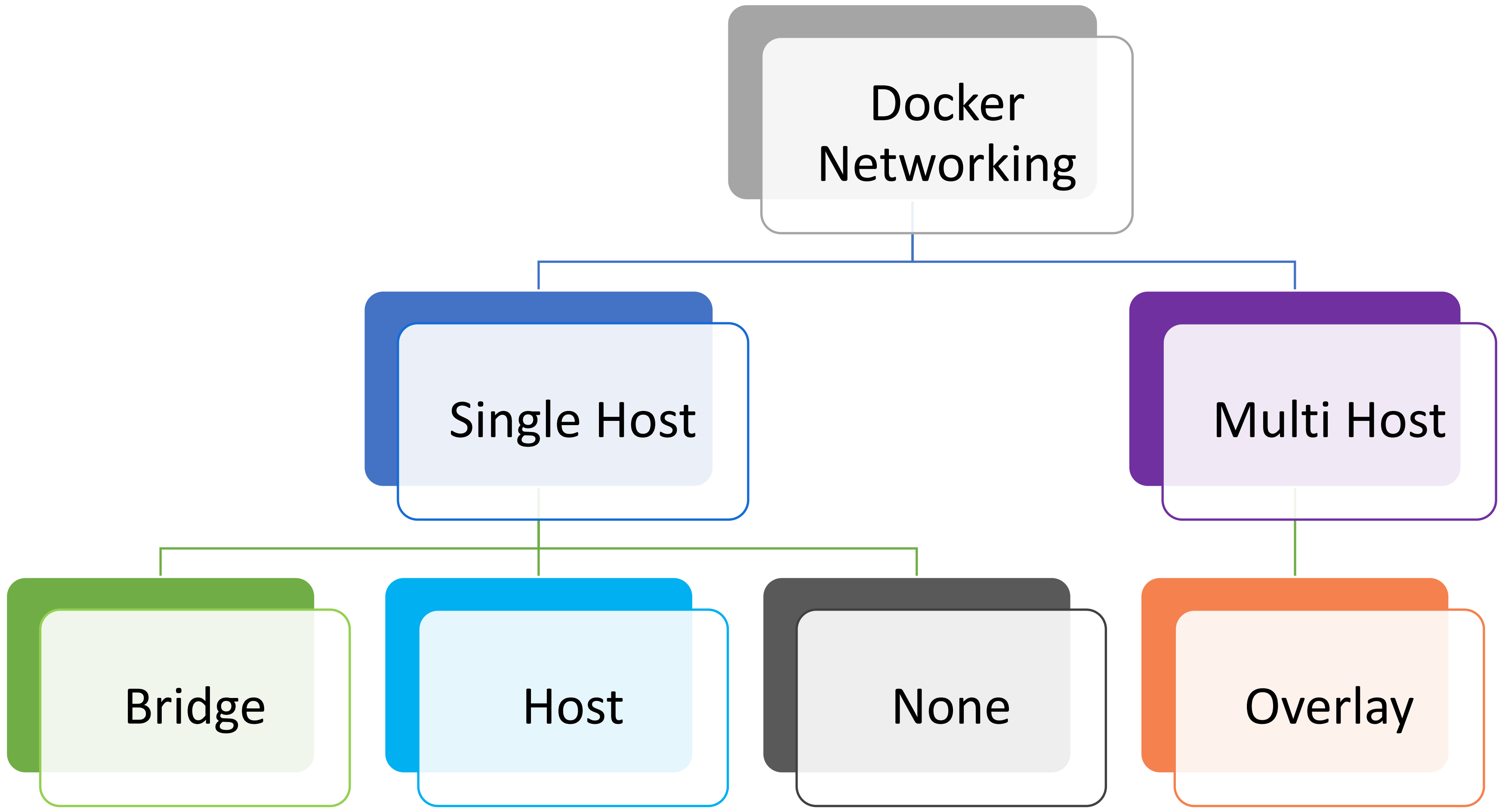
Subnet

- Used to group IP addresses and looks a lot like an ip address. A typical subnet mask is 255.255.255.0.
- These numbers range from 0 to 255.
- Each number is an eight bit number and looks like:
  - 11111111.11111111.11111111.00000000= 255.255.255.0
  - Every group of ip addresses, has a Subnet Address, Broadcast Address, and Gateway.
  - Both the Subnet and the Broadcast are used to send information to every ip address in the group. The Gateway acts sort of like the group's controller.



```
192.168.1.0 - Subnet Address
192.168.1.1 - usually the gateway
192.168.1.2
192.168.1.3
192.168.1.4
192.168.1.5
192.168.1.6
...
192.168.1.252
192.168.1.253
192.168.1.254
192.168.1.255 - Broadcast Address
```

Docker Networking

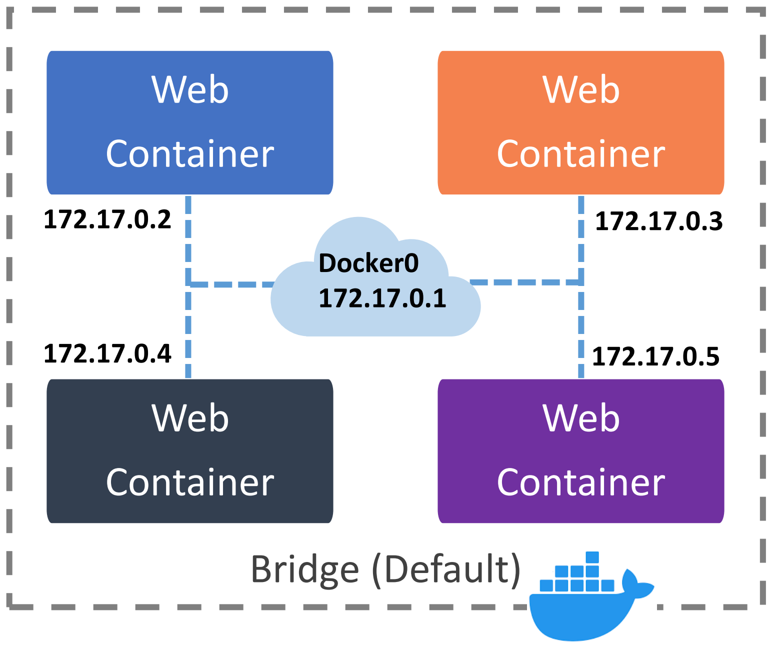


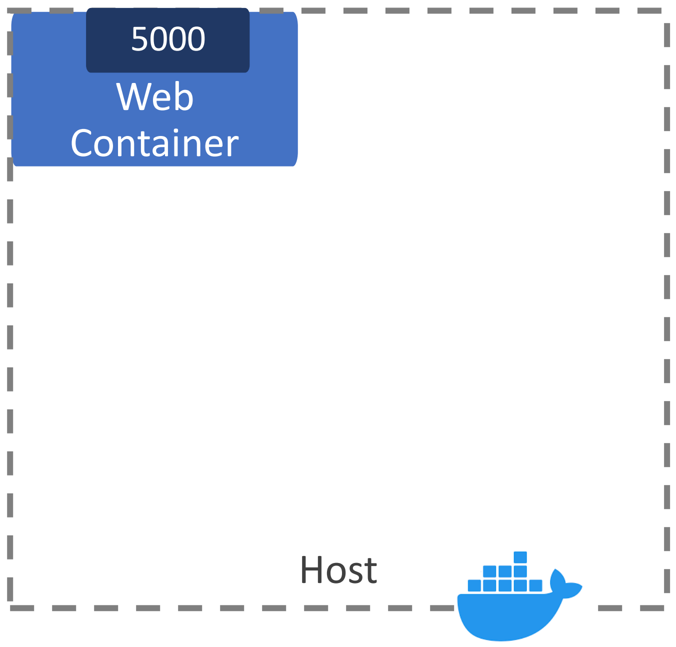
Docker Single Host Networking

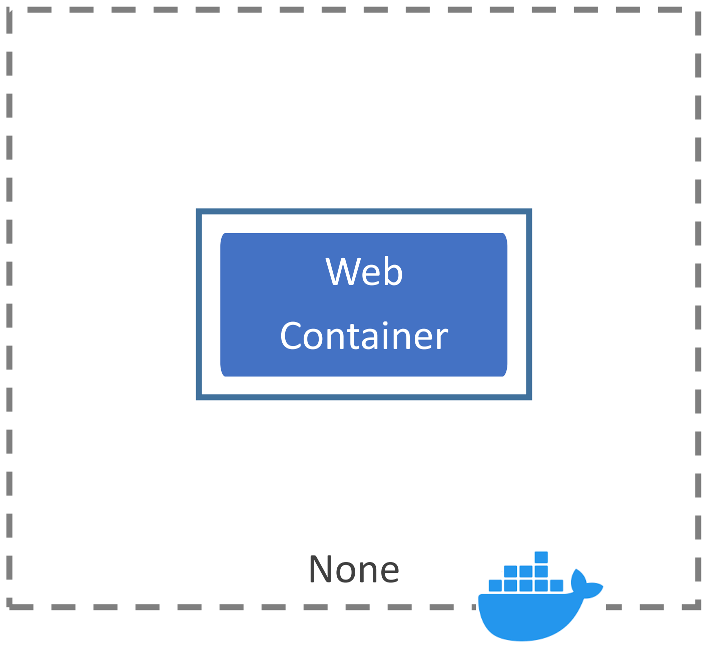
```
docker run myapp
```

```
docker run myapp --network host
```

```
docker run myapp --network none
```







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Bridge

- Default driver
- The bridge is a private network restricted to a single docker host
- Each container is placed in its own network namespace
- The bridge driver creates a bridge(virtual switch) on a single Docker host.
- All containers on a bridge network can communicate with each others but containers on different bridge network cannot communicate with each other.
- Offers external access to containers through the port mapping

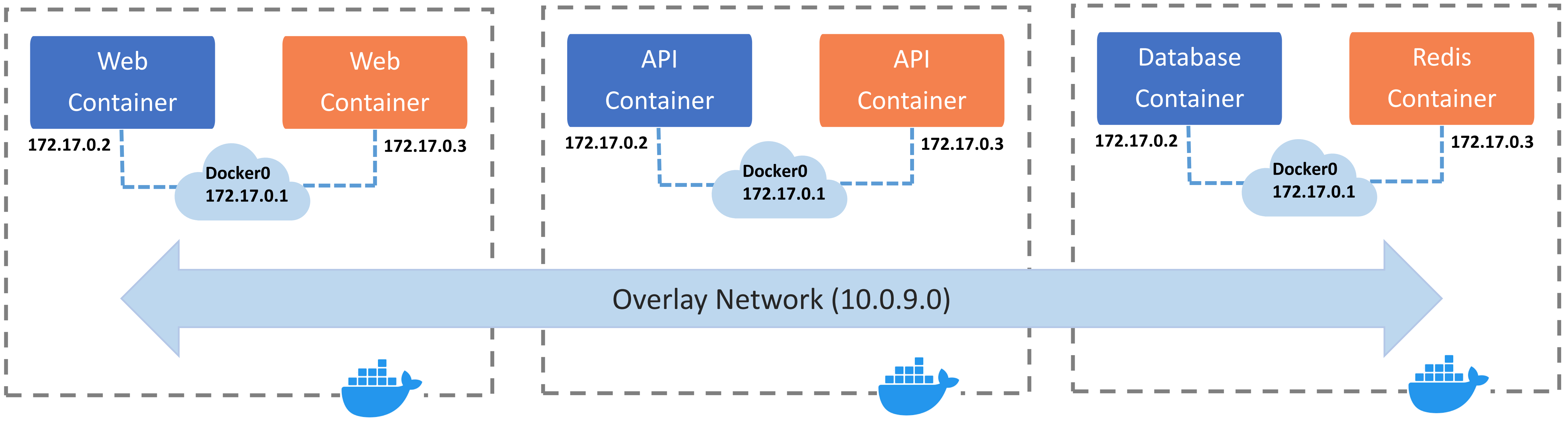
Host

- The Host Network Driver allows containers to use the host’s network stack directly.
- Removes the network isolation between the docker host and the docker containers to use the hosts networking directly.
- No two containers can use the same port(s).
- Used to setup, one or only a few containers on a single host.

None

- Completely disable the networking stack on a container.
- By using this mode, it will not configure any IP for the container and have no access to the external network as well as for other containers.

Docker Multi Host Networking



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Overlay

- Manage communications among the Docker daemons participating in the swarm.
- The overlay driver enables simple and secure multi-host networking.
- All containers on the overlay network can communicate with each other.

Docker Network Commands

```
> docker network create --driver bridge mybridge
> docker network inspect mybridge

> docker run --network mybridge --name=myapp  aspnetcrud
> docker network connect mybridge myapp
> docker network disconnect mybridge myapp

> docker network rm mybridge
> docker inspect -f "{{range .NetworkSettings.Networks}}{{.IPAddress}}{{end}}" <container_id>
```

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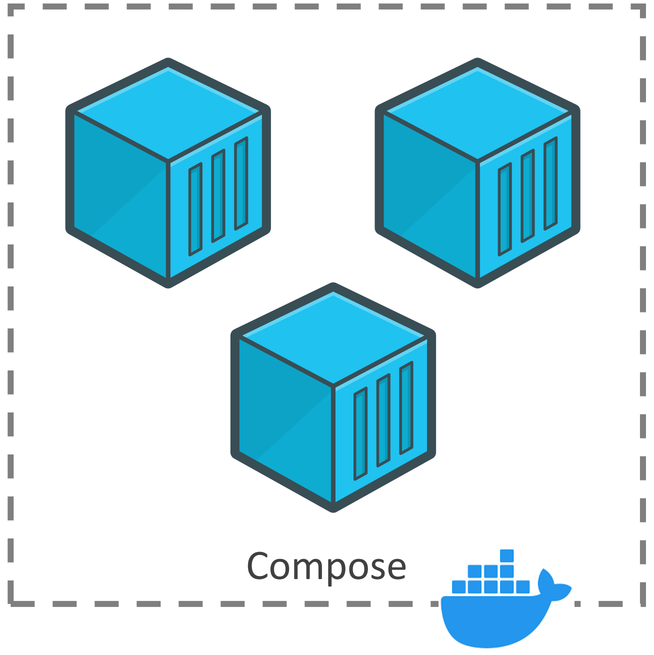
Docker Compose

- Compose is a tool for defining and running multi-container applications with Docker.
- With Compose, a multi-container application is defined using a single file and then spin your application up using a single command.
- All of that can be done by Docker Compose in the scope of a single host.
- The Docker Compose is useful for setting up development and testing workflows.



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```yaml
version: '3.4'
networks:
 docker_app:
   driver: bridge
   ipam:
      driver: default
      config:
        - subnet: 172.16.238.0/24
services:
  db:
    image: "mcr.microsoft.com/mssql/server:2019-CU4-ubuntu-16.04"
    environment:
       ACCEPT_EULA: 'Y'
       SA_PASSWORD: 'YourStrong@Passw0rd'
    container_name: 'sql_db'
    networks:
       docker_app:
         ipv4_address: 172.16.238.2
    ports:
      - "5020:1433"
  aspnetdockercrud:
    image: ${DOCKER_REGISTRY-}aspnetdockercrud
    build:
      context: .
      dockerfile: ASPNetDockerCRUD/Dockerfile
    container_name: 'aspnet_app'
    networks:
       docker_app:
          ipv4_address: 172.16.238.3
    ports:
      - "5010:80"
```

```
docker-compose -f docker-compose.yml up
docker-compose -f docker-compose.yml down
```

```
docker-compose -f docker-compose.yml start
docker-compose -f docker-compose.yml stop
```

Container Orchestration

Docker Swarm

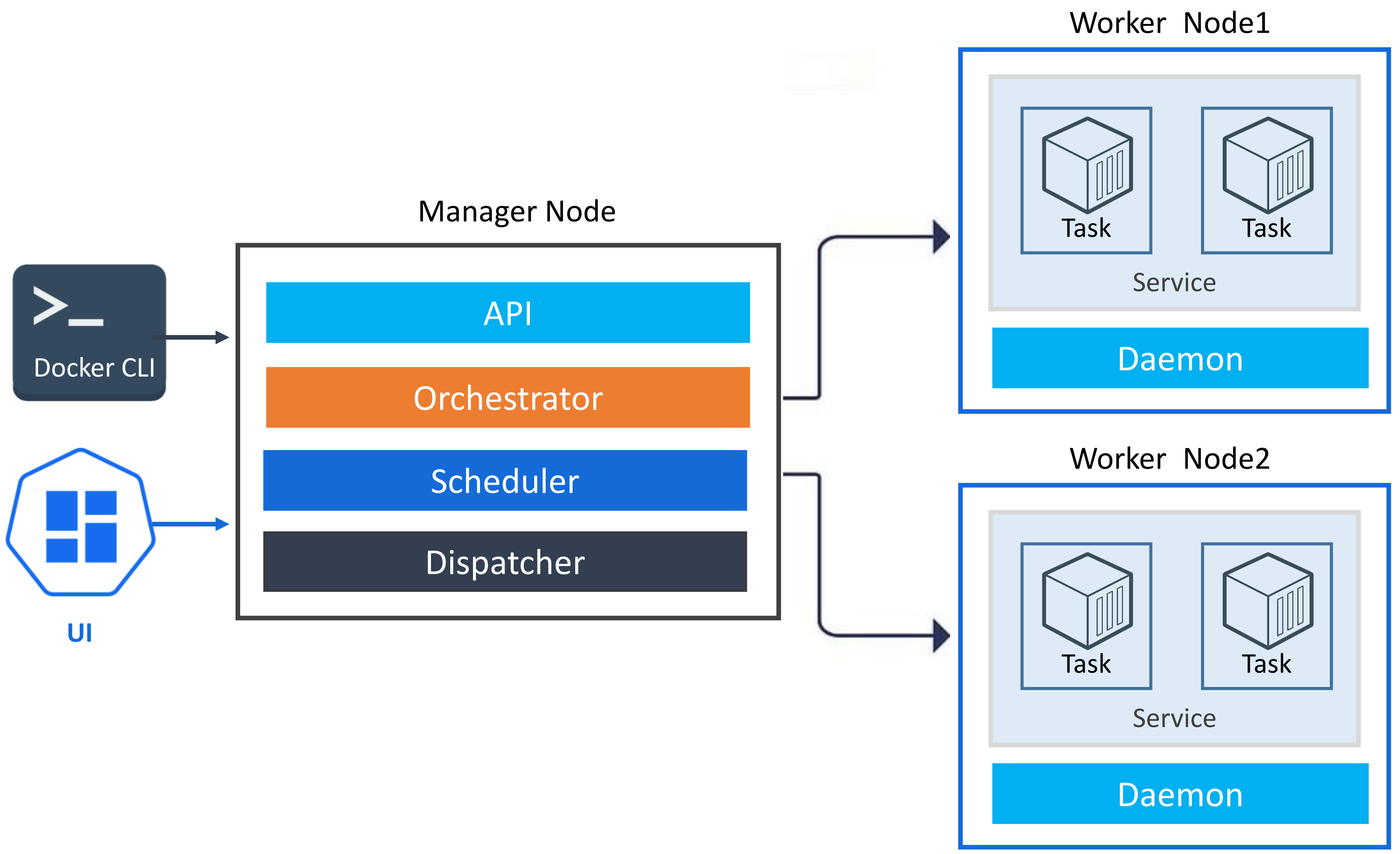
Kubernetes

MESOS

Docker Swarm

- Swarm is a cluster of Docker hosts that are called nodes.
- Docker Swarm is a native clustering tool for Docker that can turn a pool of Docker hosts into a single virtual host.
- The swarm cluster consists of a swarm manager and a set of workers.
- With swarm, you can deploy and scale your applications to multiple hosts.
- Swarm helps in containers management, scaling, service discovery, and load balancing between the nodes in the cluster.

Docker Swarm Architecture



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Docker Swarm Architecture Contd..

- **Manager nodes** are used to perform control orchestration, cluster management and task distribution.
  - API - Accepts commands from CLI and create service object
  - Orchestrator - Reconciliation loop for service objects and create tasks
  - Scheduler - Assign Nodes to tasks
  - Dispatcher - Checks in on workers
- **Worker nodes** are used for running containers whose tasks are assigned by Manager nodes. Each node can be configured as a Manager node, Worker node, or as both.

Docker Swarm Architecture Contd..

- **Tasks** - A task is a slot in which a single container is running. Tasks are the part of a Swarm service.
- **Service** is one or more containers with the same configuration running under docker's swarm mode.

Docker Service

- A docker "service" is one or more containers with the same configuration running under docker's swarm mode.
- With docker service you manage a group of containers from the same image.
- You can scale them (start multiple containers).
- Docker service is useful for a microservices based application

```
docker service create --publish 8080:80 --name myapp myapp:v1
docker service rm myapp
docker service scale myapp=3
```

Docker Container vs. Docker Service

- "docker run" command create a single independent container which is not a part of any orchestration such as docker swarm.
- Not scalable to share the excessive load.
- Containers running through Docker run will be of different configuration, such as Network adapters etc.
- High availability is less as compared to the Cluster.
- Simple networking to communicate between multiple containers.
- Don't support auto recovery in case of failure.

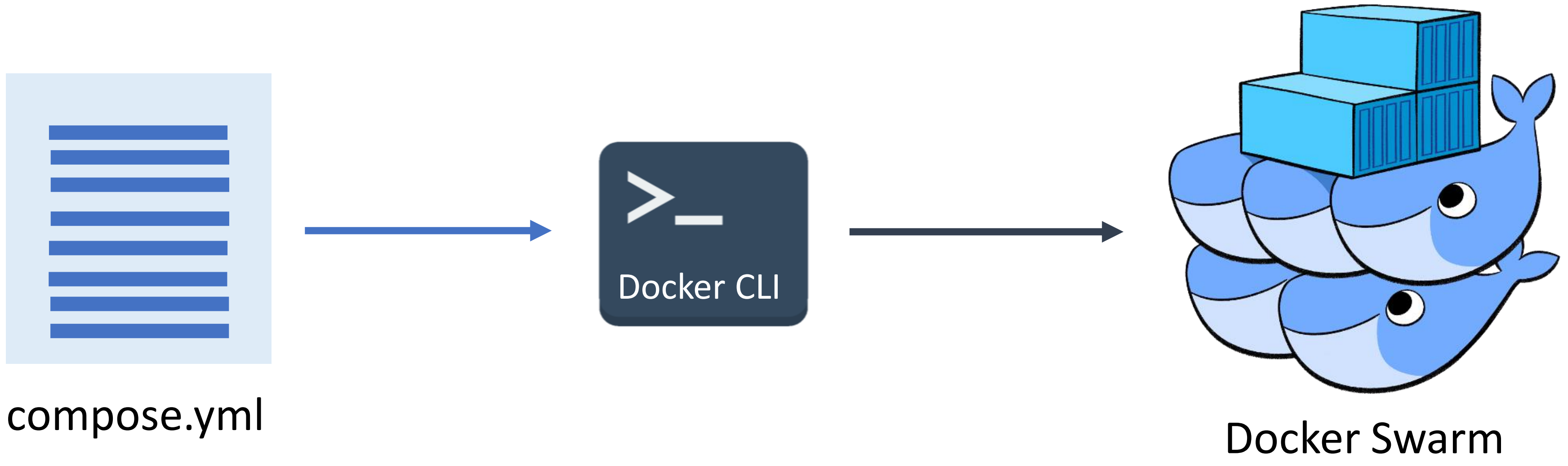
- "docker service create" command creates a service which is a part of a orchestration such as docker swarm or Kubernetes.
- Supports scaling & load balancer to manage workloads.
- Containers running through the Docker swarm will be of the same configuration.
- For service, there is a master node and another are worker nodes to supports high availability.
- Docker swarm uses mesh networking to communicate within the cluster.
- Docker Swarm can auto recover the tasks in case of failure.

Docker Stack

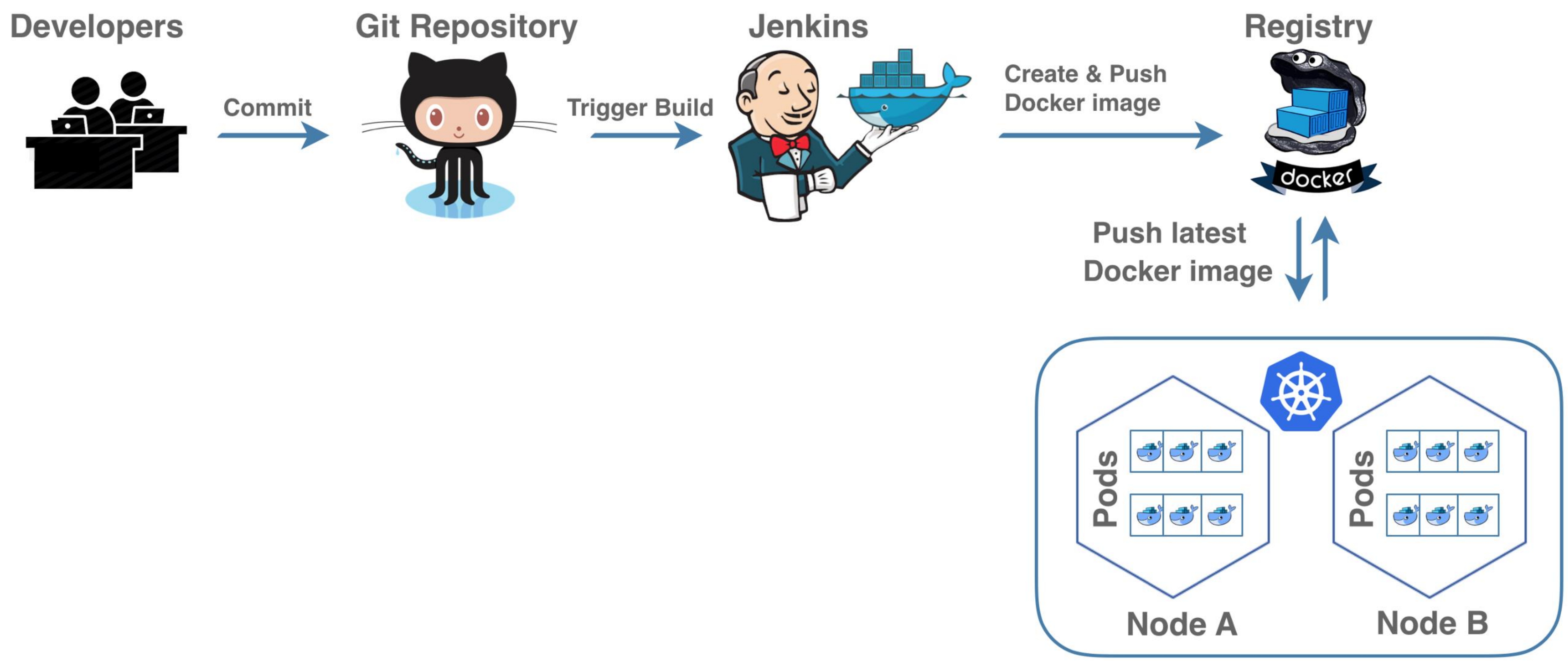
- Used to define and run multiple containers on a swarm cluster.
- Docker stack ignore “build” instructions. You **can’t build new images** using the stack commands.
- It needs pre-built images to deploy.

```
docker stack deploy -c my-stack.yaml mystack
docker stack ls
docker stack rm mystack
docker stack services mystack
```

Docker Stack with Swarm



CI/CD Pipeline



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