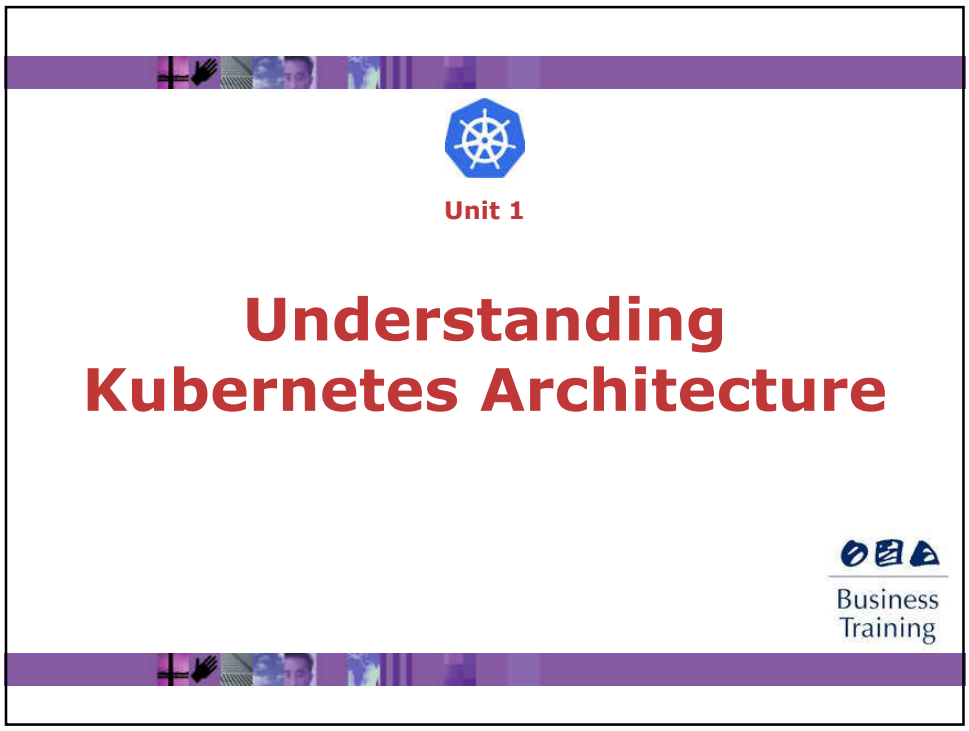

1

Outline

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

2

Introduction to Kubernetes

3

What is Kubernetes ?

- **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, combined with best-of-breed ideas and practices from the community.**
  - 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 v1.18.0 was released in March 2020

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

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Kubernets Key features

- **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

- **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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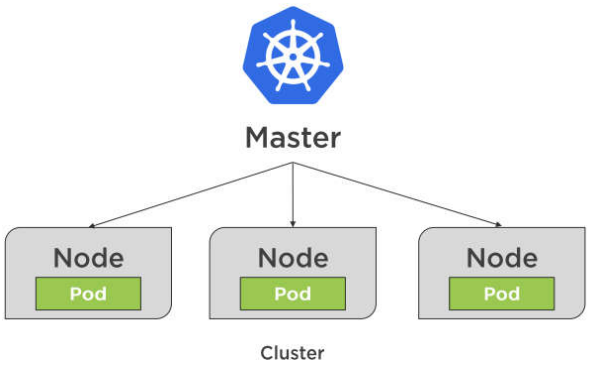
Kubernetes Architecture

7

Kubernetes Architecture

- **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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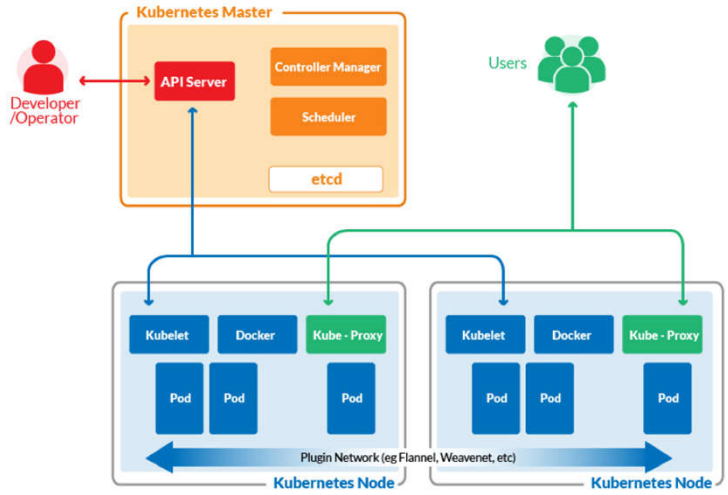
Understanding Kubernetes architecture

Kubernetes Architecture



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Understanding Kubernetes architecture

The kubernetes Master Compoents

- **The API Server**
  - The apiserver provides a facing REST interface into the kubernetes control plane and datastore. All clients, including nodes, users and other applications interact with kubernetes strictly through the API Server.
- **Etcd**
  - Etcd acts as the cluster datastore; providing a strong, consistent and highly available key-value store used for persisting cluster state.
- **The Controller Manager**
  - Controller managers are in charge of regulating the state of the system. They implement a set of the control loops that allows for Kubernetes to enforce the target desired state.
- **The Scheduler**
  - The Kubernetes scheduler is in charge of scheduling pods onto nodes. It needs to take into account individual and collective resource requirements, quality of service requirements, …

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Node Components

- **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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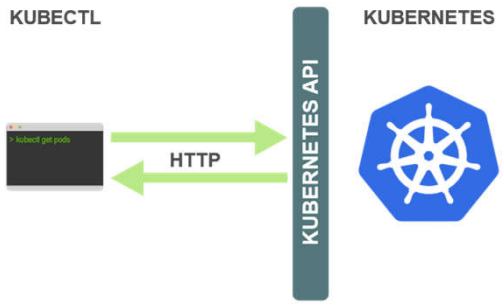
Kubectl, the CLI

- **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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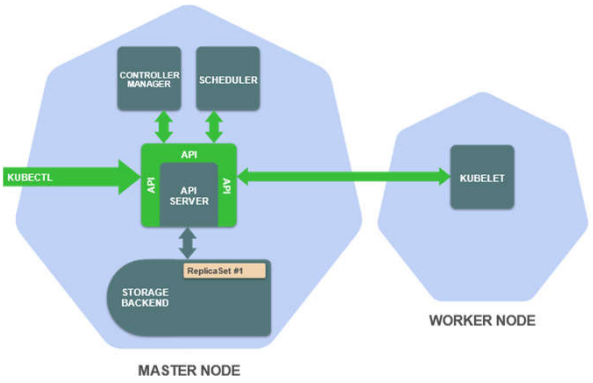
Understanding Kubernetes architecture

How Kubernetes works ?

- **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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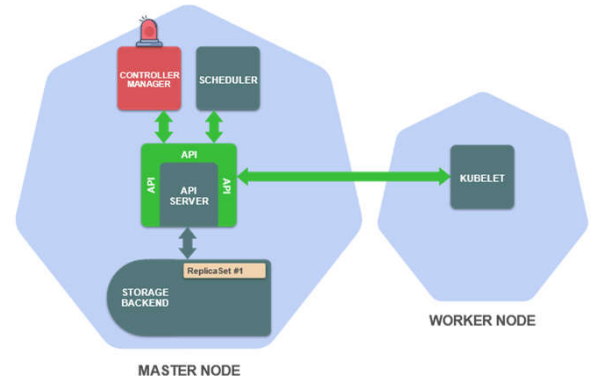
Understanding Kubernetes architecture

How Kubernetes works ?

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



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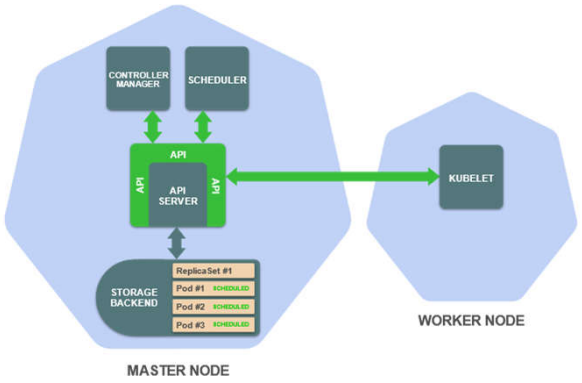
How Kubernetes works ?

- 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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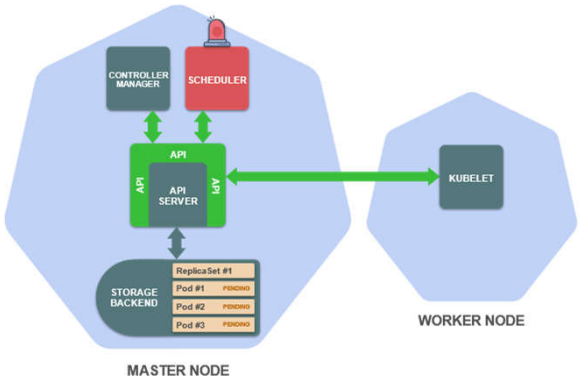
How Kubernetes works ?

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



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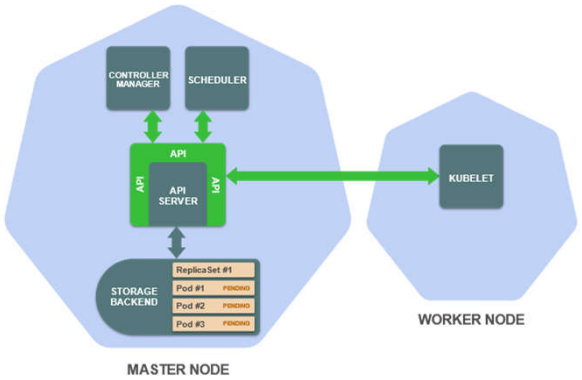
How Kubernetes works ?

- 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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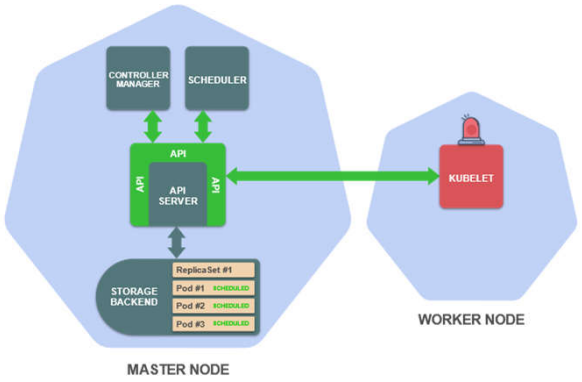
How Kubernetes works ?

- 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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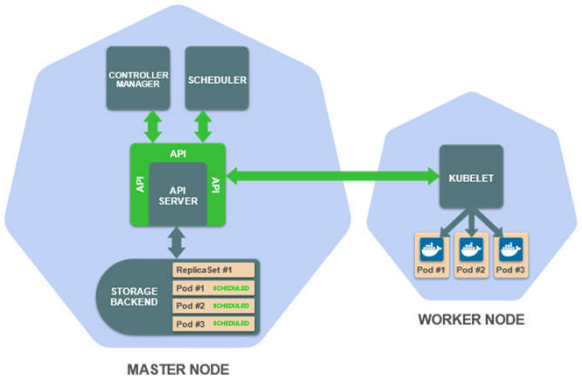
How Kubernetes works ?

- 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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Core Concepts

- **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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Workload Concepts

- **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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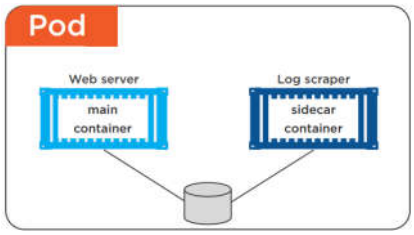
What is a Pod ?

- **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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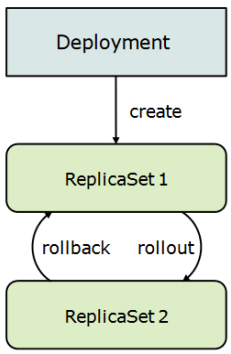
What is a deployment ?

- **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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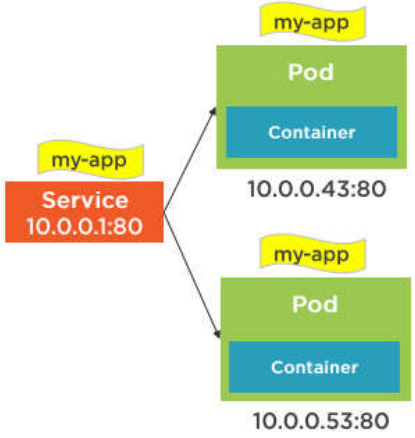
What is a Service ?

- **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

Deployment configuration:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.7.9
        ports:
        - containerPort: 80
```

Deployment

ReplicaSet

Pod

Service configuration:

```
kind: Service
apiVersion: v1
metadata:
  name: my-service
spec:
  selector:
    app: nginx
  ports:
  - protocol: TCP
    port: 80
    targetPort: 9376
```


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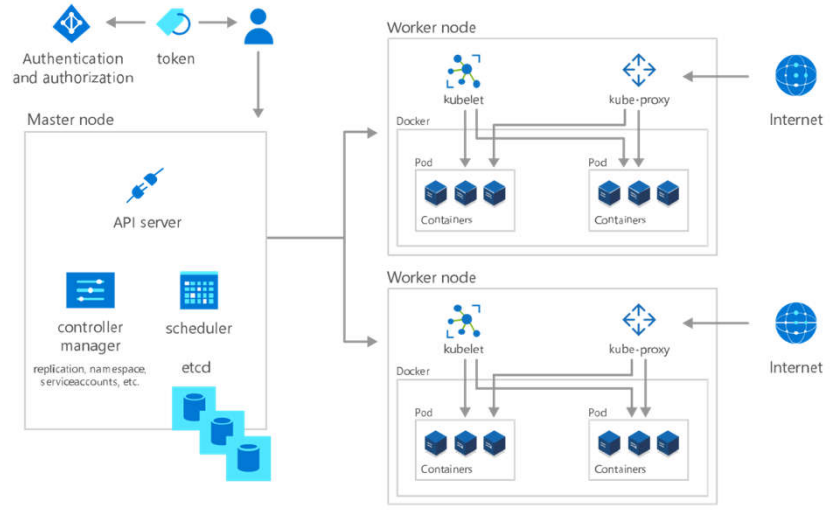
Understanding Kubernetes architecture

Kubernetes Architecture, Recap



M.Romdhani, 2020

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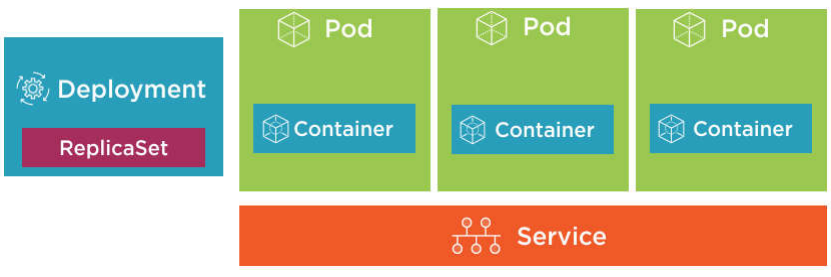
Understanding Kubernetes architecture

Workload Concepts, Recap

- **ReplicaSet ensures that a specified number of Pod replicas are running at any given time.**
- **Deployment is used to change the current state to the desired state.**



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Start a Single node cluster locally with Docker Desktop for Windows

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Kubernetes installation Options

- **There are many installation options**
  - Local installation
  - Managed installation
    - Amazon Elastic Container Service for Kubernetes
    - Azure Kubernetes Service
    - Google Kubernetes Engine
- **Local Installation Options on Windows**
  - Minikube
    - HyperV not required, unable to support Windows Containers
  - Docker Desktop for Windows
    - HyperV Required, supports Windows containers
- **Docker Desktop for Windows Community Edition**
  - Docker Desktop is the fastest and simplest way to get a Kubernetes cluster running on your desktop machine
  - It still give the freedom to choose Docker Swarm if you prefer.

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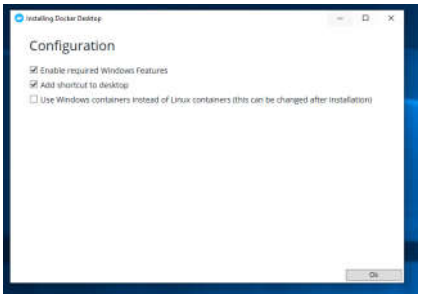
Installing Docker Desktop/Kubernetes

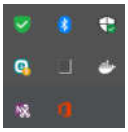
- **You can install Docker for Windows with:**
  - Chocolarey Installer

    ```
    > 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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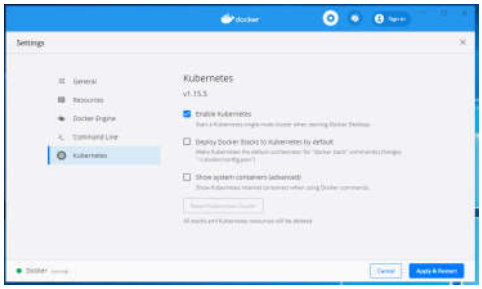
Installing Docker Desktop/Kubernetes

- **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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Using the Kubernetes dashboard

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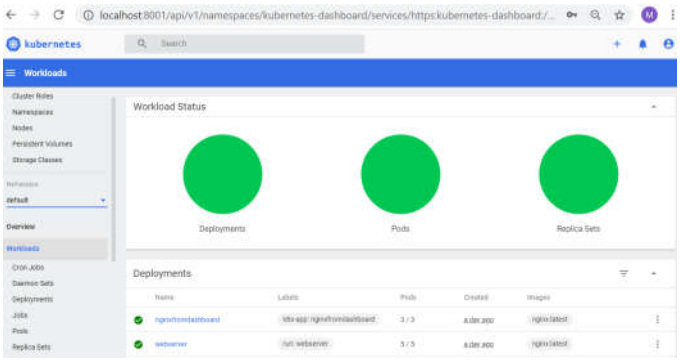
Kubernetes Dashboard

- **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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Installing Kubernetes Dashboard

- **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.

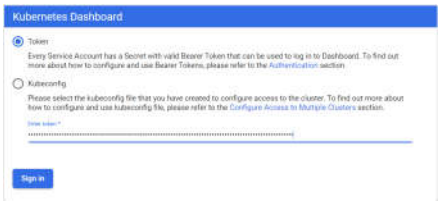
- **To view the dashboard in the browser, navigate to the following address in the browser of your Master VM:**

```
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

- **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

- **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/deployements/secrets` Prints information about resources

  `kubectl describe nodes/pods/deployements/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 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 ou 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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Kubernets manifests examples

- **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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dashboard/services/https:kubernetes-dashboard:/proxy/
```

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

Installing Kubernetes Dashboard

- **Create An Authentication Token**
  - **Create the dashboard service account**

```
› kubectl create serviceaccount admin-user -n kubernetes-dashboard
```

  - **Assign the cluster-admin role to the service account**

```
> kubectl create clusterrolebinding admin-user --clusterrole=cluster-admin --
serviceaccount=kubernetes-dashboard:admin-user
```

  - **List secrets using**

```
> kubectl -n kubernetes-dashboard get secret
```

  - **Use kubectl describe to get the access token:**

```
> kubectl -n kubernetes-dashboard describe  secret  admin-user-token-hpz44
```