


Unit 1

Understanding Kubernetes Architecture



Business
Training

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Outline

Understanding Kubernetes architecture

- Introduction to Kubernetes
- Kubernetes Architecture
- Start a Single node cluster locally with Docker Desktop for Windows
- Using the Kubernetes dashboard
- Basic Commands of Kubectl

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Introduction to Kubernetes

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What is Kubernetes ?

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architecture

- **Kubernetes is an open source system for managing containerized applications across multiple hosts.**

- It provides basic mechanisms for deployment, maintenance, and scaling of applications.



- **Kubernetes builds upon a decade and a half of experience at Google running production workloads at scale using a system called Borg.**

- Created by three Google employees initially during the summer of 2014; grew exponentially and became the first project to get donated to the [Cloud Native Computing Foundation \(CNCF\)](#).
- Hit the first production-grade version v1.0.1 in **July 2015**. Has continually released a new minor version every three months since v1.2.0 in March 2016. Lately v1.19.0 was released in August 2020

Greek for “pilot” or “Helmsman of a ship”. Kubernetes is also the abbreviated with K8S.

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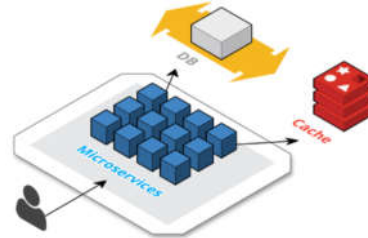
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What problems does Kubernetes solve ?

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- The trend from monoliths to the **Microservices** increased the usage of containers
 - Managing hundreds of containers across different platforms using shell scripts and self-made tools becomes complex and even impossible.
- Kubernetes provides a way to manage hundreds of containers. It provides
 - **Code deployment with** no down times
 - **High availability** dynamic scheduling of workloads
 - **Scalability** (or high performance)
 - **Disaster recovery** (backup and restore)



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Kubernets Key features

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- Kubernetes is an **orchestration system**. It runs containerized applications (such as microservices) on a cluster.
 - It's a sort of meta-process that grants the ability to automate the deployment and scaling of several containers at once
 - These containers act as replicas, and serve to load balance incoming requests. A container orchestrator, then, supervises these groups, ensuring that they are operating correctly.
- **Kubernetes features**
 - Scale-in and scale-out workload
 - Self-healing
 - Service discovery/load balancing
 - Automate Rollouts/Rollbacks
 - Secret and Configuration management

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Basic things we can ask Kubernetes to do

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- Suppose we have a 3-tier e-commerce app:
 - web frontend
 - Restful API backend
 - database
- We have built images for our frontend and backend components
- Let's see how we would deploy our app on Kubernetes !
 - Start 5 containers using image myeshop/api:1.2
 - Place an internal load balancer in front of these containers
 - Start 10 containers using image myeshop/api:1.2
 - Place a public load balancer in front of these containers
 - It's Black Friday (or Christmas), traffic spikes, grow our cluster and add containers
 - New release! Replace my containers with the new image myeshop/webfront:v1.3
 - Autoscaling
 - Advanced rollout patterns (blue/green deployment, canary deployment)

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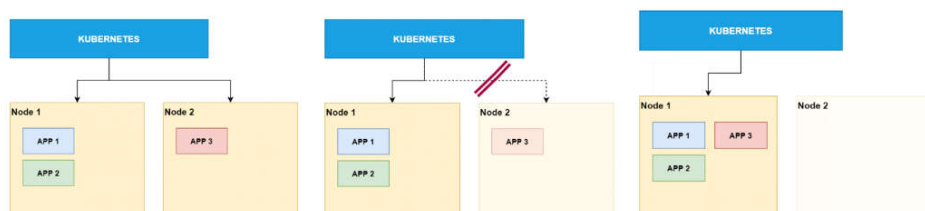
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Kubernetes Self-healing feature

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- Self-healing is a feature of Kubernetes to recover from service or node failure automatically.
 - Kubernetes's orchestration capabilities can monitor and replace unhealthy containers as per the desired configuration.



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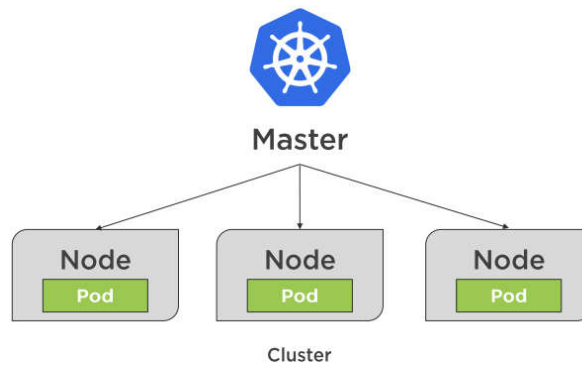
Kubernetes Architecture

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Kubernetes Architecture

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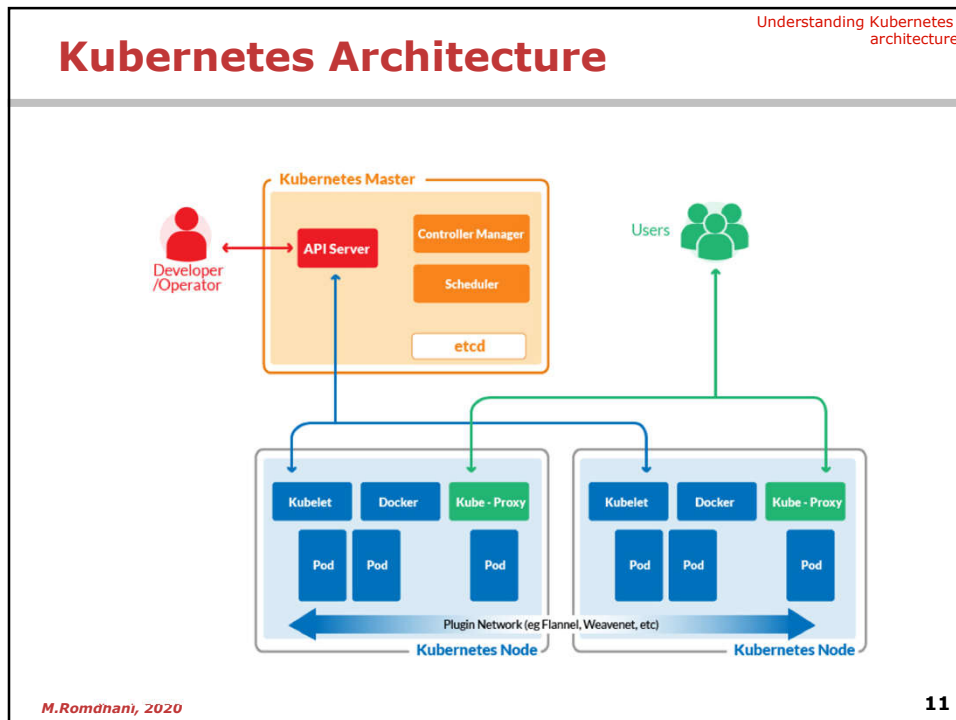
- The Master node (Control Plane) is responsible for managing whole cluster.
- The worker nodes expose the underlying compute, storage and networking to the applications.



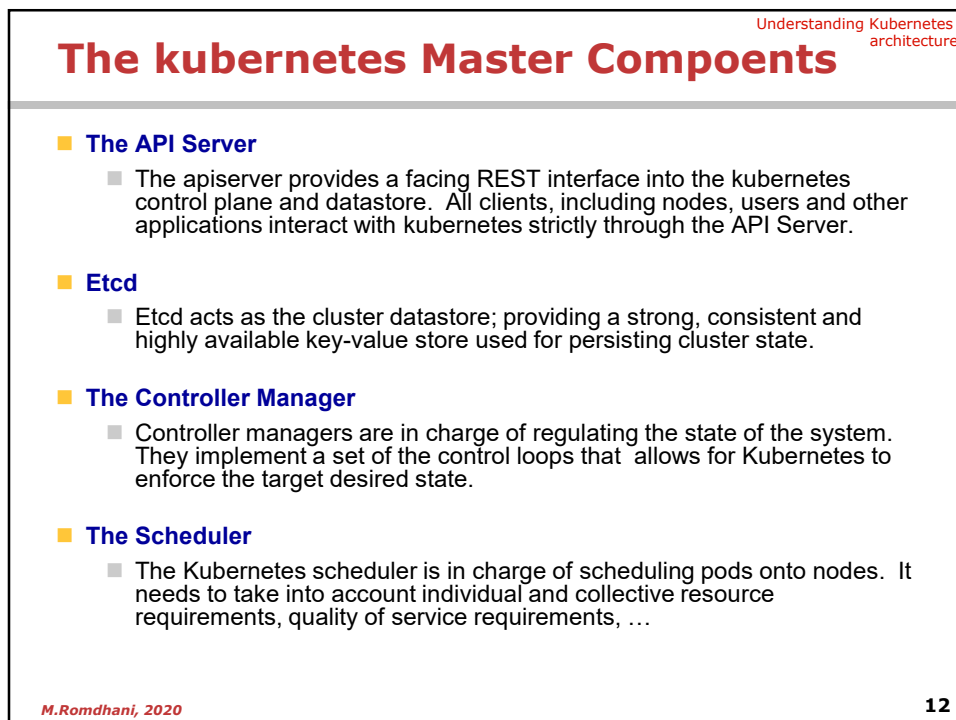
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Node Components

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■ Kubelet

- Acts as the node agent responsible for managing pod lifecycle on its host. Kubelet understands YAML container manifests that it can read from several sources:
 - File path
 - HTTP Endpoint
 - HTTP Server mode accepting container manifests over a simple API.

■ Kube-proxy

- Manages the network rules on each node and performs connection forwarding or load balancing for Kubernetes cluster services.
 - Creates the rules on the host to map and expose services
 - Uses a combination of iptables to manage networking/loadbalancing

■ Container Runtime

- With respect to Kubernetes, a container runtime is a CRI (Container Runtime Interface) compatible application that executes and manages containers.
 - Containerd (docker)/Cri-o/rkt/Kata (formerly clear and hyper)

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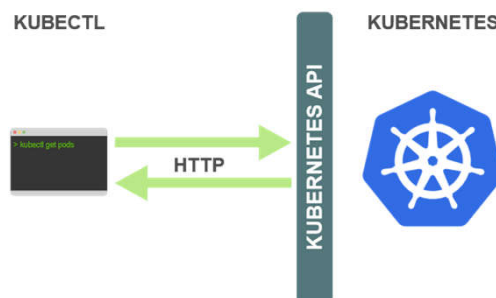
Kubectl, the CLI

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■ The Kubernetes API is RESTful

■ kubectl is (almost) the only tool we'll need to talk to Kubernetes

- It is a rich CLI tool around the Kubernetes API (Everything you can do with kubectl, you can do directly with the API)
- On our machines, there is a ~/.kube/config file with: the Kubernetes API address, the path to our TLS certificates used to authenticate



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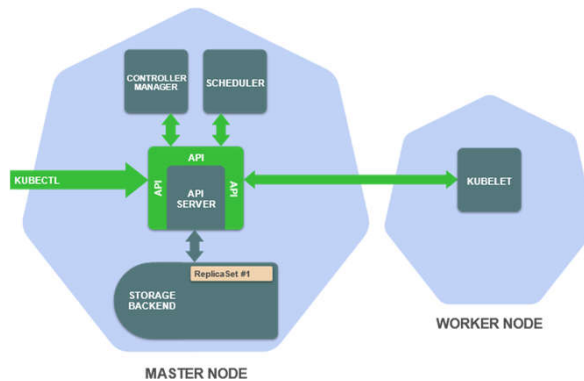
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How Kubernetes works ?

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- Assume, you just executed `> kubectl create -f replicaset.yaml` upon which kubectl made an HTTP POST request to the create ReplicaSet API endpoint (passing along your ReplicaSet resource definition).
 - The API server saves your ReplicaSet resource definition in the storage backend.



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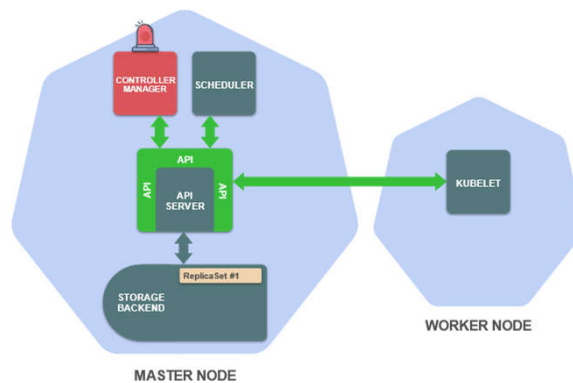
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How Kubernetes works ?

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- This triggers the ReplicaSet controller in the controller manager, who watches for creations, updates, and deletions of ReplicaSet resources.



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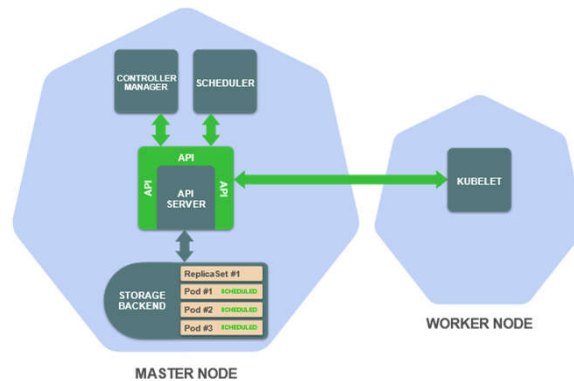
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How Kubernetes works ?

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- The ReplicaSet controller creates a Pod definition for each replica of the ReplicaSet (according to the Pod template in the ReplicaSet definition) and saves them in the storage backend.



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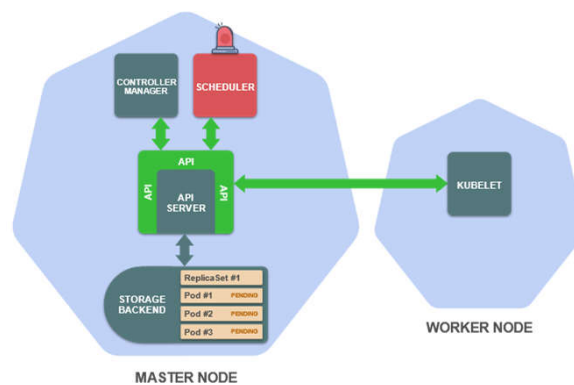
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How Kubernetes works ?

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- This triggers the scheduler who watches for Pods that have not yet been assigned to a worker node.



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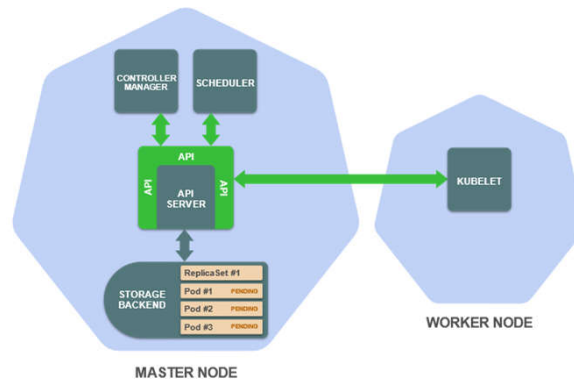
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How Kubernetes works ?

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- The scheduler chooses a suitable worker node for each Pod and adds this information to the Pod definitions in the storage backend.



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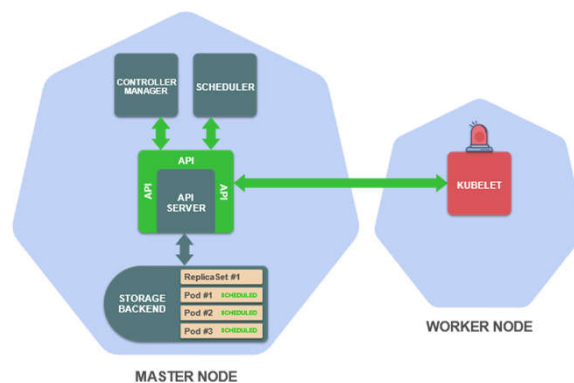
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How Kubernetes works ?

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- This triggers the kubelet on the worker node that the Pods have been scheduled to, who watches for Pods that have been scheduled to its worker node.



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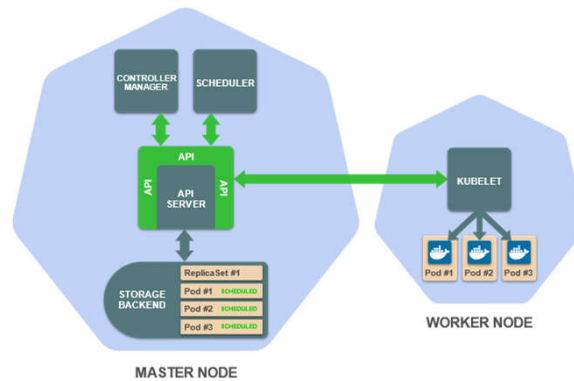
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How Kubernetes works ?

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- The kubelet reads the Pod definitions from the storage backend and instructs the container runtime (Docker, for example) to run the containers on the worker node.



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Kubernetes Concepts

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Workload Concepts

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■ Pod

- A pod is the **smallest unit of work** or management resource within Kubernetes. It is comprised of one or more containers that share their storage, network, and context (namespace, cgroups, etc).

■ Replica Set

- Method of managing pod replicas and their lifecycle. Their scheduling, scaling, and deletion. Next Generation Replication Controller.

■ Deployment

- A declarative method of managing stateless Pods and Replica Sets. Provides rollback functionality in addition to more granular update control mechanisms.

■ Service

- Services provide a method of exposing and consuming Pod network accessible resources.

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Core Concepts

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■ Namespace

- A logical cluster or environment. Primary method of dividing a cluster or scoping access.

■ Label

- Key-value pairs that are used to identify, describe and group together related sets of objects. Labels have a strict syntax and available character set.

■ Selector

- Selectors use labels to filter or select objects.

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What is a Pod ?

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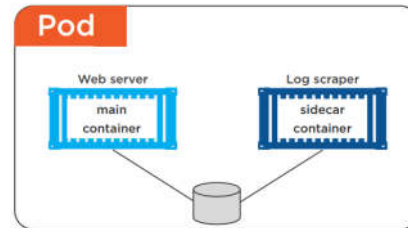
- A Pod is the **basic building block of Kubernetes**—the smallest and simplest unit in the Kubernetes object model that you create or deploy.

- A Kubernetes pod is a **group of containers** that are deployed together on the same host and share storage and networking resources. it's very common to have a group of containers work together to produce an artifact or process a set of work.

- Containers within a Pod share an IP address and port space, and can find each other via localhost.

- Pods aren't intended to be treated as durable entities. They are **ephemeral**.

- Pods serve as unit of deployment, horizontal scaling, and replication.



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What is a deployment ?

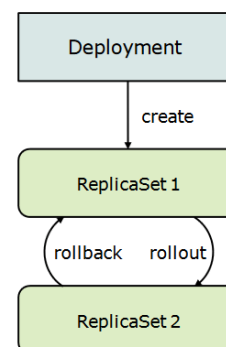
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ReplicaSets

- A ReplicaSet is a set of Pod templates that describes a set of Pod replicas. It uses a template that describes what each Pod must contain. The ReplicaSet ensures that a specified number of Pod replicas are running at any time. As such, it is often used to guarantee the availability of a specified number of identical Pods.

Deployment

- A Deployment provides declarative updates for Pods and ReplicaSets.
- You describe a desired state in a Deployment, and the Deployment Controller changes the actual state to the desired state at a controlled rate. You can define Deployments to create new ReplicaSets, or to remove existing Deployments and adopt all their resources with new Deployments.



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What is a Service ?

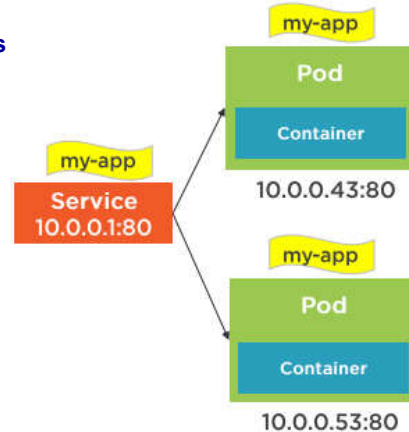
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- A service is an abstract way to expose an application running on a set of Pods as a network service.

- It acts as the unified method of accessing replicated pods.

- Services provide important features that are standardized across the cluster:

- Services abstract Pod IP Addresses from consumers
- Load-balancing between Pods
- Rely on labels to associate service with a Pod
- Node's kube-proxy creates virtual IP for services
- Services are not ephemeral

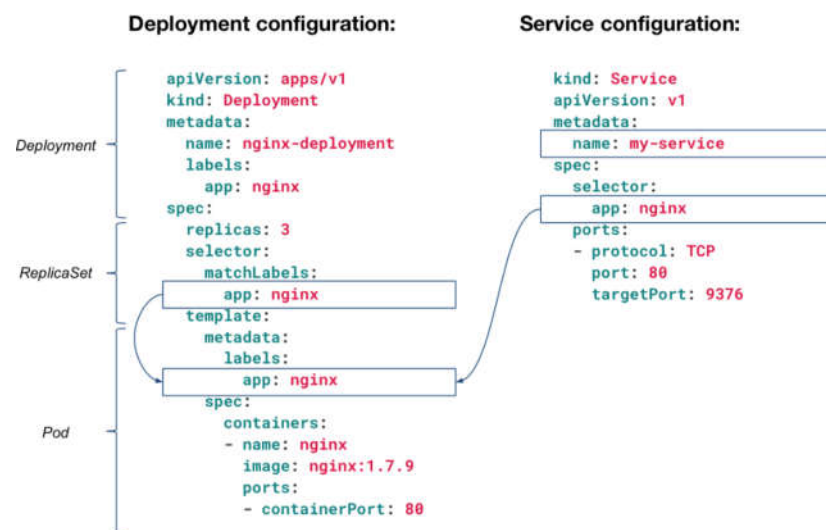


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Labels and Selectors

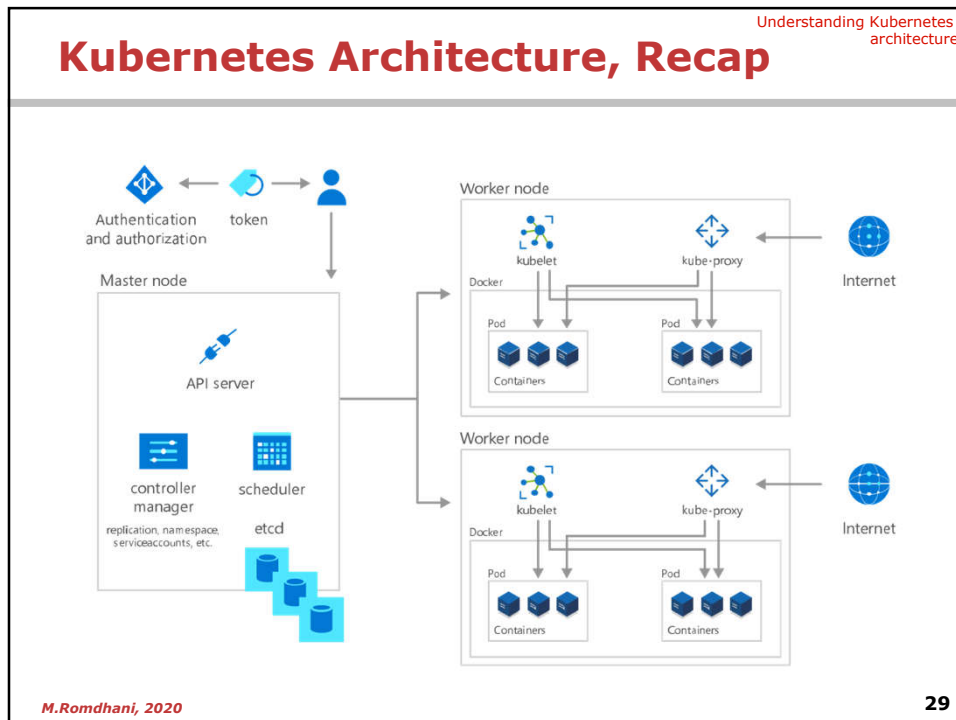
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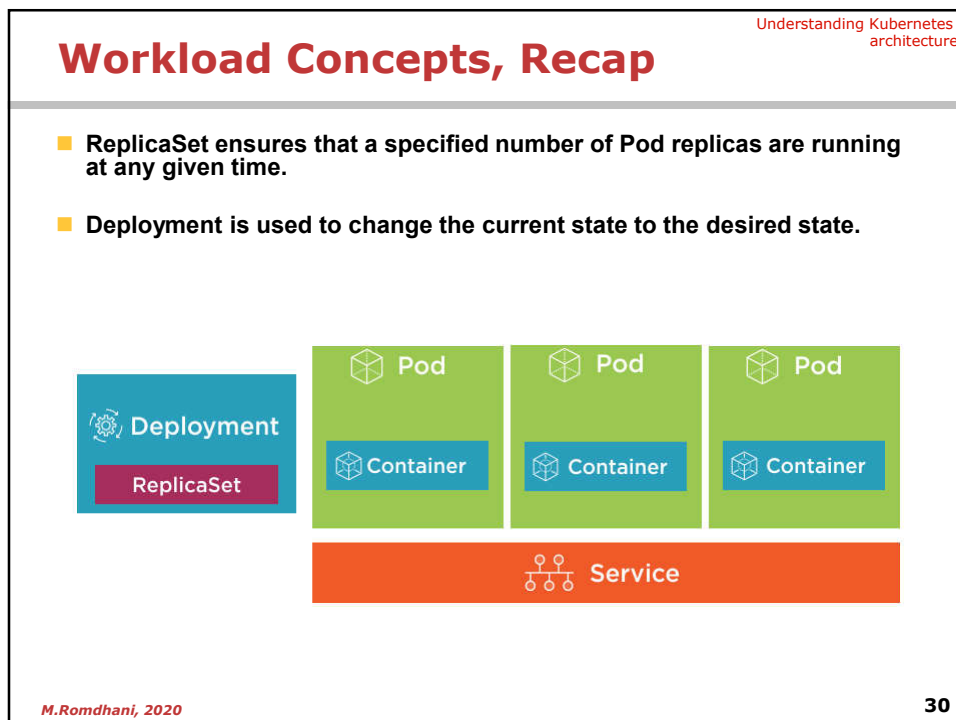
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Start a Single node cluster locally with Docker Desktop for Windows

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Kubernetes installation Options

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■ There are many installation options

- Local installation
- Managed installation
 - Amazon Elastic Container Service for Kubernetes
 - Azure Kubernetes Service
 - Google Kubernetes Engine

■ Local Installation /Single Node on Windows

- Minikube
 - HyperV not required, unable to support Windows Containers
- Docker Desktop for Windows – Kubernetes
 - HyperV Required, supports Windows containers

■ Local installation/Multiple Nodes on windows

- Networked Linux VMs : Master Node + Multiple Worker Nodes
 - VirtualBox VMs having Docker Runtime
 - Vagrant may facilitate the provisioning and the configuration of the VMs

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Installing Docker Desktop/Kubernetes

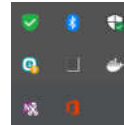
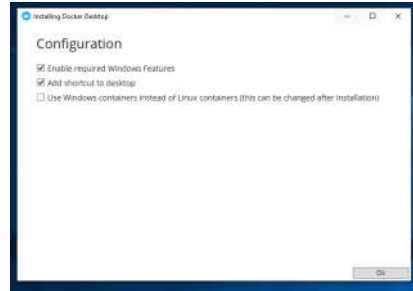
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You can install Docker for Windows with:

- Chocolatey Installer
 - > `choco install docker-desktop -y`
- Docker Desktop for Windows installer
 - Available here : <https://docs.docker.com/docker-for-windows/install>

Brining Docker to Life

- Run the installer
- Docker will ask you if you wish to enable Hyper-V
- When the installer finishes, Select close and restart, this will restart your machine and start docker when windows starts.
- Once Windows has restarted you will see a little animated docker icon in your taskbar which shows that docker is starting, this can take anything from 20 seconds to a couple of minutes.



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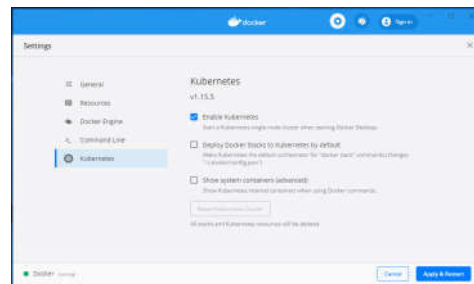
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Installing Docker Desktop/Kubernetes

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Enabling Kubernetes:

- Kubernetes can then be enabled by simply clicking “Enable Kubernetes” and then “Apply & Restart”.
- This will then download and initialise all the k8s containers required to get a local one node k8s cluster running on your local machine. Go and make a coffee this can take a long time(15–20min)



You can test that k8s is all running by using the kubectl command below.

```
> kubectl get nodes
```

NAME	STATUS	ROLES	AGE	VERSION
docker-desktop	Ready	master	167m	v1.15.5

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Deploy, Expose and Use an application

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■ Create a Deployment

- Use the `kubectl create` command to create a Deployment that manages a Pod. The Pod runs a Container based on the provided Docker image.
`kubectl create deployment hello-kubernetes --image=dockercloud/hello-world`
- View the Deployment:
`kubectl get deployments`
- View the Pod:
`kubectl get pods`

■ Create a Service

- Expose the Pod to the public internet using the `kubectl expose` command:
`kubectl expose deployment hello-kubernetes --type=LoadBalancer --port=8080 --target-port=80`
- View the Service you just created:
`kubectl get services`

■ Use the application

- open a browser and type `http://localhost:8080`

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Scale the app

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■ Let's say that now we want 5 instances of the app to be always up & running.

- `kubectl scale deployments hello-kubernetes --replicas=5`
- Let's see again the list of available pods:
`kubectl get pods`
- Thanks to the service we have previously created, our web application is still exposed through a single endpoint:
`kubectl get services`

■ Remove the application

- Delete the deployment
`kubectl delete deployment hello-Kubernetes`
- Delete the service
`kubectl delete service hello-Kubernetes`

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Using the Kubernetes dashboard

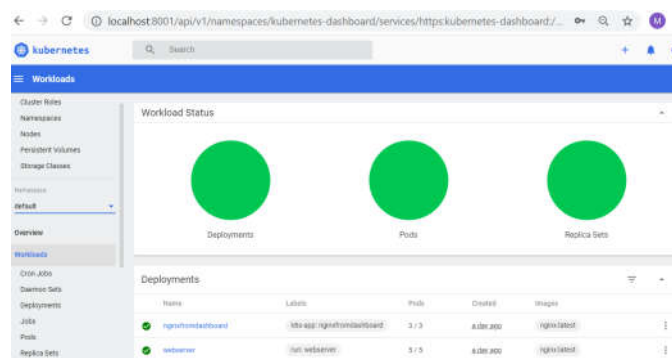
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Kubernetes Dashboard

Understanding Kubernetes architecture

■ Dashboard is a web-based Kubernetes user interface.

- You can use Dashboard to deploy containerized applications to a Kubernetes cluster, troubleshoot your containerized application, and manage the cluster resources.
- You can use Dashboard to get an overview of applications running on your cluster, as well as for creating or modifying individual Kubernetes resources (such as Deployments, Services, etc).



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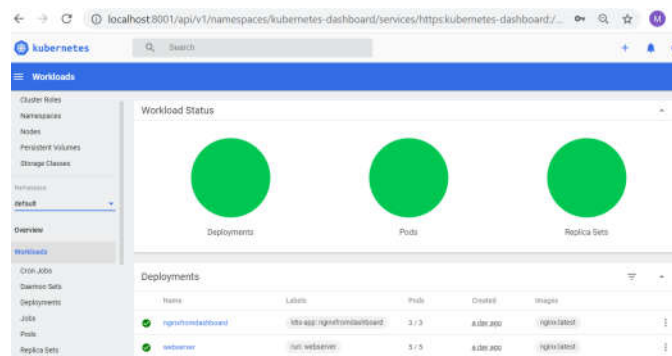
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Kubernetes Dashboard

Understanding Kubernetes architecture

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Installing Kubernetes Dashboard

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■ To deploy it, run the following command:

```
$ kubectl apply -f
https://raw.githubusercontent.com/kubernetes/dashboard/v2.0.0/aio/deploy/recommended.yaml
```

■ To access Dashboard from your local workstation, run the following command:

```
$ kubectl proxy
```

- It will proxy server between your machine and Kubernetes API server.

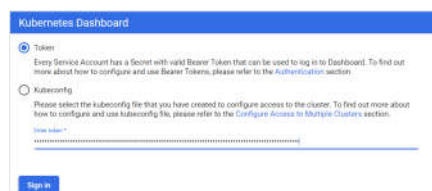
■ To view the dashboard in the browser, navigate to the following address in the browser of your Master VM:

```
http://localhost:8001/api/v1/namespaces/kubernetes-
dashboard/services/https:kubernetes-dashboard:/proxy/
```

- You will then be prompted with this page, to enter the credentials

■ Get an Authentication Token

- Get account
 - > `kubectl -n kubernetes-dashboard describe secret default`



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Basic Commands of Kubectl

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Kubectl commands format

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- Use the following syntax to run kubectl commands from your terminal window:

kubectl [command] [TYPE] [NAME] [flags]

- where command, TYPE, NAME, and flags are:

- **command**: Specifies the operation that you want to perform on one or more resources, for example **create**, **get**, **describe**, **delete**.
- **TYPE**: Specifies the resource type. Resource types are case-insensitive and you can specify the singular, plural, or abbreviated forms


```

      kubectl get pod pod1
      kubectl get pods pod1
      kubectl get po pod1
      
```
- **NAME**: Specifies the name of the resource. Names are case-sensitive. If the name is omitted, details for all resources are displayed, for example `kubectl get pods`.
- **flags**: Specifies the additional flags, which are either specific for a command or global for kubectl. For example `--namespace kube-system`

- Some commands, such as `get` or `create`, allow you to specify the output format using the `-o` or `--output` flag. For example `-o json` to force json output format

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Kubectl command examples

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■ Getting Information about Cluster

`kubectl version` Prints the client and server versions.
`kubectl cluster-info` Prints information about the control plane and add-ons.
`kubectl config get-contexts` Displays the list of cluster contexts

■ Getting information about resources

`kubectl get nodes/pods/deployments/secrets` Prints information about resources
`kubectl describe nodes/pods/deployments/secrets` Prints detailed information about resources

■ Creating/Updating a Resource from Manifest

`kubectl create/apply -f my-nginx-deployment.yaml` Creates/Updates resources described in my-nginx-deployment.yaml
`kubectl delete -f my-nginx-deployment.yaml` Deletes resources described in my-nginx-deployment.yaml

■ Editing resources

`kubectl edit deployment my-nginx` Opens NotePad (on the editor configured in EDITOR or KUBE_EDITOR env variable) with the current state of the resource. After editing and saving the resource will be updated.

■ Accessing Pod Container Logs

`kubectl logs etcd-docker-desktop -n kube-system` Prints the log of the etcd pod

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Kubernetes manifests examples

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■ The required fields in the .yaml file:

- **apiVersion** - Which version of the Kubernetes API you're using to create this object
- **kind** - What kind of object you want to create
- **metadata** - Data that helps uniquely identify the object, including a name string, UID, and optional namespace
- **spec** - What state you desire for the object

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-nginx
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: nginx:1.14.2
          ports:
            - containerPort: 80
```

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