



Kubernetes Fundamentals

.NET 5

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

[HTTPS://KUBERNETES.IO/DOCS/CONCEPTS/OVERVIEW/WHAT-IS-KUBERNETES/](https://kubernetes.io/docs/concepts/overview/what-is-kubernetes/)

Cloud Native Applications

<https://www.redhat.com/en/topics/cloud-native-apps>

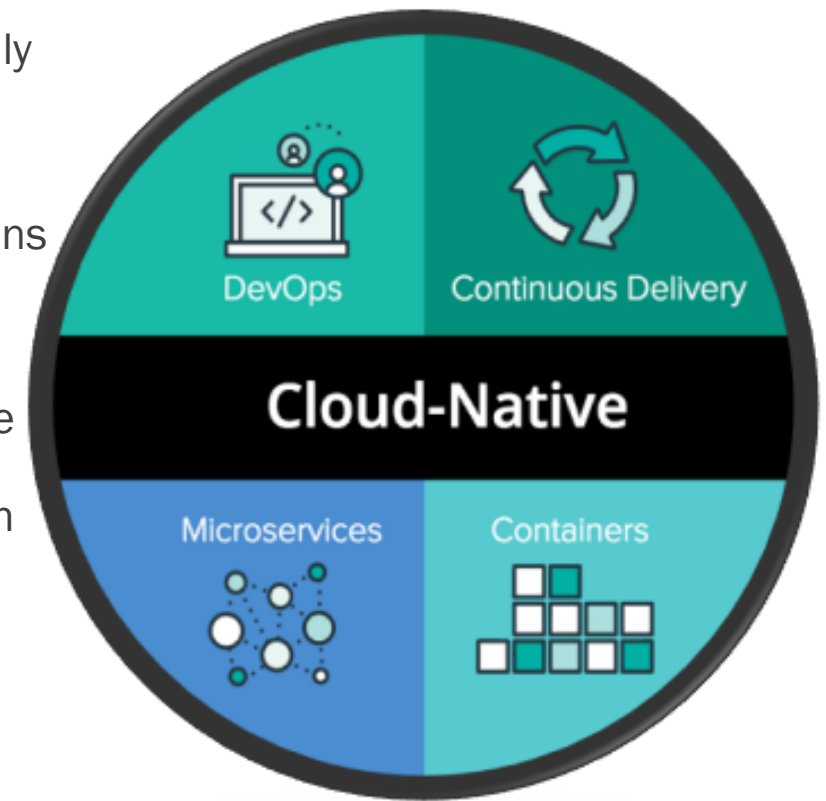
<https://medium.com/velotio-perspectives/cloud-native-applications-the-why-the-what-the-how-9b2d31897496>

Cloud-native applications are small, independent, loosely coupled services, that are designed to deliver business value such as rapidly incorporating user feedback, maintaining higher up-time, and optimizing CI/CD.

Cloud-native app development is a way to speed up how applications are built, optimize existing applications, and interconnect them.

A "cloud-native," app is specifically designed to provide consistent development, automated management, and greater fault-tolerance experience across all cloud types (private, public, hybrid). Cloud computing increases the scalability and availability of apps through self-service and on-demand provisioning of resources, as well as automating the application life cycle from development to production.

Kubernetes is one of the first and most popular cloud native applications.



Cloud Native Interactive Landscape

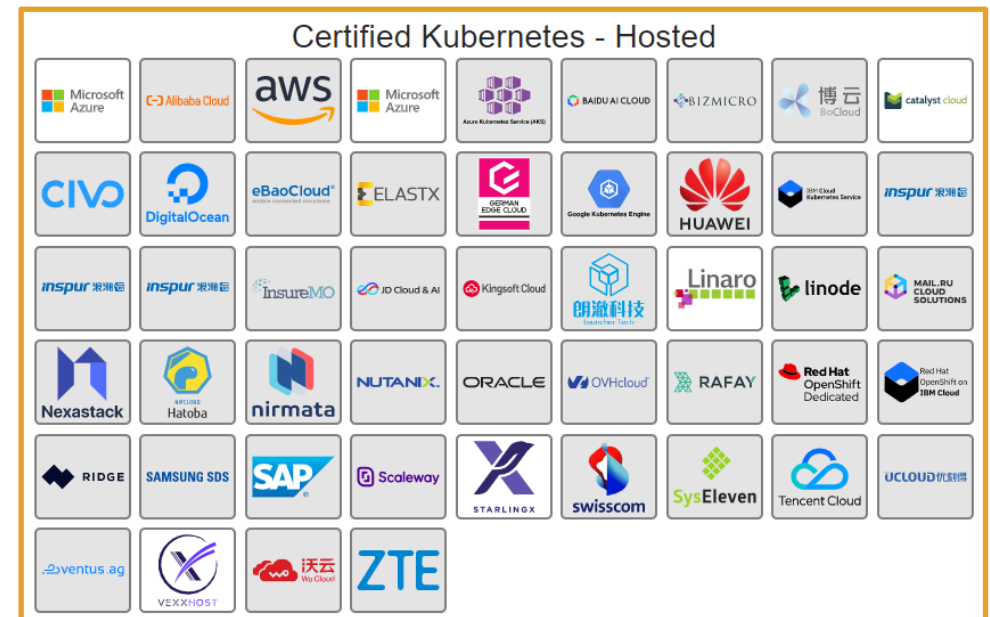
<https://landscape.cncf.io/>

<https://www.cncf.io/blog/2018/03/08/introducing-the-cloud-native-landscape-2-0-interactive-edition/>

<https://github.com/cncf/foundation/blob/master/charter.md>

Kubernetes is part of what is called the Cloud Native Interactive Landscape. This landscape is made up of “Cloud Native” services, meaning loosely coupled services solely located in the cloud and whose intent is to enhance the ability of applications to be managed and scaled as needed.

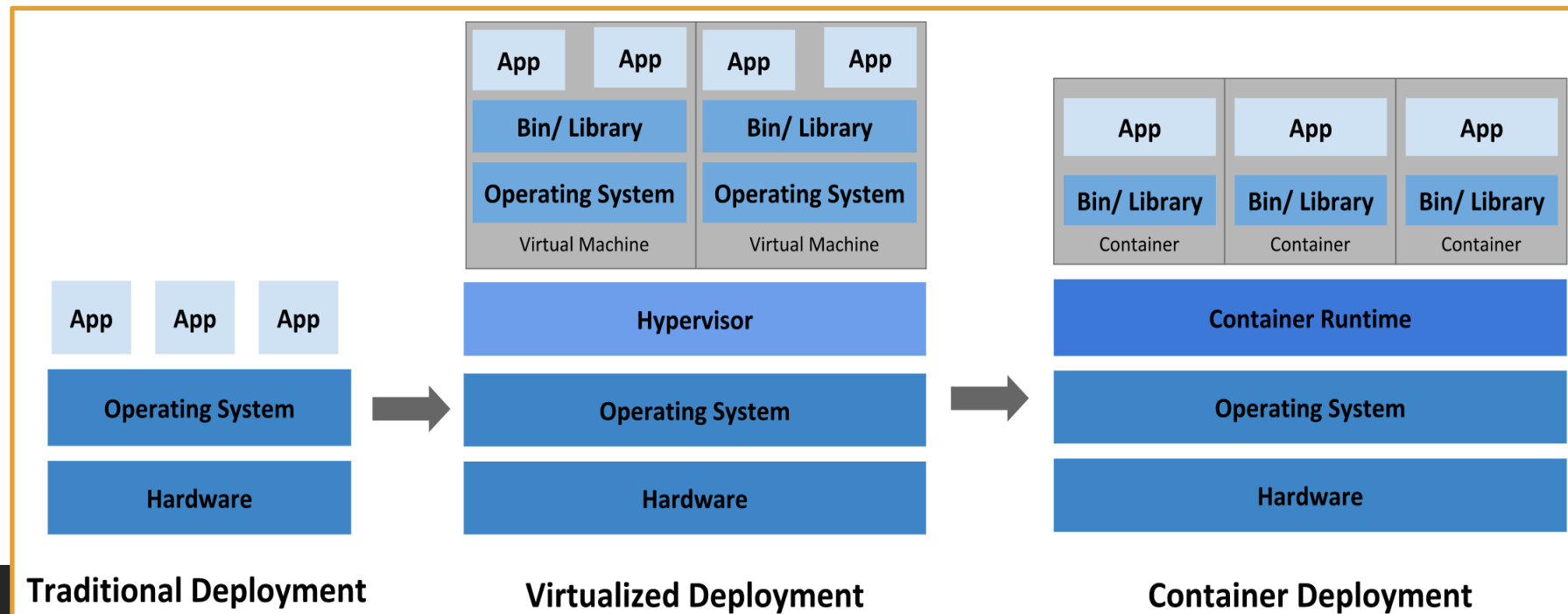
The **Cloud Native Computing Foundation (CNCF)** hosts critical components of the global technology infrastructure. The CNCF mission is to make cloud native computing ubiquitous, steward projects, foster the growth and evolution of the cloud ecosystem, promote underlying technologies, and make the technology accessible and reliable.



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/>

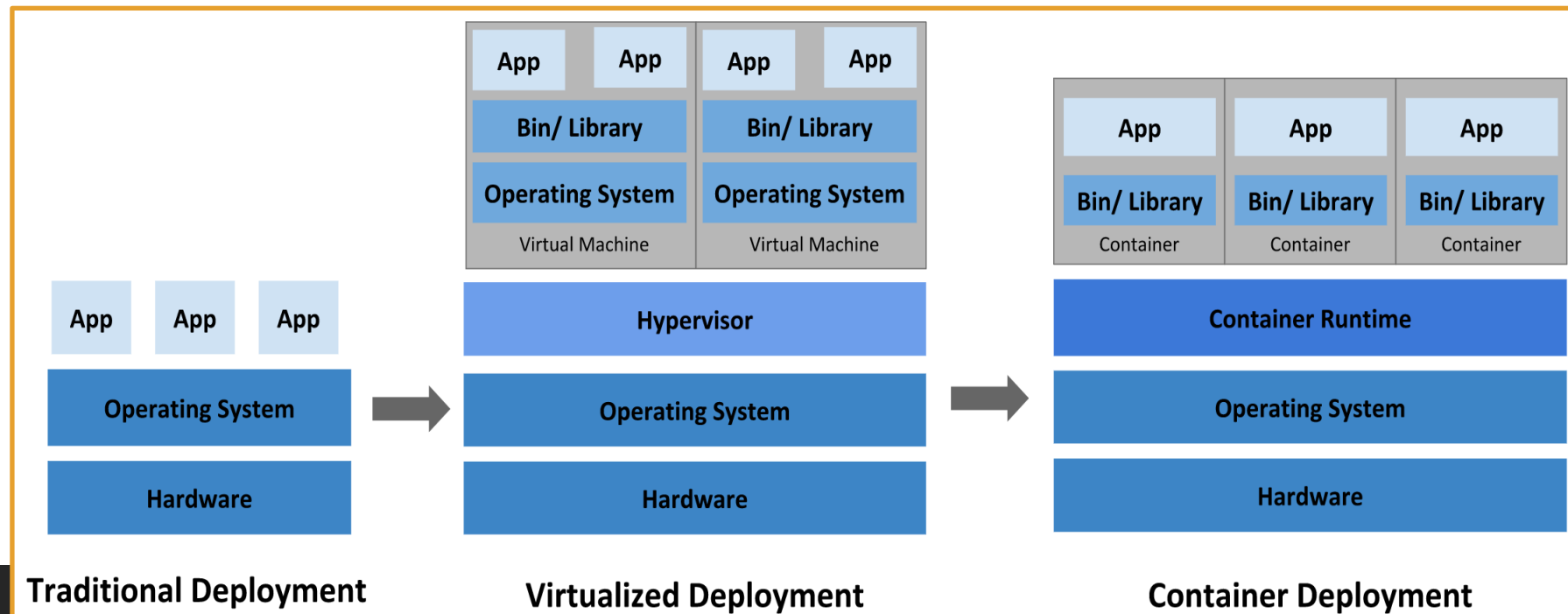
Kubernetes is a production-grade, open-source infrastructure for the deployment, scaling, management, and composition of application containers across **clusters** of hosts. It is inspired by previous work at Google **Kubernetes project**. The name **Kubernetes** originates from Greek for helmsman or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



What is Kubernetes?

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<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?

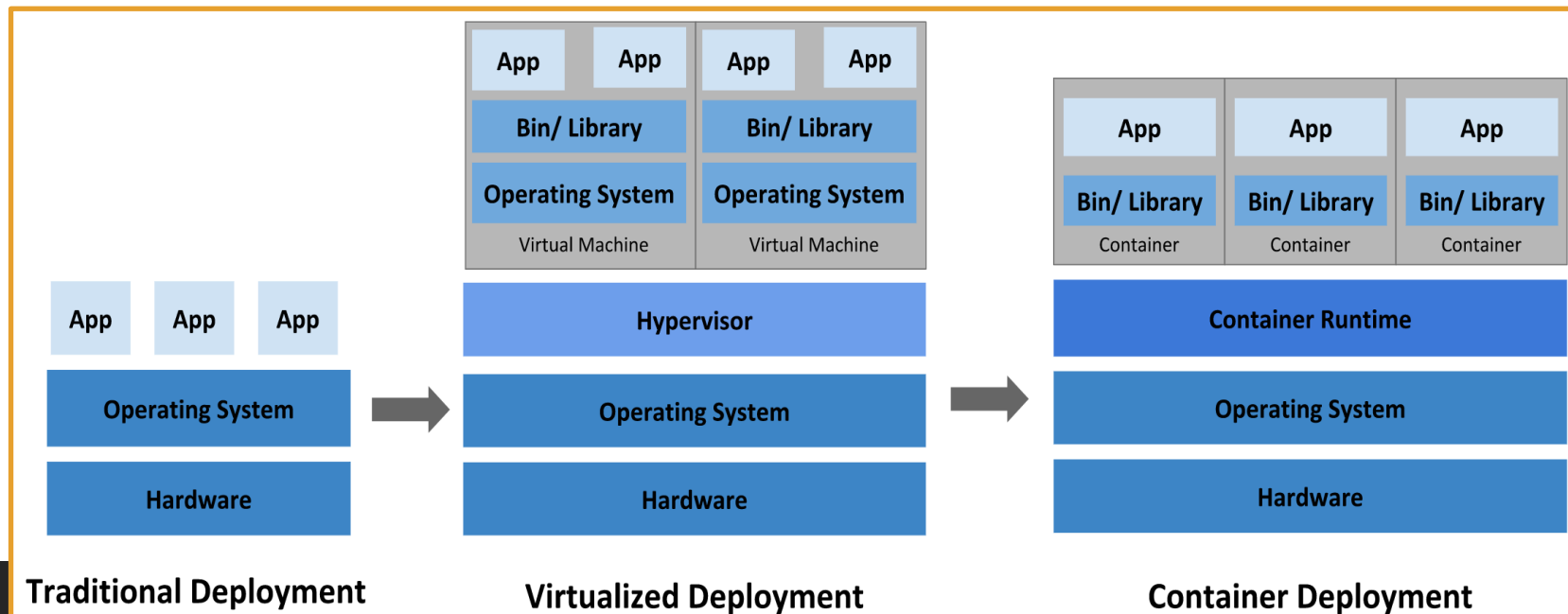
<https://developer.ibm.com/technologies/microservices/articles/why-should-we-use-microservices-and-containers/>

<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:

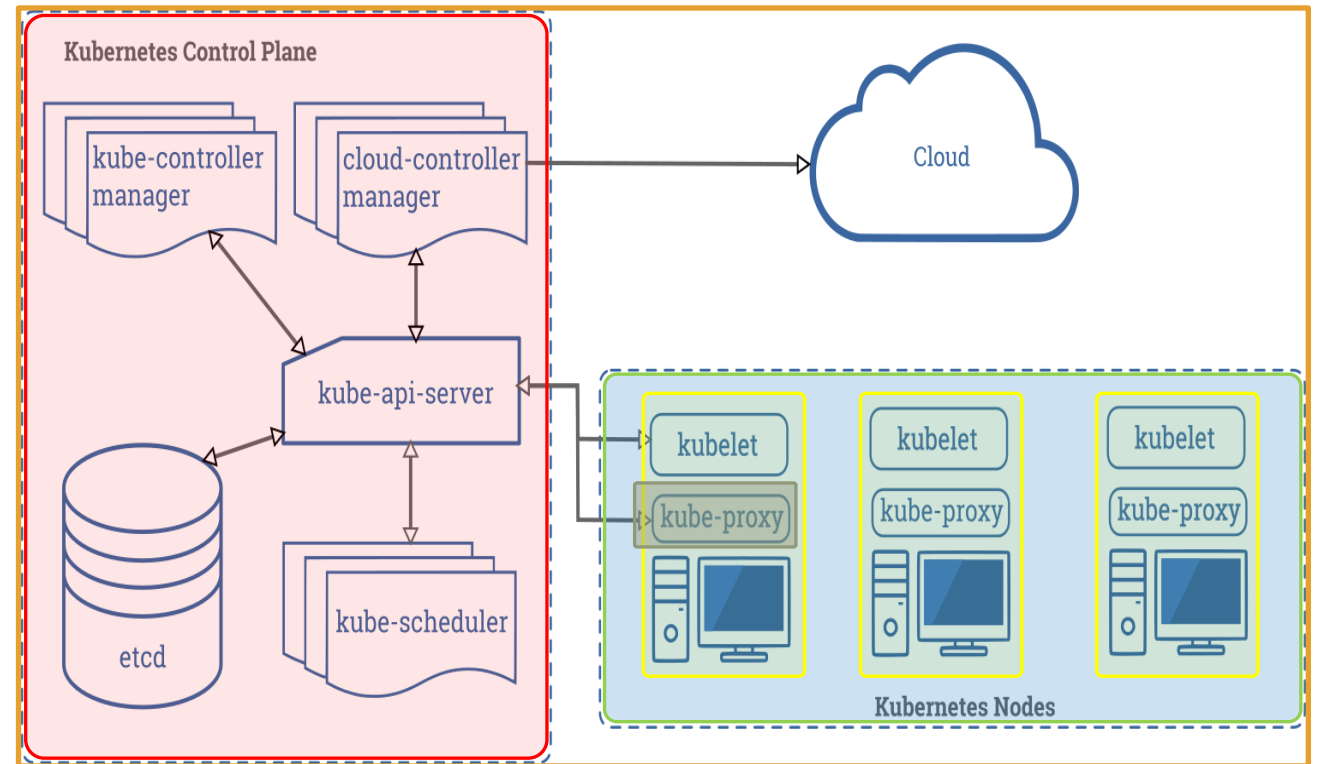
Deploy images quickly	Maintain CI/CD	Enhance Separation of Concerns	Run your application anywhere
Have an elastic, scalable MSA	Isolate resources	Use resources effectively	Run your application on any platform



Kubernetes Architecture – Overview (1/2)

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

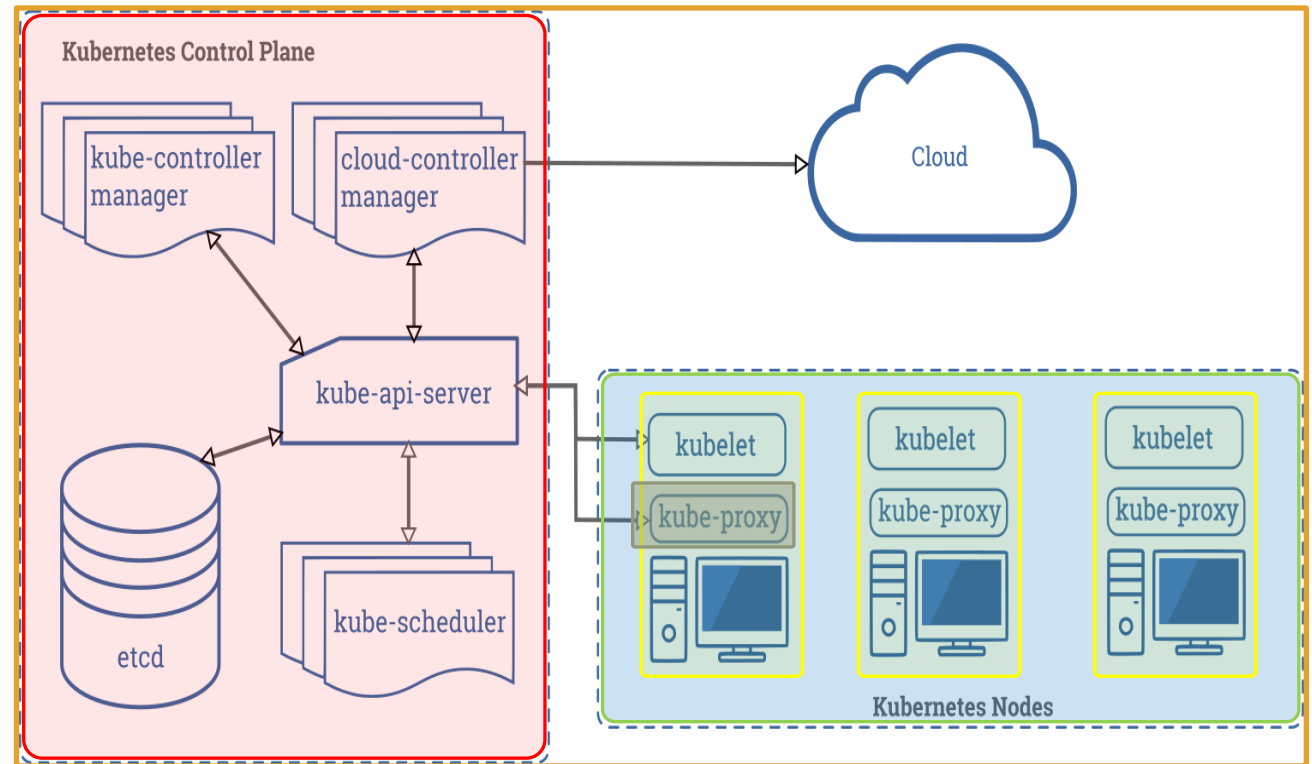
- **Kubernetes** is not a traditional, all-inclusive PaaS (Platform as a Service).
- **Kubernetes** operates at the container level rather than at the hardware level.
- When you deploy **Kubernetes**, you get a **cluster**.
- A **Cluster** consists of worker machines (**nodes**), that run **containerized**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

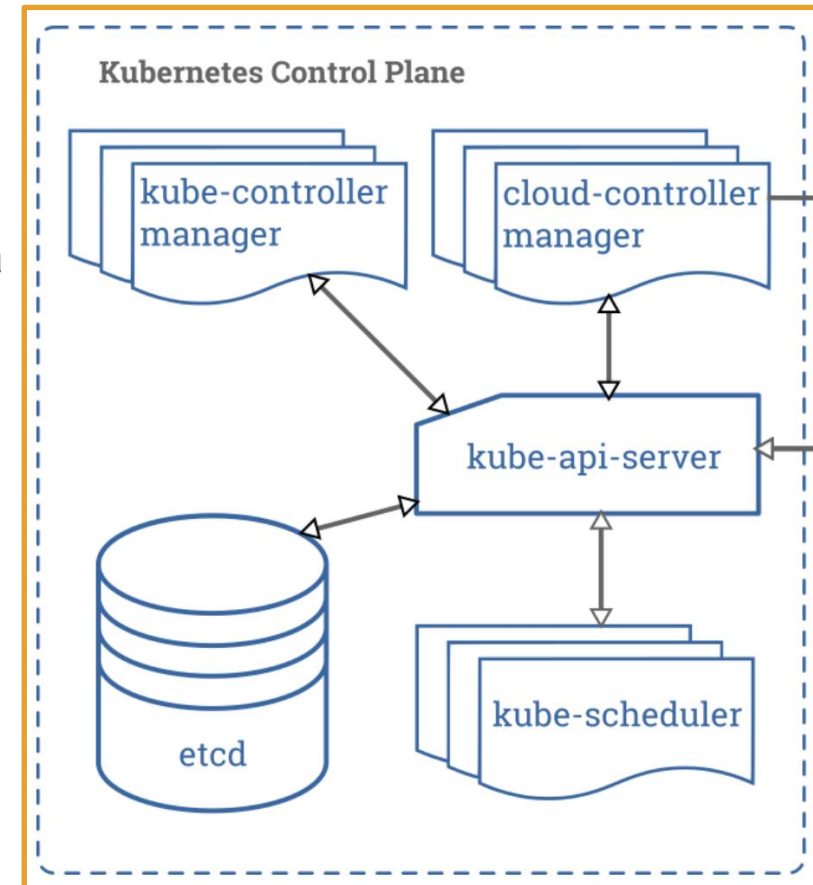


Kubernetes Control Plane (Master)

<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.

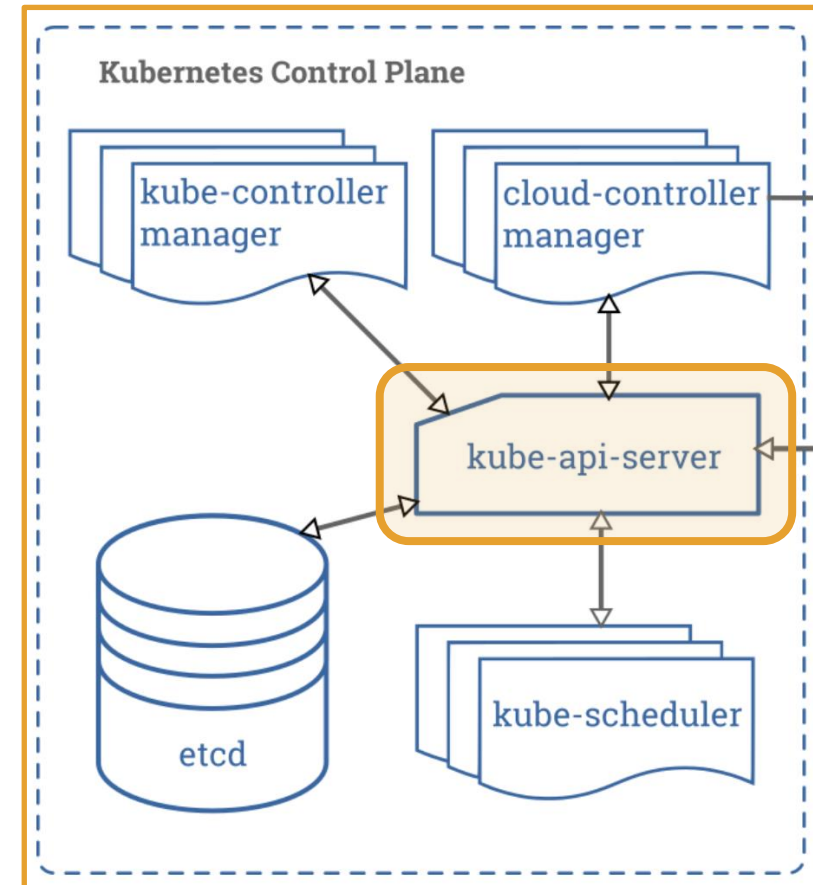
Control plane components can be run on any machine in the cluster, but typically set-up ***scripts*** start all ***control plane*** components on the same machine, and do not run user containers on that machine.



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.



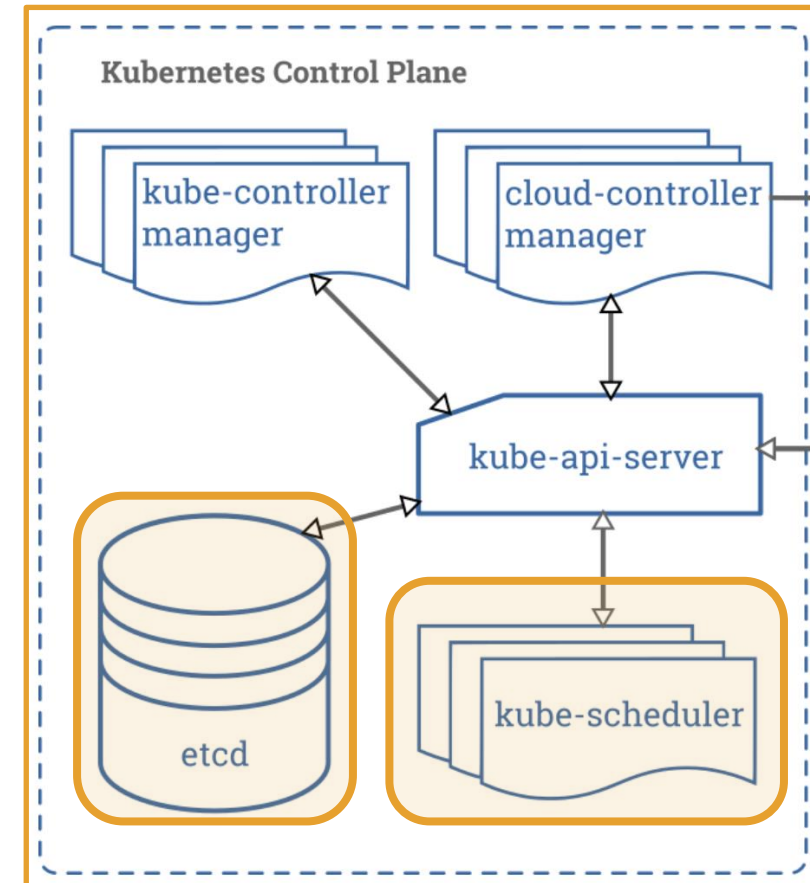
Control Plane – etcd and kube-scheduler

<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.

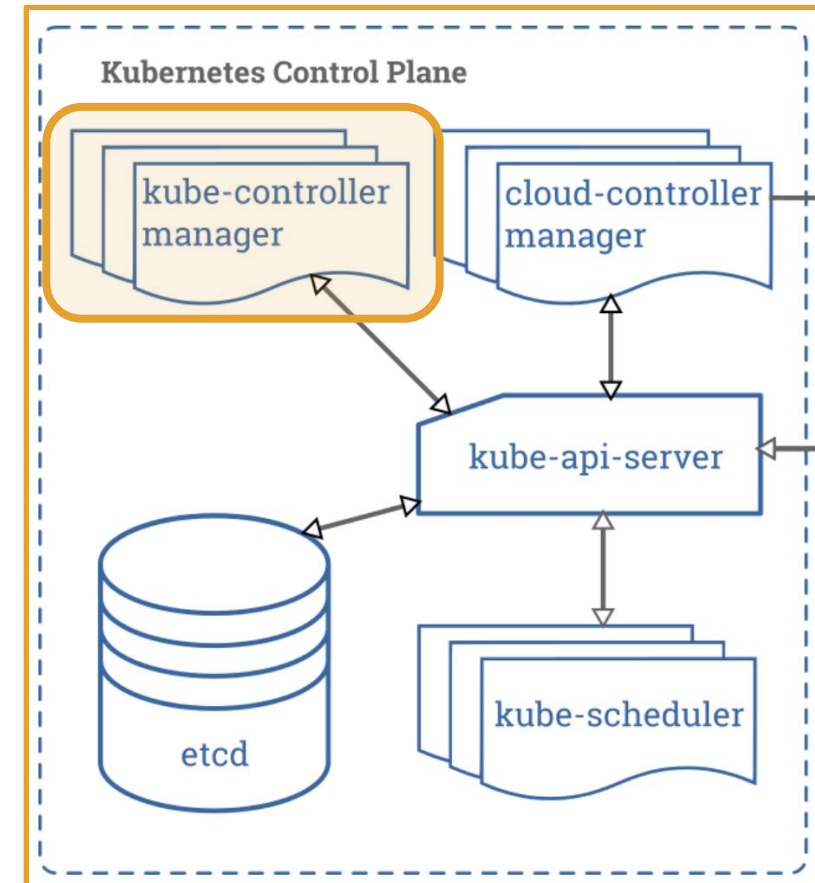


Control Plane – kube-controller manager

<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.

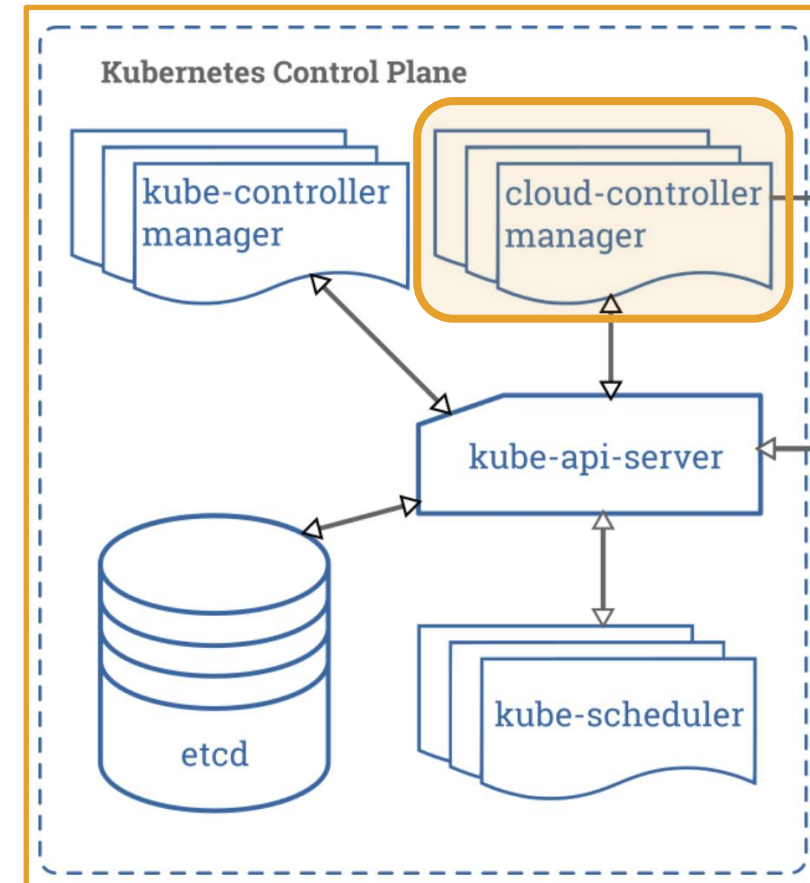


Control Plane – cloud-controller manager (1 / 2)

<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.

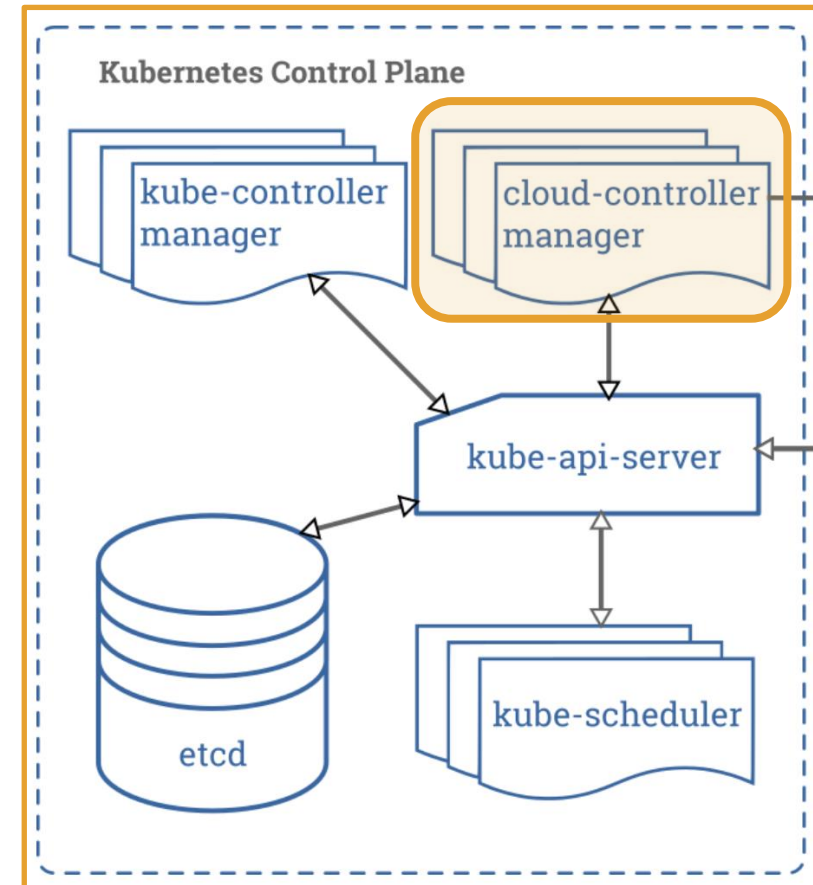


Control Plane – cloud-controller manager (2/2)

<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.



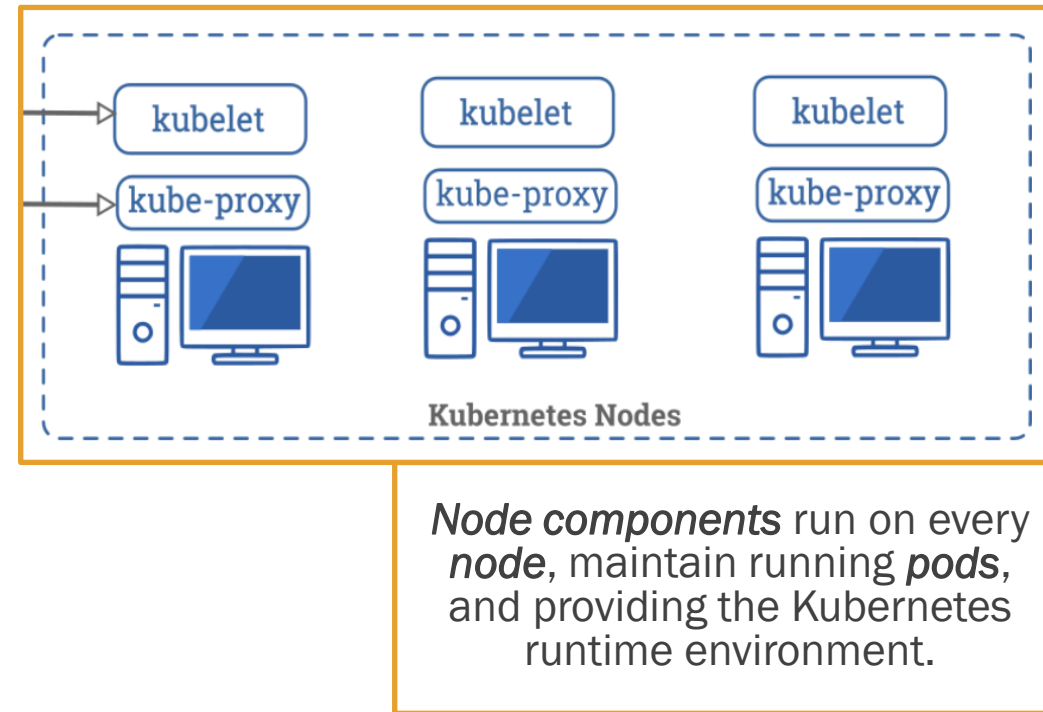
Node Components - Kubelet

<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 – kube-proxy

<https://kubernetes.io/docs/concepts/overview/components/#node-components>

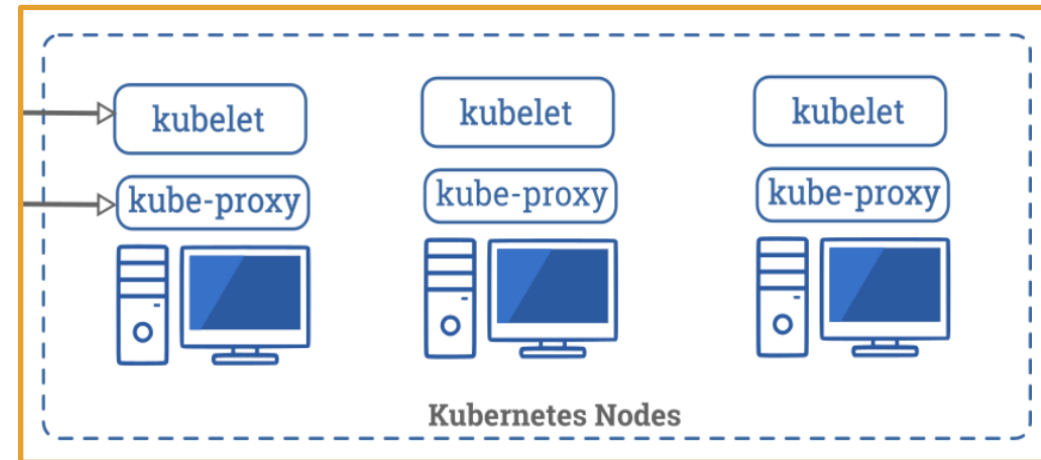
<https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/architecture.md#kubelet>

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

Node – Components

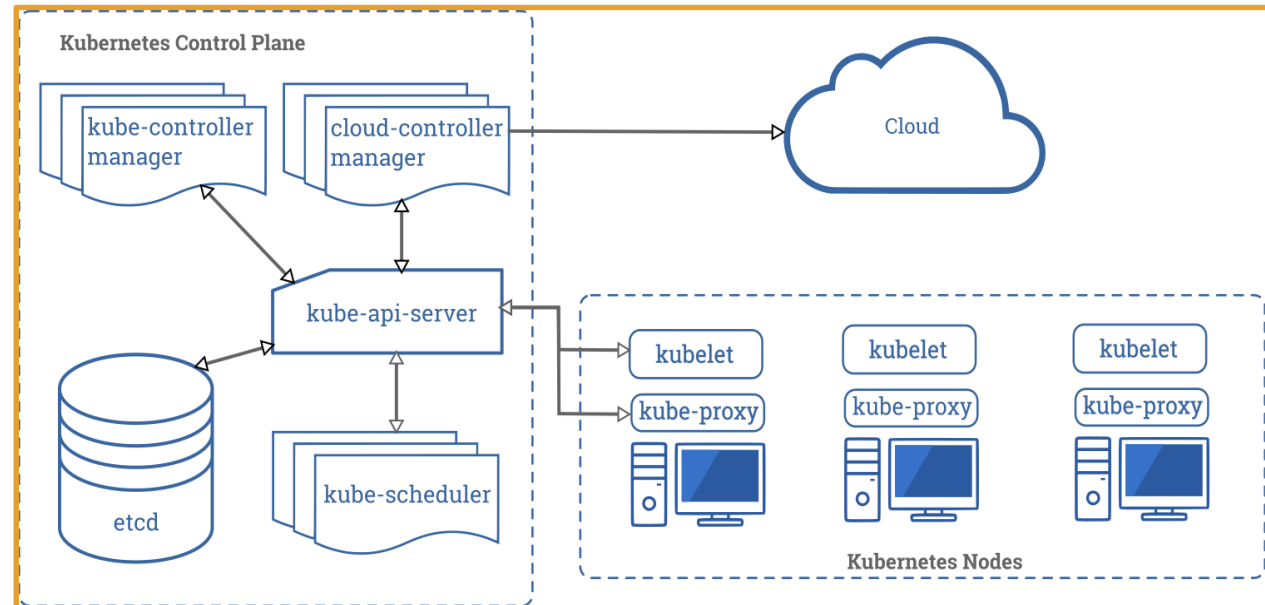
<https://kubernetes.io/docs/concepts/overview/components/#node-components>

<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

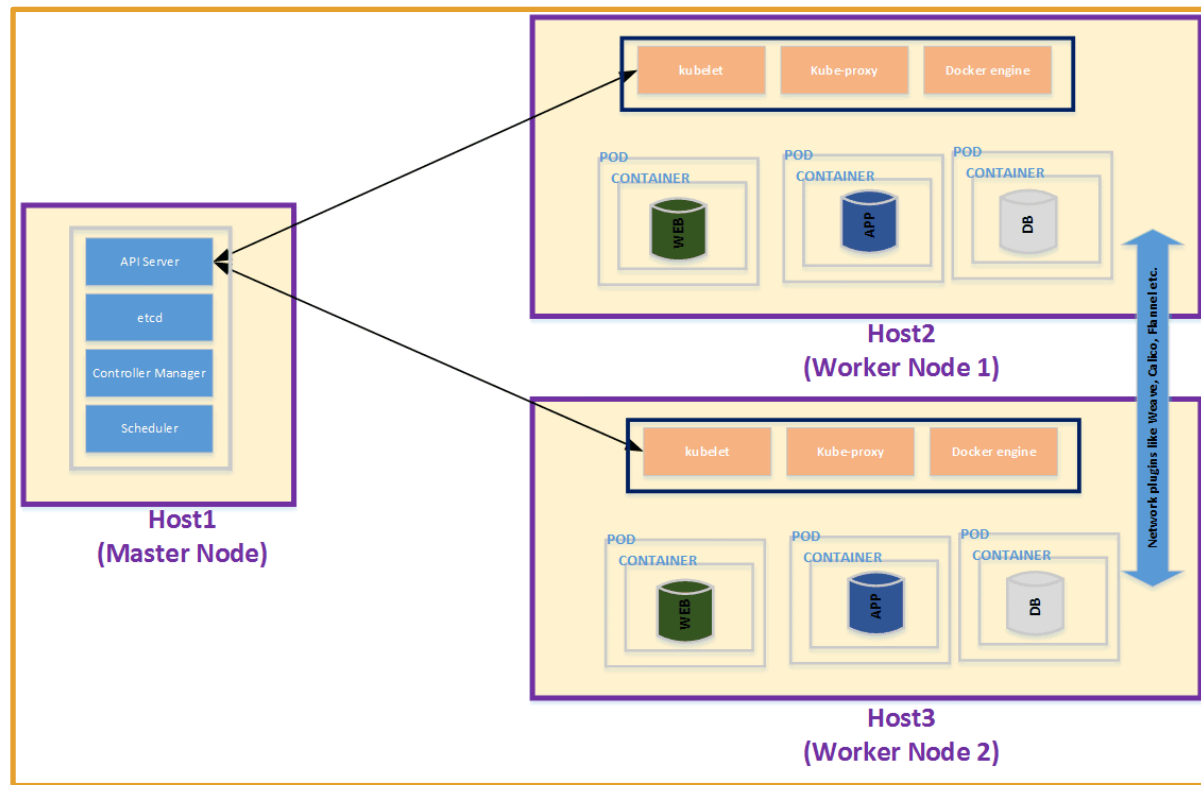


Node Structure

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

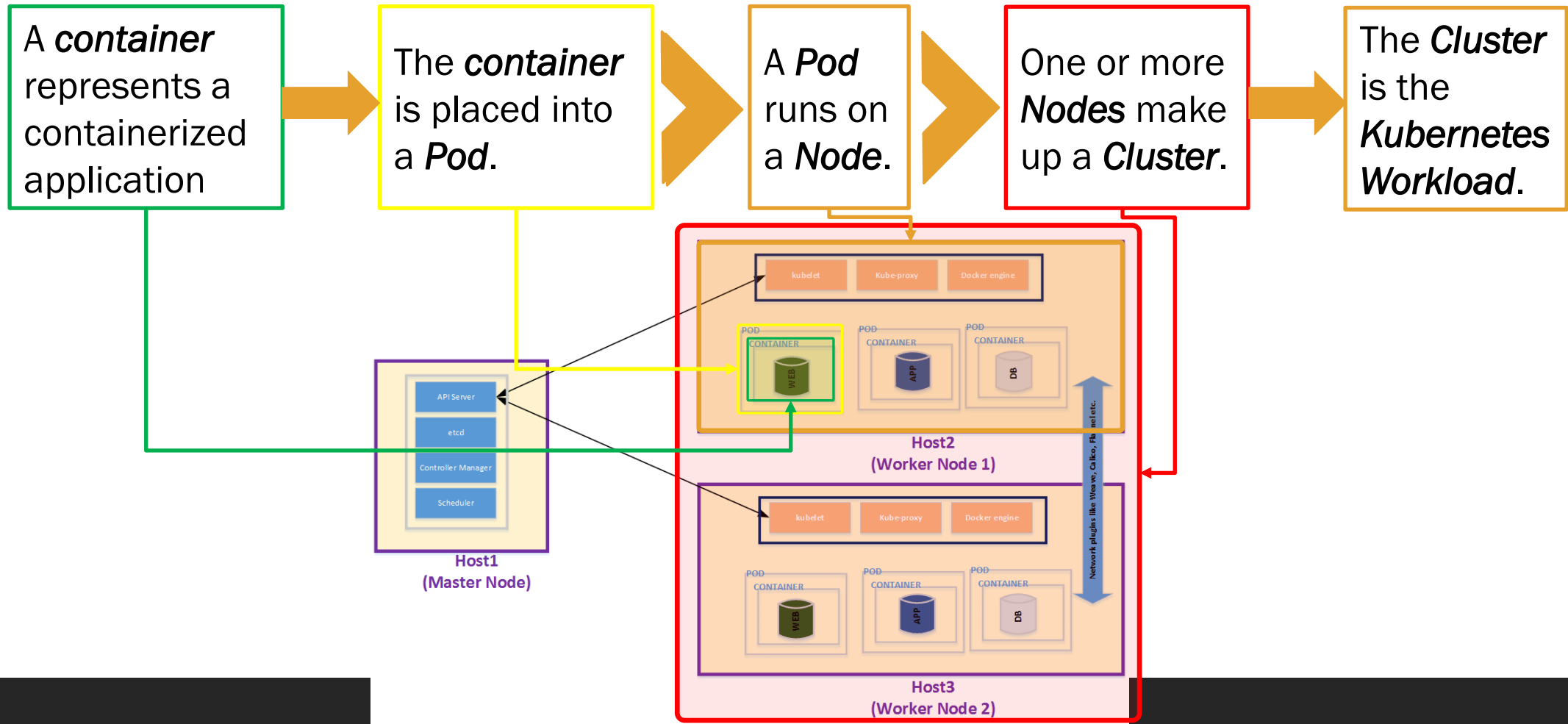
Each **node** contains the services necessary to run the **Pods** on it, which are managed by the **control plane**.

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



Node Structure

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



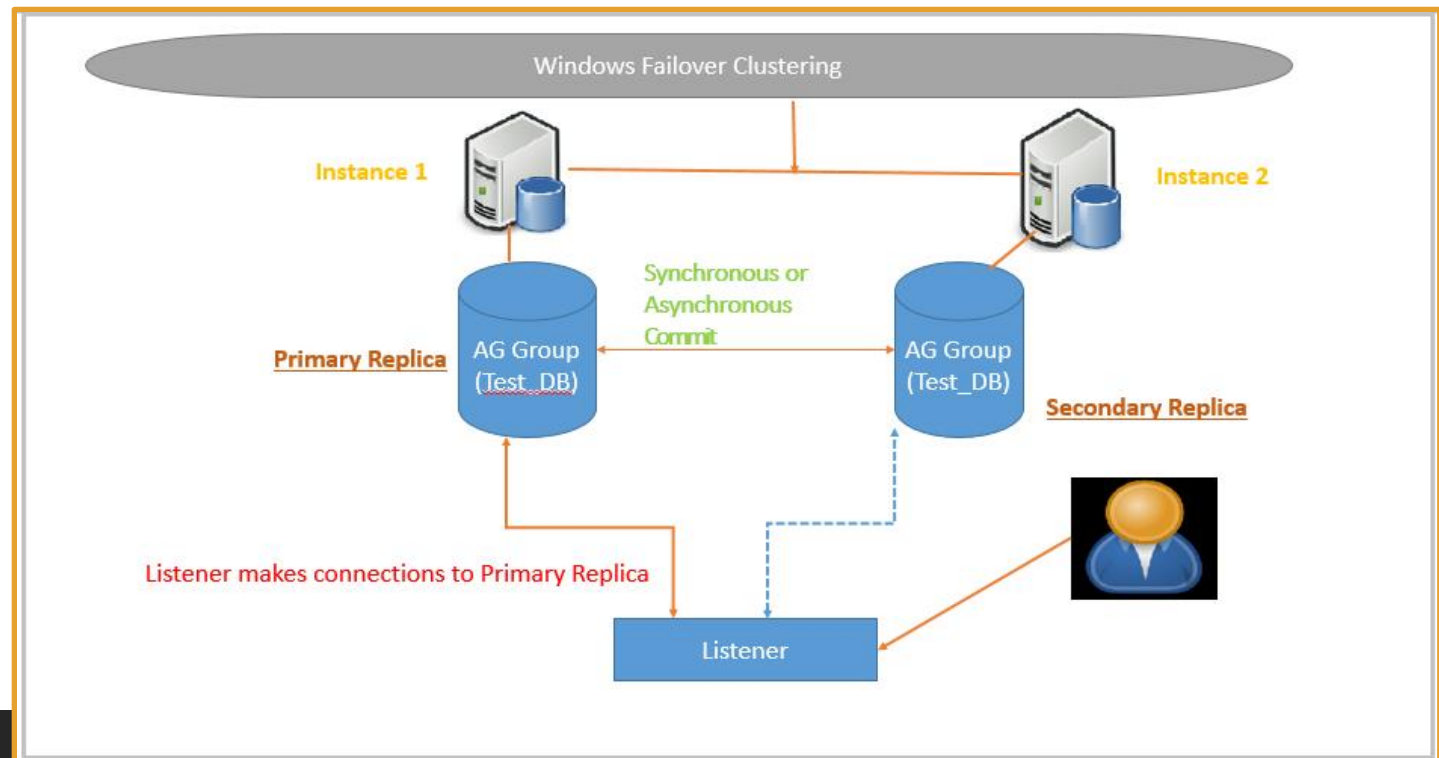
failover explained

<https://en.wikipedia.org/wiki/Failover>

<https://devopsprodigy.com/blog/failover-in-kubernetes/>

In computing and related technologies such as networking, **failover** is switching to a redundant or standby computer server, system, hardware component or network upon the failure or abnormal termination of the previously active application, server, system, hardware component, or network.

In **Kubernetes**, **failover** is avoided by creating self-balanced, self-scaled, and self-restored pods and containers BUT major issues can create circumstances where an entire region or service goes down and there needs to be a backup cluster ready to handle such instances.



FOR ME ONLY - <https://github.com/RevatureGentry/ERS-V2>