

Kubernetes the hard way

node notes

```
kube-1 192.168.1.8 192.168.2.151
kube-2 192.168.1.10 192.168.2.162
kube-3 192.168.1.6 192.168.2.157
kube-4 192.168.1.7 192.168.2.154
kube-lb 192.168.1.13 192.168.2.170
```

Controller components

- kube-apiserver: Serves the Kubernetes API. This allows users to interact with the cluster.
- etcd: Kubernetes cluster datastore.
- kube-scheduler: Schedules pods on available worker nodes.
- kube-controller-manager: Runs a series of controllers that provide a wide range of functionality.
- cloud-controller-manager: Handles interaction with underlying cloud providers.

Worker components

- kubelet: Controls each worker node, providing the APIs that are used by the control plane to manage nodes and pods, and interacts with the container runtime to manage containers.
- kube-proxy: Manages iptables rules on the node to provide virtual network access to pods.
- Container runtime: Downloads images and runs containers. Two examples of container runtimes are Docker and containerd

Add to all nodes

```
vim /etc/hosts
192.168.1.8 kube-1.myhypervisor.ca kube-1
192.168.1.10 kube-2.myhypervisor.ca kube-2
192.168.1.6 kube-3.myhypervisor.ca kube-3
```

```
192.168.1.7 kube-4.myhypervisor.ca kube-4
```

```
192.168.1.13 kube-lb.myhypervisor.ca kube-lb
```

Install kubectl / cfssl

On local workstation

<https://github.com/kelseyhightower/kubernetes-the-hard-way/blob/master/docs/02-client-tools.md>

<https://kubernetes.io/docs/tasks/tools/install-kubectl/#install-kubectl>

Gen Certs:

on local workstation

CA

```
{

cat > ca-config.json << EOF
{
  "signing": {
    "default": {
      "expiry": "8760h"
    },
    "profiles": {
      "kubernetes": {
        "usages": ["signing", "key encipherment", "server auth", "client auth"],
        "expiry": "8760h"
      }
    }
  }
}
EOF

cat > ca-csr.json << EOF
{
```

```
"CN": "Kubernetes",
"key": {
  "algo": "rsa",
  "size": 2048
},
"names": [
  {
    "C": "CA",
    "L": "Montreal",
    "O": "Kubernetes",
    "OU": "CA",
    "ST": "Quebec"
  }
]
}
EOF

cfssl gencert -initca ca-csr.json | cfssljson -bare ca

}
```

Admin Client certificate

```
{

cat > admin-csr.json << EOF
{
  "CN": "admin",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",
      "L": "Montreal",
      "O": "system:masters",
      "OU": "Kubernetes The Hard Way",
```

```
        "ST": "Quebec"
    }
]
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -profile=kubernetes \
  admin-csr.json | cfssljson -bare admin

}
```

Kubelet Client certificates

```
WORKER0_HOST=kube-3.myhypervisor.ca
WORKER0_IP=192.168.1.6
WORKER1_HOST=kube-4.myhypervisor.ca
WORKER1_IP=192.168.1.7

{
cat > ${WORKER0_HOST}-csr.json << EOF
{
  "CN": "system:node:${WORKER0_HOST}",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",
      "L": "Montreal",
      "O": "system:nodes",
      "OU": "Kubernetes The Hard Way",
      "ST": "Quebec"
    }
  ]
}
```

```
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -hostname=${WORKER0_IP},${WORKER0_HOST} \
  -profile=kubernetes \
  ${WORKER0_HOST}-csr.json | cfssljson -bare ${WORKER0_HOST}

cat > ${WORKER1_HOST}-csr.json << EOF
{
  "CN": "system:node:${WORKER1_HOST}",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",
      "L": "Montreal",
      "O": "system:nodes",
      "OU": "Kubernetes The Hard Way",
      "ST": "Quebec"
    }
  ]
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -hostname=${WORKER1_IP},${WORKER1_HOST} \
  -profile=kubernetes \
  ${WORKER1_HOST}-csr.json | cfssljson -bare ${WORKER1_HOST}
}
```

Controller Manager Client certificate:

```
{

cat > kube-controller-manager-csr.json << EOF
{
  "CN": "system:kube-controller-manager",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",
      "L": "Montreal",
      "O": "system:kube-controller-manager",
      "OU": "Kubernetes The Hard Way",
      "ST": "Quebec"
    }
  ]
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -profile=kubernetes \
  kube-controller-manager-csr.json | cfssljson -bare kube-controller-manager

}
```

Kube Proxy Client

```
{

cat > kube-proxy-csr.json << EOF
{
  "CN": "system:kube-proxy",
```

```

"key": {
  "algo": "rsa",
  "size": 2048
},
"names": [
  {
    "C": "CA",
    "L": "Montreal",
    "O": "system:node-proxier",
    "OU": "Kubernetes The Hard Way",
    "ST": "Quebec"
  }
]
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -profile=kubernetes \
  kube-proxy-csr.json | cfssljson -bare kube-proxy
}

```

Kube Scheduler Client Certificate:

```

{

cat > kube-scheduler-csr.json << EOF
{
  "CN": "system:kube-scheduler",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",

```

```

    "L": "Montreal",
    "O": "system:kube-scheduler",
    "OU": "Kubernetes The Hard Way",
    "ST": "Quebec"
  }
]
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -profile=kubernetes \
  kube-scheduler-csr.json | cfssljson -bare kube-scheduler
}

```

API server

```

CERT_HOSTNAME=10.32.0.1,192.168.1.8,kube-1.myhypervisor.ca,192.168.1.10,kube-
2.myhypervisor.ca,192.168.1.13,kube-
lb.myhypervisor.ca,127.0.0.1,localhost,kubernetes.default

```

```
{
```

```
cat > kubernetes-csr.json << EOF
```

```

{
  "CN": "kubernetes",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",
      "L": "Montreal",
      "O": "Kubernetes",
      "OU": "Kubernetes The Hard Way",

```

```
        "ST": "Quebec"
    }
]
}
EOF

cfssl gencert \
  -ca=ca.pem \
  -ca-key=ca-key.pem \
  -config=ca-config.json \
  -hostname=${CERT_HOSTNAME} \
  -profile=kubernetes \
  kubernetes-csr.json | cfssljson -bare kubernetes
}
```

service account

```
{

cat > service-account-csr.json << EOF
{
  "CN": "service-accounts",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CA",
      "L": "Montreal",
      "O": "Kubernetes",
      "OU": "Kubernetes The Hard Way",
      "ST": "Quebec"
    }
  ]
}
}
EOF
```

```
cfssl gencert \  
  -ca=ca.pem \  
  -ca-key=ca-key.pem \  
  -config=ca-config.json \  
  -profile=kubernetes \  
  service-account-csr.json | cfssljson -bare service-account  
  
}
```

scp

```
scp ca.pem kube-3.myhypervisor.ca-key.pem kube-3.myhypervisor.ca.pem root@192.168.2.157:~/  
scp ca.pem kube-4.myhypervisor.ca-key.pem kube-4.myhypervisor.ca.pem root@192.168.2.154:~/  
  
scp ca.pem ca-key.pem kubernetes-key.pem kubernetes.pem \  
  service-account-key.pem service-account.pem root@192.168.2.151:~/  
scp ca.pem ca-key.pem kubernetes-key.pem kubernetes.pem \  
  service-account-key.pem service-account.pem root@192.168.2.162:~/
```

Kubeconfig

kubelet kubeconfig for each worker node

```
KUBERNETES_ADDRESS=192.168.1.13  
for instance in kube-3.myhypervisor.ca kube-4.myhypervisor.ca; do  
  kubectll config set-cluster kubernetes-the-hard-way \  
    --certificate-authority=ca.pem \  
    --embed-certs=true \  
    --server=https://${KUBERNETES_ADDRESS}:6443 \  
    --kubeconfig=${instance}.kubeconfig
```

```
kubectl config set-credentials system:node:${instance} \  
  --client-certificate=${instance}.pem \  
  --client-key=${instance}-key.pem \  
  --embed-certs=true \  
  --kubeconfig=${instance}.kubeconfig  
  
kubectl config set-context default \  
  --cluster=kubernetes-the-hard-way \  
  --user=system:node:${instance} \  
  --kubeconfig=${instance}.kubeconfig  
  
kubectl config use-context default --kubeconfig=${instance}.kubeconfig  
done
```

Kube proxy

```
{  
  kubectl config set-cluster kubernetes-the-hard-way \  
    --certificate-authority=ca.pem \  
    --embed-certs=true \  
    --server=https://${KUBERNETES_ADDRESS}:6443 \  
    --kubeconfig=kube-proxy.kubeconfig  
  
  kubectl config set-credentials system:kube-proxy \  
    --client-certificate=kube-proxy.pem \  
    --client-key=kube-proxy-key.pem \  
    --embed-certs=true \  
    --kubeconfig=kube-proxy.kubeconfig  
  
  kubectl config set-context default \  
    --cluster=kubernetes-the-hard-way \  
    --user=system:kube-proxy \  
    --kubeconfig=kube-proxy.kubeconfig  
  
  kubectl config use-context default --kubeconfig=kube-proxy.kubeconfig  
}
```

kube-controller-manager

```
{
  kubectl config set-cluster kubernetes-the-hard-way \
    --certificate-authority=ca.pem \
    --embed-certs=true \
    --server=https://127.0.0.1:6443 \
    --kubeconfig=kube-controller-manager.kubeconfig

  kubectl config set-credentials system:kube-controller-manager \
    --client-certificate=kube-controller-manager.pem \
    --client-key=kube-controller-manager-key.pem \
    --embed-certs=true \
    --kubeconfig=kube-controller-manager.kubeconfig

  kubectl config set-context default \
    --cluster=kubernetes-the-hard-way \
    --user=system:kube-controller-manager \
    --kubeconfig=kube-controller-manager.kubeconfig

  kubectl config use-context default --kubeconfig=kube-controller-manager.kubeconfig
}
```

kube-scheduler

```
{
  kubectl config set-cluster kubernetes-the-hard-way \
    --certificate-authority=ca.pem \
    --embed-certs=true \
    --server=https://127.0.0.1:6443 \
    --kubeconfig=kube-scheduler.kubeconfig

  kubectl config set-credentials system:kube-scheduler \
    --client-certificate=kube-scheduler.pem \
    --client-key=kube-scheduler-key.pem \
    --embed-certs=true \
    --kubeconfig=kube-scheduler.kubeconfig
}
```

```
kubectl config set-context default \  
  --cluster=kubernetes-the-hard-way \  
  --user=system:kube-scheduler \  
  --kubeconfig=kube-scheduler.kubeconfig  
  
kubectl config use-context default --kubeconfig=kube-scheduler.kubeconfig  
}
```

admin

```
{  
  kubectl config set-cluster kubernetes-the-hard-way \  
    --certificate-authority=ca.pem \  
    --embed-certs=true \  
    --server=https://127.0.0.1:6443 \  
    --kubeconfig=admin.kubeconfig  
  
  kubectl config set-credentials admin \  
    --client-certificate=admin.pem \  
    --client-key=admin-key.pem \  
    --embed-certs=true \  
    --kubeconfig=admin.kubeconfig  
  
  kubectl config set-context default \  
    --cluster=kubernetes-the-hard-way \  
    --user=admin \  
    --kubeconfig=admin.kubeconfig  
  
  kubectl config use-context default --kubeconfig=admin.kubeconfig  
}
```

SCP

```
scp kube-3.myhypervisor.ca.kubeconfig kube-proxy.kubeconfig root@192.168.2.157:~/  
scp kube-4.myhypervisor.ca.kubeconfig kube-proxy.kubeconfig root@192.168.2.154:~/
```

```
scp admin.kubeconfig kube-controller-manager.kubeconfig kube-scheduler.kubeconfig
root@192.168.2.151:~/
scp admin.kubeconfig kube-controller-manager.kubeconfig kube-scheduler.kubeconfig
root@192.168.2.162:~/
```

Generating the Data Encryption Config

```
ENCRYPTION_KEY=$(head -c 32 /dev/urandom | base64)

cat > encryption-config.yaml << EOF
kind: EncryptionConfig
apiVersion: v1
resources:
  - resources:
    - secrets
  providers:
    - aescbc:
      keys:
        - name: key1
          secret: ${ENCRYPTION_KEY}
    - identity: {}
EOF
```

scp

```
scp encryption-config.yaml root@192.168.2.151:~/
scp encryption-config.yaml root@192.168.2.162:~/
```

Creating the etcd Cluster

on both controller nodes

```
wget -q --show-progress --https-only --timestamping \  
  "https://github.com/etcd-io/etcd/releases/download/v3.3.10/etcd-v3.3.10-linux-  
amd64.tar.gz"  
tar -xvf etcd-v3.3.10-linux-amd64.tar.gz  
mv etcd-v3.3.10-linux-amd64/etcd* /usr/local/bin/  
mkdir -p /etc/etcd /var/lib/etcd  
cp ca.pem kubernetes-key.pem kubernetes.pem /etc/etcd/
```

run on controller node1

```
ETCD_NAME=kube-1.myhypervisor.ca  
INTERNAL_IP=192.168.1.8  
INITIAL_CLUSTER=kube-1.myhypervisor.ca=https://192.168.1.8:2380,kube-  
2.myhypervisor.ca=https://192.168.1.10:2380
```

run on controller node2

```
ETCD_NAME=kube-2.myhypervisor.ca  
INTERNAL_IP=192.168.1.10  
INITIAL_CLUSTER=kube-1.myhypervisor.ca=https://192.168.1.8:2380,kube-  
2.myhypervisor.ca=https://192.168.1.10:2380
```

on both controller nodes

```
cat << EOF | tee /etc/systemd/system/etcd.service  
[Unit]  
Description=etcd  
Documentation=https://github.com/coreos  
  
[Service]  
ExecStart=/usr/local/bin/etcd \  
  --name ${ETCD_NAME} \  
  --cert-file=/etc/etcd/kubernetes.pem \  
  --key-file=/etc/etcd/kubernetes-key.pem \  
  --peer-cert-file=/etc/etcd/kubernetes.pem \  
  --peer-key-file=/etc/etcd/kubernetes-key.pem \  
  --trusted-ca-file=/etc/etcd/ca.pem \  
  --
```

```
--peer-trusted-ca-file=/etc/etcd/ca.pem \<\  
--peer-client-cert-auth \<\  
--client-cert-auth \<\  
--initial-advertise-peer-urls https://${INTERNAL_IP}:2380 \<\  
--listen-peer-urls https://${INTERNAL_IP}:2380 \<\  
--listen-client-urls https://${INTERNAL_IP}:2379,https://127.0.0.1:2379 \<\  
--advertise-client-urls https://${INTERNAL_IP}:2379 \<\  
--initial-cluster-token etcd-cluster-0 \<\  
--initial-cluster ${INITIAL_CLUSTER} \<\  
--initial-cluster-state new \<\  
--data-dir=/var/lib/etcd  
Restart=on-failure  
RestartSec=5  
  
[Install]  
WantedBy=multi-user.target  
EOF
```

enable and start service

```
systemctl daemon-reload  
systemctl enable etcd  
systemctl start etcd  
systemctl status etcd
```

check if working

```
ETCDCTL_API=3 etcdctl member list \  
--endpoints=https://127.0.0.1:2379 \  
--cacert=/etc/etcd/ca.pem \  
--cert=/etc/etcd/kubernetes.pem \  
--key=/etc/etcd/kubernetes-key.pem
```

if typo during config remove data in `/var/lib/etcd/*` and restart service
(`rm -rf /var/lib/etcd/*`)

kubernetes controller bin

on both controllers

```
mkdir -p /etc/kubernetes/config

wget -q --show-progress --https-only --timestamping \
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-
apiserver" \
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-
controller-manager" \
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-
scheduler" \
  "https://storage.googleapis.com/kubernetes-
release/release/v1.13.0/bin/linux/amd64/kubectl"

chmod +x kube-apiserver kube-controller-manager kube-scheduler kubectl

mv kube-apiserver kube-controller-manager kube-scheduler kubectl /usr/local/bin/
```

Kubernetes API Server

on both controllers

```
sudo mkdir -p /var/lib/kubernetes/

sudo cp ca.pem ca-key.pem kubernetes-key.pem kubernetes.pem \
  service-account-key.pem service-account.pem \
  encryption-config.yaml /var/lib/kubernetes/

wget -q --show-progress --https-only --timestamping \
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-
apiserver" \
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-
controller-manager" \
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-
scheduler" \
  "https://storage.googleapis.com/kubernetes-
release/release/v1.13.0/bin/linux/amd64/kubectl"
```

```
wget -q --show-progress --https-only --timestamping \  
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-  
apiserver" \  
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-  
controller-manager" \  
  "https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-  
scheduler" \  
  "https://storage.googleapis.com/kubernetes-  
release/release/v1.13.0/bin/linux/amd64/kubectl" \  
  
  service-account-key.pem service-account.pem \  
  encryption-config.yaml /var/lib/kubernetes/
```

controller 1

```
INTERNAL_IP=192.168.1.8  
CONTROLLER0_IP=192.168.1.8  
CONTROLLER1_IP=192.168.1.10  
  
#### controller 2  
INTERNAL_IP=192.168.1.10  
CONTROLLER0_IP=192.168.1.8  
CONTROLLER1_IP=192.168.1.10  
  
#### both  
cat << EOF | tee /etc/systemd/system/kube-apiserver.service  
[Unit]  
Description=Kubernetes API Server  
Documentation=https://github.com/kubernetes/kubernetes  
  
[Service]  
ExecStart=/usr/local/bin/kube-apiserver \  
  --advertise-address=${INTERNAL_IP} \  
  --allow-privileged=true \  
  --apiserver-count=3 \  
  --audit-log-maxage=30 \  
  --audit-log-maxbackup=3
```

```
--audit-log-maxsize=100 \\  
--audit-log-path=/var/log/audit.log \\  
--authorization-mode=Node,RBAC \\  
--bind-address=0.0.0.0 \\  
--client-ca-file=/var/lib/kubernetes/ca.pem \\  
--enable-admission-  
plugins=Initializers,NamespaceLifecycle,NodeRestriction,LimitRanger,ServiceAccount,DefaultStorageClass,ResourceQuota \\  
--enable-swagger-ui=true \\  
--etcd-cafile=/var/lib/kubernetes/ca.pem \\  
--etcd-certfile=/var/lib/kubernetes/kubernetes.pem \\  
--etcd-keyfile=/var/lib/kubernetes/kubernetes-key.pem \\  
--etcd-servers=https://$CONTROLLER0_IP:2379,https://$CONTROLLER1_IP:2379 \\  
--event-ttl=1h \\  
--experimental-encryption-provider-config=/var/lib/kubernetes/encryption-config.yaml \\  
--kubelet-certificate-authority=/var/lib/kubernetes/ca.pem \\  
--kubelet-client-certificate=/var/lib/kubernetes/kubernetes.pem \\  
--kubelet-client-key=/var/lib/kubernetes/kubernetes-key.pem \\  
--kubelet-https=true \\  
--runtime-config=api/all \\  
--service-account-key-file=/var/lib/kubernetes/service-account.pem \\  
--service-cluster-ip-range=10.32.0.0/24 \\  
--service-node-port-range=30000-32767 \\  
--tls-cert-file=/var/lib/kubernetes/kubernetes.pem \\  
--tls-private-key-file=/var/lib/kubernetes/kubernetes-key.pem \\  
--v=2 \\  
--kubelet-preferred-address-types=InternalIP,InternalDNS,Hostname,ExternalIP,ExternalDNS  
Restart=on-failure  
RestartSec=5  
  
[Install]  
WantedBy=multi-user.target  
EOF
```

Kubernetes Controller Manager

on both controllers

```
cp kube-controller-manager.kubeconfig /var/lib/kubernetes/

cat << EOF | tee /etc/systemd/system/kube-controller-manager.service
[Unit]
Description=Kubernetes Controller Manager
Documentation=https://github.com/kubernetes/kubernetes

[Service]
ExecStart=/usr/local/bin/kube-controller-manager \\\
  --address=0.0.0.0 \\\
  --cluster-cidr=10.200.0.0/16 \\\
  --cluster-name=kubernetes \\\
  --cluster-signing-cert-file=/var/lib/kubernetes/ca.pem \\\
  --cluster-signing-key-file=/var/lib/kubernetes/ca-key.pem \\\
  --kubeconfig=/var/lib/kubernetes/kube-controller-manager.kubeconfig \\\
  --leader-elect=true \\\
  --root-ca-file=/var/lib/kubernetes/ca.pem \\\
  --service-account-private-key-file=/var/lib/kubernetes/service-account-key.pem \\\
  --service-cluster-ip-range=10.32.0.0/24 \\\
  --use-service-account-credentials=true \\\
  --v=2
Restart=on-failure
RestartSec=5

[Install]
WantedBy=multi-user.target
EOF
```

Kubernetes Scheduler

on both controllers

```
cp kube-scheduler.kubeconfig /var/lib/kubernetes/

cat << EOF | tee /etc/kubernetes/config/kube-scheduler.yaml
apiVersion: kubescheduler.config.k8s.io/v1alpha1
kind: KubeSchedulerConfiguration
```

```
clientConnection:
  kubeconfig: "/var/lib/kubernetes/kube-scheduler.kubeconfig"
leaderElection:
  leaderElect: true
EOF

cat << EOF | tee /etc/systemd/system/kube-scheduler.service
[Unit]
Description=Kubernetes Scheduler
Documentation=https://github.com/kubernetes/kubernetes

[Service]
ExecStart=/usr/local/bin/kube-scheduler \\\
  --config=/etc/kubernetes/config/kube-scheduler.yaml \\\
  --v=2
Restart=on-failure
RestartSec=5

[Install]
WantedBy=multi-user.target
EOF
```

Enable services

on both controllers

```
systemctl daemon-reload
systemctl enable kube-apiserver kube-controller-manager kube-scheduler
systemctl start kube-apiserver kube-controller-manager kube-scheduler
```

check status

on both controllers

```
systemctl status kube-apiserver kube-controller-manager kube-scheduler
kubectl get componentstatuses --kubeconfig admin.kubeconfig
```

Set up RBAC for Kubelet Authorization

On controller 1

Create a role with the necessary permissions:

```
cat << EOF | kubectl apply --kubeconfig admin.kubeconfig -f -
apiVersion: rbac.authorization.k8s.io/v1beta1
kind: ClusterRole
metadata:
  annotations:
    rbac.authorization.kubernetes.io/autoupdate: "true"
  labels:
    kubernetes.io/bootstrapping: rbac-defaults
  name: system:kube-apiserver-to-kubelet
rules:
- apiGroups:
  - ""
  resources:
  - nodes/proxy
  - nodes/stats
  - nodes/log
  - nodes/spec
  - nodes/metrics
  verbs:
  - "*"
EOF
```

Bind the role to the kubernetes user:

```
cat << EOF | kubectl apply --kubeconfig admin.kubeconfig -f -
apiVersion: rbac.authorization.k8s.io/v1beta1
kind: ClusterRoleBinding
```

```
metadata:
  name: system:kube-apiserver
  namespace: ""
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: system:kube-apiserver-to-kubelet
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: User
  name: kubernetes
EOF
```

Setting up a Kube API Frontend Load Balancer

on LB

```
sudo apt-get install -y nginx
sudo systemctl enable nginx
sudo mkdir -p /etc/nginx/tcpconf.d
sudo vi /etc/nginx/nginx.conf
```

Add the following to the end of nginx.conf:

```
include /etc/nginx/tcpconf.d/*;
```

Set up some environment variables for the load balancer config file:

```
CONTROLLER0_IP=192.168.1.8
CONTROLLER1_IP=192.168.1.10
```

Create the load balancer nginx config file:

```
cat << EOF | sudo tee /etc/nginx/tcpconf.d/kubernetes.conf
stream {
    upstream kubernetes {
        server $CONTROLLER0_IP:6443;
        server $CONTROLLER1_IP:6443;
    }

    server {
        listen 6443;
        listen 443;
        proxy_pass kubernetes;
    }
}
EOF
```

Reload the nginx configuration:

```
sudo nginx -s reload
```

You can verify that the load balancer is working like so:

```
curl -k https://localhost:6443/version
```

Install bin on worker

on both worker nodes

```
sudo apt-get -y install socat conntrack ipset

wget -q --show-progress --https-only --timestamping \
```

```
https://github.com/kubernetes-sigs/cni-tools/releases/download/v1.13.0/critest-v1.13.0-
linux-amd64.tar.gz \
https://storage.googleapis.com/kubernetes-the-hard-way/runsc \
https://github.com/opencontainers/runc/releases/download/v1.0.0-rc6/runc.amd64 \
https://github.com/containernetworking/plugins/releases/download/v0.7.4/cni-plugins-amd64-
v0.7.4.tgz \
https://github.com/containerd/containerd/releases/download/v1.2.2/containerd-1.2.2.linux-
amd64.tar.gz \
https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kubectl
\
https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kube-proxy
\
https://storage.googleapis.com/kubernetes-release/release/v1.13.0/bin/linux/amd64/kubelet

sudo mkdir -p \
  /etc/cni/net.d \
  /opt/cni/bin \
  /var/lib/kubelet \
  /var/lib/kube-proxy \
  /var/lib/kubernetes \
  /var/run/kubernetes

chmod +x kubectl kube-proxy kubelet runc.amd64 runsc
sudo mv runc.amd64 runc
sudo mv kubectl kube-proxy kubelet runc runsc /usr/local/bin/
sudo tar -xvf critest-v1.13.0-linux-amd64.tar.gz -C /usr/local/bin/
sudo tar -xvf cni-plugins-amd64-v0.7.4.tgz -C /opt/cni/bin/
sudo tar -xvf containerd-1.2.2.linux-amd64.tar.gz -C /
```

Install containerd

on both worker nodes

Create the containerd config.taml:

```
sudo mkdir -p /etc/containerd/

cat << EOF | sudo tee /etc/containerd/config.toml
[plugins]
  [plugins.cri.containerd]
    snapshotter = "overlayfs"
  [plugins.cri.containerd.default_runtime]
    runtime_type = "io.containerd.runtime.v1.linux"
    runtime_engine = "/usr/local/bin/runc"
    runtime_root = ""
  [plugins.cri.containerd.untrusted_workload_runtime]
    runtime_type = "io.containerd.runtime.v1.linux"
    runtime_engine = "/usr/local/bin/runsc"
    runtime_root = "/run/containerd/runsc"
EOF
```

Create the containerd unit file:

```
cat << EOF | sudo tee /etc/systemd/system/containerd.service
[Unit]
Description=containerd container runtime
Documentation=https://containerd.io
After=network.target

[Service]
ExecStartPre=/sbin/modprobe overlay
ExecStart=/bin/containerd
Restart=always
RestartSec=5
Delegate=yes
KillMode=process
OOMScoreAdjust=-999
LimitNOFILE=1048576
LimitNPROC=infinity
LimitCORE=infinity

[Install]
```

```
WantedBy=multi-user.target
```

```
EOF
```

Config kubelet

worker1

```
HOSTNAME=kube-3.myhypervisor.ca  
sudo mv ${HOSTNAME}-key.pem ${HOSTNAME}.pem /var/lib/kubelet/  
sudo mv ${HOSTNAME}.kubeconfig /var/lib/kubelet/kubeconfig  
sudo mv ca.pem /var/lib/kubernetes/
```

worker2

```
HOSTNAME=kube-4.myhypervisor.ca  
sudo mv ${HOSTNAME}-key.pem ${HOSTNAME}.pem /var/lib/kubelet/  
sudo mv ${HOSTNAME}.kubeconfig /var/lib/kubelet/kubeconfig  
sudo mv ca.pem /var/lib/kubernetes/
```

Create the kubelet config file:

```
cat << EOF | sudo tee /var/lib/kubelet/kubelet-config.yaml  
kind: KubeletConfiguration  
apiVersion: kubelet.config.k8s.io/v1beta1  
authentication:  
  anonymous:  
    enabled: false  
  webhook:  
    enabled: true  
  x509:  
    clientCAFile: "/var/lib/kubernetes/ca.pem"  
authorization:  
  mode: Webhook  
clusterDomain: "cluster.local"  
clusterDNS:
```

```
- "10.32.0.10"
runtimeRequestTimeout: "15m"
tlsCertFile: "/var/lib/kubelet/${HOSTNAME}.pem"
tlsPrivateKeyFile: "/var/lib/kubelet/${HOSTNAME}-key.pem"
EOF
```

Create the kubelet unit file:

```
cat << EOF | sudo tee /etc/systemd/system/kubelet.service
[Unit]
Description=Kubernetes Kubelet
Documentation=https://github.com/kubernetes/kubernetes
After=containerd.service
Requires=containerd.service

[Service]
ExecStart=/usr/local/bin/kubelet \
  --config=/var/lib/kubelet/kubelet-config.yaml \
  --container-runtime=remote \
  --container-runtime-endpoint=unix:///var/run/containerd/containerd.sock \
  --image-pull-progress-deadline=2m \
  --kubeconfig=/var/lib/kubelet/kubeconfig \
  --network-plugin=cni \
  --register-node=true \
  --v=2 \
  --hostname-override=${HOSTNAME} \
  --allow-privileged=true
Restart=on-failure
RestartSec=5

[Install]
WantedBy=multi-user.target
EOF
```

Config kube-proxy

Both workers

You can configure the kube-proxy service like so. Run these commands on both worker nodes:

```
sudo mv kube-proxy.kubeconfig /var/lib/kube-proxy/kubeconfig
```

Create the kube-proxy config file:

```
cat << EOF | sudo tee /var/lib/kube-proxy/kube-proxy-config.yaml
kind: KubeProxyConfiguration
apiVersion: kubeproxy.config.k8s.io/v1alpha1
clientConnection:
  kubeconfig: "/var/lib/kube-proxy/kubeconfig"
mode: "iptables"
clusterCIDR: "10.200.0.0/16"
EOF
```

Create the kube-proxy unit file:

```
cat << EOF | sudo tee /etc/systemd/system/kube-proxy.service
[Unit]
Description=Kubernetes Kube Proxy
Documentation=https://github.com/kubernetes/kubernetes

[Service]
ExecStart=/usr/local/bin/kube-proxy \\\
  --config=/var/lib/kube-proxy/kube-proxy-config.yaml
Restart=on-failure
RestartSec=5

[Install]
WantedBy=multi-user.target
EOF
```

Now you are ready to start up the worker node services! Run these:

```
sudo systemctl daemon-reload
sudo systemctl enable containerd kubelet kube-proxy
sudo systemctl start containerd kubelet kube-proxy
```

Check the status of each service to make sure they are all active (running) on both worker nodes:

```
sudo systemctl status containerd kubelet kube-proxy
```

Finally, verify that both workers have registered themselves with the cluster. Log in to one of your control nodes and run this:

on controller node

```
kubectl get nodes
```

kubectl on workstation

```
ssh -L 6443:localhost:6443 root@192.168.2.170

kubectl config set-cluster kubernetes-the-hard-way \
  --certificate-authority=ca.pem \
  --embed-certs=true \
  --server=https://localhost:6443

kubectl config set-credentials admin \
  --client-certificate=admin.pem \
  --client-key=admin-key.pem

kubectl config set-context kubernetes-the-hard-way \
  --cluster=kubernetes-the-hard-way \
  --user=admin

kubectl config use-context kubernetes-the-hard-way
```

test commands

```
kubectl get pods
kubectl get nodes
kubectl version
```

Setup worker networking

on both worker nodes

```
sudo sysctl net.ipv4.conf.all.forwarding=1
```

Install Weave Net

on local workstation

```
kubectl apply -f "https://cloud.weave.works/k8s/net?k8s-version=$(kubectl version | base64 | tr -d '\n')&env.IPALLOC_RANGE=10.200.0.0/16"
```

check if running

```
kubectl get pods -n kube-system
```

create an Nginx deployment with 2 replicas

```
cat << EOF | kubectl apply -f -
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx
spec:
  selector:
    matchLabels:
      run: nginx
  replicas: 2
  template:
    metadata:
      labels:
        run: nginx
```

```
spec:
  containers:
  - name: my-nginx
    image: nginx
    ports:
    - containerPort: 80
EOF
```

create a service for that deployment so that we can test connectivity to services

```
kubectl expose deployment/nginx
```

start up another pod. We will use this pod to test our networking

```
kubectl run busybox --image=radial/busyboxplus:curl --command -- sleep 3600
POD_NAME=$(kubectl get pods -l run=busybox -o jsonpath="{.items[0].metadata.name}")
```

get the IP addresses of our two Nginx pods

```
kubectl get ep nginx
```

output looks like this

NAME	ENDPOINTS	AGE
nginx	10.200.0.2:80,10.200.128.1:80	14s

check that busybox pod can connect to the Nginx pods on both of those IP addresses

```
kubectl exec $POD_NAME -- curl 10.200.0.2
kubectl exec $POD_NAME -- curl 10.200.128.1
```

Delete pods

```
kubectl delete deployment busybox
kubectl delete deployment nginx
kubectl delete svc nginx
```

Install kube-dns

from workstation or controller node

```
kubectl create -f https://storage.googleapis.com/kubernetes-the-hard-way/kube-dns.yaml
```

Verify that the kube-dns pod starts up correctly

```
kubectl get pods -l k8s-app=kube-dns -n kube-system
```

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