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Basic Kubernetes

1. Kubernetes – Overview

Kubernetes in an open source container management tool hosted by Cloud Native Computing Foundation (CNCF). This is also known as the enhanced version of Borg which was developed at Google to manage both long running processes and batch jobs, which was earlier handled by separate systems.

Kubernetes comes with a capability of automating deployment, scaling of application, and operations of application containers across clusters. It is capable of creating container centric infrastructure.

Features of Kubernetes

Following are some of the important features of Kubernetes.

- Continues development, integration and deployment
- Containerized infrastructure
- Application-centric management
- Auto-scalable infrastructure
- Environment consistency across development testing and production
- Loosely coupled infrastructure, where each component can act as a separate unit
- Higher density of resource utilization
- Predictable infrastructure which is going to be created

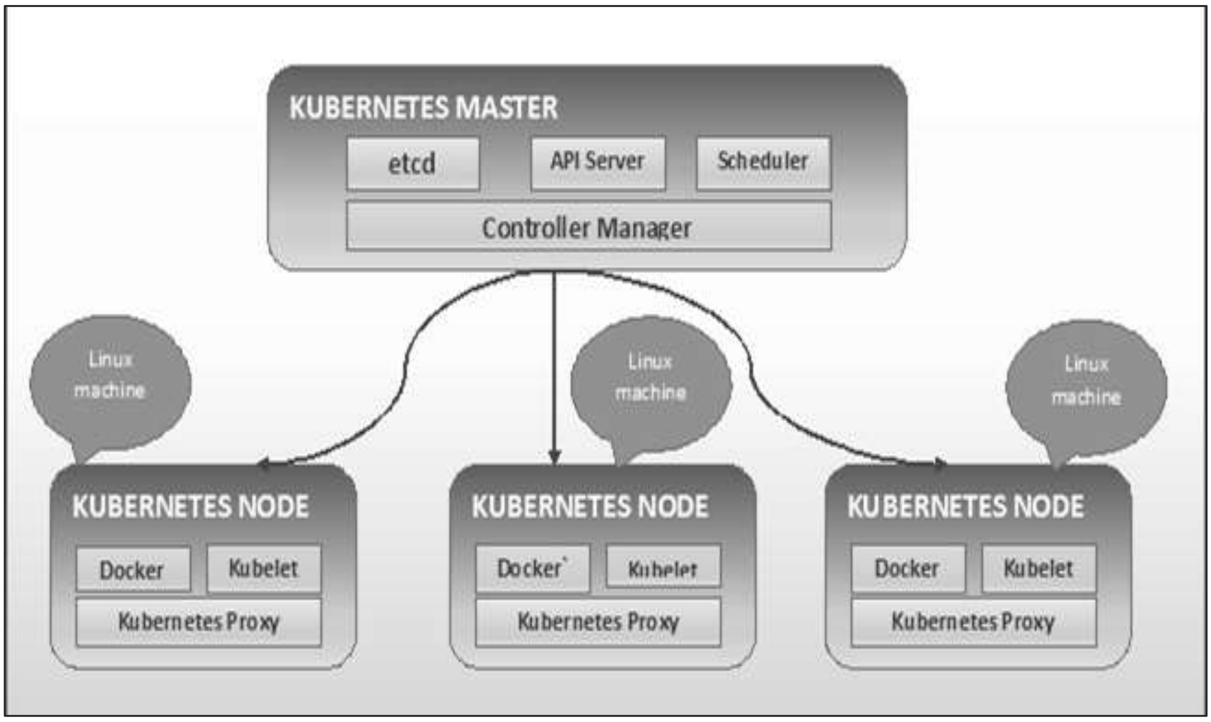
One of the key components of Kubernetes is, it can run application on clusters of physical and virtual machine infrastructure. It also has the capability to run applications on cloud. **It helps in moving from host-centric infrastructure to container-centric infrastructure.**

2. Kubernetes – Architecture

In this chapter, we will discuss the basic architecture of Kubernetes.

Kubernetes – Cluster Architecture

As seen in the following diagram, Kubernetes follows client-server architecture. Wherein, we have master installed on one machine and the node on separate Linux machines.



The key components of master and node are defined in the following section.

Kubernetes – Master Machine Components

Following are the components of Kubernetes Master Machine.

etcd

It stores the configuration information which can be used by each of the nodes in the cluster. It is a high availability key value store that can be distributed among multiple nodes. It is accessible only by Kubernetes API server as it may have some sensitive information. It is a distributed key value Store which is accessible to all.

API Server

Kubernetes is an API server which provides all the operation on cluster using the API. API server implements an interface, which means different tools and libraries can readily communicate with it. **Kubeconfig** is a package along with the server side tools that can be used for communication. It exposes Kubernetes API.

Controller Manager

This component is responsible for most of the collectors that regulates the state of cluster and performs a task. In general, it can be considered as a daemon which runs in non-terminating loop and is responsible for collecting and sending information to API server. It works toward getting the shared state of cluster and then make changes to bring the current status of the server to the desired state. The key controllers are replication controller, endpoint controller, namespace controller, and service account controller. The controller manager runs different kind of controllers to handle nodes, endpoints, etc.

Scheduler

This is one of the key components of Kubernetes master. It is a service in master responsible for distributing the workload. It is responsible for tracking utilization of working load on cluster nodes and then placing the workload on which resources are available and accept the workload. In other words, this is the mechanism responsible for allocating pods to available nodes. The scheduler is responsible for workload utilization and allocating pod to new node.

Kubernetes ─ Node Components

Following are the key components of Node server which are necessary to communicate with Kubernetes master.

Docker

The first requirement of each node is Docker which helps in running the encapsulated application containers in a relatively isolated but lightweight operating environment.

Kubelet Service

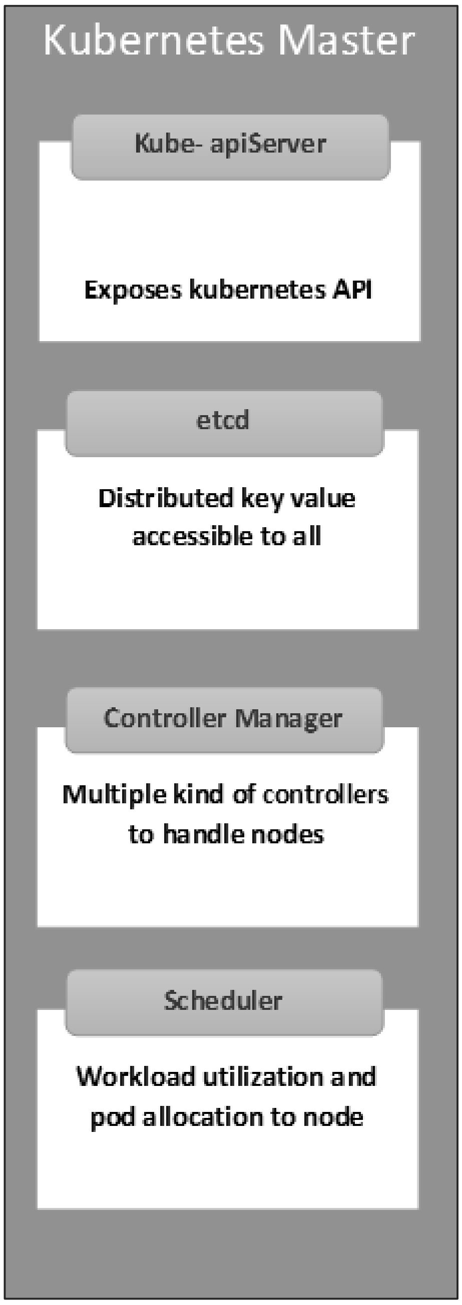
This is a small service in each node responsible for relaying information to and from control plane service. It interacts with **etcd** store to read configuration details and wright values. This communicates with the master component to receive commands and work. The **kubelet** process then assumes responsibility for maintaining the state of work and the node server. It manages network rules, port forwarding, etc.

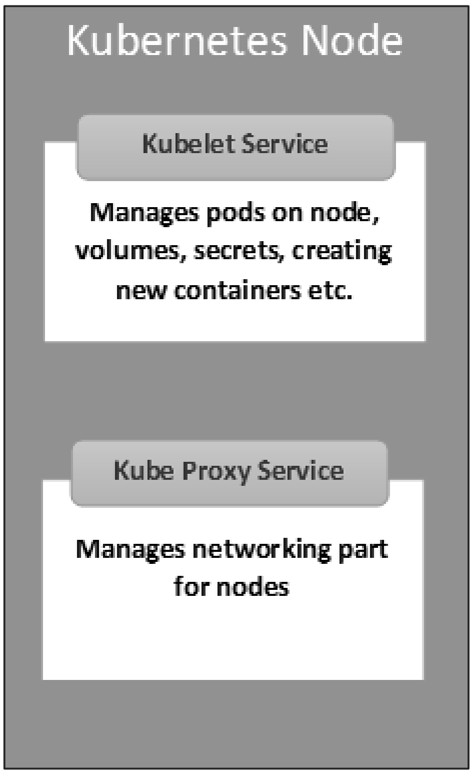
Kubernetes Proxy Service

This is a proxy service which runs on each node and helps in making services available to the external host. It helps in forwarding the request to correct containers and is capable of performing primitive load balancing. It makes sure that the networking environment is predictable and accessible and at the same time it is isolated as well. It manages pods on node, volumes, secrets, creating new containers' health checkup, etc.

Kubernetes – Master and Node Structure

The following illustrations show the structure of Kubernetes Master and Node.


Kubernetes Master
Kube- apiServer
Exposes kubernetes API
etcd
Distributed key value accessible to all
Controller Manager
Multiple kind of controllers to handle nodes
Scheduler
Workload utilization and pod allocation to node


Kubernetes Node
Kubelet Service
Manages pods on node, volumes, secrets, creating new containers etc.
Kube Proxy Service
Manages networking part for nodes

3. Kubernetes – Setup

It is important to set up the Virtual Datacenter (vDC) before setting up Kubernetes. This can be considered as a set of machines where they can communicate with each other via the network. For hands-on approach, you can set up vDC on **PROFITBRICKS** if you do not have a physical or cloud infrastructure set up.

Once the IaaS setup on any cloud is complete, you need to configure the **Master** and the **Node.**

Note: The setup is shown for Ubuntu machines. The same can be set up on other Linux machines as well.

Prerequisites

Installing Docker: Docker is required on all the instances of Kubernetes. Following are the steps to install the Docker.

Step 1: Log on to the machine with the root user account.

Step 2: Update the package information. Make sure that the apt package is working.

Step 3: Run the following commands.

```
$ sudo apt-get update

$sudo apt-get install apt-transport-https ca-certificates
```

Step 4: Add the new GPG key.

```
$ sudo apt-key adv \
               --keyserver hkp://ha.pool.sks-keyservers.net:80 \
               --recv-keys 58118E89F3A912897C070ADBF76221572C52609D


$ echo "https://apt.dockerproject.org/repo ubuntu-trusty main" | sudo tee
/etc/apt/sources.list.d/docker.list
```

Step 5: Update the API package image.

```
$ sudo apt-get update
```

Once all the above tasks are complete, you can start with the actual installation of the Docker engine. However, before this you need to verify that the kernel version you are using is correct.

Install Docker Engine

Run the following commands to install the Docker engine.

Step 1: Logon to the machine.

Step 2: Update the package index.

```
$ sudo apt-get update
```

Step 3: Install the Docker Engine using the following command.

```
$ sudo apt-get install docker-engine
```

Step 4: Start the Docker daemon.

```
$ sudo apt-get install docker-engine
```

Step 5: To very if the Docker is installed, use the following command.

```
$ sudo docker run hello-world
```

Install etcd 2.0

This needs to be installed on Kubernetes Master Machine. In order to install it, run the following commands.

```
$ curl -L  https://github.com/coreos/etcd/releases/download/v2.0.0/etcd
-v2.0.0-linux-amd64.tar.gz -o etcd-v2.0.0-linux-amd64.tar.gz ->1


$ tar xzvf etcd-v2.0.0-linux-amd64.tar.gz ------> 2


$ cd etcd-v2.0.0-linux-amd64  ------------>3
$ mkdir /opt/bin ------------->4
$ cp etcd* /opt/bin ----------->5
```

In the above set of command:

- First, we download the **etcd**. Save this with specified name.
- Then, we have to un-tar the tar package.
- We make a dir. inside the /opt named bin.
- Copy the extracted file to the target location.

Now we are ready to build Kubernetes. We need to install Kubernetes on all the machines on the cluster.

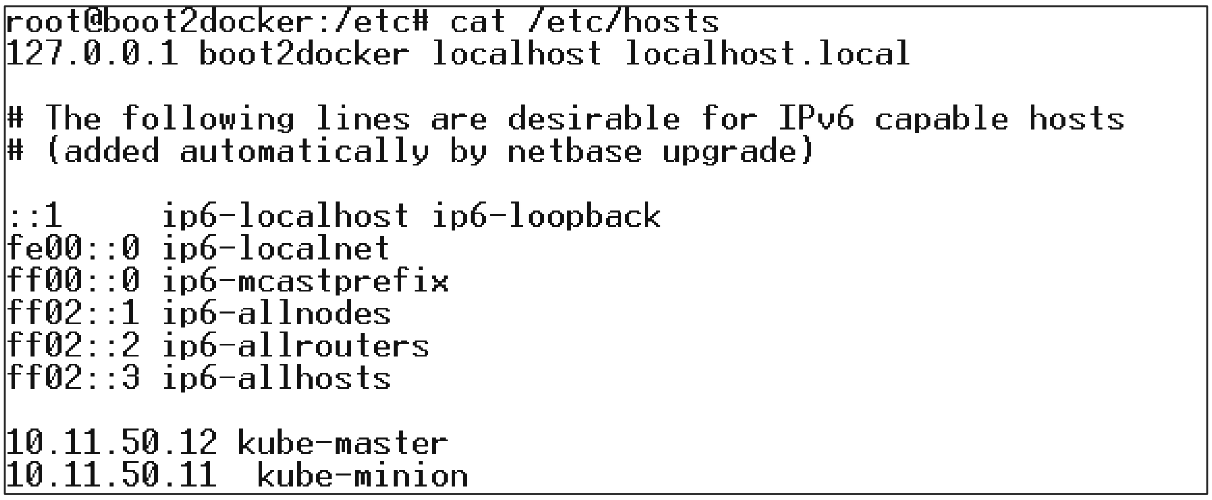
```
$ git clone https://github.com/GoogleCloudPlatform/kubernetes.git
$ cd kubernetes
$ make release
```

The above command will create a **_output** dir in the root of the kubernetes folder. Next, we can extract the directory into any of the directory of our choice /opt/bin, etc.

Next, comes the networking part wherein we need to actually start with the setup of Kubernetes master and node. In order to do this, we will make an entry in the host file which can be done on the node machine.

```
$ echo "<IP address of master machine> kube-master
                 < IP address of Node Machine>" >> /etc/hosts
```

Following will be the output of the above command.



```
root@boot2docker:/etc# cat /etc/hosts
127.0.0.1 boot2docker localhost localhost.local

# The following lines are desirable for IPv6 capable hosts
# (added automatically by netbase upgrade)

::1     ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::3 ip6-allhosts

10.11.50.12 kube-master
10.11.50.11  kube-minion
```

Now, we will start with the actual configuration on Kubernetes Master.

First, we will start copying all the configuration files to their correct location.

```
$ cp <Current dir. location>/kube-apiserver /opt/bin/
$ cp <Current dir. location>/kube-controller-manager /opt/bin/
$ cp <Current dir. location>/kube-kube-scheduler /opt/bin/
$ cp <Current dir. location>/kubecfg /opt/bin/
$ cp <Current dir. location>/kubectl /opt/bin/
$ cp <Current dir. location>/kubernetes /opt/bin/
```

The above command will copy all the configuration files to the required location. Now we will come back to the same directory where we have built the Kubernetes folder.

```
$ cp kubernetes/cluster/ubuntu/init_conf/kube-apiserver.conf /etc/init/
$ cp kubernetes/cluster/ubuntu/init_conf/kube-controller-manager.conf
/etc/init/
$ cp kubernetes/cluster/ubuntu/init_conf/kube-kube-scheduler.conf /etc/init/


$ cp kubernetes/cluster/ubuntu/initd_scripts/kube-apiserver /etc/init.d/
$ cp kubernetes/cluster/ubuntu/initd_scripts/kube-controller-manager
/etc/init.d/
$ cp kubernetes/cluster/ubuntu/initd_scripts/kube-kube-scheduler /etc/init.d/


$ cp kubernetes/cluster/ubuntu/default_scripts/kubelet /etc/default/
$ cp kubernetes/cluster/ubuntu/default_scripts/kube-proxy /etc/default/
$ cp kubernetes/cluster/ubuntu/default_scripts/kubelet /etc/default/
```

The next step is to update the copied configuration file under /etc. dir.

Configure etcd on master using the following command.

```
$ ETCD_OPTS="-listen-client-urls=http://kube-master:4001"
```

Configure kube-apiserver

For this on the master, we need to edit the **/etc/default/kube-apiserver** file which we copied earlier.

```
$ KUBE_APISERVER_OPTS="--address=0.0.0.0 \
--port=8080 \
--etcd_servers=<The path that is configured in ETCD_OPTS> \
--portal_net=11.1.1.0/24 \
--allow_privileged=false \
--kubelet_port= < Port you want to configure> \
--v=0"
```

Configure the kube Controller Manager

We need to add the following content in **/etc/default/kube-controller-manager**.

```
$ KUBE_CONTROLLER_MANAGER_OPTS="--address=0.0.0.0 \
--master=127.0.0.1:8080 \
--machines=kube-minion \ -----> #this is the kubernatics node
```

```
--v=0
```

Next, configure the kube scheduler in the corresponding file.

```
$ KUBE_SCHEDULER_OPTS="--address=0.0.0.0 \
--master=127.0.0.1:8080 \
--v=0"
```

Once all the above tasks are complete, we are good to go ahead by bring up the Kubernetes Master. In order to do this, we will restart the Docker.

```
$ service docker restart
```

Kubernetes Node Configuration

Kubernetes node will run two services the **kubelet and the kube-proxy**. Before moving ahead, we need to copy the binaries we downloaded to their required folders where we want to configure the kubernetes node.

Use the same method of copying the files that we did for kubernetes master. As it will only run the kubelet and the kube-proxy, we will configure them.

```
$ cp <Path of the extracted file>/kubelet /opt/bin/
$ cp <Path of the extracted file>/kube-proxy /opt/bin/
$ cp <Path of the extracted file>/kubecfg /opt/bin/
$ cp <Path of the extracted file>/kubectl /opt/bin/
$ cp <Path of the extracted file>/kubernetes /opt/bin/
```

Now, we will copy the content to the appropriate dir.

```
$ cp kubernetes/cluster/ubuntu/init_conf/kubelet.conf /etc/init/
$ cp kubernetes/cluster/ubuntu/init_conf/kube-proxy.conf /etc/init/

$ cp kubernetes/cluster/ubuntu/initd_scripts/kubelet /etc/init.d/
$ cp kubernetes/cluster/ubuntu/initd_scripts/kube-proxy /etc/init.d/

$ cp kubernetes/cluster/ubuntu/default_scripts/kubelet /etc/default/
$ cp kubernetes/cluster/ubuntu/default_scripts/kube-proxy /etc/default/
```