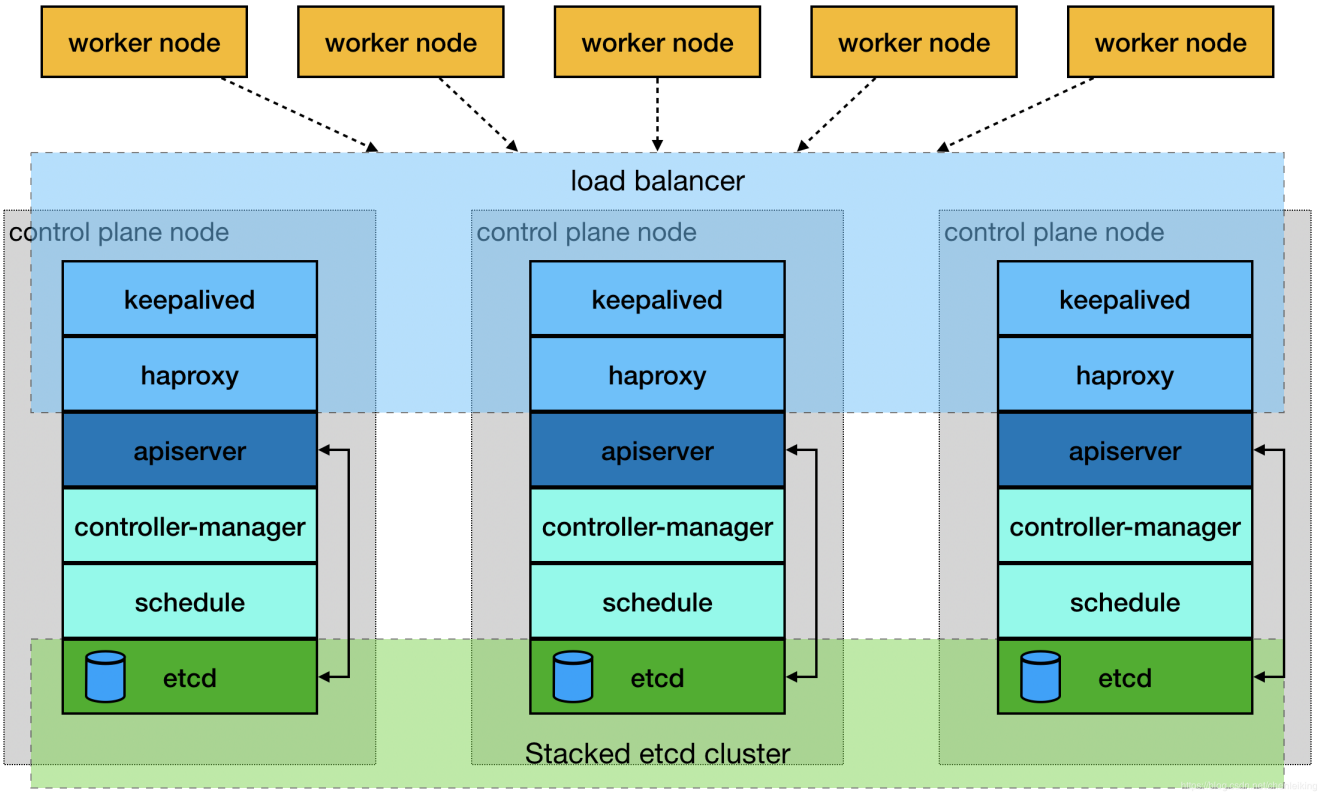
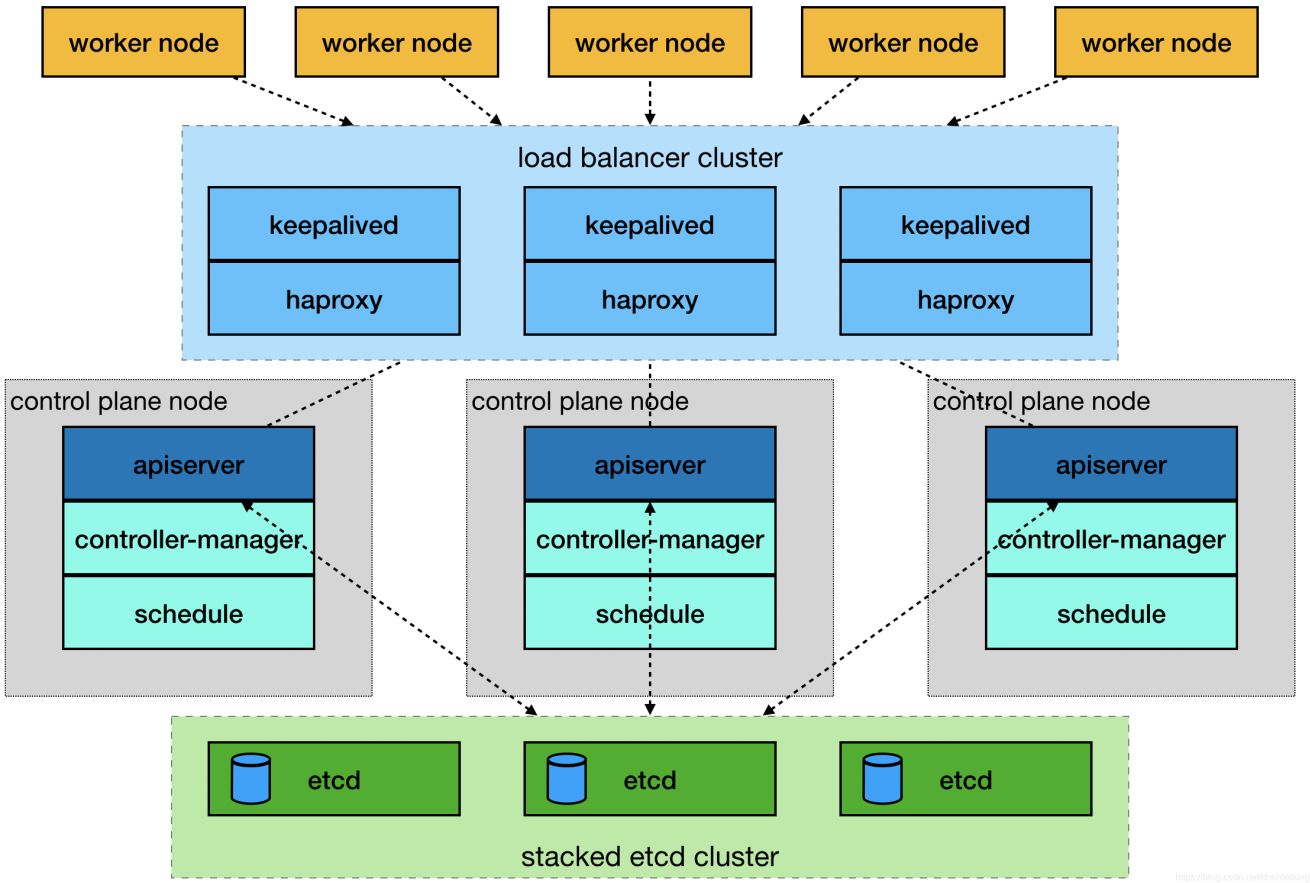
kubeadm部署kubernetes高可用集群-VIP版

> 官网提供了两种拓扑结构部署集群：**stacked control plane nodes**和**external etcd cluster**，本文基于第一种拓扑结构进行部署，使用**Keepalived** + **HAProxy**搭建高可用**Load balancer**。

stacked control plane nodes架构图



external etcd cluster架构图



一.环境准备

主机名	IP地址	说明	组件
master01	192.168.3.11	master节点	kubeadm、kubelet、kubectl、docker、haproxy、keepalived
master02	192.168.3.12	master节点	kubeadm、kubelet、kubectl、docker、haproxy、keepalived
master03	192.168.3.13	master节点	kubeadm、kubelet、kubectl、docker、haproxy、keepalived
node01	192.168.3.14	node节点	kubeadm、kubelet、docker、kube-proxy
node02	192.168.3.15	node节点	kubeadm、kubelet、docker、kube-proxy
node03	192.168.3.16	node节点	kubeadm、kubelet、docker、kube-proxy
无	192.168.3.10	keepalived虚拟IP	无

1.1.系统环境

Linux：Centos_7_5_64 (内核3.10+)

1.2.关闭防火墙

防火墙一定要提前关闭，否则在后续安装K8S集群的时候是个麻烦。执行下面语句关闭，并禁用开机启动：

```
systemctl stop firewalld & systemctl disable firewalld
```

1.3.关闭SeLinux

```
setenforce 0
sed -i 's/^SELINUX=enforcing$/SELINUX=disabled/' /etc/selinux/config
```

1.4.关闭Swap

在安装K8S集群时，Linux的Swap内存交换机制是一定要关闭的，否则会因为内存交换而影响性能以及稳定性。这里，我们可以提前进行设置：

- 执行`swapoff -a`可临时关闭，但系统重启后恢复
- 编辑`/etc/fstab`，注释掉包含`swap`的那一行即可，重启后可永久关闭，命令如下：

```
sed -i '/ swap / s/^/#/' /etc/fstab
```

1.5.设置主机名

```
#主节点
hostnamectl --static set-hostname  master01
hostnamectl --static set-hostname  master02
hostnamectl --static set-hostname  master03
#从节点
hostnamectl --static set-hostname  node01
hostnamectl --static set-hostname  node02
hostnamectl --static set-hostname  node03
```

1.6.修改hosts

```
cat >> /etc/hosts <<EOF
192.168.3.11 master01.kube.com
192.168.3.12 master02.kube.com
192.168.3.13 master03.kube.com
192.168.3.14 node01.kube.com
192.168.3.15 node02.kube.com
192.168.3.16 node03.kube.com
EOF
```

1.7.配置路由参数

CentOS_7可能会出现iptables被绕过而导致流量被错误路由的问题。确保`net.bridge.bridge-nf-call-iptables`在`sysctl`配置中设置为1。

```
# 添加配置文件
cat <<EOF >  /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-ip6tables = 1
net.bridge.bridge-nf-call-iptables = 1
net.ipv4.ip_forward = 1
EOF
# 立即生效
sysctl -p /etc/sysctl.d/k8s.conf
```

二.开始安装

2.1.配置yum源

> 所有的节点都需要配置相同的yum源

1. 使用阿里云镜像仓库，配置Docker和kubernetes的yum源。

```
cd /etc/yum.repos.d/

# 下载Docker
wget https://mirrors.aliyun.com/docker-ce/linux/centos/docker-ce.repo

# 配置kubernetes
cat << EOF > /etc/yum.repos.d/kubernetes.repo
[kubernetes]
name=Kubernetes
baseurl=http://mirrors.aliyun.com/kubernetes/yum/repos/kubernetes-el7-x86_64
enabled=1
gpgcheck=1
repo_gpgcheck=1
gpgkey=http://mirrors.aliyun.com/kubernetes/yum/doc/yum-key.gpg
http://mirrors.aliyun.com/kubernetes/yum/doc/rpm-package-key.gpg
EOF
```

2.2.部署keepalived

> 部署在所有的master节点，keeplived的主要作用是为haproxy提供vip，在三个haproxy实例之间提供主备，降低当其中一个haproxy失效的时对服务的影响。vip地址指向master1、master2、master3。

1. 安装

```
yum install -y keepalived
```

2. 配置，三台master节点配置稍微不同，根据备注修改

```
cat > /etc/keepalived/keepalived.conf << EOF
! Configuration File for keepalived

global_defs {
   router_id LVS_DEVEL
```

```
}

vrrp_script check_haproxy {
    script "killall -0 haproxy" # 根据进程名称检测进程是否存活
    interval 3
    weight -2
    fall 10
    rise 2
}

vrrp_instance VI_1 {
    state MASTER        # 备分服务器上改为BACKUP
    interface ens33     # 改为自己的网络接口
    virtual_router_id 51
    priority 250        # 备分服务器上改为小于250的数字，如200,150
    advert_int 1
    authentication {
        auth_type PASS
        auth_pass 35f18af7190d51c9f7f78f37300a0cbd
    }
    virtual_ipaddress {
        192.168.3.10 # 虚拟ip，自己设定
    }
    track_script {
        check_haproxy
    }
}
EOF
```

3. 启动并检测

```
# 启动
systemctl start keepalived.service && systemctl enable keepalived.service
# 查看状态
systemctl status keepalived.service
# 查看vip
ip address show ens33
```

2.3.部署haproxy

> 部署在所有的master节点，haproxy为apiserver提供反向代理，haproxy将所有请求轮询转发到每个master节点上。相对于仅仅使用keepalived主备模式仅单个master节点承载流量，这种方式更加合理、健壮。

1. 安装

```
yum install -y haproxy
```

2.系统配置

```
cat >> /etc/sysctl.conf << EOF
net.ipv4.ip_nonlocal_bind = 1
EOF

# 立即生效
sysctl -p
```

3. 配置，所有master节点配置相同

```
cat > /etc/haproxy/haproxy.cfg << EOF
#---------------------------------------------------------------------
# Global settings
#---------------------------------------------------------------------
global
    # to have these messages end up in /var/log/haproxy.log you will
    # need to:
    #
    # 1) configure syslog to accept network log events.  This is done
    #    by adding the '-r' option to the SYSLOGD_OPTIONS in
    #    /etc/sysconfig/syslog
    #
    # 2) configure local2 events to go to the /var/log/haproxy.log
    #   file. A line like the following can be added to
    #   /etc/sysconfig/syslog
    #
    #    local2.*                       /var/log/haproxy.log
    #
    log         127.0.0.1 local2

    chroot      /var/lib/haproxy
    pidfile     /var/run/haproxy.pid
    maxconn     4000
    user        haproxy
    group       haproxy
    daemon

    # turn on stats unix socket
    stats socket /var/lib/haproxy/stats

#---------------------------------------------------------------------
# common defaults that all the 'listen' and 'backend' sections will
# use if not designated in their block
#---------------------------------------------------------------------
defaults
    mode                    http
    log                     global
    option                  httplog
    option                  dontlognull
    option http-server-close
    option forwardfor       except 127.0.0.0/8
    option                  redispatch
    retries                 3
```

```
    timeout http-request    10s
    timeout queue           1m
    timeout connect         10s
    timeout client          1m
    timeout server          1m
    timeout http-keep-alive 10s
    timeout check           10s
    maxconn                 3000

#---------------------------------------------------------------------
# kubernetes apiserver frontend which proxys to the backends
#---------------------------------------------------------------------
frontend kubernetes
    mode                 tcp
    bind                 *:16443
    option               tcplog
    default_backend      kubernetes-apiserver

#---------------------------------------------------------------------
# round robin balancing between the various backends
#---------------------------------------------------------------------
backend kubernetes-apiserver
    mode        tcp
    balance     roundrobin
    server  master01 192.168.3.11:6443 check
    server  master02 192.168.3.12:6443 check
    server  master03 192.168.3.13:6443 check

#---------------------------------------------------------------------
# collection haproxy statistics message
#---------------------------------------------------------------------
listen stats
    bind                 *:1080
    stats auth           admin:awesomePassword
    stats refresh        5s
    stats realm          HAProxy\ Statistics
    stats uri            /admin?stats
EOF
```

4. 启动并检测

```
# 启动
systemctl start haproxy.service && systemctl enable haproxy.service
# 查看状态
systemctl status haproxy.service
# 查看端口
ss -lnt | grep -E "16443|1080"
```

2.4.安装Docker

> 所有的节点都需要安装Docker

1. 安装docker

```
yum install -y docker-ce
```

2. 启动，并设为开机自启

```
systemctl start docker & systemctl enable docker
```

2.5.安装kubernetes

2.5.1.master节点安装

> master节点需要安装kubeadm、kubectl、kubelet组件

1. 安装

```
yum install -y kubelet-1.13.0 kubeadm-1.13.0 kubectl-1.13.0 --
disableexcludes=kubernetes
```

2. 开机自启

```
systemctl enable kubelet
```

3. 确保kubelet 的cgroup drive 和docker的cgroup drive一样:

```
sed -i "s/cgroup-driver=systemd/cgroup-driver=cgroupfs/g"
/usr/lib/systemd/system/kubelet.service.d/10-kubeadm.conf
```

2.5.2.初始化matser

> 选择一个master节点初始化，其余的master节点加入

1. 编写hosts，添加vip

```
cat >> /etc/hosts << EOF
192.168.3.10 cluster.kube.com
EOF
```

2. 配置kubeadm

```
cat > /root/kubernetes/kubeadm-config.yaml << EOF
apiVersion: kubeadm.k8s.io/v1beta1
kind: ClusterConfiguration
kubernetesVersion: v1.13.0
apiServer:
  certSANs:
    - "cluster.kube.com"
controlPlaneEndpoint: "cluster.kube.com:16443"
networking:
  podSubnet: "10.244.0.0/16" # 根据选择的网络组件配置，本文使用flannel组件
EOF
```

3. 初始化一个master节点

```
kubeadm init --config=/root/kubernetes/kubeadm-config.yaml
```

- 记录如下信息

```
Your Kubernetes master has initialized successfully!

To start using your cluster, you need to run the following as a regular user:

  mkdir -p $HOME/.kube
  sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
  sudo chown $(id -u):$(id -g) $HOME/.kube/config

You should now deploy a pod network to the cluster.
Run "kubectl apply -f [podnetwork].yaml" with one of the options listed at:
  https://kubernetes.io/docs/concepts/cluster-administration/addons/

You can now join any number of machines by running the following on each node
as root:

  kubeadm join cluster.kube.com:16443 --token 5kad4d.1pa4jvjcba4tttsl --discovery-token-ca-cert-hash
sha256:f1551456908535ed0c6078a199651a01ddf5cfb470a901f3e24701ea996f978e
```

4. 要使kubectl为非root用户工作，请运行以下命令

```
mkdir -p $HOME/.kube
sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

- 如果是**root**用户，则可以运行：

```
export KUBECONFIG=/etc/kubernetes/admin.conf
```

6. 安装网络组件

> 网络组件有多种，常用的有calio和flannel，只需要选择一种就可以了。

1. **calio组件**

```
# 下载
wget https://docs.projectcalico.org/v3.3/getting-started/kubernetes/installation/hosted/rbac-kdd.yaml

wget https://docs.projectcalico.org/v3.3/getting-started/kubernetes/installation/hosted/kubernetes-datastore/calico-networking/1.7/calico.yaml
```

- 修改配置，默认会使用主机的第一张网卡，如果有多张网卡，需要通过配置单独指定。

```
# Auto-detect the BGP IP address.
- name: IP
  value: "autodetect"
# 添加如下的配置，设置使用的网卡
- name: IP_AUTODETECTION_METHOD
  value: "interface=ens*"
```

- 启动

```
kubectl apply -f rbac-kdd.yaml
kubectl apply -f calico.yaml
```

2. **flannel 组件**

```
# 下载
https://raw.githubusercontent.com/coreos/flannel/62e44c867a2846fefb68bd5f178daf4da3095ccb/Documentation/kube-flannel.yml
```

- 修改配置，flannel 默认会使用主机的第一张网卡，如果有多张网卡，需要通过配置单独指定。

```
 containers:
      - name: kube-flannel
        image: quay.io/coreos/flannel:v0.11.0-amd64
        command:
        - /opt/bin/flanneld
        args:
        - --ip-masq
        - --kube-subnet-mgr
        - --iface=ens33  # 添加
```

- 启动

```
kubectl apply -f kube-flannel.yml
```

- 查看pod状态：

```
kubectl get pods --all-namespaces
```

3. 复制证书到其他master节点，shell脚本如下

```
# 用户名
USER=root
# 服务器IP列表
CONTROL_PLANE_IPS="192.168.3.12 192.168.3.13"
# 批量发送文件
for host in ${CONTROL_PLANE_IPS}; do
  ssh "${USER}"@$host mkdir -p /etc/kubernetes/pki/etcd
    scp /etc/kubernetes/pki/ca.crt "${USER}"@$host:/etc/kubernetes/pki/ca.crt
    scp /etc/kubernetes/pki/ca.key "${USER}"@$host:/etc/kubernetes/pki/ca.key
```

```
    scp /etc/kubernetes/pki/sa.key "${USER}"@$host:/etc/kubernetes/pki/sa.key
    scp /etc/kubernetes/pki/sa.pub "${USER}"@$host:/etc/kubernetes/pki/sa.pub
    scp /etc/kubernetes/pki/front-proxy-ca.crt
"${USER}"@$host:/etc/kubernetes/pki/front-proxy-ca.crt
    scp /etc/kubernetes/pki/front-proxy-ca.key
"${USER}"@$host:/etc/kubernetes/pki/front-proxy-ca.key
    scp /etc/kubernetes/pki/etcd/ca.crt
"${USER}"@$host:/etc/kubernetes/pki/etcd/ca.crt
    scp /etc/kubernetes/pki/etcd/ca.key
"${USER}"@$host:/etc/kubernetes/pki/etcd/ca.key
  scp /etc/kubernetes/admin.conf $host:/etc/kubernetes/admin.conf
done
```

2.5.3.部署其它master

> 在其余的master节点执行，加入集群命令，注意添加 **-experimental-control-plane**

```
kubeadm join cluster.kube.com:16443 --token 5kad4d.1pa4jvjcba4tttsl --discovery-token-ca-cert-hash sha256:f1551456908535ed0c6078a199651a01ddf5cfb470a901f3e24701ea996f978e --experimental-control-plane
```

- 查看集群状态

```
# 节点状态
kubectl get nodes -o wide

# 组件状态
kubectl get cs

# 服务账户
kubectl get serviceaccount

# 集群信息
kubectl cluster-info
```

2.5.4.etcd集群

1. 查看etcd集群状态

```
# 进入容器内部
kubectl exec -ti -n kube-system etcd-master01 sh
# 执行命令
export ETCDCTL_API=3
etcdctl --endpoints=https://[127.0.0.1]:2379 --cacert=/etc/kubernetes/pki/etcd/ca.crt --cert=/etc/kubernetes/pki/etcd/healthcheck-client.crt --key=/etc/kubernetes/pki/etcd/healthcheck-client.key member list
```

- 如果出现如下错误

```
client: etcd cluster is unavailable or misconfigured; error #0: malformed HTTP response
"\x15\x03\x01\x00\x02\x02"
; error #1: dial tcp 127.0.0.1:4001: getsockopt: connection refused
```

- 在容器内执行命令，修改环境变量，之后再查看

```
# 修改环境变量
export ETCDCTL_ENDPOINT=https://127.0.0.1:2379
# 查看集群列表
etcdctl --endpoints=https://[127.0.0.1]:2379 --cacert=/etc/kubernetes/pki/etcd/ca.crt --
cert=/etc/kubernetes/pki/etcd/healthcheck-client.crt --
key=/etc/kubernetes/pki/etcd/healthcheck-client.key member list
```

- 出现如下结果，表示正常，退出容器

```
3cbf32015864aa27, started, master02, https://192.168.3.12:2380,
https://192.168.3.12:2379
71f26872cb1756fc, started, master01, https://192.168.3.11:2380,
https://192.168.3.11:2379
da9bb37422ca7d8d, started, master03, https://192.168.3.13:2380,
https://192.168.3.13:2379
```

2.5.4.node节点安装

> node节点需要安装kubeadm、kubelet组件，kubectl可以不安装

1. 安装

```
yum install -y kubelet-1.13.0 kubeadm-1.13.0 --disableexcludes=kubernetes
```

2. 开机自启

```
systemctl enable kubelet
```

3. 确保kubelet 的cgroup drive 和docker的cgroup drive一样:

```
sed -i "s/cgroup-driver=systemd/cgroup-driver=cgroupfs/g"
/usr/lib/systemd/system/kubelet.service.d/10-kubeadm.conf
```

4. 编写hosts，添加vip

```
cat >> /etc/hosts << EOF
192.168.3.10 cluster.kube.com
EOF
```

5. 加入集群

```
kubeadm join cluster.kube.com:16443 --token 5kad4d.1pa4jvjcba4tttsl --discovery-token-ca-cert-hash sha256:f1551456908535ed0c6078a199651a01ddf5cfb470a901f3e24701ea996f978e
```

2.5.5.安装dashboard

> 在node节点上安装，节点上需要有相关镜像。

2.5.5.1.简易安装

1.安装

- 下载配置文件

```
wget https://raw.githubusercontent.com/kubernetes/dashboard/master/aio/deploy/recommended/kubernetes-dashboard.yaml
```

- 修改配置文件（主要是设置端口类型为 NodePort）

```
# ------------------- Dashboard Service ------------------- #

kind: Service
apiVersion: v1
metadata:
  labels:
    k8s-app: kubernetes-dashboard
  name: kubernetes-dashboard
  namespace: kube-system
spec:
  type: NodePort
  ports:
    - port: 443
      targetPort: 8443
      nodePort: 30001
  selector:
    k8s-app: kubernetes-dashboard
```

- 执行安装命令：

```
kubectl create -f kubernetes-dashboard.yaml
```

2.查看节点端口

```
kubectl get service -n kube-system -o wide
```

```
[root@k8s-master ~]# kubectl get service -n kube-system -o wide
NAME                   TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)         AGE     SELECTOR
calico-typha           ClusterIP   10.111.171.61    <none>        5473/TCP        9d      k8s-app=calico-typha
kube-dns               ClusterIP   10.96.0.10       <none>        53/UDP,53/TCP   9d      k8s-app=kube-dns
kubernetes-dashboard   NodePort    10.103.148.129   <none>        443:30001/TCP   6d17h   k8s-app=kubernetes-dashboard
```

记录下端口号，登录页面时需要用到。

3.创建用户

- 创建dashboard-rbac.yaml文件，内容如下：

```yaml
apiVersion: v1
kind: ServiceAccount
metadata:
  labels:
    k8s-app: kubernetes-dashboard
  name: admin
  namespace: kube-system
---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: admin
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: cluster-admin
subjects:
- kind: ServiceAccount
  name: admin
  namespace: kube-system
```

- 运行命令：

```
kubectl create -f dashboard-rbac.yaml
```

4.获取登录token

```
kubectl describe secret admin -n kube-system
```

```
[root@k8s-master docker]# kubectl describe secret admin-token-99t6x  -n kube-system
Name:         admin-token-99t6x
Namespace:    kube-system
Labels:       <none>
Annotations:  kubernetes.io/service-account.name: admin
              kubernetes.io/service-account.uid: 7b165fda-1258-11e9-846c-000c29f210a4

Type:  kubernetes.io/service-account-token

Data
====
ca.crt:     1025 bytes
namespace:  11 bytes
token:      eyJhbGciOiJSUzI1NiIsImtpZCI6IiJ9.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYW
Njb3VudC9uYW1lc3BhY2UiOiJrdWJlLXN5c3RlbSIsImt1YmVybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VjcmV0Lm5hbWUiOiJhZG1pbi10b2tlbi05OXQ2e
CIsImt1YmVybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VydmljZS1hY2NvdW50Lm5hbWUiOiJhZG1pbiIsImt1YmVybmV0ZXMuaW8vc2VydmljZWFjY291bnQv
c2VydmljZS1hY2NvdW50LnVpZCI6IjdiMTY1ZmRhLTEyNTgtMTFlOS04NDZjLTAwMGMyOWYyMTBhNCIsInN1YiI6InN5c3RlbTpzZXJ2aWNlYWNjb3VudDprdW
lLXN5c3RlbTphZG1pbiJ9.cQG12NyGCpkBl-nAd7nG1fxpRXmsY0GnJBfETsaqxvoybNXP2deh0t09VSkAAf0cXUZj8edYiro6BUH6v-Ah57VRWZtm0ke6C47w8
JelBlCCtrItBc7ukSjEGp9bYtcfYMzY2lXUDX0Bnkfxxc4F-3gGNpSqSHXQoJWxaPxRutlt5bGZzWamiSWMSutGJnQlDm2PAJ5ZQUHiIuXjioTSIKZlJkZ4j1E
MfkCMyAMFPHDWgel6HEHXtv8g7RDZlwMPvJ4gTZNHq00qSgWeuFwI8HXp_H5r_rSYt8BSFCe5KXn1Y_i971Jr2gFhH84Jk4AYmzbLnl7LLomzd9M9pw-qg
```

5.登录页面

- 打开连接（**火狐**）： https://192.168.3.11:30001
- 选择**令牌**登录方式
- 输入上图中的token，点击登录

2.5.5.2.证书安装

1.**创建自签名CA**

- 生成私钥

```
openssl genrsa -out ca.key 2048
```

- 生成自签名证书

```
openssl req -new -x509 -key ca.key -out ca.crt -days 3650 -subj
"/C=CN/ST=HB/L=WH/O=DM/OU=YPT/CN=CA"
```

- 查看CA内容

```
openssl x509 -in ca.crt -noout -text
```

2.**签发Dashboard证书**

- 生成私钥

```
openssl genrsa -out dashboard.key 2048
```

- 申请签名请求

```
openssl req -new -sha256 -key dashboard.key -out dashboard.csr -subj
"/C=CN/ST=HB/L=WH/O=DM/OU=YPT/CN=192.168.3.11"
```

- 配置文件

```
cat >> /root/kubernetes/certs/dashboard.cnf << EOF
extensions = san
[san]
keyUsage = digitalSignature
extendedKeyUsage = clientAuth,serverAuth
subjectKeyIdentifier = hash
authorityKeyIdentifier = keyid,issuer
subjectAltName = IP:192.168.3.11,IP:127.0.0.1,DNS:192.168.3.11,DNS:localhost
EOF
```

- 签发证书

```
openssl x509 -req -sha256 -days 3650 -in dashboard.csr -out dashboard.crt -CA ca.crt -
CAkey ca.key -CAcreateserial -extfile dashboard.cnf
```

- 查看证书

```
openssl x509 -in dashboard.crt -noout -text
```

3.**重新部署dashboard**

- 删除已经部署的dashboard

```
kubectl delete -f kubernetes-dashboard.yaml
```

- 创建 secret "kubernetes-dashboard-certs"

```
kubectl create secret generic kubernetes-dashboard-certs --from-
file=/root/kubernetes/certs -n kube-system
```

- 查看secret内容

```
kubectl get secret kubernetes-dashboard-certs -n kube-system -o yaml
```

- 重新部署dashboard

```
kubectl apply -f kubernetes-dashboard.yaml
```

4.**浏览器导入证书**

- 将生成的自签名证书**ca.crt**文件，导入浏览器。
- 访问页面： https://192.168.3.11:30001