Kubernetes Fundmentals

.NET 5

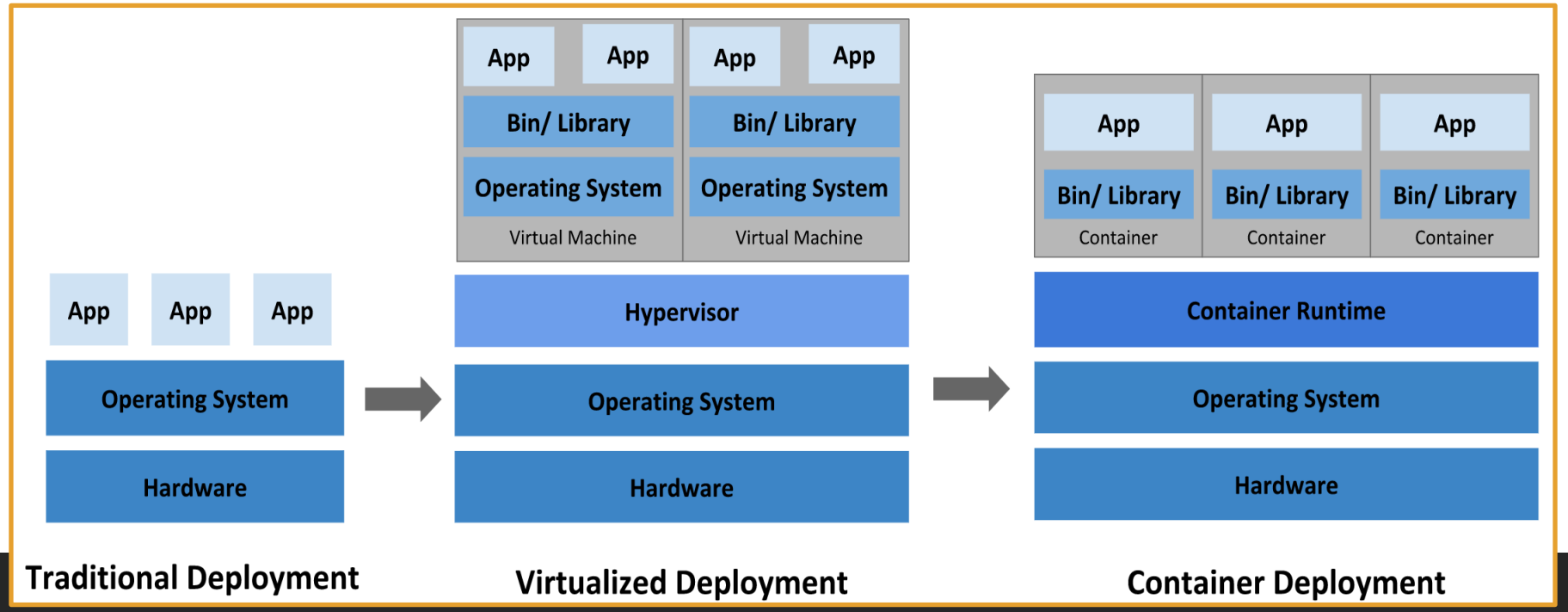
Kubernetes is a portable, extensible, open-source platform for managing containerized workloads and services.

https://kubernetes.io/docs/concepts/overview/what-is-kubernetes/

What is Kubernetes?

https://developer.ibm.com/technologies/microservices/articles/why-should-we-use-microservices-and-containers/
https://kubernetes.io/docs/concepts/overview/what-is-kubernetes/

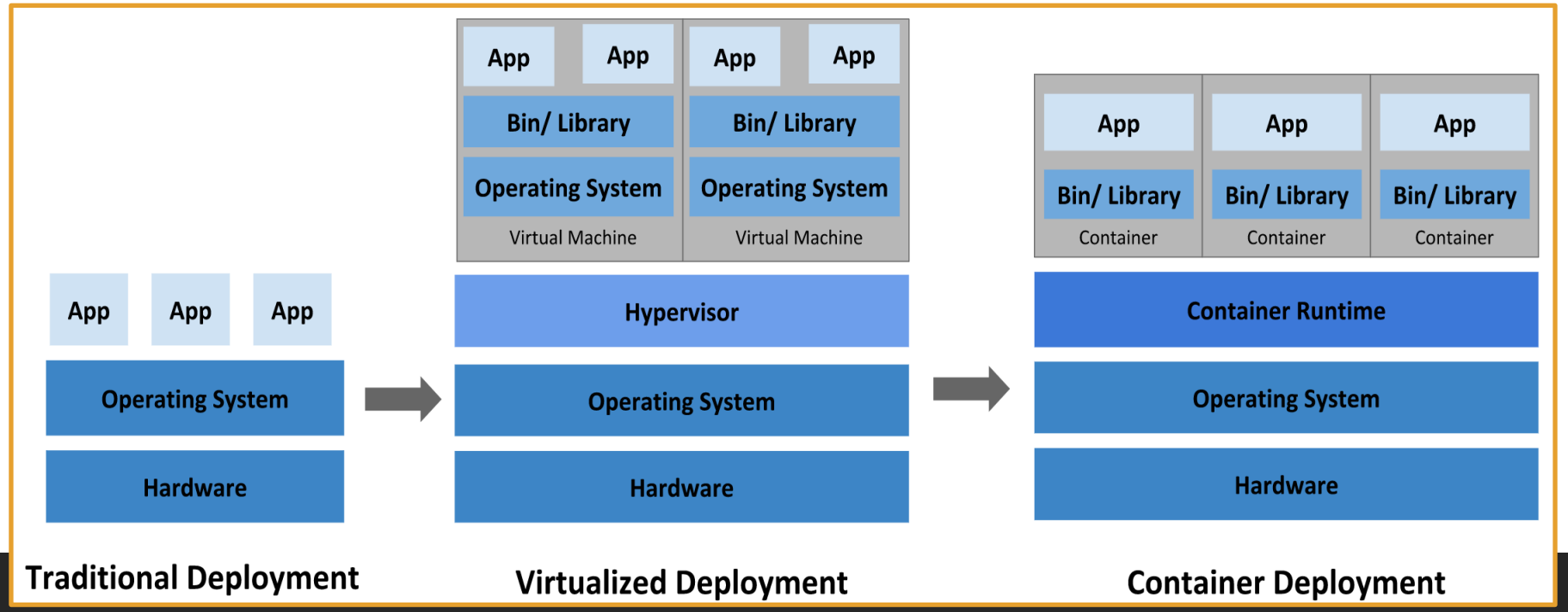
Kubernetes is a production-grade, open-source infrastructure for the deployment, scaling, management, and composition of application containers across ***clusters*** of hosts. It is inspired by previous work at Google ***Kubernetes project***. The name ***Kubernetes*** originates from Greek for helmsman or pilot.



What is Kubernetes?

https://developer.ibm.com/technologies/microservices/articles/why-should-we-use-microservices-and-containers/
https://kubernetes.io/docs/concepts/overview/what-is-kubernetes/

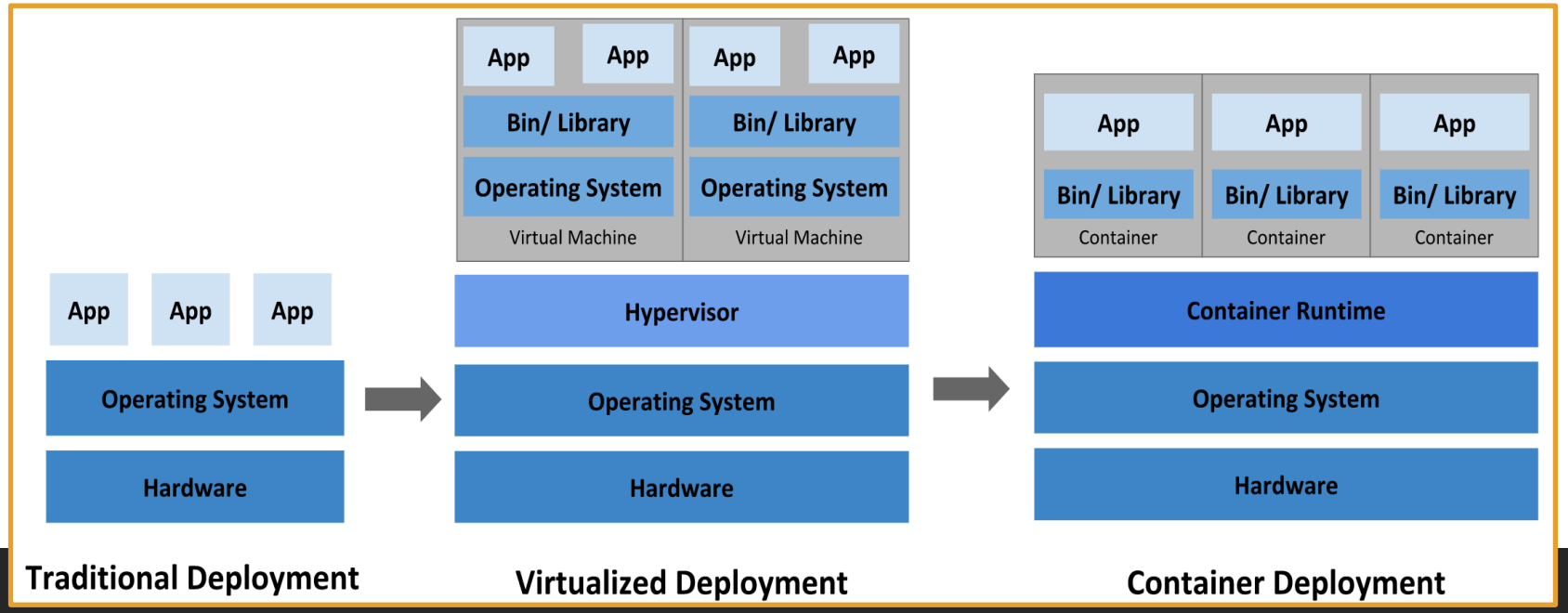
Kubernetes provides you with a framework to run distributed systems resiliently. It manages scaling and failover and provides deployment patterns. ***Kubernetes*** allows you to automate the deployment of containerized microservices. This makes it easier to manage the components and microservices in your application.



What is Kubernetes?

https://developer.ibm.com/technologies/microservices/articles/why-should-we-use-microservices-and-containers/
https://kubernetes.io/docs/concepts/overview/what-is-kubernetes/
https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#kubernetes-design-and-architecture

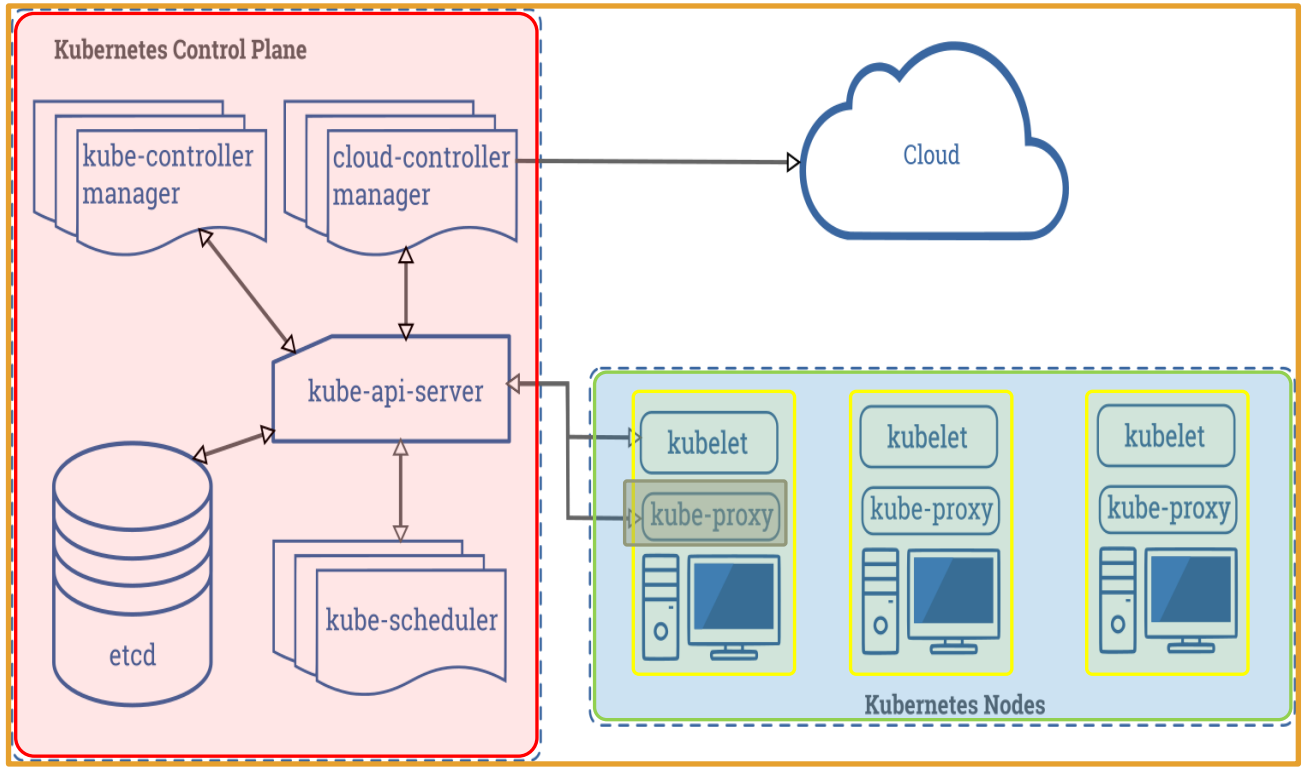
Kubernetes containers allow you to:			
Deploy images quickly	Maintain CI/CD	Enhance Separation of Concerns	Run your application anywhere
Have an elastic, scalable MSA	Isolate resources	Use resources effectively	Run your application on any platform



Kubernetes Architecture – Overview (1/2)

https://kubernetes.io/docs/concepts/overview/components/

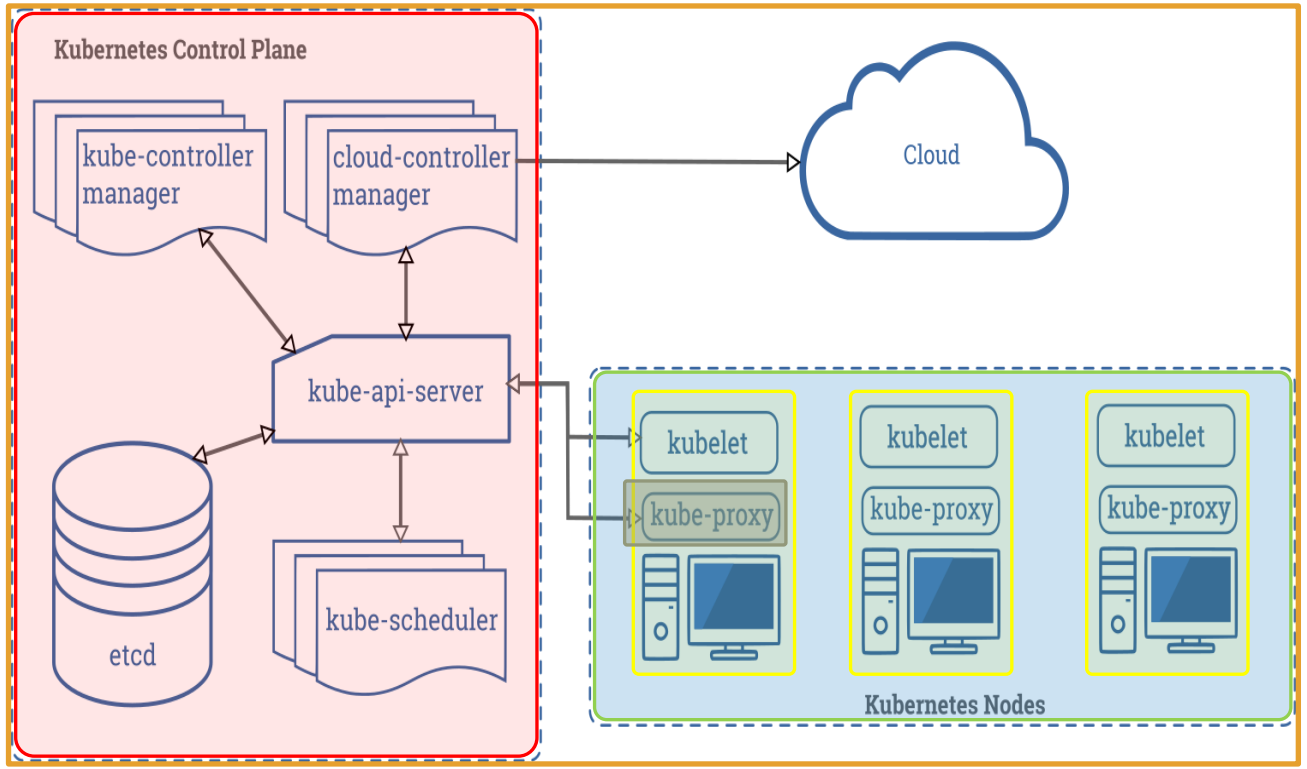
- ***Kubernetes*** is not a traditional, all-inclusive PaaS (Platform as a Service).
- ***Kubernetes*** operates at the container level rather than at the hardware level.
- When you deploy ***Kubernetes***, you get a cluster.
- A Cluster consists of worker machines (nodes), that run ***containerized*** applications.



Kubernetes Architecture – Overview (2/2)

https://kubernetes.io/docs/concepts/overview/components/

- The worker node(s) host the Pods that are the components of the application workload.
- The control plane manages the worker nodes and the Pods in the cluster.
- In production environments, the control plane usually operates across multiple computers and a cluster usually runs multiple nodes. This enhances fault-tolerance and provides high availability.

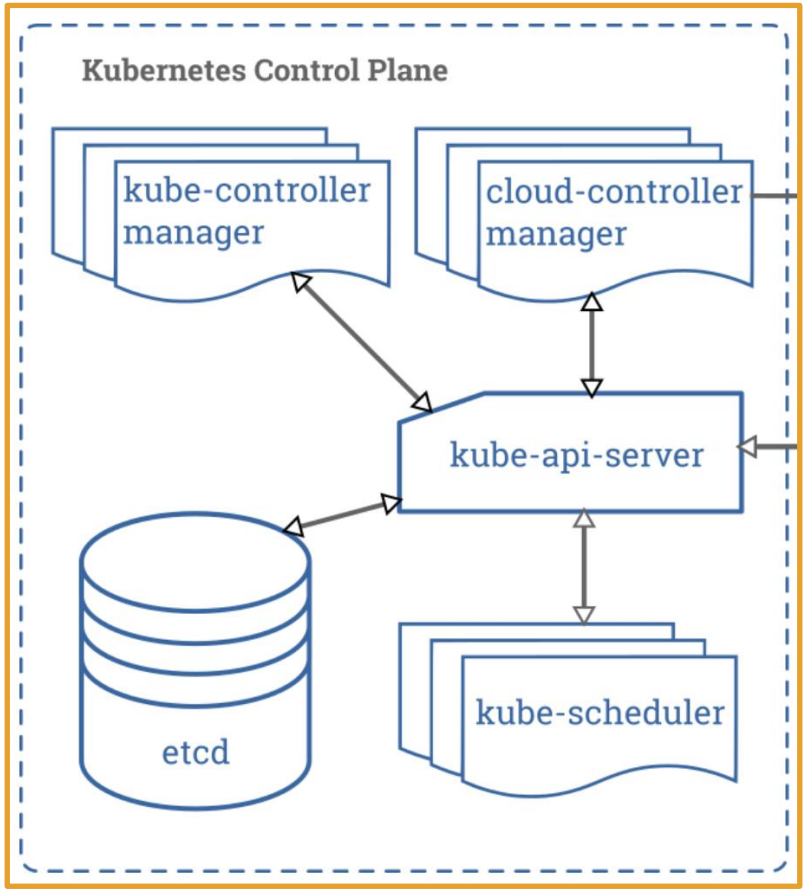


Kubernetes Control Plane (Master)

https://kubernetes.io/docs/concepts/overview/components/#control-plane-components

The ***control plane's*** components make global decisions about the cluster, as well as detecting and responding to ***cluster*** events, like starting up a new pod when a deployment's 'replicas' field is unsatisfied.

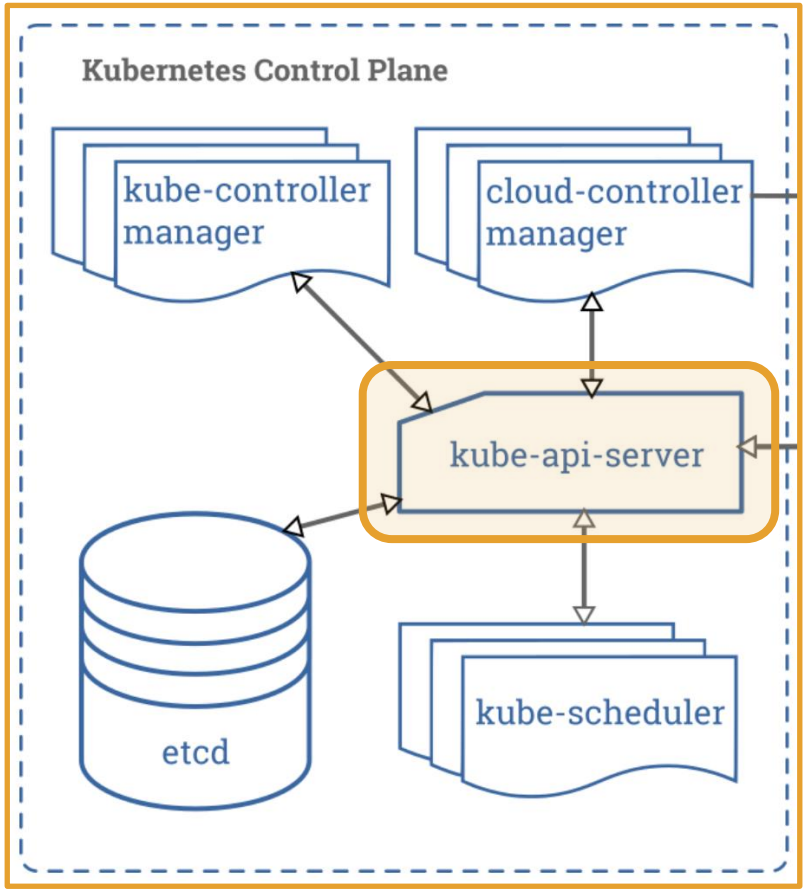
Control plane components can be run on any machine in the cluster, but typically set-up ***scripts*** start all ***control plane*** components on the same machine, and do not run user containers on that machine.



Control Plane – kube-apiserver

https://kubernetes.io/docs/concepts/overview/components/#kube-apiserver

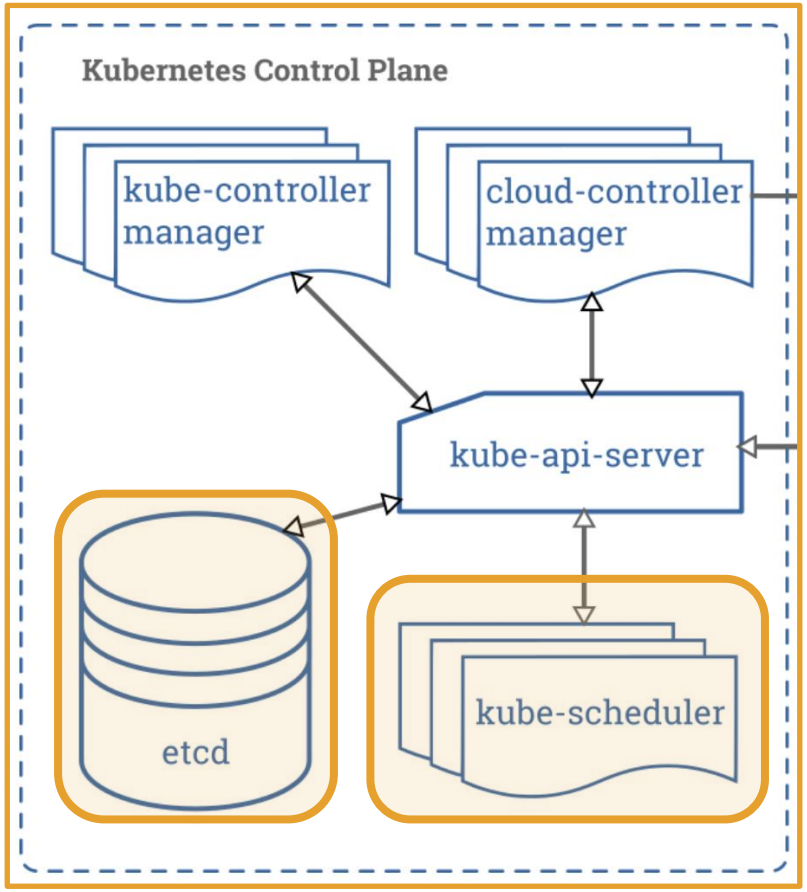
- The ***API server*** exposes the Kubernetes API. The ***API server*** is the front end for the Kubernetes ***control plane***.
- The main implementation of a Kubernetes API server is ***kube-apiserver***.
- ***kube-apiserver*** is designed to scale horizontally (deploying more instances).
- You can run several instances of ***kube-apiserver*** and balance traffic between the instances.



Control Plane – etcd and kube-scheduler

https://kubernetes.io/docs/concepts/overview/components/#etcd
https://kubernetes.io/docs/concepts/overview/components/#kube-scheduler
https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#scheduler

- ***Etcd*** is a key-value store. It maintains the ***clusters'*** data.
- ***kube-scheduler*** watches for new ***Pods*** and assigns a ***node*** to them to run on based on predetermined requirements like:
  - hardware constraints,
  - affinity/anti-affinity specifications,
  - deadlines,
  - and many more.

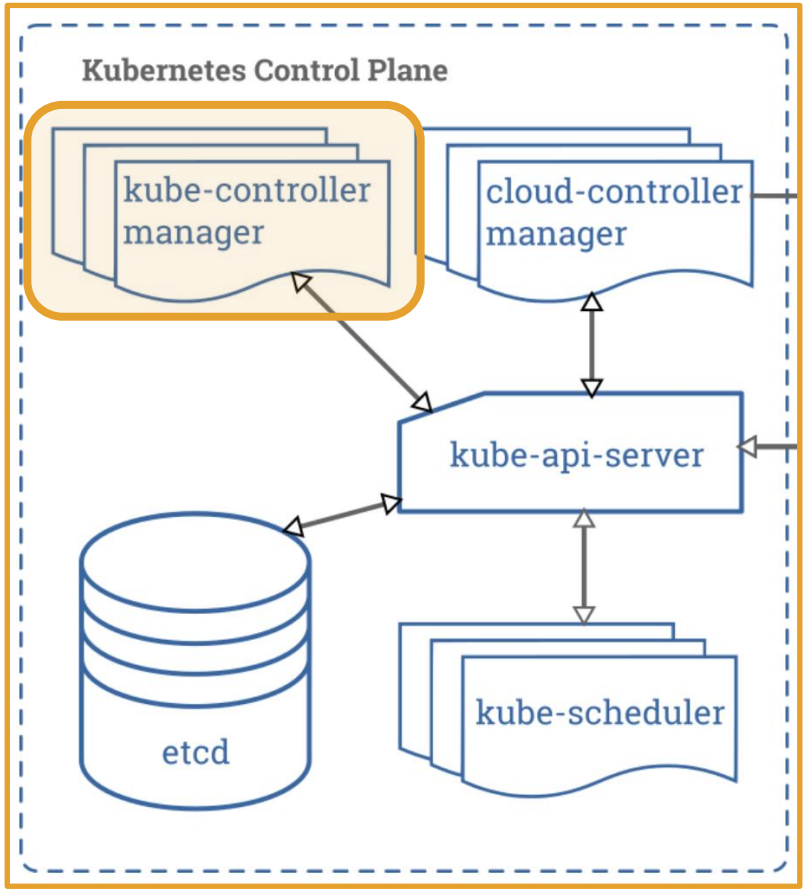


Control Plane – kube-controller manager

https://kubernetes.io/docs/concepts/overview/components/#kube-controller-manager

Kube-manager-controller runs the ***controller processes***. There are 4 ***controller*** types:

- Node controller: notices and responds when nodes go down.
- Replication controller: maintains the correct number of pods for every replication controller object in the system.
- Endpoints controller: Populates the Endpoints object (joins Services & Pods).
- Service Account & Token controllers: Create default accounts and API access tokens for new namespaces.

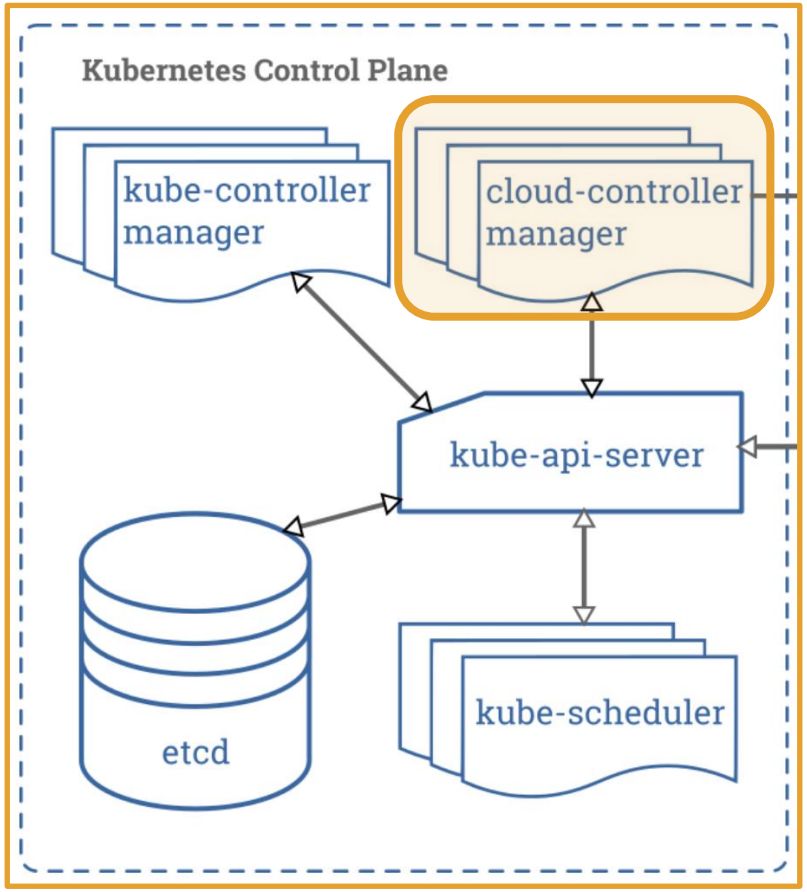


Control Plane – cloud-controller manager (1/2)

https://kubernetes.io/docs/concepts/overview/components/#cloud-controller-manager

The ***cloud-controller-manager*** allows linking a cluster into the cloud providers API. It will separate the components that interact with the cloud platform from components that only interact with the cluster.

cloud-controller-manager combines several logically independent control loops into a single binary that is run as a single process. Horizontal scaling (running more instances) allows for improved performance or help with failure tolerance.

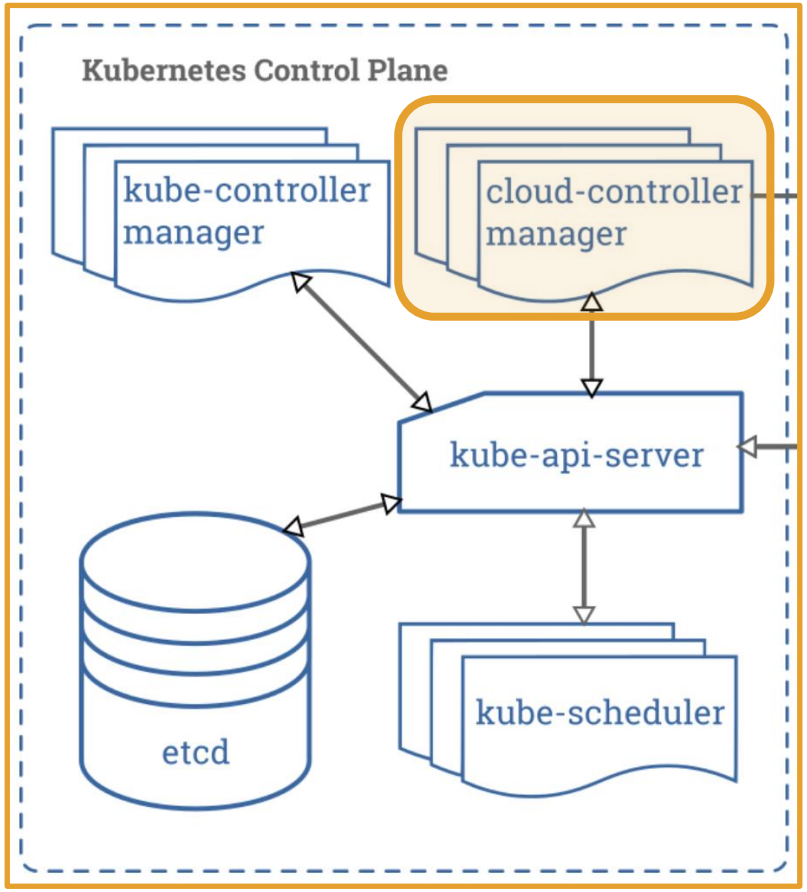


Control Plane – cloud-controller manager (2/2)

https://kubernetes.io/docs/concepts/overview/components/#cloud-controller-manager

These three ***controllers*** can have cloud provider dependencies:

- Node controller: For checking the cloud provider to determine if a node has been deleted in the cloud after it stops responding
- Route controller: For setting up routes in the underlying cloud infrastructure
- Service controller: For creating, updating and deleting cloud provider load balancers.

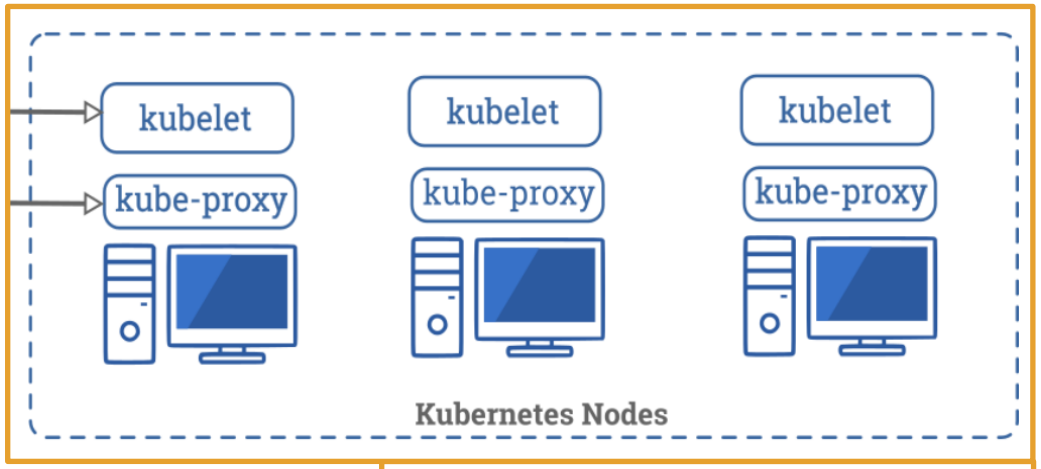


Node Components - Kubelet

https://kubernetes.io/docs/concepts/overview/components/#node-components
https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#kubelet
https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#kube-proxy

---

A ***Kubelet*** agent runs on each ***node*** in the cluster. It is the primary implementer of the ***Pod*** and Node APIs that drive the container execution layer. The ***Kubelet*** uses ***PodSpecs*** to verify that containers described in those ***PodSpecs*** are running in the ***Pods***. The ***kubelet*** doesn't manage containers which were not created by ***Kubernetes***.



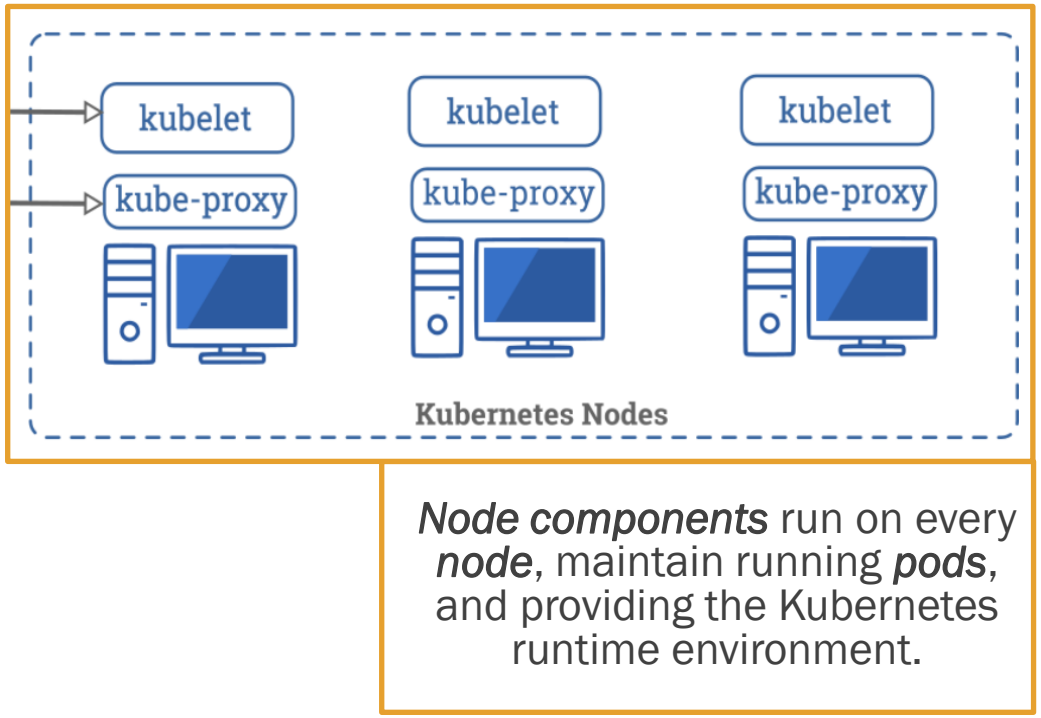
Node components run on every ***node***, maintain running ***pods***, and providing the Kubernetes runtime environment.

Node Components – kube-proxy

https://kubernetes.io/docs/concepts/overview/components/#node-components
https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#kubelet
https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#kube-proxy

---

A ***kube-proxy*** is a network proxy that runs on each ***node*** in your cluster. ***kube-proxy*** provides a way to group pods under a common access policy (e.g., ***load-balanced***).
This creates a virtual IP that clients can access which is transparently proxied (forwarded) to the ***pods*** in a Service.
Every ***node*** runs a ***kube-proxy*** process.
Kube-proxy programs IpTables rules to trap access to service IPs and redirect them to the correct backend.



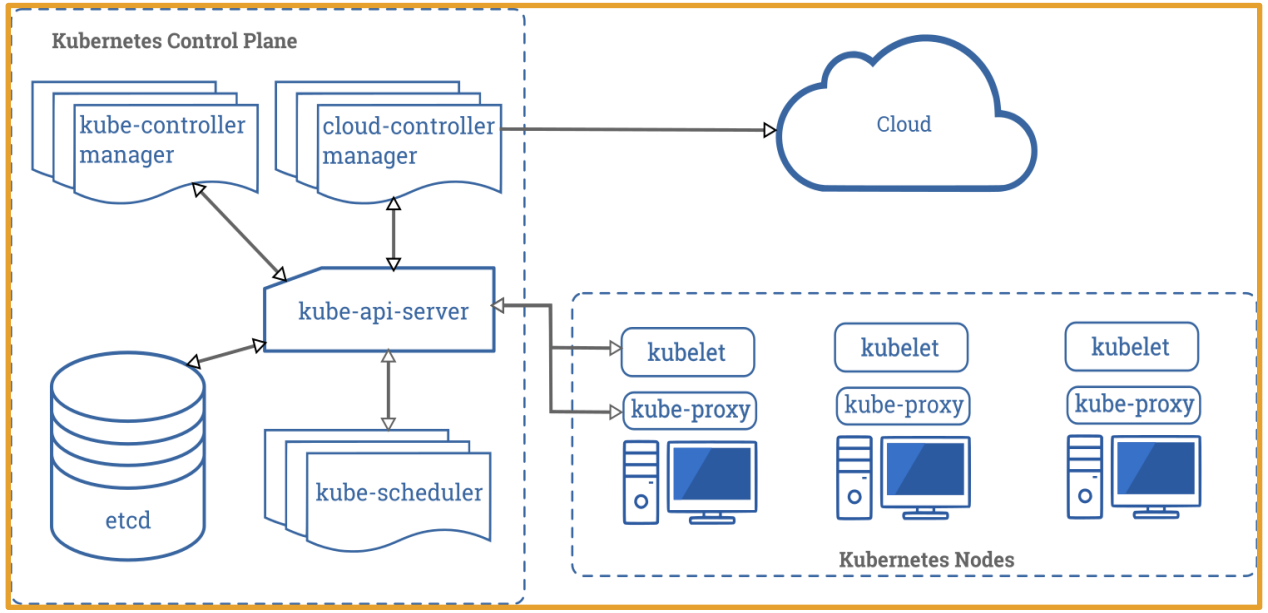
Node – Components

https://kubernetes.io/docs/concepts/overview/components/#node-components
https://kubernetes.io/docs/concepts/architecture/nodes/#management

The ***container runtime*** is the software that is responsible for running containers.

Kubernetes supports several container runtimes.

- Kubernetes Container Runtime Interface (CRI
- Docker
- containerd
- CRI-O

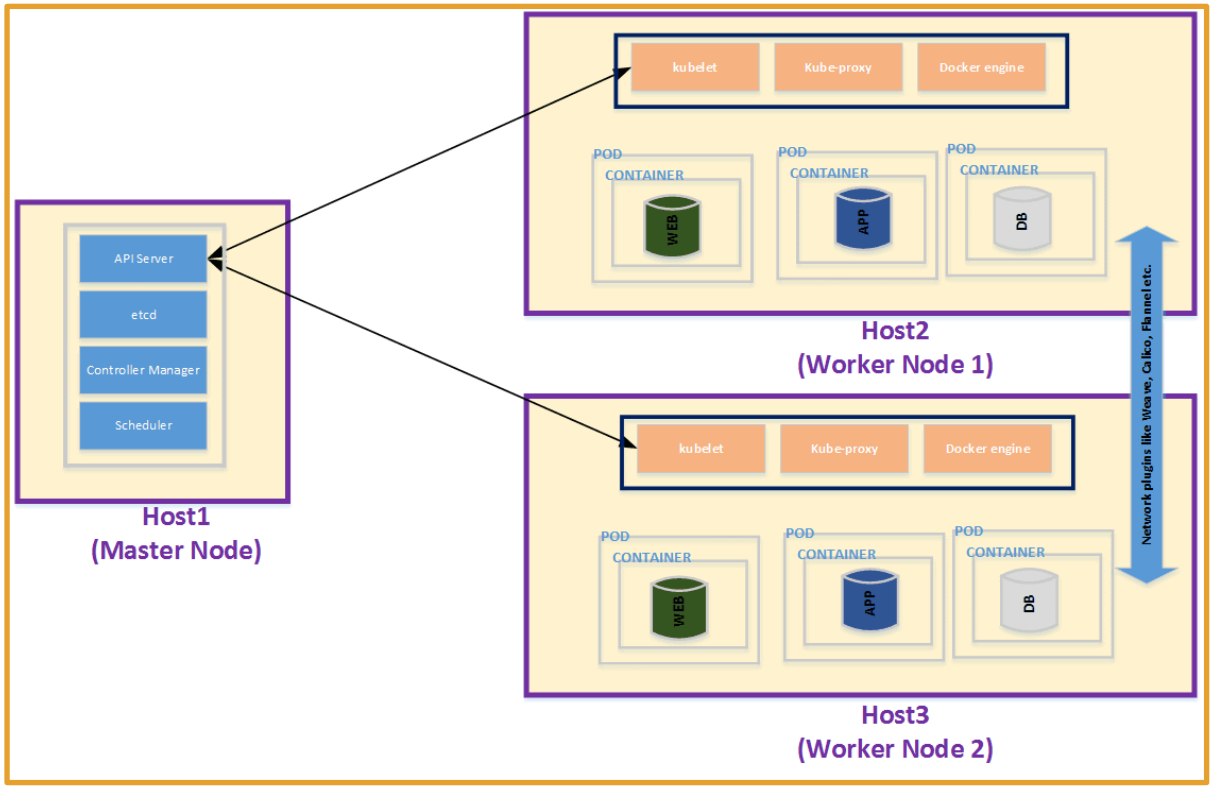


Node Structure

https://kubernetes.io/docs/concepts/architecture/nodes/

Each ***node*** contains the services necessary to run the ***Pods*** on it, which are managed by the ***control plane***.

A ***node*** may be a virtual or physical machine.



Node Structure

https://kubernetes.io/docs/concepts/architecture/nodes/

A ***container*** represents a containerized application

The ***container*** is placed into a ***Pod***.

A ***Pod*** runs on a ***Node***.

One or more ***Nodes*** make up a ***Cluster***.

The ***Cluster*** is the ***Kubernetes Workload***.