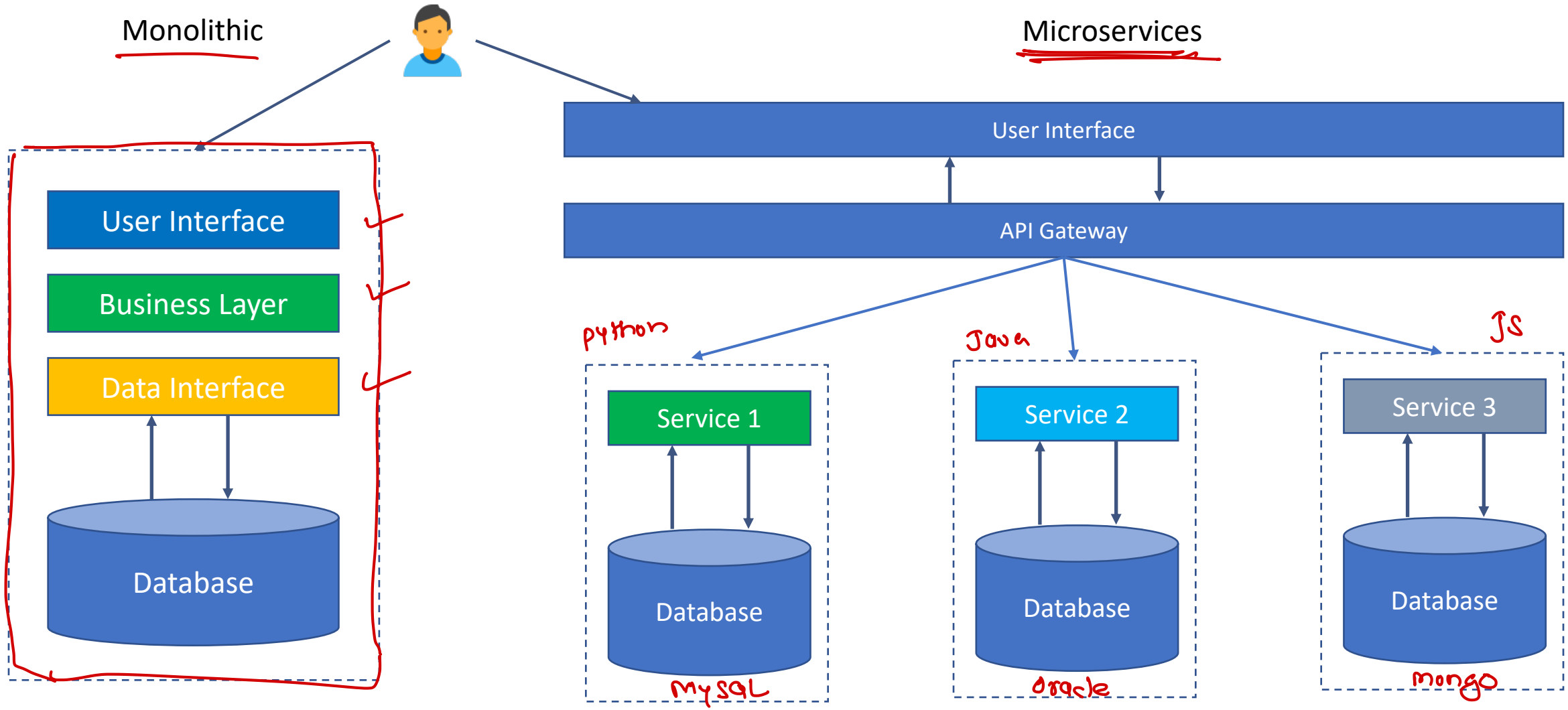
kubernetes

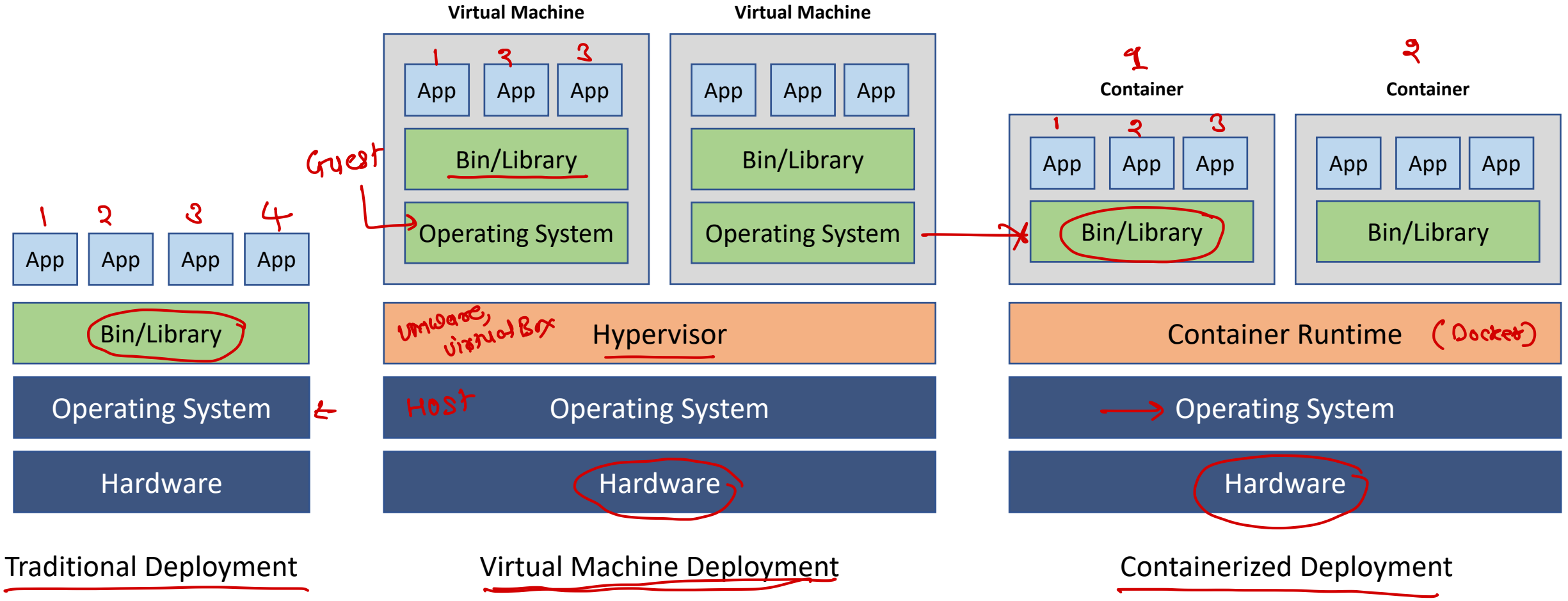
Microservice

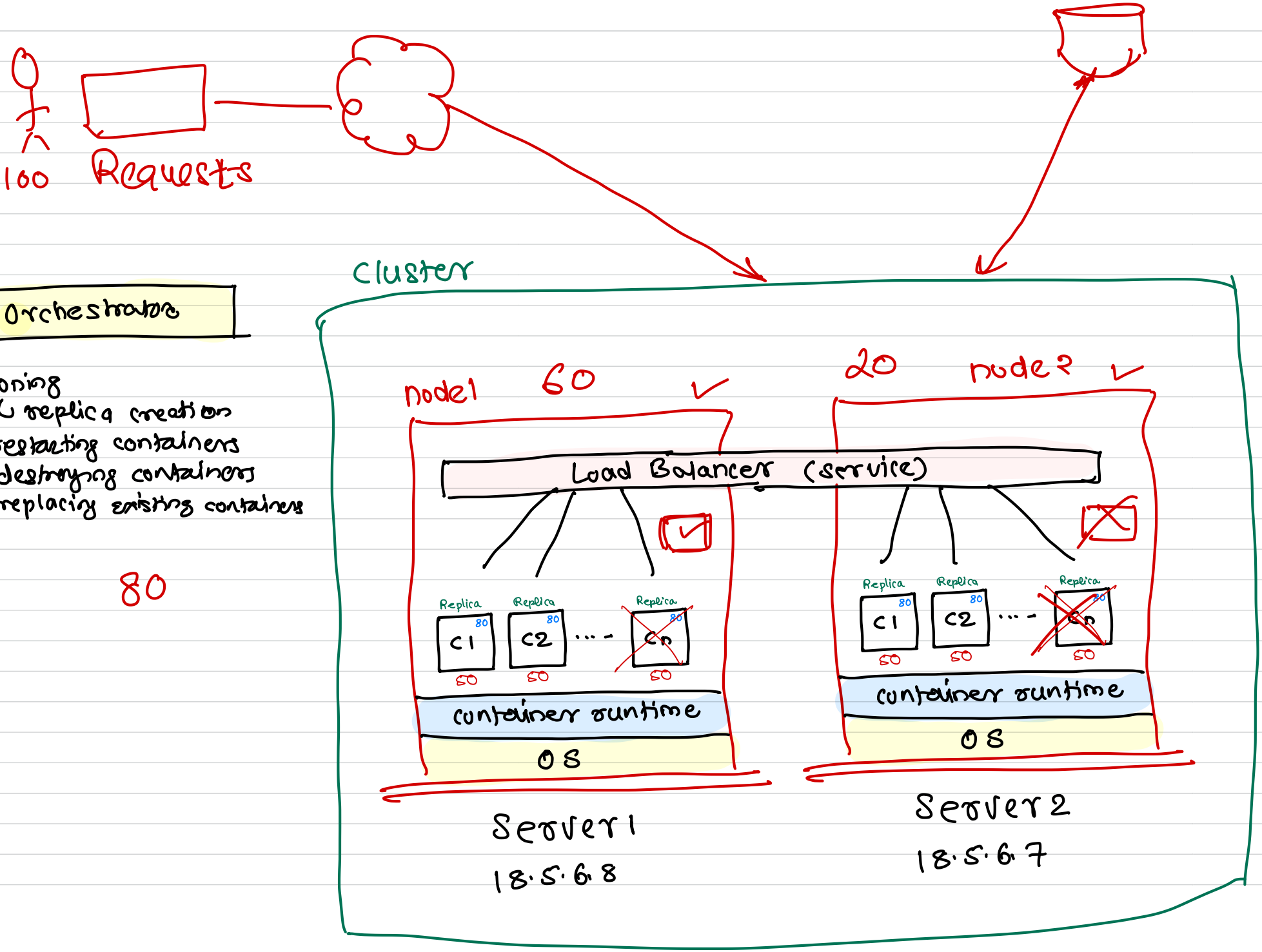
- Distinctive method of developing software systems that tries to focus on building single-function modules with well-defined interfaces and operations
- Is an architectural style that structures an application as a collection of services that are
  - Highly maintainable and testable
  - Loosely coupled
  - Independently deployable
  - Organized around business capabilities

Monolithic vs Microservice



Deployment options



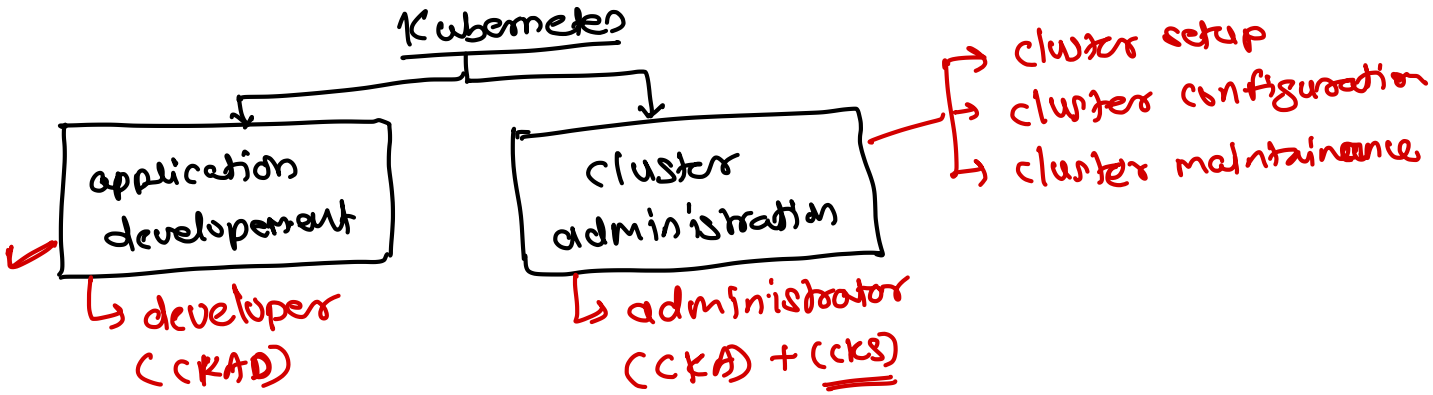

100
Requests
Cluster
Orchestrator
① cloning
↳ replica creation
② restarting containers
③ destroying containers
④ replacing existing containers
80
node1
60
node2
20
Load Balancer (service)
Replica
C1
C2
Cn
80
50
container runtime
OS
Server1
18.5.6.8
Server2
18.5.6.7

Container orchestration

- Container orchestration is all about managing the lifecycles of containers
- Software teams use container orchestration to control and automate many tasks
  - Provisioning and deployment of containers
  - Redundancy and availability of containers
  - Scaling up or removing containers to spread application load evenly across host infrastructure
  - Allocation of resources between containers
  - External exposure of services running in a container with the outside world
  - Load balancing of service discovery between containers
  - Health monitoring of containers and hosts
  - Configuration of an application in relation to the containers running it
  - Movement of containers from one host to another if there is a shortage of resources, or if a host dies
- Tools
  - Docker Swarm → <10,000
  - Kubernetes → >10,000
  - Apache Mesos and Marathon

Introduction

- Kubernetes is an open source system for automating deployments, scaling and management of containerized applications
- It is a container orchestration system
- It enables organizations to automate deployment and manage the containers, thus helping them to streamline and simply the day to day routines
- If you are using Kubernetes that means your application is following the microservices architecture and is already containerized

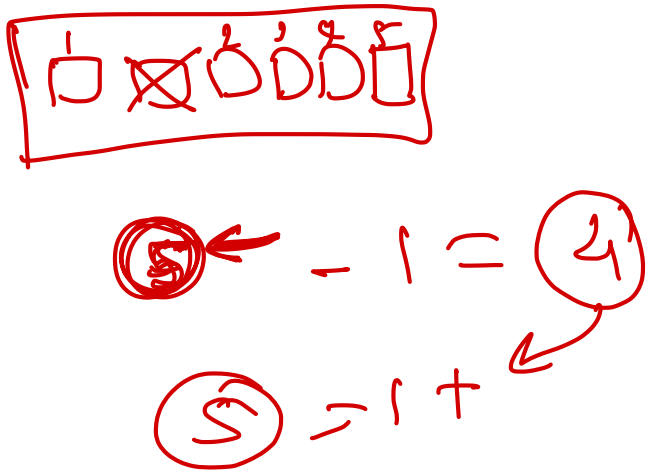


History

- Kubernetes was originally developed at Google having emerged from project Borg
- Now it has been taken over by Cloud Native Computing Foundation (CNCF)
- It is not only open source but it is managed by open community

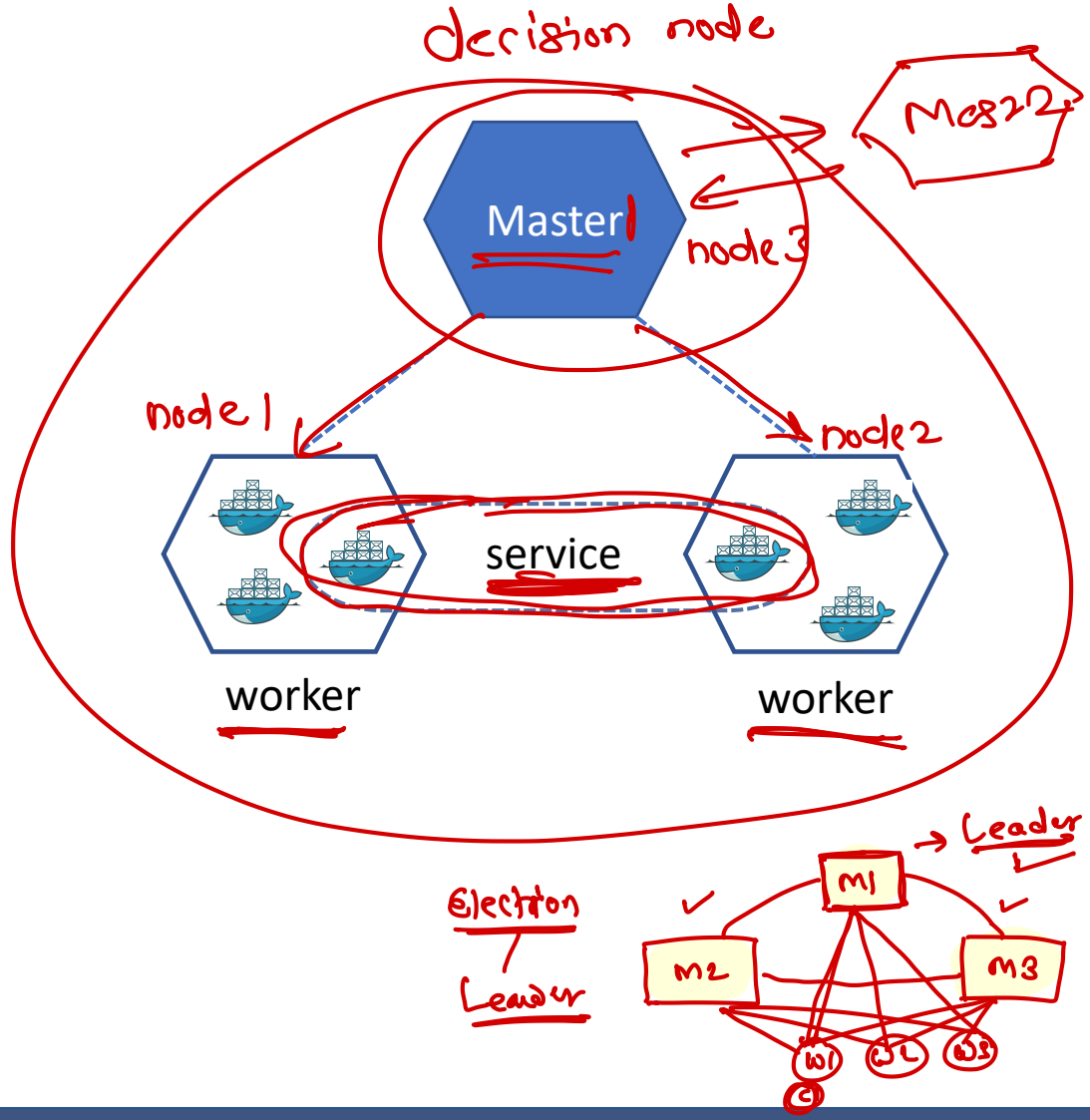
Kubernetes Features

- Provisioning and deployment of containers
- Self healing
- Service discovery and load balancing
- Storage orchestration
- Auto scaling
- Run anywhere
- Automated rollouts and rollbacks
- Secrets and configuration management
- Scale
- REST APIs at its core
- Security

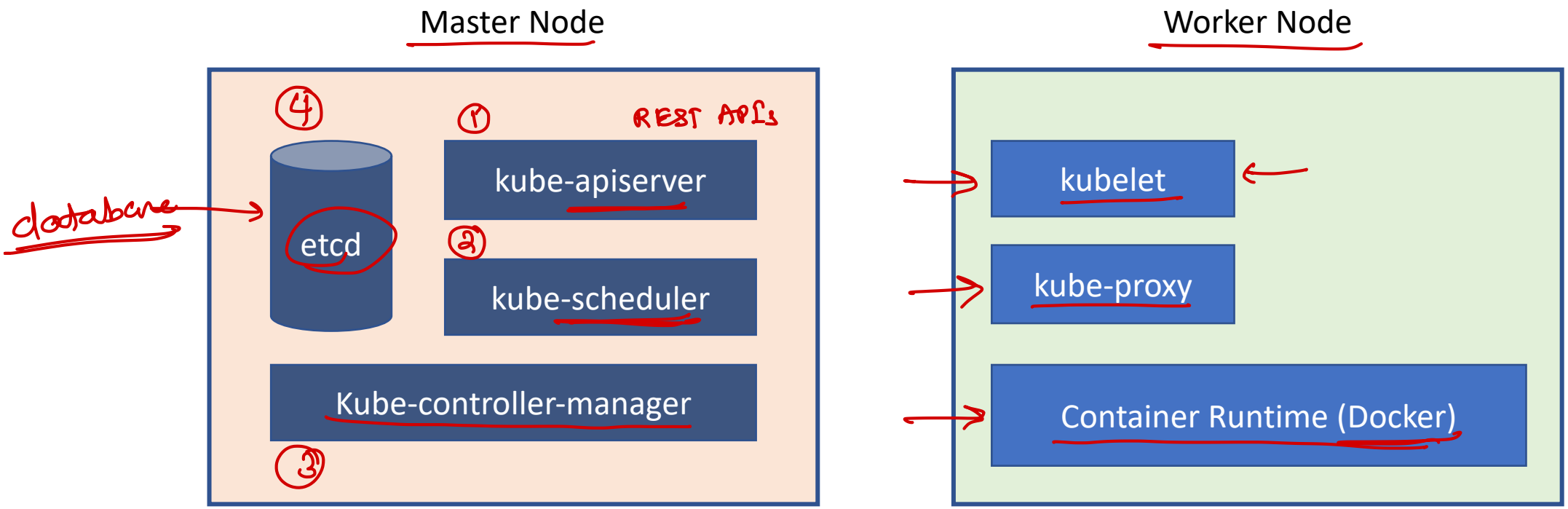


Kubernetes Cluster

- When you deploy Kubernetes, you get a cluster.
- A cluster is a set of machines (nodes), that run containerized applications managed by Kubernetes
- A cluster has at least one worker node and at least one master node
- The worker node(s) host the pods that are the components of the application
- The master node(s) manages the worker nodes and the pods in the cluster
- Multiple master nodes are used to provide a cluster with failover and high availability

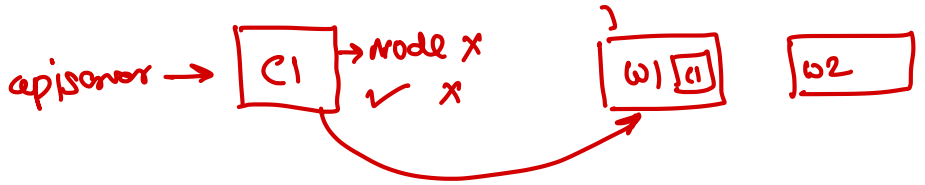


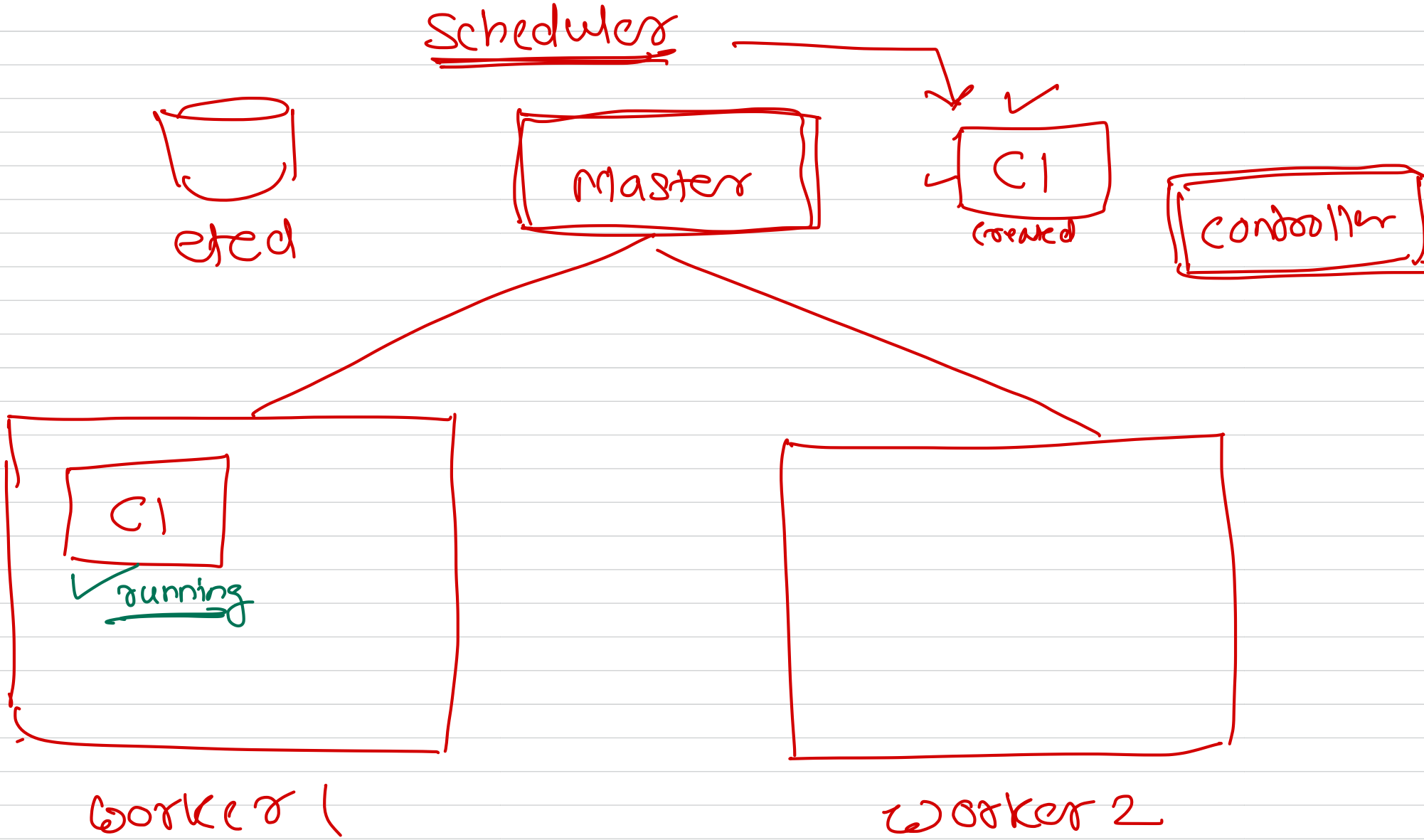
Kubernetes Components



Master Components

- Master components make global decisions about the and they detect and respond to cluster events
- Master components can be run on any machine in the cluster
- **kube-apiserver**
  - The API server is a component that exposes the Kubernetes REST API
  - The API server is the front end for the Kubernetes
- **etcd**
  - Consistent and highly-available key value store used as Kubernetes' backing store for all cluster data
  - The configuration data the etcd stores represents the cluster state
  - e.g. which nodes are running the containers, which applications are running etc
- **kube-scheduler**
  - Component on the master that watches newly created pods that have no node assigned, and selects a node for them to run on




Scheduler
etcd
Master
C1
created
controller
C1
running
worker 1
worker 2

Master Components

- **kube-controller-manager**
  - Component on the master that runs controllers
  - Logically, each controller is a separate process, but to reduce complexity, they are all compiled into a single binary and run in a single process
  - Types
    - **Node Controller**: Responsible for noticing and responding when nodes go down.
    - **Replication Controller**: Responsible for maintaining the correct number of pods for every replication controller object in the system
    - **Endpoints Controller**: Populates the Endpoints object (that is, joins Services & Pods)
    - **Service Account & Token Controllers**: Create default accounts and API access tokens for new namespaces
- **cloud-controller-manager**
  - Runs controllers that interact with the underlying cloud providers
  - The cloud-controller-manager binary is an alpha feature introduced in Kubernetes release 1.6

Node Components

[both master & worker run these components]

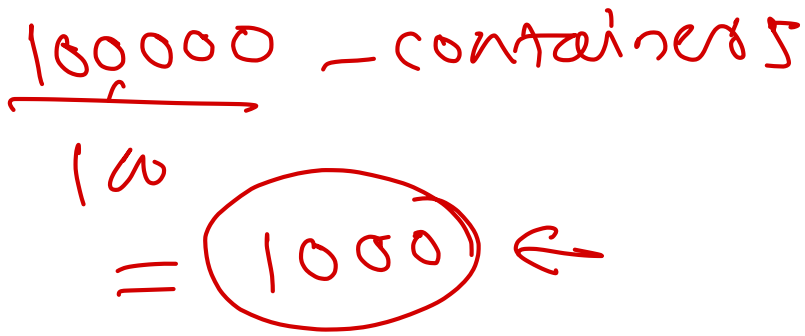
- Node components run on every node, maintaining running pods and providing the Kubernetes runtime environment
- **kubelet**
  - An agent that runs on each node in the cluster
  - It makes sure that containers are running in a pod

] worker kubelet updates the current status to master

- **kube-proxy**
  - Network proxy that runs on each node in your cluster, implementing part of the Kubernetes service concept
  - kube-proxy maintains network rules on nodes
  - These network rules allow network communication to your Pods from network sessions inside or outside of your cluster
- **Container Runtime**
  - The container runtime is the software that is responsible for running containers
  - Kubernetes supports several container runtimes: Docker, containerd, rktlet, cri-o etc.

Designing a cluster

- Application components and the number of replicas required to run the application smoothly
- Kubernetes v1.16 has following restrictions
  - 5000 nodes
  - 150000 pods
  - 300000 containers
  - 100 pods per node
- Resource requirements of the pods
  - Processor, Memory and HDD requirements for the pods
  - Application Data Storage
- Co-located or external etcd
- Cluster monitoring
- Infrastructure: on-premises, bare metal or managed cloud cluster
- Security



AKS, EKS

Designing a cluster

- Worker nodes requirements
- Number of workers required to run the pods
- Configuration of worker nodes
- https://kubernetes.io/docs/setup/best-practices/cluster-large/

Nodes	Configuration
1-5 nodes	2 vCPU / 4 GB RAM
6-10 nodes	2 vCPU / 7.5 GB RAM
11-100 nodes	4 vCPU / 15 GB RAM
101-250 nodes	8 vCPU / 30 GB RAM
251-500 nodes	16 vCPU / 30 GB RAM
More than nodes	36 vCPU / 60 GB RAM

Cluster node requirements

- Cluster can be installed on physical or virtual machine
- Following operating systems are supported with v1.16
  - Ubuntu 16.04+
  - Debian 9+
  - Centos 7+
  - RHEL 7+
  - Fedora 25+
  - Container Linux
  - HypriotOS 1.0.1+
- Minimum configuration on each node is 2CPU and 2 GB RAM
- Control plane ports needed to open
  - 6443, 2379-2380, 10250, 10251, 10252
- Worker nodes ports needed to open
  - 10250, 30000-32767

High Availability Cluster

- No single point of failure
- Kube-apiserver is exposed to worker nodes using a load balancer
- Stacked etcd or External etcd

Create Cluster

- Use following commands on both master and worker nodes

> sudo apt-get update && sudo apt-get install -y apt-transport-https curl

> curl -s https://packages.cloud.google.com/apt/doc/apt-key.gpg I sudo apt-key add -

> cat <<EOF I sudo tee /etc/apt/sources.list.d/kubernetes.list deb https://apt.kubernetes.io/kubernetes-xenial main EOF

> sudo apt-get update
> sudo apt-get install -y kubelet kubeadm kubectl
> sudo apt-mark hold kubelet kubeadm kubectl

Initialize Cluster Master Node

- Execute following commands on master node

```
> kubeadm init --apiserver-advertise-address=<ip-address> --pod-network-cidr=10.244.0.0/16
> mkdir -p $HOME/.kube
> sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
> sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

- Install pod network add-on

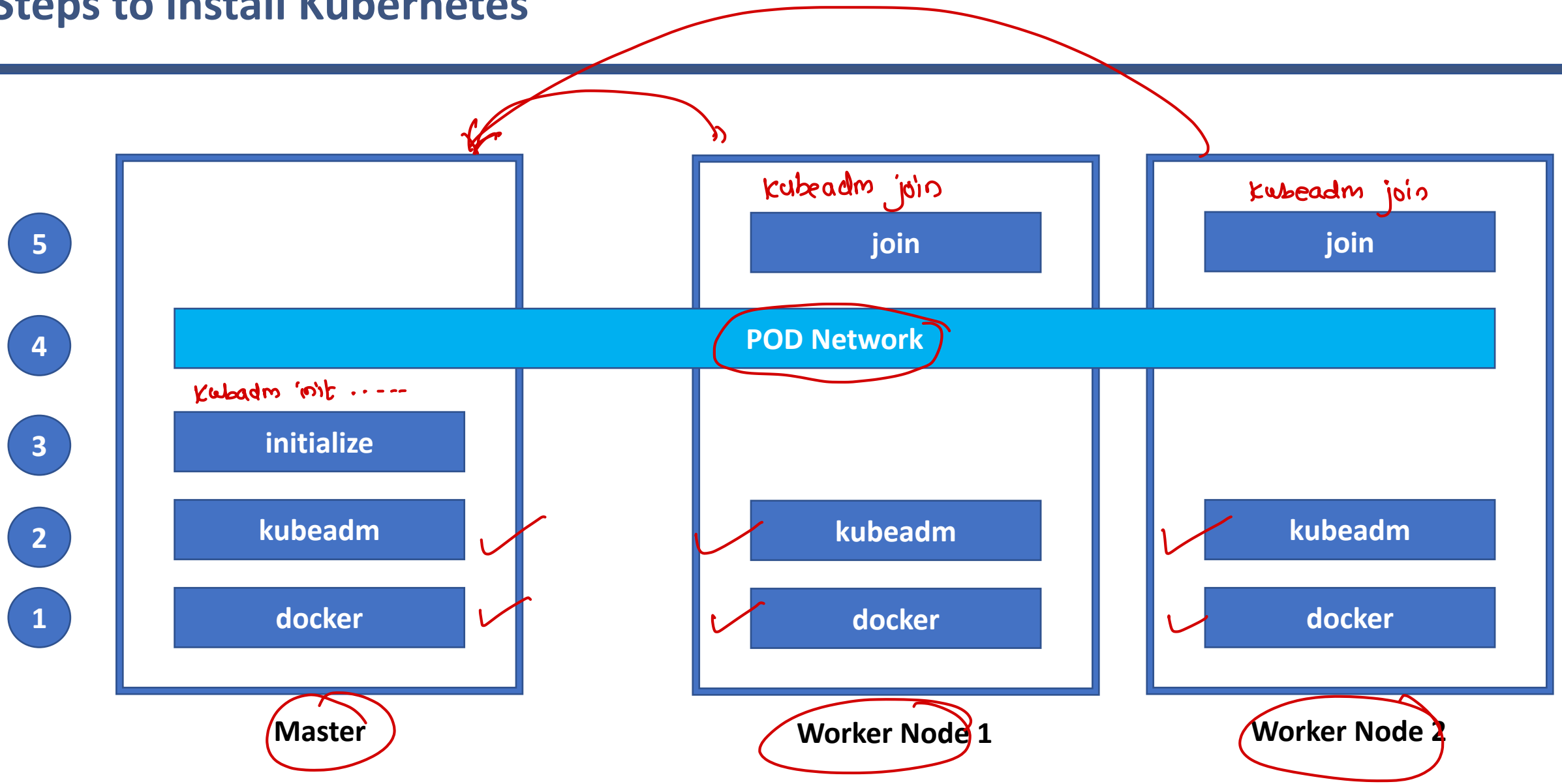
```
> kubectl apply -f https://raw.githubusercontent.com/coreos/flannel/2140ac876ef134e0ed5af15c65e414cf26827915/Documentation/kube-flannel.yml
```

Add worker nodes

- Execute following command on every worker node

> kubeadm join --token <token> <control-plane-host>:<control-plane-port> --discovery-token-ca-cert-hash sha256:<hash>

Steps to install Kubernetes



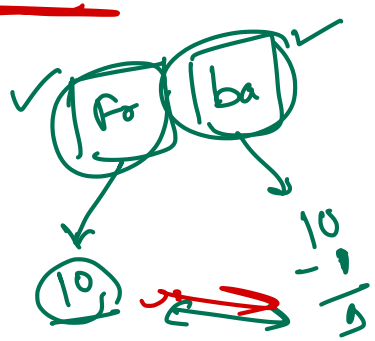
Core Concepts

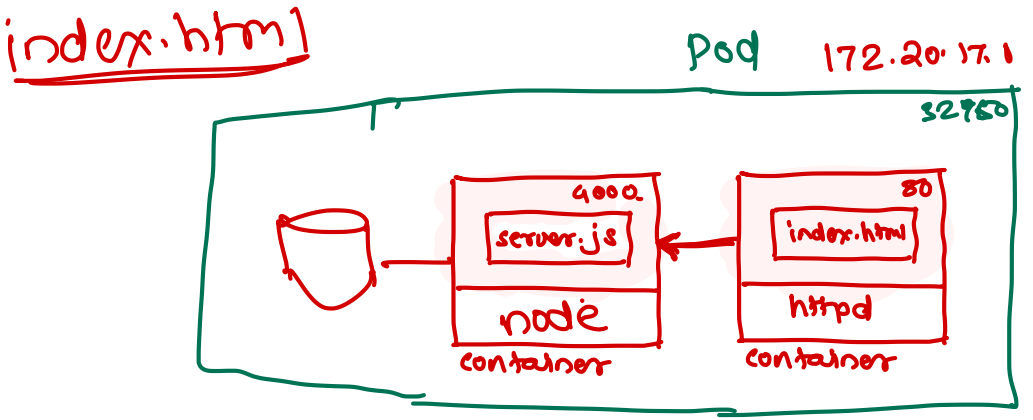
Kubernetes objects

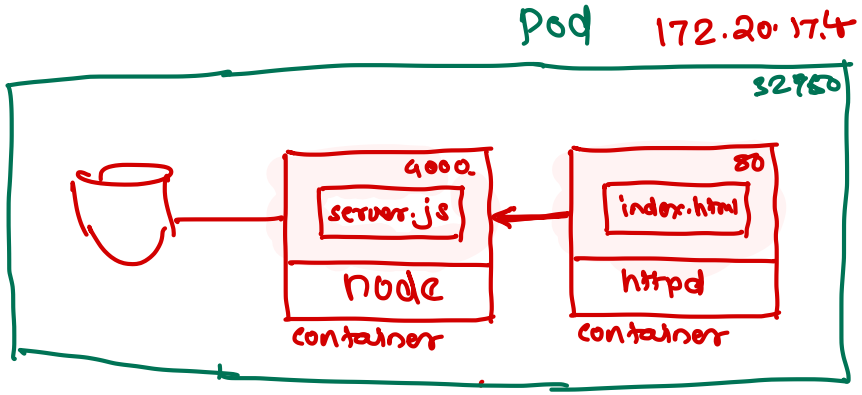
- Persistent entities expressed in YAML format
- Represent the desired state of the cluster
- Describes the following
  - Containerized application running in the cluster
  - Resources made available to these applications
  - Policies for these applications
- Objects can be created using command line utility (kubectl)
- You can also use client libraries to make the API calls direcly
  - C#, java, JS, python → REST

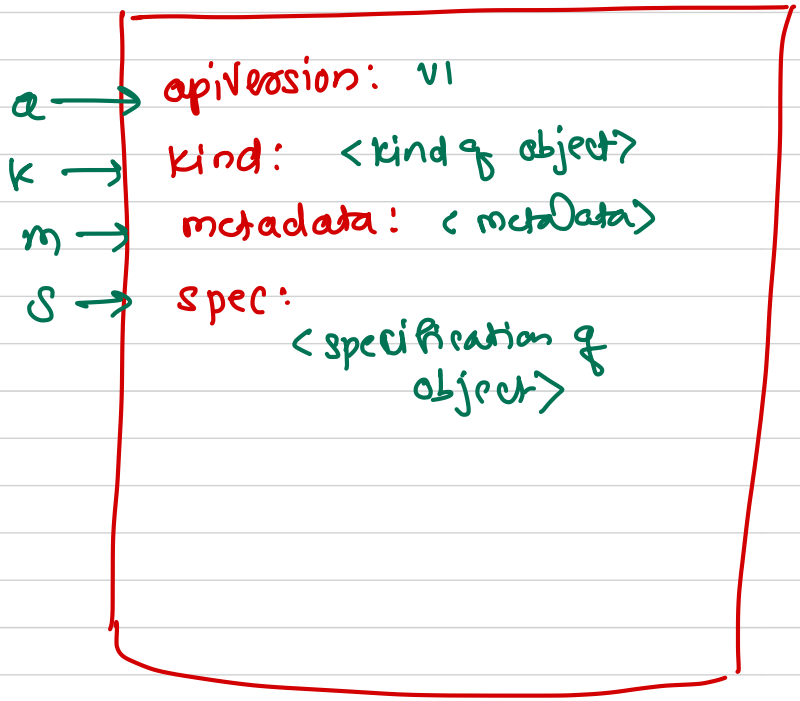
Pods

- Smallest deployable unit in the Kubernetes
- A pod encapsulates
  - Single or multiple containers (Init or App containers)
  - Storage resources
  - Unique Network IP
  - Options governing how the containers should run
  - Ephemeral and disposable entities
- Task
  - Create your first pod using yaml file








a
k
m
s
apiVersion: v1
kind: <kind of object>
metadata: <metaData>
spec:
<specification of object>

pod.yml

Phases of Pod

- Phase of a Pod is a simple high level summary showing what state the Pod is in
- Pending
  - Accepted by the cluster
  - Waiting to be scheduled
- Running
  - Scheduled on one of the worker nodes
  - In running/starting/restarting state
- Succeeded
  - All containers in the Pod are terminated successfully and will not be restarted
- Failed
  - At least one container terminated with failure state
- Unknown
  - For some reason the state is not known (may be due to the node communication error)

Kubernetes Object Management

- The kubectl supports 3 ways to manage the objects
- Imperative commands
  - Operates directly on the live objects
  - Simple with single step commands
  - Do not provide template for creating new objects
  - E.g. kubectl run nginx --image nginx
- Imperative object configurations
  - Specify the file containing the full definitions of obejcts
  - Configuration is simple to understand and can be source controlled
  - Requires additional step of creating YAML file
  - E.g. kubectl create -f config1.yml
- Declarative object configuration
  - User does not define the operations to be taken
  - Create, update and delete operations are automatically detected per-object by kubectl
  - Harder to debug and understand results
  - E.g. kubectl apply –f <directory>/