Kubernetes1.6集群部署完全指南 ——基于CentOS7二进制方式部署并开启TLS安全认证

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前言

本系列文档介绍使用二进制部署 kubernetes 集群的所有步骤，而不是使用 kubeadm 等自动化方式来部署集群，同时开启了集群的TLS安全认证；

在部署的过程中，将详细列出各组件的启动参数，给出配置文件，详解它们的含义和可能遇到的问题。

部署完成后，你将理解系统各组件的交互原理，进而能快速解决实际问题。

所以本文档主要适合于那些有一定 kubernetes 基础，想通过一步步部署的方式来学习和了解系统配置、运行原理的人。

注：本文档中不包括docker和私有镜像仓库的安装。

集群详情

- CentOS 7.2.1511
- Docker 1.12.5
- Kubernetes 1.6.0
- Docker 1.12.5（使用yum安装）
- Etcd 3.1.5
- Flanneld 0.7 vxlan 网络
- TLS 认证通信 (所有组件，如 etcd、kubernetes master 和 node)
- RBAC 授权
- kublet TLS BootStrapping
- kubedns、dashboard、heapster(influxdb、grafana)、EFK(elasticsearch、fluentd、kibana) 集群插件
- 私有docker镜像仓库harbor（请自行部署，harbor提供离线安装包，直接使用docker-compose启动即可）

准备

主机角色分配

IP	Hostname	Roles
172.20.0.112	sz-pg-oam-docker-hub-001.tendcloud.com	Harbor（私有镜像仓库）
172.20.0.113	sz-pg-oam-docker-test-001.tendcloud.com	master node kube-apiserver kube-controller-manager kube-scheduler kubelet kube-proxy etcd flannel
172.20.0.114	sz-pg-oam-docker-test-002.tendcloud.com	node kubectl kube-proxy flannel etcd
172.20.0.115	sz-pg-oam-docker-test-003.tendcloud.com	node kubectl kube-proxy flannel etcd

注：

- 172.20.0.112作为harbor私有镜像仓库，本文档不包括harbor的安装，请参考http://github.com/vmware/harbor上的文档自行安装。
- 172.20.0.113既作为master也作为node。

镜像准备

Google官方提供的kubernetes组件镜像在墙外，国内下载有困难，我将所有的镜像克隆的了一份放到了时速云上，以下公有镜像可以直接使用：

index.tenxcloud.com/jimmy/elasticsearch:v2.4.1-2

index.tenxcloud.com/jimmy/fluentd-elasticsearch:1.22

index.tenxcloud.com/jimmy/kibana:v4.6.1-1

index.tenxcloud.com/jimmy/kubernetes-dashboard-amd64:v1.6.0

index.tenxcloud.com/jimmy/heapster-grafana-amd64:v4.0.2

index.tenxcloud.com/jimmy/heapster-amd64:v1.3.0-beta.1

index.tenxcloud.com/jimmy/heapster-influxdb-amd64:v1.1.1

index.tenxcloud.com/jimmy/k8s-dns-kube-dns-amd64:1.14.1

index.tenxcloud.com/jimmy/k8s-dns-dnsmasq-nanny-amd64:1.14.1

index.tenxcloud.com/jimmy/k8s-dns-sidecar-amd64:1.14.1

注：

文档中使用的是我们的私有镜像仓库中的镜像，地址与上述不同。

1.创建 kubernetes 各组件 TLS 加密通信的证书和秘钥

`kubernetes` 系统的各组件需要使用 `TLS` 证书对通信进行加密，本文档使用 `CloudFlare` 的 PKI 工具集 cfssl 来生成 Certificate Authority (CA) 和其它证书；

生成的 CA 证书和秘钥文件如下：

- ca-key.pem
- ca.pem
- kubernetes-key.pem
- kubernetes.pem
- kube-proxy.pem
- kube-proxy-key.pem
- admin.pem
- admin-key.pem

使用证书的组件如下：

- etcd：使用 ca.pem、kubernetes-key.pem、kubernetes.pem；
- kube-apiserver：使用 ca.pem、kubernetes-key.pem、kubernetes.pem；
- kubelet：使用 ca.pem；
- kube-proxy：使用 ca.pem、kube-proxy-key.pem、kube-proxy.pem；
- kubectl：使用 ca.pem、admin-key.pem、admin.pem；

`kube-controller`、`kube-scheduler` 当前需要和 `kube-apiserver` 部署在同一台机器上且使用非安全端口通信，故不需要证书。

安装 `CFSSL`

方式一：直接使用二进制源码包安装

```
$ wget https://pkg.cfssl.org/R1.2/cfssl_linux-amd64
$ chmod +x cfssl_linux-amd64
$ sudo mv cfssl_linux-amd64 /root/local/bin/cfssl

$ wget https://pkg.cfssl.org/R1.2/cfssljson_linux-amd64
$ chmod +x cfssljson_linux-amd64
$ sudo mv cfssljson_linux-amd64 /root/local/bin/cfssljson

$ wget https://pkg.cfssl.org/R1.2/cfssl-certinfo_linux-amd64
$ chmod +x cfssl-certinfo_linux-amd64
$ sudo mv cfssl-certinfo_linux-amd64 /root/local/bin/cfssl-certinfo

$ export PATH=/root/local/bin:$PATH
```

方式二：使用go命令安装

我们的系统中安装了Go1.7.5，使用以下命令安装更快捷：

```
$go get -u github.com/cloudflare/cfssl/cmd/...
$echo $GOPATH
/usr/local
$ls /usr/local/bin/cfssl*
cfssl cfssl-bundle cfssl-certinfo cfssljson cfssl-newkey cfssl-scan
```

在 `$GOPATH/bin` 目录下得到以cfssl开头的几个命令。

创建 CA (Certificate Authority)

创建 CA 配置文件

```
$ mkdir /root/ssl
$ cd /root/ssl
$ cfssl print-defaults config > config.json
$ cfssl print-defaults csr > csr.json
$ cat ca-config.json
{
  "signing": {
    "default": {
      "expiry": "8760h"
    },
    "profiles": {
      "kubernetes": {
        "usages": [
            "signing",
            "key encipherment",
            "server auth",
            "client auth"
        ],
        "expiry": "8760h"
      }
    }
  }
}
```

字段说明

- `ca-config.json`：可以定义多个 profiles，分别指定不同的过期时间、使用场景等参数；后续在签名证书时使用某个 profile；
- `signing`：表示该证书可用于签名其它证书；生成的 ca.pem 证书中 `CA=TRUE`；
- `server auth`：表示client可以用该 CA 对server提供的证书进行验证；
- `client auth`：表示server可以用该CA对client提供的证书进行验证；

创建 CA 证书签名请求

```
$ cat ca-csr.json
{
  "CN": "kubernetes",
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CN",
      "ST": "BeiJing",
      "L": "BeiJing",
      "O": "k8s",
      "OU": "System"
    }
  ]
}
```

- "CN"： `Common Name` ，kube-apiserver 从证书中提取该字段作为请求的用户名 (User Name)；浏览器使用该字段验证网站是否合法；
- "O"： `Organization` ，kube-apiserver 从证书中提取该字段作为请求用户所属的组 (Group)；

生成 CA 证书和私钥

```
$ cfssl gencert -initca ca-csr.json | cfssljson -bare ca
$ ls ca*
ca-config.json  ca.csr  ca-csr.json  ca-key.pem  ca.pem
```

2.创建 kubernetes 证书

创建 kubernetes 证书签名请求

```
$ cat kubernetes-csr.json
{
    "CN": "kubernetes",
    "hosts": [
      "127.0.0.1",
      "172.20.0.112",
      "172.20.0.113",
      "172.20.0.114",
      "172.20.0.115",
      "10.254.0.1",
      "kubernetes",
      "kubernetes.default",
      "kubernetes.default.svc",
      "kubernetes.default.svc.cluster",
      "kubernetes.default.svc.cluster.local"
    ],
    "key": {
        "algo": "rsa",
        "size": 2048
    },
    "names": [
        {
            "C": "CN",
            "ST": "BeiJing",
            "L": "BeiJing",
            "O": "k8s",
            "OU": "System"
        }
    ]
}
```

- 如果 hosts 字段不为空则需要指定授权使用该证书的 **IP 或域名列表**，由于该证书后续被 `etcd` 集群和 `kubernetes master` 集群使用，所以上面分别指定了 `etcd` 集群、`kubernetes master` 集群的主机 IP 和 **`kubernetes` 服务的服务 IP**（一般是 `kue-apiserver` 指定的 `service-cluster-ip-range` 网段的第一个IP，如 10.254.0.1。

生成 kubernetes 证书和私钥

```
$ cfssl gencert -ca=ca.pem -ca-key=ca-key.pem -config=ca-config.json -profile=kubernetes kubernetes-csr.json | cfssljson -bare kubernetes
$ ls kubernetes*
kubernetes.csr  kubernetes-csr.json  kubernetes-key.pem  kubernetes.pem
```

或者直接在命令行上指定相关参数：

```
$ echo '{"CN":"kubernetes","hosts":[""],"key":{"algo":"rsa","size":2048}}' | cfssl
gencert -ca=ca.pem -ca-key=ca-key.pem -config=ca-config.json -profile=kubernetes -
hostname="127.0.0.1,172.20.0.112,172.20.0.113,172.20.0.114,172.20.0.115,kubernetes,
kubernetes.default" - | cfssljson -bare kubernetes
```

创建 admin 证书

创建 admin 证书签名请求

```
$ cat admin-csr.json
{
  "CN": "admin",
  "hosts": [],
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CN",
      "ST": "BeiJing",
      "L": "BeiJing",
      "O": "system:masters",
      "OU": "System"
    }
  ]
}
```

- 后续 `kube-apiserver` 使用 `RBAC` 对客户端(如 `kubelet`、`kube-proxy`、`Pod`)请求进行授权；
- `kube-apiserver` 预定义了一些 `RBAC` 使用的 `RoleBindings`，如 `cluster-admin` 将 Group `system:masters` 与 Role `cluster-admin` 绑定，该 Role 授予了调用`kube-apiserver` 的**所有 API**的权限；
- OU 指定该证书的 Group 为 `system:masters`，`kubelet` 使用该证书访问 `kube-apiserver` 时，由于证书被 CA 签名，所以认证通过，同时由于证书用户组为经过预授权的 `system:masters`，所以被授予访问所有 API 的权限；

生成 admin 证书和私钥

```
$ cfssl gencert -ca=ca.pem -ca-key=ca-key.pem -config=ca-config.json -
profile=kubernetes admin-csr.json | cfssljson -bare admin
$ ls admin*
admin.csr  admin-csr.json  admin-key.pem  admin.pem
```

创建 kube-proxy 证书

创建 kube-proxy 证书签名请求

```
$ cat kube-proxy-csr.json
{
  "CN": "system:kube-proxy",
  "hosts": [],
  "key": {
    "algo": "rsa",
    "size": 2048
  },
  "names": [
    {
      "C": "CN",
      "ST": "BeiJing",
      "L": "BeiJing",
      "O": "k8s",
      "OU": "System"
    }
  ]
}
```

- CN 指定该证书的 User 为 `system:kube-proxy`；
- `kube-apiserver` 预定义的 RoleBinding `cluster-admin` 将User `system:kube-proxy` 与 Role `system:node-proxier` 绑定，该 Role 授予了调用 `kube-apiserver` Proxy 相关 API 的权限；

生成 kube-proxy 客户端证书和私钥

```
$ cfssl gencert -ca=ca.pem -ca-key=ca-key.pem -config=ca-config.json -
profile=kubernetes  kube-proxy-csr.json | cfssljson -bare kube-proxy
$ ls kube-proxy*
kube-proxy.csr  kube-proxy-csr.json  kube-proxy-key.pem  kube-proxy.pem
```

校验证书

以 kubernetes 证书为例

使用 `opsnssl` 命令

```
$ openssl x509  -noout -text -in  kubernetes.pem
...
    Signature Algorithm: sha256WithRSAEncryption
        Issuer: C=CN, ST=BeiJing, L=BeiJing, O=k8s, OU=System, CN=Kubernetes
        Validity
            Not Before: Apr  5 05:36:00 2017 GMT
            Not After : Apr  5 05:36:00 2018 GMT
        Subject: C=CN, ST=BeiJing, L=BeiJing, O=k8s, OU=System, CN=kubernetes
...
        X509v3 extensions:
            X509v3 Key Usage: critical
                Digital Signature, Key Encipherment
            X509v3 Extended Key Usage:
                TLS Web Server Authentication, TLS Web Client Authentication
            X509v3 Basic Constraints: critical
                CA:FALSE
            X509v3 Subject Key Identifier:
                DD:52:04:43:10:13:A9:29:24:17:3A:0E:D7:14:DB:36:F8:6C:E0:E0
            X509v3 Authority Key Identifier:
                keyid:44:04:3B:60:BD:69:78:14:68:AF:A0:41:13:F6:17:07:13:63:58:CD

            X509v3 Subject Alternative Name:
                DNS:kubernetes, DNS:kubernetes.default, DNS:kubernetes.default.svc,
DNS:kubernetes.default.svc.cluster, DNS:kubernetes.default.svc.cluster.local, IP
Address:127.0.0.1, IP Address:172.20.0.112, IP Address:172.20.0.113, IP
Address:172.20.0.114, IP Address:172.20.0.115, IP Address:10.254.0.1
...
```

- 确认 `Issuer` 字段的内容和 `ca-csr.json` 一致；
- 确认 `Subject` 字段的内容和 `kubernetes-csr.json` 一致；
- 确认 `X509v3 Subject Alternative Name` 字段的内容和 `kubernetes-csr.json` 一致；
- 确认 `X509v3 Key Usage、Extended Key Usage` 字段的内容和 `ca-config.json` 中 `kubernetes` profile 一致；

使用 `cfssl-certinfo` 命令

```
$ cfssl-certinfo -cert kubernetes.pem
...
{
  "subject": {
    "common_name": "kubernetes",
    "country": "CN",
    "organization": "k8s",
    "organizational_unit": "System",
    "locality": "BeiJing",
    "province": "BeiJing",
    "names": [
      "CN",
      "BeiJing",
      "BeiJing",
      "k8s",
      "System",
      "kubernetes"
    ]
  },
  "issuer": {
    "common_name": "Kubernetes",
    "country": "CN",
    "organization": "k8s",
    "organizational_unit": "System",
    "locality": "BeiJing",
    "province": "BeiJing",
    "names": [
      "CN",
      "BeiJing",
      "BeiJing",
      "k8s",
      "System",
      "Kubernetes"
    ]
  },
  "serial_number": "174360492872423263473151971632292895707129022309",
  "sans": [
    "kubernetes",
    "kubernetes.default",
    "kubernetes.default.svc",
    "kubernetes.default.svc.cluster",
    "kubernetes.default.svc.cluster.local",
    "127.0.0.1",
    "10.64.3.7",
    "10.254.0.1"
  ],
  "not_before": "2017-04-05T05:36:00Z",
  "not_after": "2018-04-05T05:36:00Z",
  "sigalg": "SHA256WithRSA",
...
```

分发证书

将生成的证书和秘钥文件（后缀名为`.pem`）拷贝到所有机器的 `/etc/kubernetes/ssl` 目录下备用；

```
$ sudo mkdir -p /etc/kubernetes/ssl
$ sudo cp *.pem /etc/kubernetes/ssl
```

参考

- Generate self-signed certificates
- Setting up a Certificate Authority and Creating TLS Certificates
- Client Certificates V/s Server Certificates
- 数字证书及 CA 的扫盲介绍

2.创建 kubeconfig 文件

`kubelet`、`kube-proxy` 等 Node 机器上的进程与 Master 机器的 `kube-apiserver` 进程通信时需要认证和授权；

kubernetes 1.4 开始支持由 `kube-apiserver` 为客户端生成 TLS 证书的 TLS Bootstrapping 功能，这样就不需要为每个客户端生成证书了；该功能**当前仅支持为 `kubelet`** 生成证书；

创建 TLS Bootstrapping Token

Token auth file

Token可以是任意的包涵128 bit的字符串，可以使用安全的随机数发生器生成。

```
export BOOTSTRAP_TOKEN=$(head -c 16 /dev/urandom | od -An -t x | tr -d ' ')
cat > token.csv <<EOF
${BOOTSTRAP_TOKEN},kubelet-bootstrap,10001,"system:kubelet-bootstrap"
EOF
```

> 后三行是一句，直接复制上面的脚本运行即可。

将token.csv发到所有机器（Master 和 Node）的 `/etc/kubernetes/` 目录。

```
$cp token.csv /etc/kubernetes/
```

创建 kubelet bootstrapping kubeconfig 文件

```
$ cd /etc/kubernetes
$ export KUBE_APISERVER="https://172.20.0.113:6443"
$ # 设置集群参数
$ kubectl config set-cluster kubernetes \
  --certificate-authority=/etc/kubernetes/ssl/ca.pem \
  --embed-certs=true \
  --server=${KUBE_APISERVER} \
  --kubeconfig=bootstrap.kubeconfig
$ # 设置客户端认证参数
$ kubectl config set-credentials kubelet-bootstrap \
  --token=${BOOTSTRAP_TOKEN} \
  --kubeconfig=bootstrap.kubeconfig
$ # 设置上下文参数
$ kubectl config set-context default \
  --cluster=kubernetes \
  --user=kubelet-bootstrap \
  --kubeconfig=bootstrap.kubeconfig
$ # 设置默认上下文
$ kubectl config use-context default --kubeconfig=bootstrap.kubeconfig
```

- `--embed-certs` 为 `true` 时表示将 `certificate-authority` 证书写入到生成的 `bootstrap.kubeconfig` 文件中；
- 设置客户端认证参数时**没有**指定秘钥和证书，后续由 `kube-apiserver` 自动生成；

创建 kube-proxy kubeconfig 文件

```
$ export KUBE_APISERVER="https://172.20.0.113:6443"
$ # 设置集群参数
$ kubectl config set-cluster kubernetes \
  --certificate-authority=/etc/kubernetes/ssl/ca.pem \
  --embed-certs=true \
  --server=${KUBE_APISERVER} \
  --kubeconfig=kube-proxy.kubeconfig
$ # 设置客户端认证参数
$ kubectl config set-credentials kube-proxy \
  --client-certificate=/etc/kubernetes/ssl/kube-proxy.pem \
  --client-key=/etc/kubernetes/ssl/kube-proxy-key.pem \
  --embed-certs=true \
  --kubeconfig=kube-proxy.kubeconfig
$ # 设置上下文参数
$ kubectl config set-context default \
  --cluster=kubernetes \
  --user=kube-proxy \
  --kubeconfig=kube-proxy.kubeconfig
$ # 设置默认上下文
$ kubectl config use-context default --kubeconfig=kube-proxy.kubeconfig
```

- 设置集群参数和客户端认证参数时 `--embed-certs` 都为 `true`，这会将 `certificate-authority`、`client-certificate` 和 `client-key` 指向的证书文件内容写入到生成的 `kube-proxy.kubeconfig` 文件中；
- `kube-proxy.pem` 证书中 CN 为 `system:kube-proxy`，`kube-apiserver` 预定义的 RoleBinding `cluster-admin` 将User `system:kube-proxy` 与 Role `system:node-proxier` 绑定，该 Role 授予了调用 `kube-apiserver` Proxy 相关 API 的权限；

分发 kubeconfig 文件

将两个 kubeconfig 文件分发到所有 Node 机器的 `/etc/kubernetes/` 目录

```
$ cp bootstrap.kubeconfig kube-proxy.kubeconfig /etc/kubernetes/
```

3.创建高可用 etcd 集群

kuberntes 系统使用 etcd 存储所有数据，本文档介绍部署一个三节点高可用 etcd 集群的步骤，这三个节点复用 kubernetes master 机器，分别命名为`sz-pg-oam-docker-test-001.tendcloud.com`、`sz-pg-oam-docker-test-002.tendcloud.com`、`sz-pg-oam-docker-test-003.tendcloud.com`：

- sz-pg-oam-docker-test-001.tendcloud.com：172.20.0.113
- sz-pg-oam-docker-test-002.tendcloud.com：172.20.0.114
- sz-pg-oam-docker-test-003.tendcloud.com：172.20.0.115

TLS 认证文件

需要为 etcd 集群创建加密通信的 TLS 证书，这里复用以前创建的 kubernetes 证书

```
$ cp ca.pem kubernetes-key.pem kubernetes.pem /etc/kubernetes/ssl
```

- kubernetes 证书的 `hosts` 字段列表中包含上面三台机器的 IP，否则后续证书校验会失败；

下载二进制文件

到 `https://github.com/coreos/etcd/releases` 页面下载最新版本的二进制文件

```
$ https://github.com/coreos/etcd/releases/download/v3.1.5/etcd-v3.1.5-linux-
amd64.tar.gz
$ tar -xvf etcd-v3.1.4-linux-amd64.tar.gz
$ sudo mv etcd-v3.1.4-linux-amd64/etcd* /root/local/bin
```

创建 etcd 的 systemd unit 文件

注意替换 `ETCD_NAME` 和 `INTERNAL_IP` 变量的值；

```
$ export ETCD_NAME=sz-pg-oam-docker-test-001.tendcloud.com
$ export INTERNAL_IP=172.20.0.113
$ sudo mkdir -p /var/lib/etcd /var/lib/etcd
$ cat > etcd.service <<EOF
[Unit]
Description=Etcd Server
After=network.target
After=network-online.target
Wants=network-online.target
Documentation=https://github.com/coreos

[Service]
Type=notify
WorkingDirectory=/var/lib/etcd/
EnvironmentFile=-/etc/etcd/etcd.conf
ExecStart=/root/local/bin/etcd \\
  --name ${ETCD_NAME} \\
  --cert-file=/etc/kubernetes/ssl/kubernetes.pem \\
  --key-file=/etc/kubernetes/ssl/kubernetes-key.pem \\
  --peer-cert-file=/etc/kubernetes/ssl/kubernetes.pem \\
  --peer-key-file=/etc/kubernetes/ssl/kubernetes-key.pem \\
  --trusted-ca-file=/etc/kubernetes/ssl/ca.pem \\
  --peer-trusted-ca-file=/etc/kubernetes/ssl/ca.pem \\
  --initial-advertise-peer-urls https://${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 sz-pg-oam-docker-test-
001.tendcloud.com=https://172.20.0.113:2380,sz-pg-oam-docker-test-
002.tendcloud.com=https://172.20.0.114:2380,sz-pg-oam-docker-test-
003.tendcloud.com=https://172.20.0.115:2380 \\
  --initial-cluster-state new \\
  --data-dir=/var/lib/etcd
Restart=on-failure
RestartSec=5
LimitNOFILE=65536

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

- 指定 `etcd` 的工作目录为 `/var/lib/etcd`，数据目录为 `/var/lib/etcd`，需在启动服务前创建这两个目录；
- 为了保证通信安全，需要指定 etcd 的公私钥(cert-file和key-file)、Peers 通信的公私钥和 CA 证书(peer-cert-file、peer-key-file、peer-trusted-ca-file)、客户端的CA证书（trusted-ca-file）；
- 创建 `kubernetes.pem` 证书时使用的 `kubernetes-csr.json` 文件的 `hosts` 字段**包含所有 etcd 节点的 INTERNAL_IP**，否则证书校验会出错；

- `--initial-cluster-state` 值为 `new` 时，`--name` 的参数值必须位于 `--initial-cluster` 列表中；

完整 unit 文件见：etcd.service

启动 etcd 服务

```
$ sudo mv etcd.service /etc/systemd/system/
$ sudo systemctl daemon-reload
$ sudo systemctl enable etcd
$ sudo systemctl start etcd
$ systemctl status etcd
```

在所有的 kubernetes master 节点重复上面的步骤，直到所有机器的 etcd 服务都已启动。

验证服务

在任一 kubernetes master 机器上执行如下命令：

```
$ etcdctl \
  --ca-file=/etc/kubernetes/ssl/ca.pem \
  --cert-file=/etc/kubernetes/ssl/kubernetes.pem \
  --key-file=/etc/kubernetes/ssl/kubernetes-key.pem \
  cluster-health
2017-04-11 15:17:09.082250 I | warning: ignoring ServerName for user-provided CA
for backwards compatibility is deprecated
2017-04-11 15:17:09.083681 I | warning: ignoring ServerName for user-provided CA
for backwards compatibility is deprecated
member 9a2ec640d25672e5 is healthy: got healthy result from
https://172.20.0.115:2379
member bc6f27ae3be34308 is healthy: got healthy result from
https://172.20.0.114:2379
member e5c92ea26c4edba0 is healthy: got healthy result from
https://172.20.0.113:2379
cluster is healthy
```

结果最后一行为 `cluster is healthy` 时表示集群服务正常。

4.下载和配置 kubectl 命令行工具

下载 kubectl

```
$ wget https://dl.k8s.io/v1.6.0/kubernetes-client-linux-amd64.tar.gz
$ tar -xzvf kubernetes-client-linux-amd64.tar.gz
$ cp kubernetes/client/bin/kube* /usr/bin/
$ chmod a+x /usr/bin/kube*
```

创建 kubectl kubeconfig 文件

```
$ export KUBE_APISERVER="https://172.20.0.113:6443"
$ # 设置集群参数
$ kubectl config set-cluster kubernetes \
  --certificate-authority=/etc/kubernetes/ssl/ca.pem \
  --embed-certs=true \
  --server=${KUBE_APISERVER}
$ # 设置客户端认证参数
$ kubectl config set-credentials admin \
  --client-certificate=/etc/kubernetes/ssl/admin.pem \
  --embed-certs=true \
  --client-key=/etc/kubernetes/ssl/admin-key.pem
$ # 设置上下文参数
$ kubectl config set-context kubernetes \
  --cluster=kubernetes \
  --user=admin
$ # 设置默认上下文
$ kubectl config use-context kubernetes
```

- `admin.pem` 证书 OU 字段值为 `system:masters`，`kube-apiserver` 预定义的 RoleBinding `cluster-admin` 将 Group `system:masters` 与 Role `cluster-admin` 绑定，该 Role 授予了调用 `kube-apiserver` 相关 API 的权限；
- 生成的 kubeconfig 被保存到 `~/.kube/config` 文件；

5.部署高可用 kubernetes master 集群

kubernetes master 节点包含的组件：

- kube-apiserver
- kube-scheduler
- kube-controller-manager

目前这三个组件需要部署在同一台机器上。

- `kube-scheduler`、`kube-controller-manager` 和 `kube-apiserver` 三者的功能紧密相关；
- 同时只能有一个 `kube-scheduler`、`kube-controller-manager` 进程处于工作状态，如果运行多个，则需要通过选举产生一个 leader；

本文档记录部署一个三个节点的高可用 kubernetes master 集群步骤。（后续创建一个 load balancer 来代理访问 kube-apiserver 的请求）

TLS 证书文件

pem和token.csv证书文件我们在TLS证书和秘钥这一步中已经创建过了。我们再检查一下。

```
$ ls /etc/kubernetes/ssl
admin-key.pem  admin.pem  ca-key.pem  ca.pem  kube-proxy-key.pem  kube-proxy.pem
kubernetes-key.pem  kubernetes.pem
```

下载最新版本的二进制文件

有两种下载方式

方式一

从 github release 页面 下载发布版 tarball，解压后再执行下载脚本

```
$ wget
https://github.com/kubernetes/kubernetes/releases/download/v1.6.0/kubernetes.tar.gz
$ tar -xzvf kubernetes.tar.gz
...
$ cd kubernetes
$ ./cluster/get-kube-binaries.sh
...
```

方式二

从 `CHANGELOG`页面 下载 `client` 或 `server` tarball 文件

`server` 的 tarball `kubernetes-server-linux-amd64.tar.gz` 已经包含了 `client`(`kubectl`) 二进制文件，所以不用单独下载`kubernetes-client-linux-amd64.tar.gz`文件；

```
$ # wget https://dl.k8s.io/v1.6.0/kubernetes-client-linux-amd64.tar.gz
$ wget https://dl.k8s.io/v1.6.0/kubernetes-server-linux-amd64.tar.gz
$ tar -xzvf kubernetes-server-linux-amd64.tar.gz
...
$ cd kubernetes
$ tar -xzvf  kubernetes-src.tar.gz
```

将二进制文件拷贝到指定路径

```
$ cp -r server/bin/{kube-apiserver,kube-controller-manager,kube-
scheduler,kubectl,kube-proxy,kubelet} /root/local/bin/
```

配置和启动 kube-apiserver

创建 kube-apiserver的service配置文件

serivce配置文件`/usr/lib/systemd/system/kube-apiserver.service`内容：

```
[Unit]
Description=Kubernetes API Service
Documentation=https://github.com/GoogleCloudPlatform/kubernetes
After=network.target
After=etcd.service

[Service]
EnvironmentFile=-/etc/kubernetes/config
EnvironmentFile=-/etc/kubernetes/apiserver
ExecStart=/usr/bin/kube-apiserver \
        $KUBE_LOGTOSTDERR \
        $KUBE_LOG_LEVEL \
        $KUBE_ETCD_SERVERS \
        $KUBE_API_ADDRESS \
        $KUBE_API_PORT \
        $KUBELET_PORT \
        $KUBE_ALLOW_PRIV \
        $KUBE_SERVICE_ADDRESSES \
        $KUBE_ADMISSION_CONTROL \
        $KUBE_API_ARGS
Restart=on-failure
Type=notify
LimitNOFILE=65536

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

`/etc/kubernetes/config`文件的内容为：

```
###
# kubernetes system config
#
# The following values are used to configure various aspects of all
# kubernetes services, including
#
#   kube-apiserver.service
#   kube-controller-manager.service
#   kube-scheduler.service
#   kubelet.service
#   kube-proxy.service
# logging to stderr means we get it in the systemd journal
KUBE_LOGTOSTDERR="--logtostderr=true"

# journal message level, 0 is debug
KUBE_LOG_LEVEL="--v=0"

# Should this cluster be allowed to run privileged docker containers
KUBE_ALLOW_PRIV="--allow-privileged=true"

# How the controller-manager, scheduler, and proxy find the apiserver
#KUBE_MASTER="--master=http://sz-pg-oam-docker-test-001.tendcloud.com:8080"
KUBE_MASTER="--master=http://172.20.0.113:8080"
```

该配置文件同时被kube-apiserver、kube-controller-manager、kube-scheduler、kubelet、kube-proxy使用。

apiserver配置文件`/etc/kubernetes/apiserver`内容为：

```
###
## kubernetes system config
##
## The following values are used to configure the kube-apiserver
##
#
## The address on the local server to listen to.
#KUBE_API_ADDRESS="--insecure-bind-address=sz-pg-oam-docker-test-001.tendcloud.com"
KUBE_API_ADDRESS="--advertise-address=172.20.0.113 --bind-address=172.20.0.113 --insecure-bind-address=172.20.0.113"
#
## The port on the local server to listen on.
#KUBE_API_PORT="--port=8080"
#
## Port minions listen on
#KUBELET_PORT="--kubelet-port=10250"
#
## Comma separated list of nodes in the etcd cluster
KUBE_ETCD_SERVERS="--etcd-servers=https://172.20.0.113:2379,172.20.0.114:2379,172.20.0.115:2379"
#
## Address range to use for services
KUBE_SERVICE_ADDRESSES="--service-cluster-ip-range=10.254.0.0/16"
#
## default admission control policies
KUBE_ADMISSION_CONTROL="--admission-control=ServiceAccount,NamespaceLifecycle,NamespaceExists,LimitRanger,ResourceQuota"
#
## Add your own!
KUBE_API_ARGS="--authorization-mode=RBAC --runtime-config=rbac.authorization.k8s.io/v1beta1 --kubelet-https=true --experimental-bootstrap-token-auth --token-auth-file=/etc/kubernetes/token.csv --service-node-port-range=30000-32767 --tls-cert-file=/etc/kubernetes/ssl/kubernetes.pem --tls-private-key-file=/etc/kubernetes/ssl/kubernetes-key.pem --client-ca-file=/etc/kubernetes/ssl/ca.pem --service-account-key-file=/etc/kubernetes/ssl/ca-key.pem --etcd-cafile=/etc/kubernetes/ssl/ca.pem --etcd-certfile=/etc/kubernetes/ssl/kubernetes.pem --etcd-keyfile=/etc/kubernetes/ssl/kubernetes-key.pem --enable-swagger-ui=true --apiserver-count=3 --audit-log-maxage=30 --audit-log-maxbackup=3 --audit-log-maxsize=100 --audit-log-path=/var/lib/audit.log --event-ttl=1h"
```

- `--authorization-mode=RBAC` 指定在安全端口使用 RBAC 授权模式，拒绝未通过授权的请求；
- kube-scheduler、kube-controller-manager 一般和 kube-apiserver 部署在同一台机器上，它们使用**非安全端口**和 kube-apiserver通信;
- kubelet、kube-proxy、kubectl 部署在其它 Node 节点上，如果通过**安全端口**访问 kube-apiserver，则必须先通过 TLS 证书认证，再通过 RBAC 授权；
- kube-proxy、kubectl 通过在使用的证书里指定相关的 User、Group 来达到通过 RBAC 授权的

目的；

- 如果使用了 kubelet TLS Boostrap 机制，则不能再指定 `--kubelet-certificate-authority`、`--kubelet-client-certificate` 和 `--kubelet-client-key` 选项，否则后续 kube-apiserver 校验 kubelet 证书时出现 ”x509: certificate signed by unknown authority“ 错误；
- `--admission-control` 值必须包含 `ServiceAccount`；
- `--bind-address` 不能为 `127.0.0.1`；
- `runtime-config`配置为`rbac.authorization.k8s.io/v1beta1`，表示运行时的apiVersion；
- `--service-cluster-ip-range` 指定 Service Cluster IP 地址段，该地址段不能路由可达；
- 缺省情况下 kubernetes 对象保存在 etcd `/registry` 路径下，可以通过 `--etcd-prefix` 参数进行调整；

完整 unit 见 kube-apiserver.service

启动kube-apiserver

```
$ systemctl daemon-reload
$ systemctl enable kube-apiserver
$ systemctl start kube-apiserver
$ systemctl status kube-apiserver
```

配置和启动 kube-controller-manager

创建 kube-controller-manager的serivce配置文件

文件路径`/usr/lib/systemd/system/kube-controller-manager.service`

```
Description=Kubernetes Controller Manager
Documentation=https://github.com/GoogleCloudPlatform/kubernetes

[Service]
EnvironmentFile=-/etc/kubernetes/config
EnvironmentFile=-/etc/kubernetes/controller-manager
ExecStart=/usr/bin/kube-controller-manager \
        $KUBE_LOGTOSTDERR \
        $KUBE_LOG_LEVEL \
        $KUBE_MASTER \
        $KUBE_CONTROLLER_MANAGER_ARGS
Restart=on-failure
LimitNOFILE=65536

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

配置文件`/etc/kubernetes/controller-manager`。

```
###
# The following values are used to configure the kubernetes controller-manager

# defaults from config and apiserver should be adequate

# Add your own!
KUBE_CONTROLLER_MANAGER_ARGS="--address=127.0.0.1 --service-cluster-ip-range=10.254.0.0/16 --cluster-name=kubernetes --cluster-signing-cert-file=/etc/kubernetes/ssl/ca.pem --cluster-signing-key-file=/etc/kubernetes/ssl/ca-key.pem  --service-account-private-key-file=/etc/kubernetes/ssl/ca-key.pem --root-ca-file=/etc/kubernetes/ssl/ca.pem --leader-elect=true"
```

- `--service-cluster-ip-range` 参数指定 Cluster 中 Service 的CIDR范围，该网络在各 Node 间必须路由不可达，必须和 kube-apiserver 中的参数一致；
- `--cluster-signing-*` 指定的证书和私钥文件用来签名为 TLS BootStrap 创建的证书和私钥；
- `--root-ca-file` 用来对 kube-apiserver 证书进行校验，**指定该参数后，才会在Pod 容器的 ServiceAccount 中放置该 CA 证书文件**；
- `--address` 值必须为 `127.0.0.1`，因为当前 kube-apiserver 期望 scheduler 和 controller-manager 在同一台机器，否则：

  ```
  $ kubectl get componentstatuses
  NAME                 STATUS      MESSAGE
                                                   ERROR
  scheduler            Unhealthy   Get http://127.0.0.1:10251/healthz: dial tcp
  127.0.0.1:10251: getsockopt: connection refused
  controller-manager   Healthy     ok

  etcd-2               Unhealthy   Get http://172.20.0.113:2379/health:
  malformed HTTP response "\x15\x03\x01\x00\x02\x02"
  etcd-0               Healthy     {"health": "true"}

  etcd-1               Healthy     {"health": "true"}
  ```

  参考：https://github.com/kubernetes-incubator/bootkube/issues/64

完整 unit 见 kube-controller-manager.service

启动 kube-controller-manager

```
$ systemctl daemon-reload
$ systemctl enable kube-controller-manager
$ systemctl start kube-controller-manager
```

配置和启动 kube-scheduler

创建 kube-scheduler的serivce配置文件

文件路径 `/usr/lib/systemd/system/kube-scheduler.serivce`。

```
[Unit]
Description=Kubernetes Scheduler Plugin
Documentation=https://github.com/GoogleCloudPlatform/kubernetes

[Service]
EnvironmentFile=-/etc/kubernetes/config
EnvironmentFile=-/etc/kubernetes/scheduler
ExecStart=/usr/bin/kube-scheduler \
            $KUBE_LOGTOSTDERR \
            $KUBE_LOG_LEVEL \
            $KUBE_MASTER \
            $KUBE_SCHEDULER_ARGS
Restart=on-failure
LimitNOFILE=65536

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

配置文件 `/etc/kubernetes/scheduler`。

```
###
# kubernetes scheduler config

# default config should be adequate

# Add your own!
KUBE_SCHEDULER_ARGS="--leader-elect=true --address=127.0.0.1"
```

- `--address` 值必须为 `127.0.0.1`，因为当前 kube-apiserver 期望 scheduler 和 controller-manager 在同一台机器；

完整 unit 见 kube-scheduler.service

启动 kube-scheduler

```
$ systemctl daemon-reload
$ systemctl enable kube-scheduler
$ systemctl start kube-scheduler
```

验证 master 节点功能

```
$ kubectl get componentstatuses
NAME                 STATUS    MESSAGE              ERROR
scheduler            Healthy   ok
controller-manager   Healthy   ok
etcd-0               Healthy   {"health": "true"}
etcd-1               Healthy   {"health": "true"}
etcd-2               Healthy   {"health": "true"}
```

6.部署kubernetes node节点

kubernetes node 节点包含如下组件：

- Flanneld：参考我之前写的文章Kubernetes基于Flannel的网络配置，之前没有配置TLS，现在需要在serivce配置文件中增加TLS配置。
- Docker1.12.5：docker的安装很简单，这里也不说了。
- kubelet
- kube-proxy

下面着重讲`kubelet`和`kube-proxy`的安装，同时还要将之前安装的flannel集成TLS验证。

目录和文件

我们再检查一下三个节点上，经过前几步操作生成的配置文件。

```
$ ls /etc/kubernetes/ssl
admin-key.pem  admin.pem  ca-key.pem  ca.pem  kube-proxy-key.pem  kube-proxy.pem
kubernetes-key.pem  kubernetes.pem
$ ls /etc/kubernetes/
apiserver  bootstrap.kubeconfig  config  controller-manager  kubelet  kube-
proxy.kubeconfig  proxy  scheduler  ssl  token.csv
```

配置Flanneld

参考我之前写的文章Kubernetes基于Flannel的网络配置，之前没有配置TLS，现在需要在serivce配置文件中增加TLS配置。

service配置文件`/usr/lib/systemd/system/flanneld.service`。

```
[Unit]
Description=Flanneld overlay address etcd agent
After=network.target
After=network-online.target
Wants=network-online.target
After=etcd.service
Before=docker.service

[Service]
Type=notify
EnvironmentFile=/etc/sysconfig/flanneld
EnvironmentFile=-/etc/sysconfig/docker-network
ExecStart=/usr/bin/flanneld-start $FLANNEL_OPTIONS
ExecStartPost=/usr/libexec/flannel/mk-docker-opts.sh -k DOCKER_NETWORK_OPTIONS -d /run/flannel/docker
Restart=on-failure

[Install]
WantedBy=multi-user.target
RequiredBy=docker.service
```

`/etc/sysconfig/flanneld`配置文件。

```
# Flanneld configuration options

# etcd url location.  Point this to the server where etcd runs
FLANNEL_ETCD_ENDPOINTS="https://172.20.0.113:2379,https://172.20.0.114:2379,https://172.20.0.115:2379"

# etcd config key.  This is the configuration key that flannel queries
# For address range assignment
FLANNEL_ETCD_PREFIX="/kube-centos/network"

# Any additional options that you want to pass
FLANNEL_OPTIONS="-etcd-cafile=/etc/kubernetes/ssl/ca.pem -etcd-certfile=/etc/kubernetes/ssl/kubernetes.pem -etcd-keyfile=/etc/kubernetes/ssl/kubernetes-key.pem"
```

在FLANNEL_OPTIONS中增加TLS的配置。

安装和配置 kubelet

kubelet 启动时向 kube-apiserver 发送 TLS bootstrapping 请求，需要先将 bootstrap token 文件中的 kubelet-bootstrap 用户赋予 system:node-bootstrapper cluster 角色(role)，
然后 kubelet 才能有权限创建认证请求(certificate signing requests)：

```
$ cd /etc/kubernetes
$ kubectl create clusterrolebinding kubelet-bootstrap \
  --clusterrole=system:node-bootstrapper \
  --user=kubelet-bootstrap
```

- `--user=kubelet-bootstrap` 是在 `/etc/kubernetes/token.csv` 文件中指定的用户名，同时也写入了 `/etc/kubernetes/bootstrap.kubeconfig` 文件；

下载最新的 kubelet 和 kube-proxy 二进制文件

```
$ wget https://dl.k8s.io/v1.6.0/kubernetes-server-linux-amd64.tar.gz
$ tar -xzvf kubernetes-server-linux-amd64.tar.gz
$ cd kubernetes
$ tar -xzvf  kubernetes-src.tar.gz
$ cp -r ./server/bin/{kube-proxy,kubelet} /usr/bin/
```

创建 kubelet 的service配置文件

文件位置`/usr/lib/systemd/system/kubelet.serivce`。

```
[Unit]
Description=Kubernetes Kubelet Server
Documentation=https://github.com/GoogleCloudPlatform/kubernetes
After=docker.service
Requires=docker.service

[Service]
WorkingDirectory=/var/lib/kubelet
EnvironmentFile=-/etc/kubernetes/config
EnvironmentFile=-/etc/kubernetes/kubelet
ExecStart=/usr/bin/kubelet \
            $KUBE_LOGTOSTDERR \
            $KUBE_LOG_LEVEL \
            $KUBELET_API_SERVER \
            $KUBELET_ADDRESS \
            $KUBELET_PORT \
            $KUBELET_HOSTNAME \
            $KUBE_ALLOW_PRIV \
            $KUBELET_POD_INFRA_CONTAINER \
            $KUBELET_ARGS
Restart=on-failure

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

kubelet的配置文件`/etc/kubernetes/kubelet`。其中的IP地址更改为你的每台node节点的IP地址。

```
###
## kubernetes kubelet (minion) config
#
## The address for the info server to serve on (set to 0.0.0.0 or "" for all interfaces)
KUBELET_ADDRESS="--address=172.20.0.113"
#
## The port for the info server to serve on
#KUBELET_PORT="--port=10250"
#
## You may leave this blank to use the actual hostname
KUBELET_HOSTNAME="--hostname-override=172.20.0.113"
#
## location of the api-server
KUBELET_API_SERVER="--api-servers=http://172.20.0.113:8080"
#
## pod infrastructure container
KUBELET_POD_INFRA_CONTAINER="--pod-infra-container-image=sz-pg-oam-docker-hub-001.tendcloud.com/library/pod-infrastructure:rhel7"
#
## Add your own!
KUBELET_ARGS="--cgroup-driver=systemd --cluster-dns=10.254.0.2 --experimental-bootstrap-kubeconfig=/etc/kubernetes/bootstrap.kubeconfig --kubeconfig=/etc/kubernetes/kubelet.kubeconfig --require-kubeconfig --cert-dir=/etc/kubernetes/ssl --cluster-domain=cluster.local. --hairpin-mode promiscuous-bridge --serialize-image-pulls=false"
```

- `--address` 不能设置为 `127.0.0.1`，否则后续 Pods 访问 kubelet 的 API 接口时会失败，因为 Pods 访问的 `127.0.0.1` 指向自己而不是 kubelet；
- 如果设置了 `--hostname-override` 选项，则 `kube-proxy` 也需要设置该选项，否则会出现找不到 Node 的情况；
- `--experimental-bootstrap-kubeconfig` 指向 bootstrap kubeconfig 文件，kubelet 使用该文件中的用户名和 token 向 kube-apiserver 发送 TLS Bootstrapping 请求；
- 管理员通过了 CSR 请求后，kubelet 自动在 `--cert-dir` 目录创建证书和私钥文件(`kubelet-client.crt` 和 `kubelet-client.key`)，然后写入 `--kubeconfig` 文件；
- 建议在 `--kubeconfig` 配置文件中指定 `kube-apiserver` 地址，如果未指定 `--api-servers` 选项，则必须指定 `--require-kubeconfig` 选项后才从配置文件中读取 kube-apiserver 的地址，否则 kubelet 启动后将找不到 kube-apiserver (日志中提示未找到 API Server），`kubectl get nodes` 不会返回对应的 Node 信息;
- `--cluster-dns` 指定 kubedns 的 Service IP(可以先分配，后续创建 kubedns 服务时指定该 IP)，`--cluster-domain` 指定域名后缀，这两个参数同时指定后才会生效；

完整 unit 见 kubelet.service

启动kublet

```
$ systemctl daemon-reload
$ systemctl enable kubelet
$ systemctl start kubelet
$ systemctl status kubelet
```

通过 kublet 的 TLS 证书请求

kubelet 首次启动时向 kube-apiserver 发送证书签名请求，必须通过后 kubernetes 系统才会将该 Node 加入到集群。

查看未授权的 CSR 请求

```
$ kubectl get csr
NAME        AGE       REQUESTOR           CONDITION
csr-2b308   4m        kubelet-bootstrap   Pending
$ kubectl get nodes
No resources found.
```

通过 CSR 请求

```
$ kubectl certificate approve csr-2b308
certificatesigningrequest "csr-2b308" approved
$ kubectl get nodes
NAME        STATUS    AGE       VERSION
10.64.3.7   Ready     49m       v1.6.1
```

自动生成了 kubelet kubeconfig 文件和公私钥

```
$ ls -l /etc/kubernetes/kubelet.kubeconfig
-rw------- 1 root root 2284 Apr  7 02:07 /etc/kubernetes/kubelet.kubeconfig
$ ls -l /etc/kubernetes/ssl/kubelet*
-rw-r--r-- 1 root root 1046 Apr  7 02:07 /etc/kubernetes/ssl/kubelet-client.crt
-rw------- 1 root root  227 Apr  7 02:04 /etc/kubernetes/ssl/kubelet-client.key
-rw-r--r-- 1 root root 1103 Apr  7 02:07 /etc/kubernetes/ssl/kubelet.crt
-rw------- 1 root root 1675 Apr  7 02:07 /etc/kubernetes/ssl/kubelet.key
```

配置 kube-proxy

创建 kube-proxy 的service配置文件

文件路径 `/usr/lib/systemd/system/kube-proxy.service`。

```
[Unit]
Description=Kubernetes Kube-Proxy Server
Documentation=https://github.com/GoogleCloudPlatform/kubernetes
After=network.target

[Service]
EnvironmentFile=-/etc/kubernetes/config
EnvironmentFile=-/etc/kubernetes/proxy
ExecStart=/usr/bin/kube-proxy \
        $KUBE_LOGTOSTDERR \
        $KUBE_LOG_LEVEL \
        $KUBE_MASTER \
        $KUBE_PROXY_ARGS
Restart=on-failure
LimitNOFILE=65536

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

kube-proxy配置文件`/etc/kubernetes/proxy`。

```
###
# kubernetes proxy config

# default config should be adequate

# Add your own!
KUBE_PROXY_ARGS="--bind-address=172.20.0.113 --hostname-override=172.20.0.113 --kubeconfig=/etc/kubernetes/kube-proxy.kubeconfig --cluster-cidr=10.254.0.0/16"
```

- `--hostname-override` 参数值必须与 kubelet 的值一致，否则 kube-proxy 启动后会找不到该 Node，从而不会创建任何 iptables 规则；
- kube-proxy 根据 `--cluster-cidr` 判断集群内部和外部流量，指定 `--cluster-cidr` 或 `--masquerade-all` 选项后 kube-proxy 才会对访问 Service IP 的请求做 SNAT；
- `--kubeconfig` 指定的配置文件嵌入了 kube-apiserver 的地址、用户名、证书、秘钥等请求和认证信息；
- 预定义的 RoleBinding `cluster-admin` 将User `system:kube-proxy` 与 Role `system:node-proxier` 绑定，该 Role 授予了调用 `kube-apiserver` Proxy 相关 API 的权限；

完整 unit 见 kube-proxy.service

启动 kube-proxy

```
$ systemctl daemon-reload
$ systemctl enable kube-proxy
$ systemctl start kube-proxy
$ systemctl status kube-proxy
```

验证测试

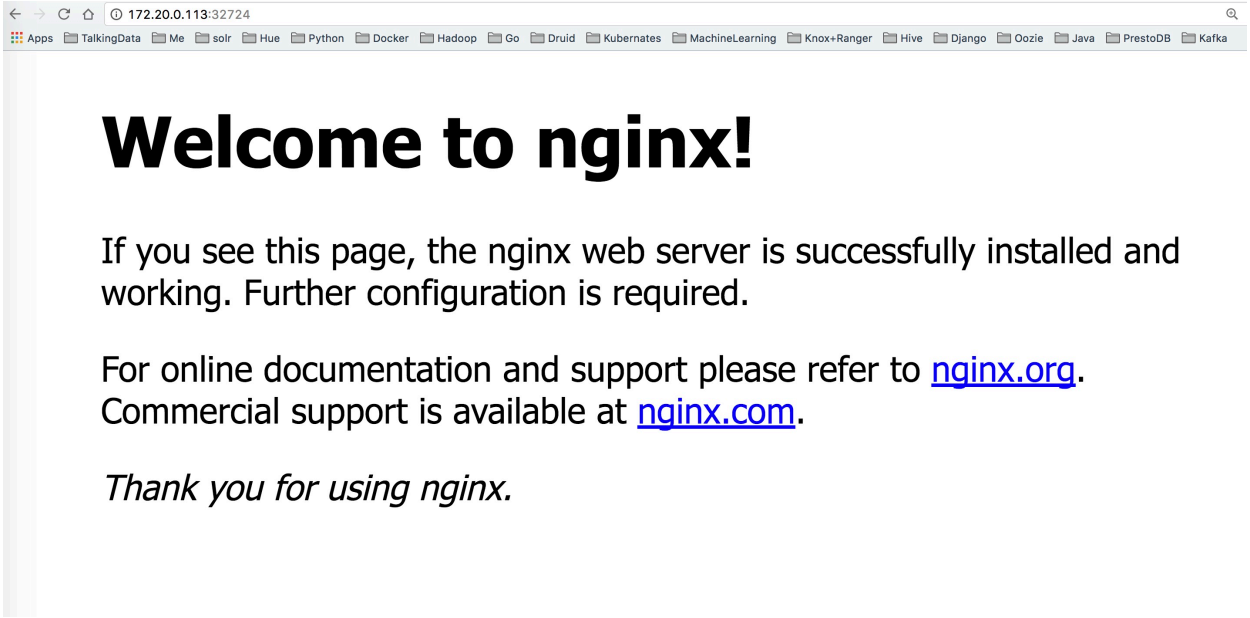
我们创建一个niginx的service试一下集群是否可用。

```
$ kubectl run nginx --replicas=2 --labels="run=load-balancer-example" --image=sz-pg-oam-docker-hub-001.tendcloud.com/library/nginx:1.9  --port=80
deployment "nginx" created
$ kubectl expose deployment nginx --type=NodePort --name=example-service
service "example-service" exposed
$ kubectl describe svc example-service
Name:            example-service
Namespace:      default
Labels:          run=load-balancer-example
Annotations:         <none>
Selector:        run=load-balancer-example
Type:            NodePort
IP:          10.254.62.207
Port:            <unset> 80/TCP
NodePort:        <unset> 32724/TCP
Endpoints:      172.30.60.2:80,172.30.94.2:80
Session Affinity:   None
Events:          <none>
$ curl "10.254.62.207:80"
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
    body {
        width: 35em;
        margin: 0 auto;
        font-family: Tahoma, Verdana, Arial, sans-serif;
    }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and working. Further configuration is required.</p>

<p>For online documentation and support please refer to
<a href="http://nginx.org/">nginx.org</a>.<br/>
Commercial support is available at
<a href="http://nginx.com/">nginx.com</a>.</p>

<p><em>Thank you for using nginx.</em></p>
</body>
</html>
```

访问`172.20.0.113:32724`或`172.20.0.114:32724`或者`172.20.0.115:32724`都可以得到nginx的页面。



Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.

7.安装和配置 kubedns 插件

官方的yaml文件目录：`kubernetes/cluster/addons/dns`。

该插件直接使用kubernetes部署，官方的配置文件中包含以下镜像：

```
gcr.io/google_containers/k8s-dns-dnsmasq-nanny-amd64:1.14.1
gcr.io/google_containers/k8s-dns-kube-dns-amd64:1.14.1
gcr.io/google_containers/k8s-dns-sidecar-amd64:1.14.1
```

我clone了上述镜像，上传到我的私有镜像仓库：

```
sz-pg-oam-docker-hub-001.tendcloud.com/library/k8s-dns-dnsmasq-nanny-amd64:1.14.1
sz-pg-oam-docker-hub-001.tendcloud.com/library/k8s-dns-kube-dns-amd64:1.14.1
sz-pg-oam-docker-hub-001.tendcloud.com/library/k8s-dns-sidecar-amd64:1.14.1
```

同时上传了一份到时速云备份：

```
index.tenxcloud.com/jimmy/k8s-dns-dnsmasq-nanny-amd64:1.14.1
index.tenxcloud.com/jimmy/k8s-dns-kube-dns-amd64:1.14.1
index.tenxcloud.com/jimmy/k8s-dns-sidecar-amd64:1.14.1
```

以下yaml配置文件中使用的是私有镜像仓库中的镜像。

```
 kubedns-cm.yaml
 kubedns-sa.yaml
 kubedns-controller.yaml
 kubedns-svc.yaml
```

已经修改好的 yaml 文件见：dns

系统预定义的 RoleBinding

预定义的 RoleBinding `system:kube-dns` 将 kube-system 命名空间的 `kube-dns` ServiceAccount 与 `system:kube-dns` Role 绑定， 该 Role 具有访问 kube-apiserver DNS 相关 API 的权限；

```
$ kubectl get clusterrolebindings system:kube-dns -o yaml
apiVersion: rbac.authorization.k8s.io/v1beta1
kind: ClusterRoleBinding
metadata:
  annotations:
    rbac.authorization.kubernetes.io/autoupdate: "true"
  creationTimestamp: 2017-04-11T11:20:42Z
  labels:
    kubernetes.io/bootstrapping: rbac-defaults
  name: system:kube-dns
  resourceVersion: "58"
  selfLink:
/apis/rbac.authorization.k8s.io/v1beta1/clusterrolebindingssystem%3Akube-dns
  uid: e61f4d92-1ea8-11e7-8cd7-f4e9d49f8ed0
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: system:kube-dns
subjects:
- kind: ServiceAccount
  name: kube-dns
  namespace: kube-system
```

`kubedns-controller.yaml` 中定义的 Pods 时使用了 `kubedns-sa.yaml` 文件定义的 `kube-dns` ServiceAccount，所以具有访问 kube-apiserver DNS 相关 API 的权限。

配置 kube-dns ServiceAccount

无需修改。

配置 `kube-dns` 服务

```
$ diff kubedns-svc.yaml.base kubedns-svc.yaml
30c30
<   clusterIP: __PILLAR__DNS__SERVER__
---
>   clusterIP: 10.254.0.2
```

- spec.clusterIP = 10.254.0.2，即明确指定了 kube-dns Service IP，这个 IP 需要和 kubelet 的 `--cluster-dns` 参数值一致；

配置 `kube-dns` Deployment

```
$ diff kubedns-controller.yaml.base kubedns-controller.yaml
58c58
<         image: gcr.io/google_containers/k8s-dns-kube-dns-amd64:1.14.1
---
>         image: sz-pg-oam-docker-hub-001.tendcloud.com/library/k8s-dns-kube-dns-amd64:v1.14.1
88c88
<         - --domain=__PILLAR__DNS__DOMAIN__.
---
>         - --domain=cluster.local.
92c92
<         __PILLAR__FEDERATIONS__DOMAIN__MAP__
---
>         #__PILLAR__FEDERATIONS__DOMAIN__MAP__
110c110
<         image: gcr.io/google_containers/k8s-dns-dnsmasq-nanny-amd64:1.14.1
---
>         image: sz-pg-oam-docker-hub-001.tendcloud.com/library/k8s-dns-dnsmasq-nanny-amd64:v1.14.1
129c129
<         - --server=/__PILLAR__DNS__DOMAIN__/127.0.0.1#10053
---
>         - --server=/cluster.local./127.0.0.1#10053
148c148
<         image: gcr.io/google_containers/k8s-dns-sidecar-amd64:1.14.1
---
>         image: sz-pg-oam-docker-hub-001.tendcloud.com/library/k8s-dns-sidecar-amd64:v1.14.1
161,162c161,162
<         - --probe=kubedns,127.0.0.1:10053,kubernetes.default.svc.__PILLAR__DNS__DOMAIN__,5,A
<         - --probe=dnsmasq,127.0.0.1:53,kubernetes.default.svc.__PILLAR__DNS__DOMAIN__,5,A
---
>         - --probe=kubedns,127.0.0.1:10053,kubernetes.default.svc.cluster.local.,5,A
>         - --probe=dnsmasq,127.0.0.1:53,kubernetes.default.svc.cluster.local.,5,A
```

- 使用系统已经做了 RoleBinding 的 `kube-dns` ServiceAccount，该账户具有访问 kube-apiserver DNS 相关 API 的权限；

执行所有定义文件

```
$ pwd
/root/kubedns
$ ls *.yaml
kubedns-cm.yaml  kubedns-controller.yaml  kubedns-sa.yaml  kubedns-svc.yaml
$ kubectl create -f .
```

检查 kubedns 功能

新建一个 Deployment

```
$ cat  my-nginx.yaml
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: my-nginx
spec:
  replicas: 2
  template:
    metadata:
      labels:
        run: my-nginx
    spec:
      containers:
      - name: my-nginx
        image: sz-pg-oam-docker-hub-001.tendcloud.com/library/nginx:1.9
        ports:
        - containerPort: 80
$ kubectl create -f my-nginx.yaml
```

Export 该 Deployment, 生成 `my-nginx` 服务

```
$ kubectl expose deploy my-nginx
$ kubectl get services --all-namespaces |grep my-nginx
default       my-nginx     10.254.179.239   <none>        80/TCP          42m
```

创建另一个 Pod，查看 `/etc/resolv.conf` 是否包含 `kubelet` 配置的 `--cluster-dns` 和 `--cluster-domain`，是否能够将服务 `my-nginx` 解析到 Cluster IP `10.254.179.239`。

```
$ kubectl create -f nginx-pod.yaml
$ kubectl exec  nginx -i -t -- /bin/bash
root@nginx:/# cat /etc/resolv.conf
nameserver 10.254.0.2
search default.svc.cluster.local. svc.cluster.local. cluster.local. tendcloud.com
options ndots:5

root@nginx:/# ping my-nginx
PING my-nginx.default.svc.cluster.local (10.254.179.239): 56 data bytes
76 bytes from 119.147.223.109: Destination Net Unreachable
^C--- my-nginx.default.svc.cluster.local ping statistics ---

root@nginx:/# ping kubernetes
PING kubernetes.default.svc.cluster.local (10.254.0.1): 56 data bytes
^C--- kubernetes.default.svc.cluster.local ping statistics ---
11 packets transmitted, 0 packets received, 100% packet loss

root@nginx:/# ping kube-dns.kube-system.svc.cluster.local
PING kube-dns.kube-system.svc.cluster.local (10.254.0.2): 56 data bytes
^C--- kube-dns.kube-system.svc.cluster.local ping statistics ---
6 packets transmitted, 0 packets received, 100% packet loss
```

从结果来看，service名称可以正常解析。

8.配置和安装 dashboard

官方文件目录：`kubernetes/cluster/addons/dashboard`

我们使用的文件

```
$ ls *.yaml
dashboard-controller.yaml  dashboard-service.yaml dashboard-rbac.yaml
```

已经修改好的 yaml 文件见：dashboard

由于 `kube-apiserver` 启用了 `RBAC` 授权，而官方源码目录的 `dashboard-controller.yaml` 没有定义授权的 ServiceAccount，所以后续访问 `kube-apiserver` 的 API 时会被拒绝，web中提示：

```
Forbidden (403)

User "system:serviceaccount:kube-system:default" cannot list jobs.batch in the
namespace "default". (get jobs.batch)
```

增加了一个`dashboard-rbac.yaml`文件，定义一个名为 dashboard 的 ServiceAccount，然后将它和 Cluster Role view 绑定。

配置dashboard-service

```
$ diff dashboard-service.yaml.orig dashboard-service.yaml
10a11
>   type: NodePort
```

- 指定端口类型为 NodePort，这样外界可以通过地址 nodeIP:nodePort 访问 dashboard；

配置dashboard-controller

```
$ diff dashboard-controller.yaml.orig dashboard-controller.yaml
23c23
<           image: gcr.io/google_containers/kubernetes-dashboard-amd64:v1.6.0
---
>           image: sz-pg-oam-docker-hub-001.tendcloud.com/library/kubernetes-
dashboard-amd64:v1.6.0
```

执行所有定义文件

```
$ pwd
/root/kubernetes/cluster/addons/dashboard
$ ls *.yaml
dashboard-controller.yaml  dashboard-service.yaml
$ kubectl create -f  .
service "kubernetes-dashboard" created
deployment "kubernetes-dashboard" created
```

检查执行结果

查看分配的 NodePort

```
$ kubectl get services kubernetes-dashboard -n kube-system
NAME                   CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
kubernetes-dashboard   10.254.224.130   <nodes>       80:30312/TCP   25s
```

- NodePort 30312映射到 dashboard pod 80端口；

检查 controller

```
$ kubectl get deployment kubernetes-dashboard  -n kube-system
NAME                   DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
kubernetes-dashboard   1         1         1            1           3m
$ kubectl get pods  -n kube-system | grep dashboard
kubernetes-dashboard-1339745653-pmn6z   1/1       Running   0          4m
```

访问dashboard

有以下三种方式：

- kubernetes-dashboard 服务暴露了 NodePort，可以使用 `http://NodeIP:nodePort` 地址访问 dashboard；
- 通过 kube-apiserver 访问 dashboard（https 6443端口和http 8080端口方式）；
- 通过 kubectl proxy 访问 dashboard：

通过 kubectl proxy 访问 dashboard

启动代理

```
$ kubectl proxy --address='172.20.0.113' --port=8086 --accept-hosts='^*$'
Starting to serve on 172.20.0.113:8086
```

- 需要指定 `--accept-hosts` 选项，否则浏览器访问 dashboard 页面时提示 “Unauthorized”；

浏览器访问 URL：`http://172.20.0.113:8086/ui`
自动跳转到：`http://172.20.0.113:8086/api/v1/proxy/namespaces/kube-system/services/kubernetes-dashboard/#/workload?namespace=default`

通过 kube-apiserver 访问dashboard

获取集群服务地址列表

```
$ kubectl cluster-info
Kubernetes master is running at https://172.20.0.113:6443
KubeDNS is running at https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/kube-dns
kubernetes-dashboard is running at
https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/kubernetes-dashboard
```

浏览器访问 URL：`https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/kubernetes-dashboard`（浏览器会提示证书验证，因为通过加密通道，以改方式访问的话，需要提前导入证书到你的计算机中）。这是我当时在这遇到的坑：通过 kube-apiserver 访问dashboard，提示User "system:anonymous" cannot proxy services in the namespace "kube-system". #5，已经解决。

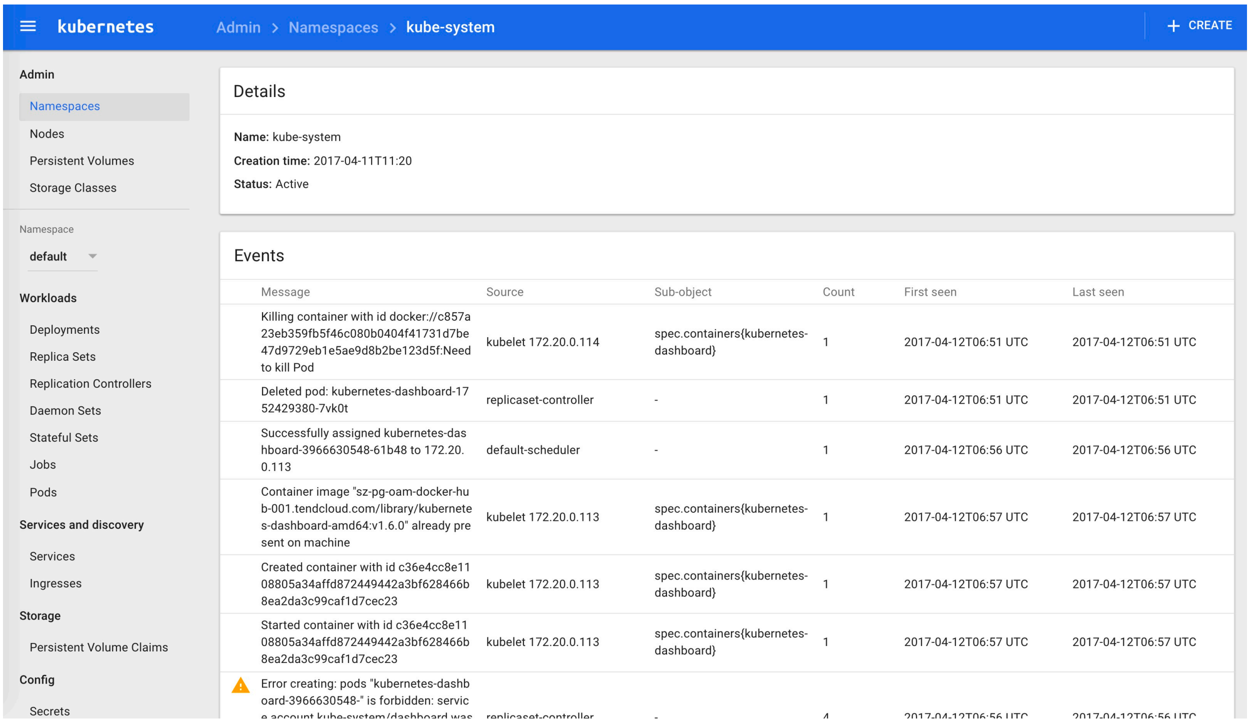
导入证书

将生成的admin.pem证书转换格式

```
openssl pkcs12 -export -in admin.pem  -out admin.p12 -inkey admin-key.pem
```

将生成的`admin.p12`证书导入的你的电脑，导出的时候记住你设置的密码，导入的时候还要用到。

如果你不想使用**https**的话，可以直接访问insecure port 8080端口：`http://172.20.0.113:8080/api/v1/proxy/namespaces/kube-system/services/kubernetes-dashboard`



Details

Name: kube-system
Creation time: 2017-04-11T11:20
Status: Active

Events

	Message	Source	Sub-object	Count	First seen	Last seen
	Killing container with id docker://c857a23eb359fb5f46c080b0404f41731d7be47d9729eb1e5ae9d8b2be123d5f:Need to kill Pod	kubelet 172.20.0.114	spec.containers{kubernetes-dashboard}	1	2017-04-12T06:51 UTC	2017-04-12T06:51 UTC
	Deleted pod: kubernetes-dashboard-1752429380-7vk0t	replicaset-controller	-	1	2017-04-12T06:51 UTC	2017-04-12T06:51 UTC
	Successfully assigned kubernetes-dashboard-3966630548-61b48 to 172.20.0.113	default-scheduler	-	1	2017-04-12T06:56 UTC	2017-04-12T06:56 UTC
	Container image "sz-pg-oam-docker-hub-001.tendcloud.com/library/kubernetes-dashboard-amd64:v1.6.0" already present on machine	kubelet 172.20.0.113	spec.containers{kubernetes-dashboard}	1	2017-04-12T06:57 UTC	2017-04-12T06:57 UTC
	Created container with id c36e4cc8e1108805a34affd872449442a3bf628466b8ea2da3c99caf1d7cec23	kubelet 172.20.0.113	spec.containers{kubernetes-dashboard}	1	2017-04-12T06:57 UTC	2017-04-12T06:57 UTC
	Started container with id c36e4cc8e1108805a34affd872449442a3bf628466b8ea2da3c99caf1d7cec23	kubelet 172.20.0.113	spec.containers{kubernetes-dashboard}	1	2017-04-12T06:57 UTC	2017-04-12T06:57 UTC
⚠	Error creating: pods "kubernetes-dashboard-3966630548-" is forbidden: service account kube-system/dashboard was	replicaset-controller	-	4	2017-04-12T06:56 UTC	2017-04-12T06:56 UTC

由于缺少 Heapster 插件，当前 dashboard 不能展示 Pod、Nodes 的 CPU、内存等 metric 图形。

9.配置和安装 Heapster

到 heapster release 页面 下载最新版本的 heapster。

```
$ wget https://github.com/kubernetes/heapster/archive/v1.3.0.zip
$ unzip v1.3.0.zip
$ mv v1.3.0.zip heapster-1.3.0
```

文件目录： `heapster-1.3.0/deploy/kube-config/influxdb`

```
$ cd heapster-1.3.0/deploy/kube-config/influxdb
$ ls *.yaml
grafana-deployment.yaml  grafana-service.yaml  heapster-deployment.yaml  heapster-service.yaml  influxdb-deployment.yaml  influxdb-service.yaml heapster-rbac.yaml
```

我们自己创建了heapster的rbac配置`heapster-rbac.yaml`。

已经修改好的 yaml 文件见：heapster

配置 grafana-deployment

```
$ diff grafana-deployment.yaml.orig grafana-deployment.yaml
16c16
<         image: gcr.io/google_containers/heapster-grafana-amd64:v4.0.2
---
>         image: sz-pg-oam-docker-hub-001.tendcloud.com/library/heapster-grafana-amd64:v4.0.2
40,41c40,41
<           # value: /api/v1/proxy/namespaces/kube-system/services/monitoring-grafana/
<           value: /
---
>           value: /api/v1/proxy/namespaces/kube-system/services/monitoring-grafana/
>           #value: /
```

- 如果后续使用 kube-apiserver 或者 kubectl proxy 访问 grafana dashboard，则必须将 `GF_SERVER_ROOT_URL` 设置为 `/api/v1/proxy/namespaces/kube-system/services/monitoring-grafana/`，否则后续访问grafana时访问时提示找不到 `http://10.64.3.7:8086/api/v1/proxy/namespaces/kube-system/services/monitoring-grafana/api/dashboards/home` 页面；

配置 heapster-deployment

```
$ diff heapster-deployment.yaml.orig heapster-deployment.yaml
16c16
<         image: gcr.io/google_containers/heapster-amd64:v1.3.0-beta.1
---
>         image: sz-pg-oam-docker-hub-001.tendcloud.com/library/heapster-amd64:v1.3.0-beta.1
```

配置 influxdb-deployment

influxdb 官方建议使用命令行或 HTTP API 接口来查询数据库，从 v1.1.0 版本开始默认关闭 admin UI，将在后续版本中移除 admin UI 插件。

开启镜像中 admin UI的办法如下：先导出镜像中的 influxdb 配置文件，开启 admin 插件后，再将配置文件内容写入 ConfigMap，最后挂载到镜像中，达到覆盖原始配置的目的：

注意：manifests 目录已经提供了 修改后的 ConfigMap 定义文件

```
$ # 导出镜像中的 influxdb 配置文件
$ docker run --rm --entrypoint 'cat'  -ti lvanneo/heapster-influxdb-amd64:v1.1.1
/etc/config.toml >config.toml.orig
$ cp config.toml.orig config.toml
$ # 修改：启用 admin 接口
$ vim config.toml
$ diff config.toml.orig config.toml
35c35
<   enabled = false
---
>   enabled = true
$ # 将修改后的配置写入到 ConfigMap 对象中
$ kubectl create configmap influxdb-config --from-file=config.toml  -n kube-system
configmap "influxdb-config" created
$ # 将 ConfigMap 中的配置文件挂载到 Pod 中，达到覆盖原始配置的目的
$ diff influxdb-deployment.yaml.orig influxdb-deployment.yaml
16c16
<         image: grc.io/google_containers/heapster-influxdb-amd64:v1.1.1
---
>         image: sz-pg-oam-docker-hub-001.tendcloud.com/library/heapster-influxdb-
amd64:v1.1.1
19a20,21
>         - mountPath: /etc/
>           name: influxdb-config
22a25,27
>       - name: influxdb-config
>         configMap:
>           name: influxdb-config
```

配置 monitoring-influxdb Service

```
$ diff influxdb-service.yaml.orig influxdb-service.yaml
12a13
>   type: NodePort
15a17,20
>     name: http
>   - port: 8083
>     targetPort: 8083
>     name: admin
```

- 定义端口类型为 NodePort，额外增加了 admin 端口映射，用于后续浏览器访问 influxdb 的 admin UI 界面；

执行所有定义文件

```
$ pwd
/root/heapster-1.3.0/deploy/kube-config/influxdb
$ ls *.yaml
grafana-service.yaml      heapster-rbac.yaml     influxdb-cm.yaml
influxdb-service.yaml
grafana-deployment.yaml  heapster-deployment.yaml  heapster-service.yaml  influxdb-deployment.yaml
$ kubectl create -f  .
deployment "monitoring-grafana" created
service "monitoring-grafana" created
deployment "heapster" created
serviceaccount "heapster" created
clusterrolebinding "heapster" created
service "heapster" created
configmap "influxdb-config" created
deployment "monitoring-influxdb" created
service "monitoring-influxdb" created
```

检查执行结果

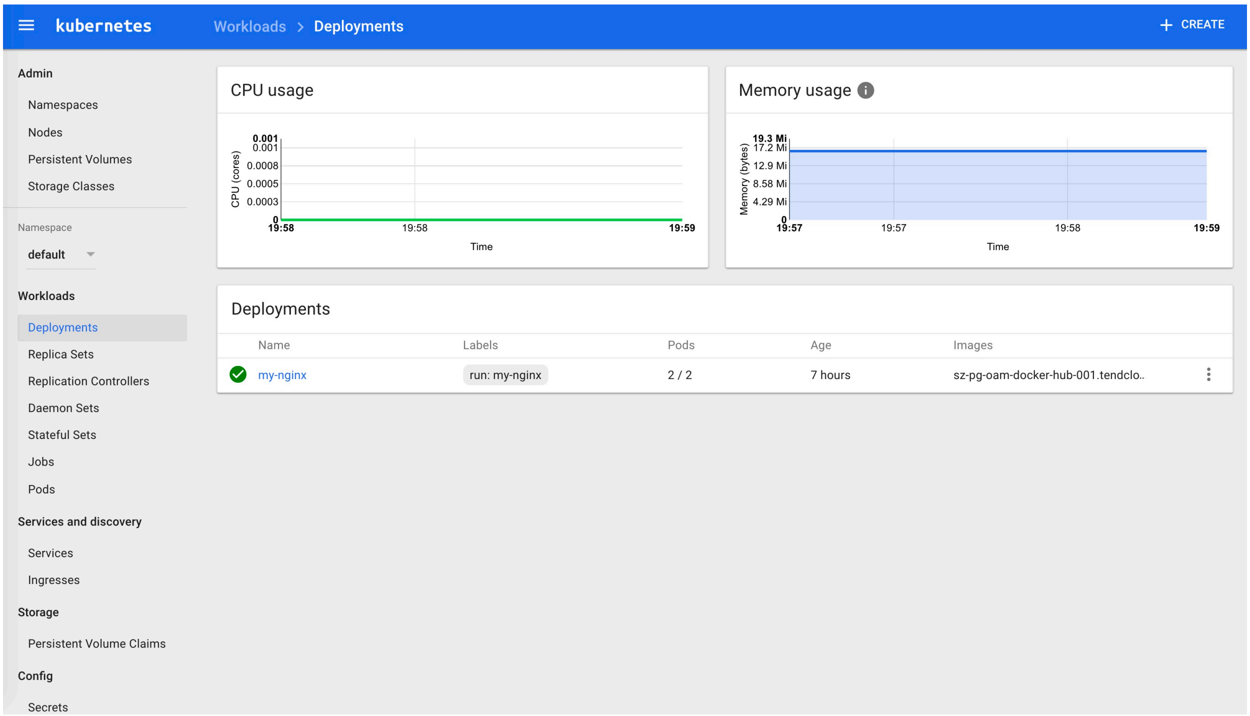
检查 Deployment

```
$ kubectl get deployments -n kube-system | grep -E 'heapster|monitoring'
heapster               1         1         1            1           2m
monitoring-grafana     1         1         1            1           2m
monitoring-influxdb    1         1         1            1           2m
```

检查 Pods

```
$ kubectl get pods -n kube-system | grep -E 'heapster|monitoring'
heapster-110704576-gpg8v                1/1       Running   0          2m
monitoring-grafana-2861879979-9z89f     1/1       Running   0          2m
monitoring-influxdb-1411048194-lzrpc    1/1       Running   0          2m
```

检查 kubernets dashboard 界面，看是显示各 Nodes、Pods 的 CPU、内存、负载等利用率曲线图；



Deployments

	Name	Labels	Pods	Age	Images
✓	my-nginx	run: my-nginx	2 / 2	7 hours	sz-pg-oam-docker-hub-001.tendclo..

访问 grafana

1. 通过 kube-apiserver 访问：

   获取 monitoring-grafana 服务 URL

   ```
   $ kubectl cluster-info
   Kubernetes master is running at https://172.20.0.113:6443
   Heapster is running at https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/heapster
   KubeDNS is running at https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/kube-dns
   kubernetes-dashboard is running at
   https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/kubernetes-dashboard
   monitoring-grafana is running at
   https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/monitoring-grafana
   monitoring-influxdb is running at
   https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/monitoring-influxdb

   To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.
   ```

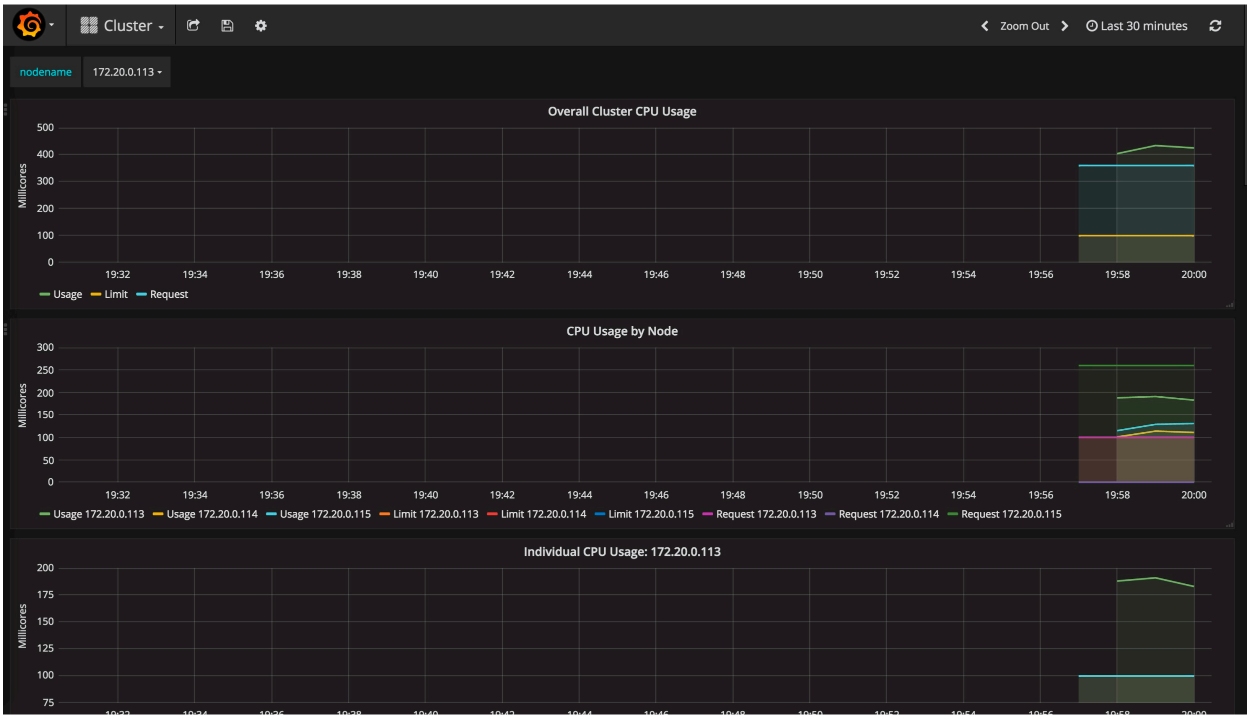
   浏览器访问 URL： `http://172.20.0.113:8080/api/v1/proxy/namespaces/kube-system/services/monitoring-grafana`

2. 通过 kubectl proxy 访问：

   创建代理

```
$ kubectl proxy --address='172.20.0.113' --port=8086 --accept-hosts='^*$'
Starting to serve on 172.20.0.113:8086
```

浏览器访问 URL： `http://172.20.0.113:8086/api/v1/proxy/namespaces/kube-system/services/monitoring-grafana`



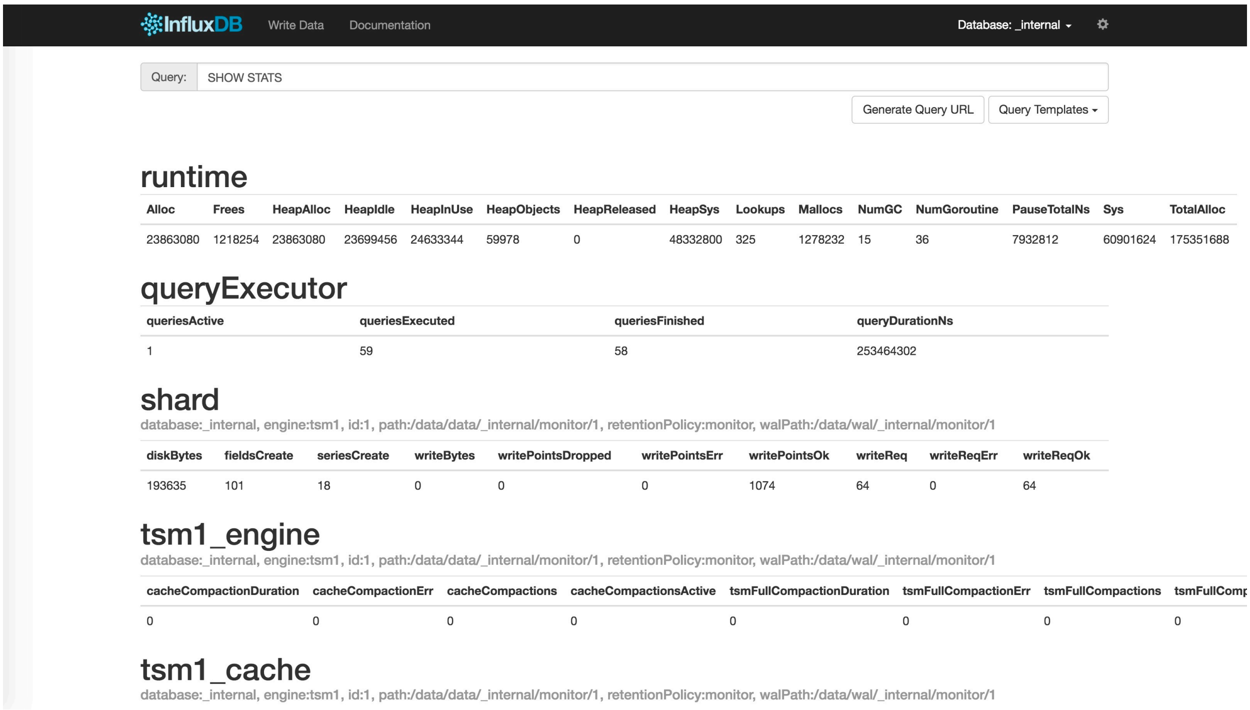
访问 influxdb admin UI

获取 influxdb http 8086 映射的 NodePort

```
$ kubectl get svc -n kube-system|grep influxdb
monitoring-influxdb    10.254.22.46    <nodes>       8086:32299/TCP,8083:30269/TCP
9m
```

通过 kube-apiserver 的**非安全端口**访问 influxdb 的 admin UI 界面： `http://172.20.0.113:8080/api/v1/proxy/namespaces/kube-system/services/monitoring-influxdb:8083/`

在页面的 “Connection Settings” 的 Host 中输入 node IP， Port 中输入 8086 映射的 nodePort 如上面的 32299，点击 “Save” 即可（我的集群中的地址是172.20.0.113:32299）：



Query: SHOW STATS

runtime

Alloc	Frees	HeapAlloc	HeapIdle	HeapInUse	HeapObjects	HeapReleased	HeapSys	Lookups	Mallocs	NumGC	NumGoroutine	PauseTotalNs	Sys	TotalAlloc
23863080	1218254	23863080	23699456	24633344	59978	0	48332800	325	1278232	15	36	7932812	60901624	175351688

queryExecutor

queriesActive	queriesExecuted	queriesFinished	queryDurationNs
1	59	58	253464302

shard

database:_internal, engine:tsm1, id:1, path:/data/data/_internal/monitor/1, retentionPolicy:monitor, walPath:/data/wal/_internal/monitor/1

diskBytes	fieldsCreate	seriesCreate	writeBytes	writePointsDropped	writePointsErr	writePointsOk	writeReq	writeReqErr	writeReqOk
193635	101	18	0	0	0	1074	64	0	64

tsm1_engine

database:_internal, engine:tsm1, id:1, path:/data/data/_internal/monitor/1, retentionPolicy:monitor, walPath:/data/wal/_internal/monitor/1

cacheCompactionDuration	cacheCompactionErr	cacheCompactions	cacheCompactionsActive	tsmFullCompactionDuration	tsmFullCompactionErr	tsmFullCompactions	tsmFullComp
0	0	0	0	0	0	0	0

tsm1_cache

database:_internal, engine:tsm1, id:1, path:/data/data/_internal/monitor/1, retentionPolicy:monitor, walPath:/data/wal/_internal/monitor/1

10.配置和安装 EFK

官方文件目录：`cluster/addons/fluentd-elasticsearch`

```
$ ls *.yaml
es-controller.yaml  es-service.yaml  fluentd-es-ds.yaml  kibana-controller.yaml
kibana-service.yaml efk-rbac.yaml
```

同样EFK服务也需要一个`efk-rbac.yaml`文件，配置serviceaccount为`efk`。

已经修改好的 yaml 文件见：EFK

配置 es-controller.yaml

```
$ diff es-controller.yaml.orig es-controller.yaml
24c24
<       - image: gcr.io/google_containers/elasticsearch:v2.4.1-2
---
>       - image: sz-pg-oam-docker-hub-
001.tendcloud.com/library/elasticsearch:v2.4.1-2
```

配置 es-service.yaml

无需配置；

配置 fluentd-es-ds.yaml

```
$ diff fluentd-es-ds.yaml.orig fluentd-es-ds.yaml
26c26
<          image: gcr.io/google_containers/fluentd-elasticsearch:1.22
---
>          image: sz-pg-oam-docker-hub-001.tendcloud.com/library/fluentd-
elasticsearch:1.22
```

配置 kibana-controller.yaml

```
$ diff kibana-controller.yaml.orig kibana-controller.yaml
22c22
<          image: gcr.io/google_containers/kibana:v4.6.1-1
---
>          image: sz-pg-oam-docker-hub-001.tendcloud.com/library/kibana:v4.6.1-1
```

给 Node 设置标签

定义 DaemonSet `fluentd-es-v1.22` 时设置了 nodeSelector `beta.kubernetes.io/fluentd-ds-ready=true` ，所以需要在期望运行 fluentd 的 Node 上设置该标签；

```
$ kubectl get nodes
NAME        STATUS    AGE       VERSION
172.20.0.113   Ready     1d        v1.6.0

$ kubectl label nodes 172.20.0.113 beta.kubernetes.io/fluentd-ds-ready=true
node "172.20.0.113" labeled
```

给其他两台node打上同样的标签。

执行定义文件

```
$ kubectl create -f .
serviceaccount "efk" created
clusterrolebinding "efk" created
replicationcontroller "elasticsearch-logging-v1" created
service "elasticsearch-logging" created
daemonset "fluentd-es-v1.22" created
deployment "kibana-logging" created
service "kibana-logging" created
```

检查执行结果

```
$ kubectl get deployment -n kube-system|grep kibana
kibana-logging         1         1         1            1           2m

$ kubectl get pods -n kube-system|grep -E 'elasticsearch|fluentd|kibana'
elasticsearch-logging-v1-mlstp          1/1       Running   0          1m
elasticsearch-logging-v1-nfbbf          1/1       Running   0          1m
fluentd-es-v1.22-31sm0                  1/1       Running   0          1m
fluentd-es-v1.22-bpgqs                  1/1       Running   0          1m
fluentd-es-v1.22-qmn7h                  1/1       Running   0          1m
kibana-logging-1432287342-0gdng         1/1       Running   0          1m

$ kubectl get service  -n kube-system|grep -E 'elasticsearch|kibana'
elasticsearch-logging   10.254.77.62    <none>        9200/TCP
2m
kibana-logging          10.254.8.113    <none>        5601/TCP
2m
```

kibana Pod 第一次启动时会用**较长时间(10-20分钟)**来优化和 Cache 状态页面，可以 tailf 该 Pod 的日志观察进度：

```
$ kubectl logs kibana-logging-1432287342-0gdng -n kube-system -f
ELASTICSEARCH_URL=http://elasticsearch-logging:9200
server.basePath: /api/v1/proxy/namespaces/kube-system/services/kibana-logging
{"type":"log","@timestamp":"2017-04-12T13:08:06Z","tags":
["info","optimize"],"pid":7,"message":"Optimizing and caching bundles for kibana and
statusPage. This may take a few minutes"}
{"type":"log","@timestamp":"2017-04-12T13:18:17Z","tags":
["info","optimize"],"pid":7,"message":"Optimization of bundles for kibana and
statusPage complete in 610.40 seconds"}
{"type":"log","@timestamp":"2017-04-12T13:18:17Z","tags":
["status","plugin:kibana@1.0.0","info"],"pid":7,"state":"green","message":"Status
changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:18Z","tags":
["status","plugin:elasticsearch@1.0.0","info"],"pid":7,"state":"yellow","message":"S
tatus changed from uninitialized to yellow - Waiting for
Elasticsearch","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["status","plugin:kbn_vislib_vis_types@1.0.0","info"],"pid":7,"state":"green","messa
ge":"Status changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["status","plugin:markdown_vis@1.0.0","info"],"pid":7,"state":"green","message":"Sta
tus changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["status","plugin:metric_vis@1.0.0","info"],"pid":7,"state":"green","message":"Statu
s changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["status","plugin:spyModes@1.0.0","info"],"pid":7,"state":"green","message":"Status
changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["status","plugin:statusPage@1.0.0","info"],"pid":7,"state":"green","message":"Statu
s changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["status","plugin:table_vis@1.0.0","info"],"pid":7,"state":"green","message":"Status
changed from uninitialized to green -
Ready","prevState":"uninitialized","prevMsg":"uninitialized"}
{"type":"log","@timestamp":"2017-04-12T13:18:19Z","tags":
["listening","info"],"pid":7,"message":"Server running at http://0.0.0.0:5601"}
{"type":"log","@timestamp":"2017-04-12T13:18:24Z","tags":
["status","plugin:elasticsearch@1.0.0","info"],"pid":7,"state":"yellow","message":"S
tatus changed from yellow to yellow - No existing Kibana index
found","prevState":"yellow","prevMsg":"Waiting for Elasticsearch"}
{"type":"log","@timestamp":"2017-04-12T13:18:29Z","tags":
["status","plugin:elasticsearch@1.0.0","info"],"pid":7,"state":"green","message":"St
atus changed from yellow to green - Kibana index
ready","prevState":"yellow","prevMsg":"No existing Kibana index found"}
```

访问 kibana

1. 通过 kube-apiserver 访问：

   获取 monitoring-grafana 服务 URL

```
$ kubectl cluster-info
Kubernetes master is running at https://172.20.0.113:6443
Elasticsearch is running at
https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/elasticsearch-logging
Heapster is running at https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/heapster
Kibana is running at https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/kibana-logging
KubeDNS is running at https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/kube-dns
kubernetes-dashboard is running at
https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/kubernetes-dashboard
monitoring-grafana is running at
https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/monitoring-grafana
monitoring-influxdb is running at
https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-
system/services/monitoring-influxdb
```

浏览器访问 URL： `https://172.20.0.113:6443/api/v1/proxy/namespaces/kube-system/services/kibana-logging/app/kibana`

2. 通过 kubectl proxy 访问：

   创建代理

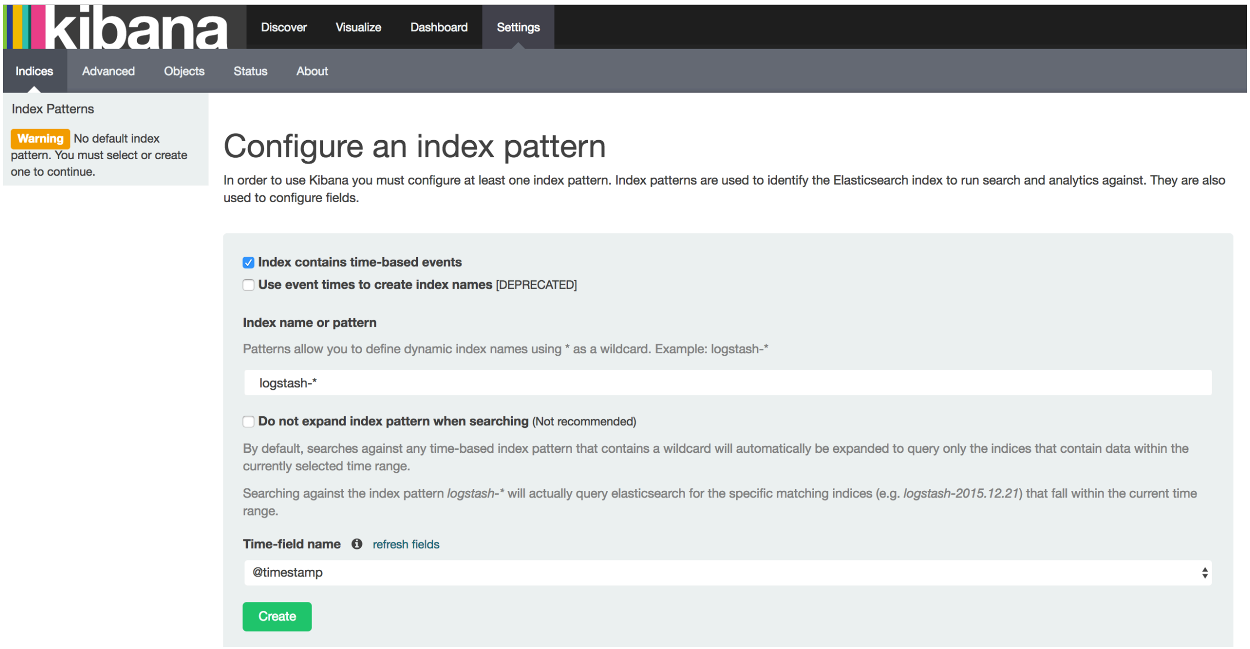
```
$ kubectl proxy --address='172.20.0.113' --port=8086 --accept-hosts='^*$'
Starting to serve on 172.20.0.113:8086
```

浏览器访问 URL： `http://172.20.0.113:8086/api/v1/proxy/namespaces/kube-system/services/kibana-logging`

在 Settings -> Indices 页面创建一个 index（相当于 mysql 中的一个 database），选中 `Index contains time-based events`，使用默认的 `logstash-*` pattern，点击 `Create`；

可能遇到的问题

如果你在这里发现Create按钮是灰色的无法点击，且Time-filed name中没有选项，fluentd要读取`/var/log/containers/`目录下的log日志，这些日志是从`/var/lib/docker/containers/${CONTAINER_ID}/${CONTAINER_ID}-json.log`链接过来的，查看你的docker配置，`–log-dirver`需要设置为**json-file**格式，默认的可能是**journald**，参考docker logging。



Warning No default index pattern. You must select or create one to continue.

Configure an index pattern

In order to use Kibana you must configure at least one index pattern. Index patterns are used to identify the Elasticsearch index to run search and analytics against. They are also used to configure fields.

☑ Index contains time-based events

□ Use event times to create index names [DEPRECATED]

Index name or pattern

Patterns allow you to define dynamic index names using * as a wildcard. Example: logstash-*

logstash-*

□ Do not expand index pattern when searching (Not recommended)

By default, searches against any time-based index pattern that contains a wildcard will automatically be expanded to query only the indices that contain data within the currently selected time range.

Searching against the index pattern *logstash-** will actually query elasticsearch for the specific matching indices (e.g. *logstash-2015.12.21*) that fall within the current time range.

Time-field name

@timestamp

创建Index后，可以在 `Discover` 下看到 ElasticSearch logging 中汇聚的日志；

到此整个kubernetes集群和插件已经安装完毕。

11.安装Traefik ingress

Ingress简介

如果你还不了解，ingress是什么，可以先看下我翻译的Kubernetes官网上ingress的介绍Kubernetes Ingress解析。

理解Ingress

简单的说，ingress就是从kubernetes集群外访问集群的入口，将用户的URL请求转发到不同的service上。Ingress相当于nginx、apache等负载均衡方向代理服务器，其中还包括规则定义，即URL的路由信息，路由信息得的刷新由Ingress controller来提供。

理解Ingress Controller

Ingress Controller 实质上可以理解为是个监视器，Ingress Controller 通过不断地跟 kubernetes API 打交道，实时的感知后端 service、pod 等变化，比如新增和减少 pod，service 增加与减少等；当得到这些变化信息后，Ingress Controller 再结合下文的 Ingress 生成配置，然后更新反向代理负载均衡器，并刷新其配置，达到服务发现的作用。

部署Traefik

介绍traefik

Traefik是一款开源的反向代理与负载均衡工具。它最大的优点是能够与常见的微服务系统直接整合，可以实现自动化动态配置。目前支持Docker, Swarm, Mesos/Marathon, Mesos, Kubernetes, Consul, Etcd, Zookeeper, BoltDB, Rest API等等后端模型。

以下配置文件可以在kubernetes-handbookGitHub仓库中的manifests/traefik-ingress/目录下找到。

创建ingress-rbac.yaml

将用于service account验证。

```yaml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: ingress
  namespace: kube-system

---

kind: ClusterRoleBinding
apiVersion: rbac.authorization.k8s.io/v1beta1
metadata:
  name: ingress
subjects:
  - kind: ServiceAccount
    name: ingress
    namespace: kube-system
roleRef:
  kind: ClusterRole
  name: cluster-admin
  apiGroup: rbac.authorization.k8s.io
```

创建名为`traefik-ingress`的ingress，文件名traefik.yaml

```yaml
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: traefik-ingress
spec:
  rules:
  - host: traefik.nginx.io
    http:
      paths:
      - path: /
        backend:
          serviceName: my-nginx
          servicePort: 80
  - host: traefik.frontend.io
    http:
      paths:
      - path: /
        backend:
          serviceName: frontend
          servicePort: 80
```

这其中的`backend`中要配置default namespace中启动的service名字。`path`就是URL地址后的路径，如traefik.frontend.io/path，service将会接受path这个路径，host最好使用service-name.filed1.filed2.domain-name这种类似主机名称的命名方式，方便区分服务。

根据你自己环境中部署的service的名字和端口自行修改，有新service增加时，修改该文件后可以使用`kubectl replace -f traefik.yaml`来更新。

我们现在集群中已经有两个service了，一个是nginx，另一个是官方的`guestbook`例子。

创建Depeloyment

```yaml
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: traefik-ingress-lb
  namespace: kube-system
  labels:
    k8s-app: traefik-ingress-lb
spec:
  template:
    metadata:
      labels:
        k8s-app: traefik-ingress-lb
        name: traefik-ingress-lb
    spec:
      terminationGracePeriodSeconds: 60
      hostNetwork: true
      restartPolicy: Always
      serviceAccountName: ingress
      containers:
      - image: traefik
        name: traefik-ingress-lb
        resources:
          limits:
            cpu: 200m
            memory: 30Mi
          requests:
            cpu: 100m
            memory: 20Mi
        ports:
        - name: http
          containerPort: 80
          hostPort: 80
        - name: admin
          containerPort: 8580
          hostPort: 8580
        args:
        - --web
        - --web.address=:8580
        - --kubernetes
```

注意我们这里用的是Deploy类型，没有限定该pod运行在哪个主机上。Traefik的端口是8580。

Traefik UI

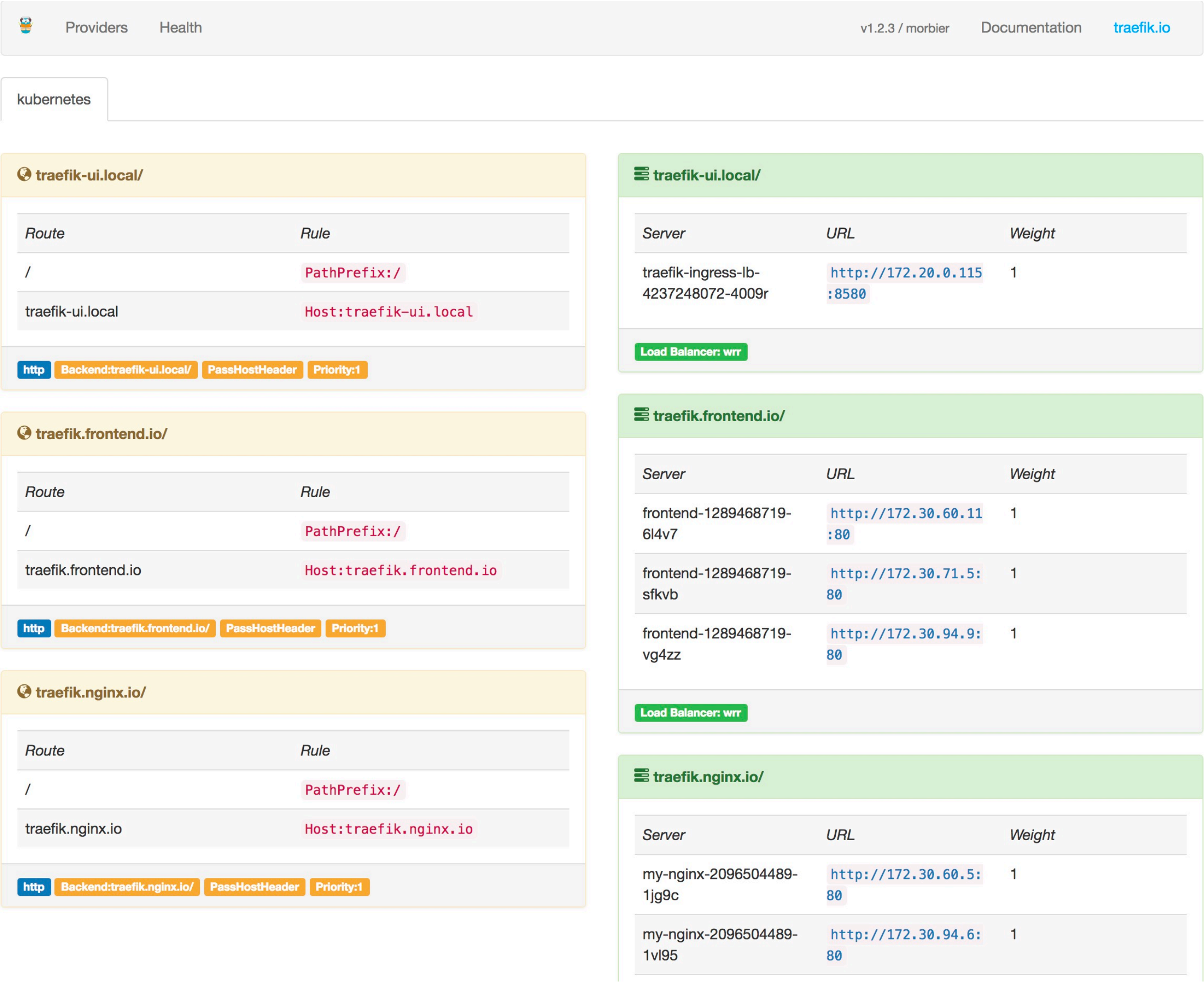
```yaml
apiVersion: v1
kind: Service
metadata:
  name: traefik-web-ui
  namespace: kube-system
spec:
  selector:
    k8s-app: traefik-ingress-lb
  ports:
  - name: web
    port: 80
    targetPort: 8580
---
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: traefik-web-ui
  namespace: kube-system
spec:
  rules:
  - host: traefik-ui.local
    http:
      paths:
      - path: /
        backend:
          serviceName: traefik-web-ui
          servicePort: web
```

配置完成后就可以启动treafik ingress了。

```
kubectl create -f .
```

我查看到traefik的pod在`172.20.0.115`这台节点上启动了。

访问该地址`http://172.20.0.115:8580/`将可以看到dashboard。



traefik-ui.local/

Route	Rule
/	PathPrefix:/
traefik-ui.local	Host:traefik-ui.local

http Backend:traefik-ui.local/ PassHostHeader Priority:1

traefik.frontend.io/

Route	Rule
/	PathPrefix:/
traefik.frontend.io	Host:traefik.frontend.io

http Backend:traefik.frontend.io/ PassHostHeader Priority:1

traefik.nginx.io/

Route	Rule
/	PathPrefix:/
traefik.nginx.io	Host:traefik.nginx.io

http Backend:traefik.nginx.io/ PassHostHeader Priority:1

traefik-ui.local/

Server	URL	Weight
traefik-ingress-lb-4237248072-4009r	http://172.20.0.115:8580	1

Load Balancer: wrr

traefik.frontend.io/

Server	URL	Weight
frontend-1289468719-6l4v7	http://172.30.60.11:80	1
frontend-1289468719-sfkvb	http://172.30.71.5:80	1
frontend-1289468719-vg4zz	http://172.30.94.9:80	1

Load Balancer: wrr

traefik.nginx.io/

Server	URL	Weight
my-nginx-2096504489-1jg9c	http://172.30.60.5:80	1
my-nginx-2096504489-1vl95	http://172.30.94.6:80	1

左侧黄色部分部分列出的是所有的rule，右侧绿色部分是所有的backend。

测试

在集群的任意一个节点上执行。假如现在我要访问nginx的"/"路径。

```
$ curl -H Host:traefik.nginx.io http://172.20.0.115/
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
    body {
        width: 35em;
        margin: 0 auto;
        font-family: Tahoma, Verdana, Arial, sans-serif;
    }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and
working. Further configuration is required.</p>

<p>For online documentation and support please refer to
<a href="http://nginx.org/">nginx.org</a>.<br/>
Commercial support is available at
<a href="http://nginx.com/">nginx.com</a>.</p>

<p><em>Thank you for using nginx.</em></p>
</body>
</html>
```

如果你需要在kubernetes集群以外访问就需要设置DNS，或者修改本机的hosts文件。

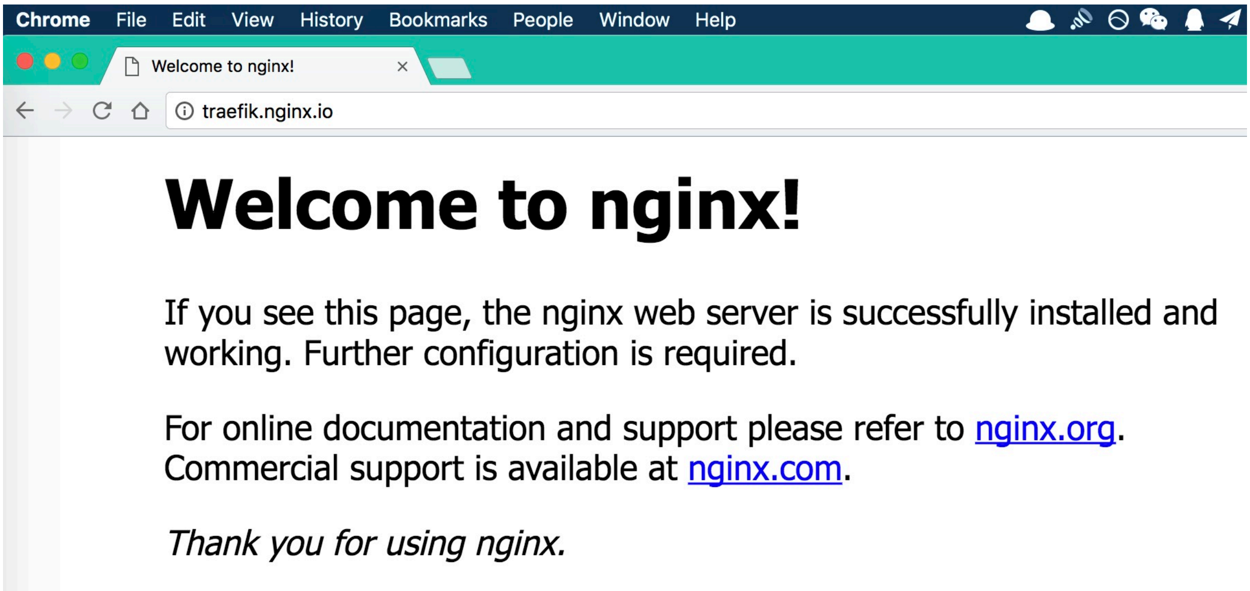
在其中加入：

```
172.20.0.115 traefik.nginx.io
172.20.0.115 traefik.frontend.io
```

所有访问这些地址的流量都会发送给172.20.0.115这台主机，就是我们启动traefik的主机。

Traefik会解析http请求header里的Host参数将流量转发给Ingress配置里的相应service。

修改hosts后就就可以在kubernetes集群外访问以上两个service，如下图：

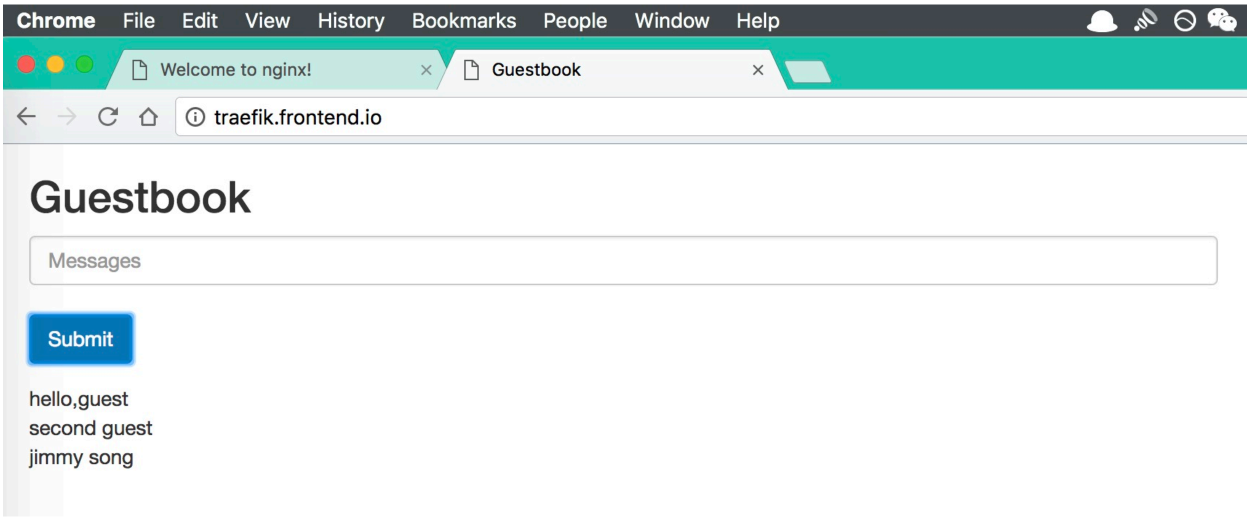


Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.



Guestbook

hello,guest
second guest
jimmy song

参考

[Traefik-kubernetes 初试]()

[Traefik简介]()

[Guestbook example]()