Kubernetes 完全教程

Kubernetes 网络与存储

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Agenda

1. Kubernetes 的网络
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    ii. Kubernetes 的 ClusterIP 机制
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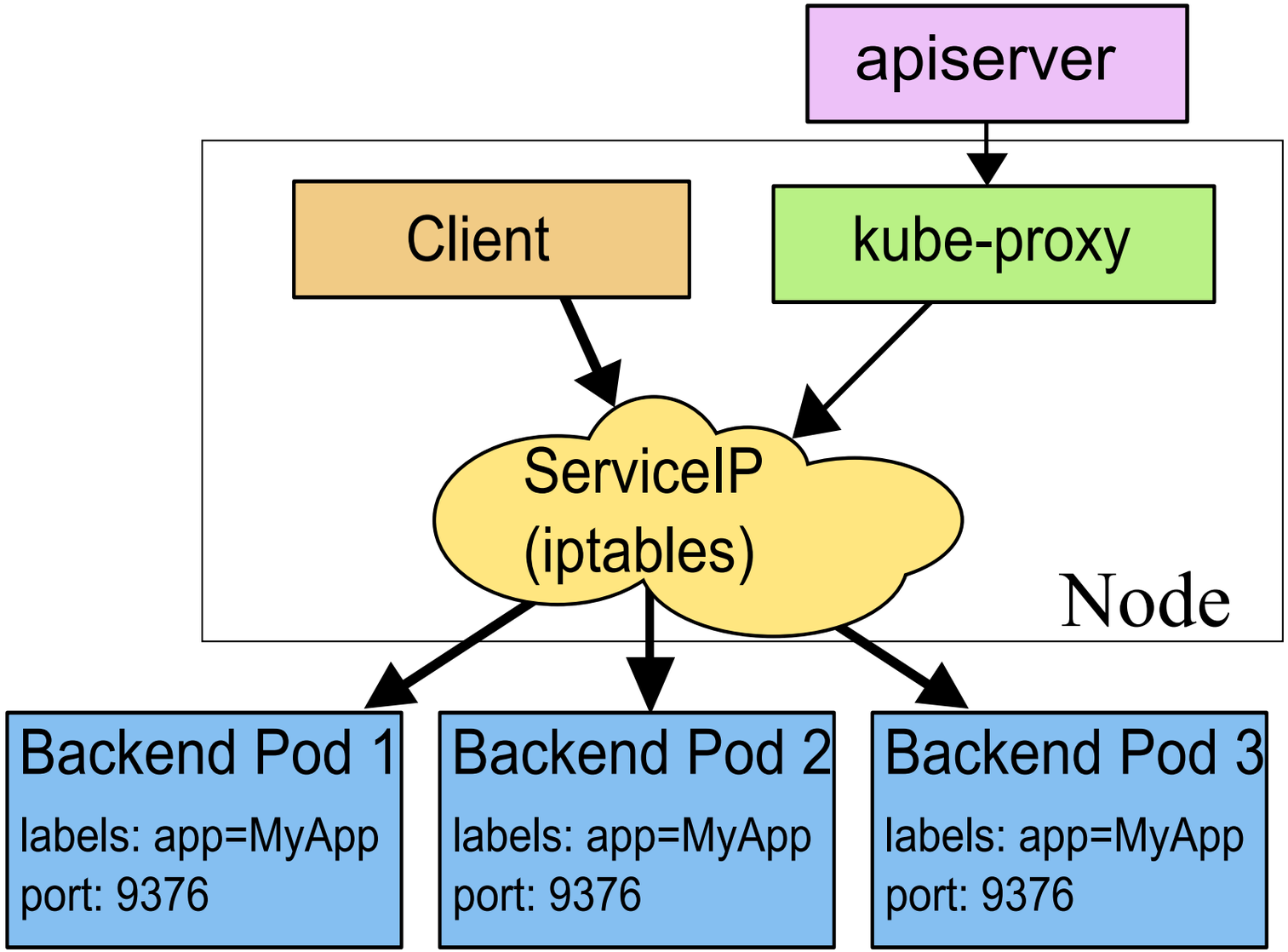
2. Kubernetes 的存储
    i. Kubernetes Volume
    ii. Kubernetes PersistentVolume
    iii. Kubernetes PersistentVolumeClaim 和 StorageClass

Kubernetes 网络概述

1. Service ClusterIP
2. Pod 网络
    - 容器之间可以直接互通，不需要 NAT
    - 节点可以和容器直接互通，不需要 NAT
    - 容器看到的自己 IP 应该和其他容器看到的一样

> Network address translation (NAT) is a method of remapping one IP address space into another by modifying network address information in Internet Protocol (IP) datagram packet headers while they are in transit across a traffic routing device.

Service ClusterIP

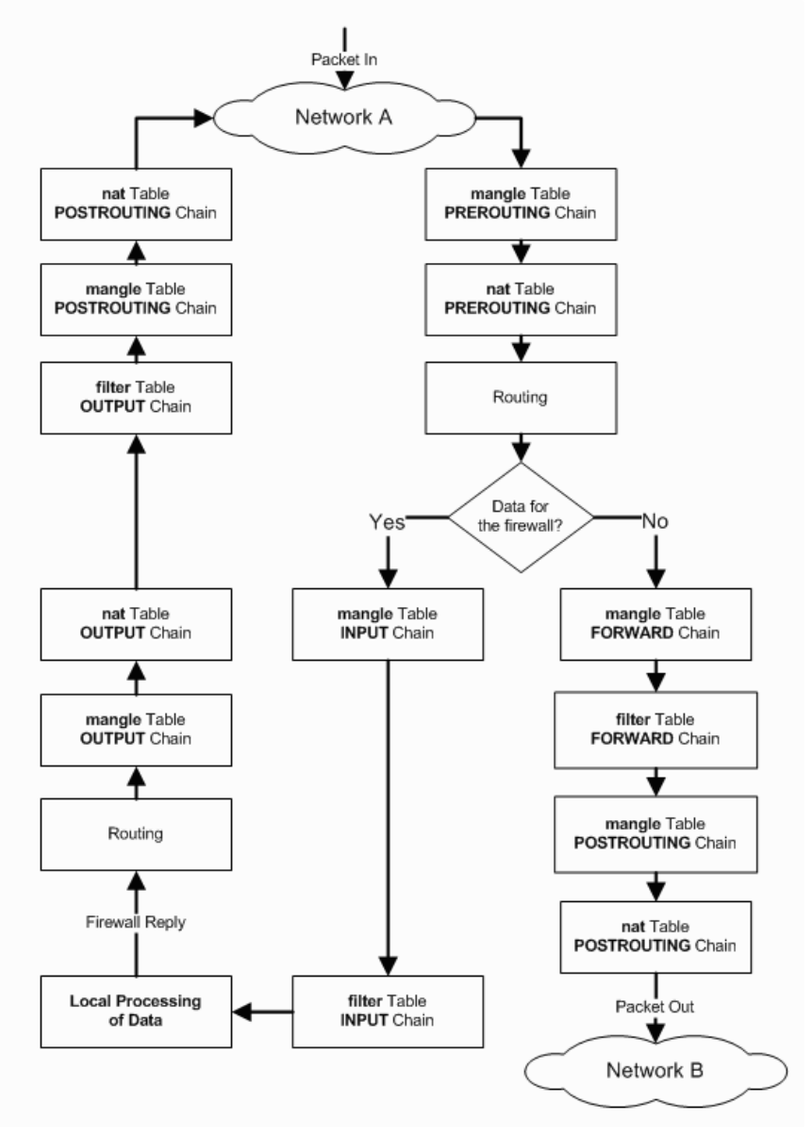


Iptables

> iptables是一个配置Linux内核防火墙的命令行工具，它基于内核的netfilter机制

Tables↓/Chains→	PREROUTING	INPUT	FORWARD	OUTPUT	POSTROUTING
raw	✓			✓	
(connection tracking)	✓			✓	
mangle	✓	✓	✓	✓	✓
nat (DNAT)	✓			✓	
filter (default)		✓	✓	✓	
security		✓	✓	✓	
nat (SNAT)		✓			✓

Iptables data flow



Iptables example Docker

```
iptables -A INPUT -p tcp --dport 22 -j ACCEPT

iptables -P INPUT DROP
iptables -P FORWARD DROP

# docker iptables nat

iptables -S -t nat

-N DOCKER
-A PREROUTING -m addrtype --dst-type LOCAL -j DOCKER
-A OUTPUT ! -d 127.0.0.0/8 -m addrtype --dst-type LOCAL -j DOCKER
-A POSTROUTING -s 172.17.0.0/16 ! -o docker0 -j MASQUERADE
-A DOCKER ! -i docker0 -p tcp -m tcp --dport 80 -j DNAT --to-destination 172.17.0.2:80
```

Iptables example Kubernetes ClusterIP

```
kubectl get service
NAME         CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
helloworld   10.105.189.133   <nodes>       80:31061/TCP   1d
```

```
-N KUBE-NODEPORTS
-N KUBE-POSTROUTING

-N KUBE-SERVICES
-N KUBE-SVC-2WB5SOAIQNMPIUJO

-A PREROUTING -m comment --comment "kubernetes service portals" -j KUBE-SERVICES
-A OUTPUT -m comment --comment "kubernetes service portals" -j KUBE-SERVICES
-A POSTROUTING -m comment --comment "kubernetes postrouting rules" -j KUBE-POSTROUTING

-A KUBE-NODEPORTS -p tcp -m comment --comment "default/helloworld:" -m tcp --dport 31061
-A KUBE-SERVICES -d 10.105.189.133/32 -p tcp -m comment --comment "default/helloworld: c
-A KUBE-SVC-2WB5SOAIQNMPIUJO -m comment --comment "default/helloworld:"-j KUBE-SEP-3F6YT
-A KUBE-SEP-3F6YTS3NO7JJQOGS -p tcp -m comment --comment "default/helloworld:" -m tcp -j
```

CNI (Container Network Interface)

```
CNI_COMMAND (add/del)
CNI_PATH (/opt/cni/bin)
CNI_CONTAINERID
CNI_NETNS
```

```
$ cat /etc/cni/net.d/10-mynet.conf
{
        "cniVersion": "0.2.0",
        "name": "mynet",
        "type": "bridge",
        "bridge": "cni0",
        "isGateway": true,
        "ipMasq": true,
        "ipam": {
                "type": "host-local",
                "subnet": "10.22.0.0/16",
                "routes": [
                        { "dst": "0.0.0.0/0" }
                ]
        }
}
```

容器的跨主机网络

1. 容器网络（详情参看预备课）
2. 容器的跨主机网络需要解决的问题
    i. IP 分配
    ii. 跨主机网络数据转发
3. 手动实现跨主机容器网络（演示）

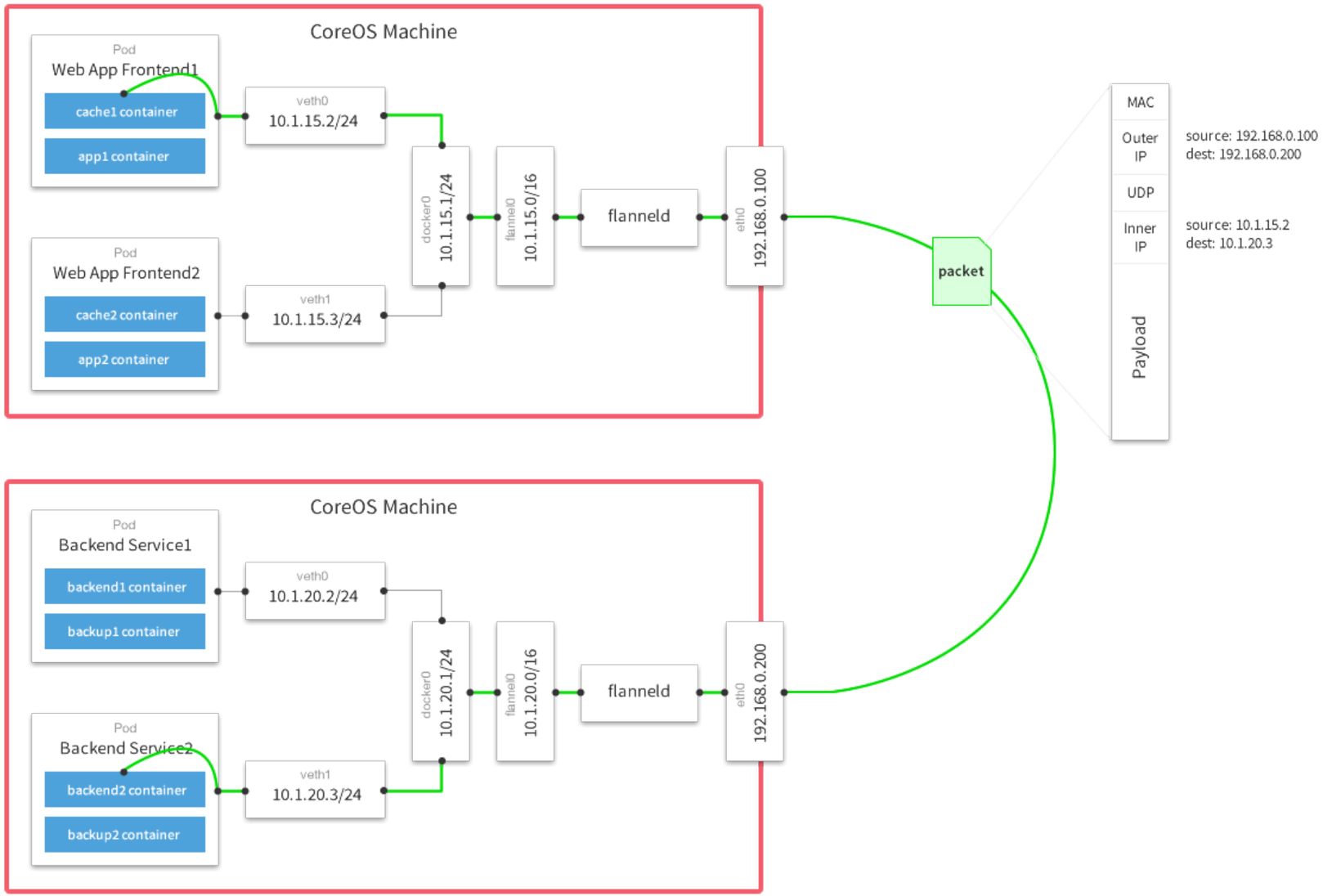
```
node1(192.168.0.11) docker: 172.17.0.0/16
node2(192.168.0.12) docker: 172.18.0.0/16 (/etc/docker/daemon.json {"bip":"172.18.0.1/16

# node1
iptables -P FORWARD ACCEPT
ip route add 172.18.0.0/16 via 192.168.0.12
# node2
iptables -P FORWARD ACCEPT
ip route add 172.17.0.0/16 via 192.168.0.11
```

Flannel

Backend Type

1. udp
2. vxlan
3. host-gw
4. aws-vpc



QingCloud SDN Passthrough

创建一个网卡(192.168.0.101)，绑定到主机，通过命令将网卡移动到容器的 netns

```
container_id=$(docker run --network none -d jolestar/go-probe)
docker exec $container_id ifconfig
# 创建 netns 文件夹连接
pid=$(docker inspect -f '{{.State.Pid}}' ${container_id})
mkdir -p /var/run/netns/
ln -sfT /proc/$pid/ns/net /var/run/netns/$container_id
# 移动网卡并激活
ip link set eth1 netns ${container_id}
ip netns exec ${container_id} ip addr add 192.168.0.101/24 dev eth1
ip netns exec ${container_id} ip link set dev eth1 up
ip netns exec ${container_id} ip route add default via 192.168.0.1

docker exec $container_id ifconfig
docker exec $container_id -- nping 192.168.0.12
```

Kubernetes 网络故障排查

1. 确认同一主机上的 pod 网络是否互通，否，排查本机网络 arp, iptables
2. 确认跨主机 pod 网络是否互通
3. 确认 dns 服务是否正常
4. 确认请求 Service ClusterIP 是否正常 （排查 Service iptables)
5. 确认 pod 到 apiserver 请求是否正常
6. 确认出 pod 请求公网是否正常

```
# iptables debug
iptables -t raw -A PREROUTING -s 172.17.0.0/16 -j TRACE
iptables -t nat -A POSTROUTING -p tcp -m tcp -d 172.17.0.0/16 -j LOG --log-prefix "POSTR
tail -f /var/log/kern.log
```

Kubernetes 网络故障排查工具

- arp/arping
- ping/nping/traceroute
- iproute2
- nmap/telnet/curl
- nslookup/dig
- tcpdump
- iptables

```
# iptables debug
iptables -t raw -A PREROUTING -s 172.17.0.0/16 -j TRACE
iptables -t nat -A POSTROUTING -p tcp -m tcp -d 172.17.0.0/16 -j LOG --log-prefix "POSTR
tail -f /var/log/kern.log
```

Kubernetes Volume

```
apiVersion: v1
kind: Pod
metadata:
  name: test-pd
spec:
  containers:
  - image: jolestar/go-probe
    name: test-container
    volumeMounts:
    - mountPath: /cache
      name: cache-volume
  volumes:
  - name: cache-volume
    emptyDir: {}
```

Kubernetes Volume

- emptyDir
- hostPath

```
volumes:
- name: test-volume
hostPath:
  path: /data
```

- downwardAPI
- secret
- configMap

Kubernetes Volume

- projected (secret, downwardAPI, configMap)
- gitRepo

```
volumes:
  - name: git-volume
    gitRepo:
      repository: "git@xxxx:me/my-repo.git"
      revision: "22f1d8406d464"
```

```
apiVersion: v1
kind: Pod
metadata:
  name: volume-test
spec:
  containers:
  - name: container-test
    image: busybox
    volumeMounts:
    - name: all-in-one
      mountPath: "/projected-volume"
      readOnly: true
  volumes:
  - name: all-in-one
    projected:
      sources:
      - secret:
          name: mysecret
          items:
            - key: username
              path: my-group/my-username
      - downwardAPI:
          items:
            - path: "labels"
              fieldRef:
                fieldPath: metadata.labels
            - path: "cpu_limit"
              resourceFieldRef:
                containerName: container-test
                resource: limits.cpu
      - configMap:
          name: myconfigmap
          items:
            - key: config
              path: my-group/my-config
```

Kubernetes Volume

- NFS/CephFS/Glusterfs

```
volumes:
  - name: nfs-volume
    nfs:
      path: /opt/nfs
      server: nfs.f22
```

- Cloud Disk(GCEPersistentDisk, AWSElasticBlockStore, AzureDisk)

```
volumes:
  - name: test-volume
    awsElasticBlockStore:
      volumeID: <volume-id>
      fsType: ext4
```

Kubernetes VolumeMount Option

- mountPath
- name
- readOnly
- subPath

PersistentVolume 以及 PersistentVolumeClaim

以及为什么要有 PersistentVolume，PersistentVolumeClaim

- 生命周期管理
- 资源清理以及复用
- Pod 副本
- 环境

Kubernetes PersistentVolume 规范

```yaml
kind: PersistentVolume
apiVersion: v1
metadata:
  name: qingcloud-pv
  labels:
    type: qingcloud
spec:
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  flexVolume:
      driver: "qingcloud/flex-volume"
      fsType: "ext4"
      options:
        volumeID: "vol-xxxx
```

Kubernetes PersistentVolume 规范

- Capacity
- Access Modes
  - ReadWriteOnce
  - ReadOnlyMany
  - ReadWriteMany
- Mount Options
- Phase （Available，Bound，Released，Failed）

Kubernetes PersistentVolumeClaim 规范

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: qingcloud-pvc
spec:
  storageClassName: qingcloud-storageclass
  persistentVolumeReclaimPolicy: Recycle
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 3Gi
```

```
volumes:
  - name: wordpress-persistent-storage
    persistentVolumeClaim:
       claimName: qingcloud-pvc
```

Reclaim Policy (Retain,Recycle,Delete)

Kubernetes StorageClass 规范

```yaml
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: qingcloud-storageclass
  annotations:
      storageclass.kubernetes.io/is-default-class: "true"
provisioner: qingcloud/volume-provisioner
```

```yaml
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: slow
provisioner: kubernetes.io/glusterfs
parameters:
  resturl: "http://192.168.10.100:8080"
  restuser: ""
  secretNamespace: ""
  secretName: ""
allowVolumeExpansion: true
```

作业

1. 尝试另外一种网络方案，比如 calico，分析其实现方式，并进行简单的性能比较。
2. 尝试在 Kubernetes 上运行 glusterfs server，并在 Kubernetes 中使用。

参考资料

1. https://github.com/feiskyer/sdn-handbook
2. 《Linux iptables Pocket Reference》Gregor N. Purdy
3. 《图解 TCP/IP 》[日]竹下隆史 / [日]村山公保 / [日]荒井透 / [日]苅田幸雄
4. 《计算机网络：自顶向下方法》[美] James F.Kurose / [美] Keith W.Ross

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个人博客: http://jolestar.com

课程 Github： https://github.com/jolestar/kubernetes-complete-course

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