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Multiple Networks and Isolation in Kubernetes
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Agenda

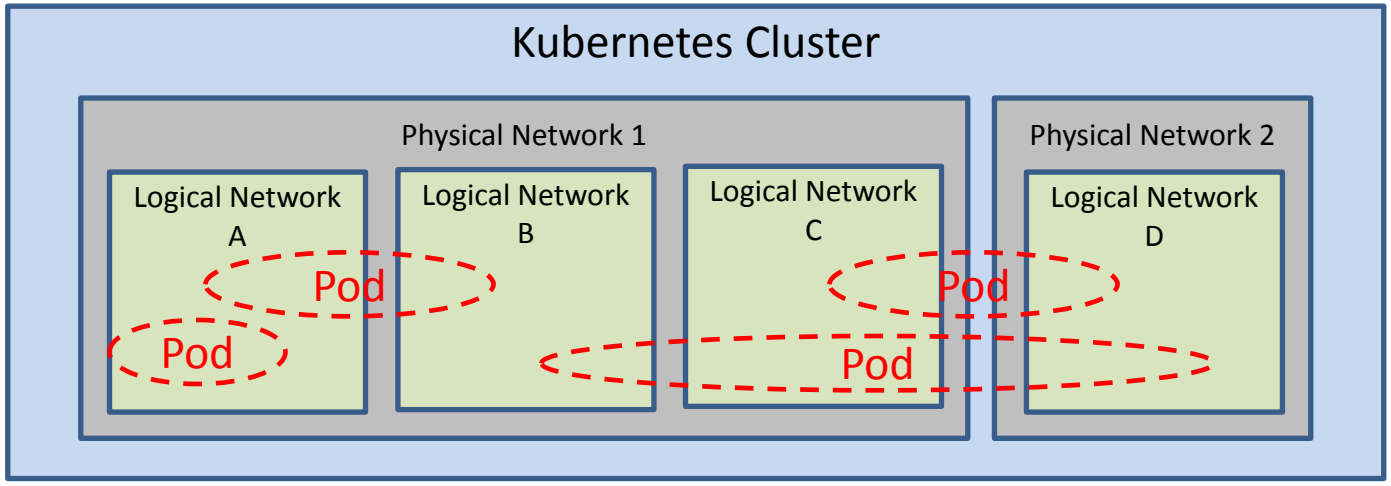
- CNI and network plug-ins
- Multiple network use cases, design and implementation
- Network multi-tenancy requirement and implementation
- Demo

CNI and Network Plug-ins

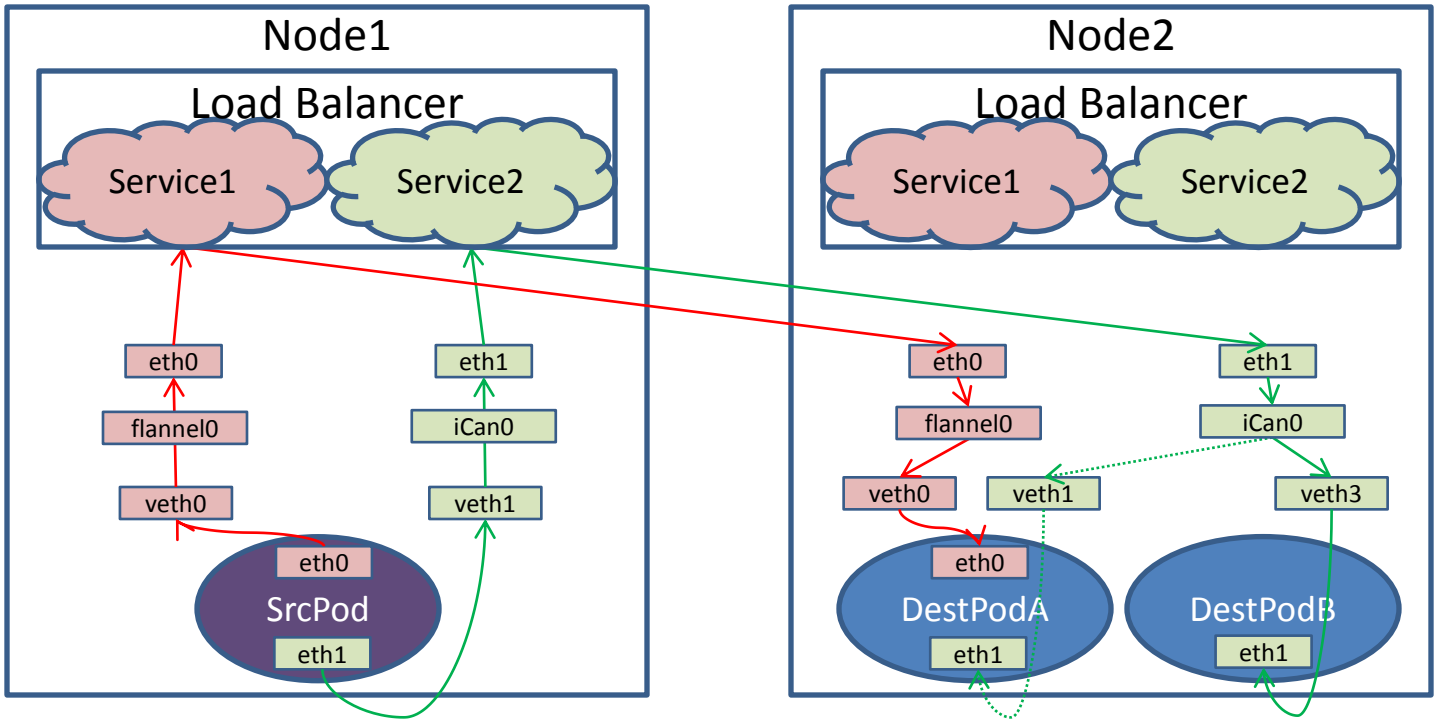
- What is CNI
  - Common container network interface specification and libraries for writing plugins to configure network interfaces in Linux containers.
- Assign IP to pod
  - Kubelet startup parameter --network-plugin=cni
  - --pod-cidr for pod IP addresses
  - Network plugin assigns one IP from the CIDR to each pod
- Many third party network plugins
  - https://github.com/containernetworking/cni

Definition of Multiple Networks

- Multiple physical networks
- Multiple logical networks
  - Multiple network interfaces per container
  - Multiple network address spaces per cluster
  - Multiple network tenants per cluster
  - …



Multiple Networks



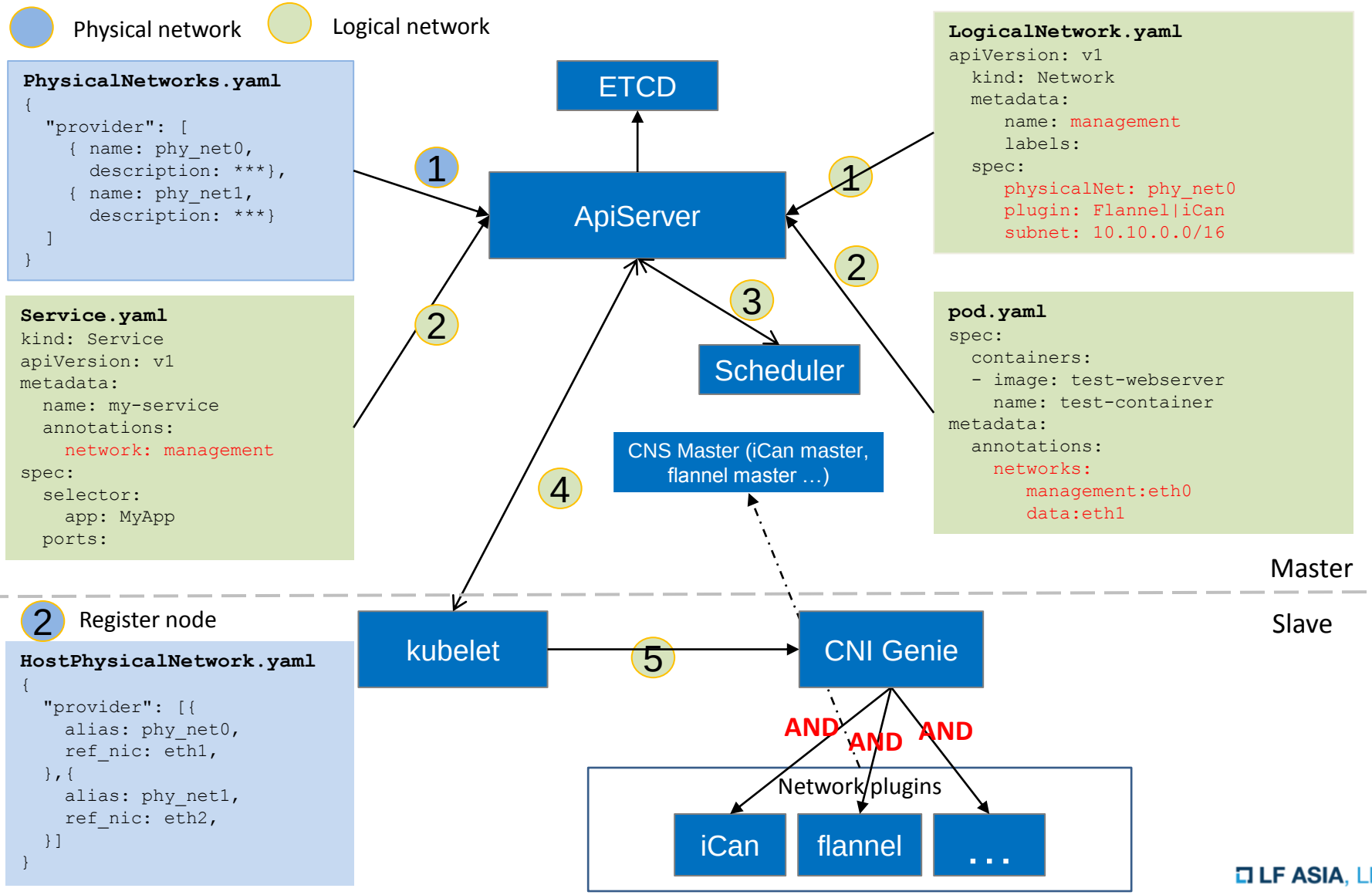
Why Multiple Networks

- Logical network abstraction
  - IP space, quota/speed, network policies
- Multiple network tenants
  - Physical isolation and logical isolation
- Use multiple network solutions
- User scenarios:
  - NFV: access to control plane, data plane and monitor plane
  - Applications that want to separate different traffic such as video streaming application
  - IPV6 co-existing with IPV4
  - Applications have both internal and public access
  - Servers that want to isolate traffic from multiple clients
  - Utilizing multiple physical NICs on host

Changes to Kubernetes

- New physical network object
- New logical network object
- Pod object with multiple networks
- Service in specific logical network
- Network based scheduling
- Network tenancy – isolation, bandwidth, QPS limiting etc

Multiple Network Workflow



Network Tenancy Requirements

- Network isolation among tenants
  - Limit access to other tenants' containers/services
  - Limit access to host network
  - Limit access to other tenant's network resources like load balancers and DNS records
- Network connectivity
  - Containers have internet access
  - Allow services to have external IP for ingress
  - Access other tenants' containers/services

Network Tenancy How

- Logical network, Kubernetes namespace and tenant mappings
- Network isolation:
  - Physical isolation
  - IPTables
  - VLAN/VXLAN
- DNS isolation – access control, dedicated DNS
- Gateway for ingress/egress
- Misc:
  - NodePort?
  - Support multiple namespaces and/or multiple logical networks in one tenant
  - Network based scheduling
  - Network quota allocation
  - Tenancy in federated clusters, cross data center or region

CNI-Genie

- Multiple physical and logical networks
- Adaptor to any network plug-in
- Network isolation with policy
- Admission control: validation, access control, scheduling
- SLA monitoring and enforcement

Example Usage

List of slave nodes

```
SHA1000136564:/home/test # /opt/paas/kubernetes/kubectl --client-certificate=tls.crt --client-key=tls.key --certificate-authority=ca.crt -s
https://100.106.74.140:5443 get nodes -n multinet
NAME         STATUS    AGE
multinet-1   Ready     5d
multinet-2   Ready     6d
multinet-3   Ready     6d
```

Node description

```
SHA1000136564:/home/test # /opt/paas/kubernetes/kubectl --client-certificate=tls.crt --client-key=tls.key --certificate-authority=ca.crt -s
https://100.106.74.140:5443 get node multinet-1 -n multinet -o yaml
apiVersion: v1
kind: Node
metadata:
  annotations:
    network.alpha.kubernetes.io/mappings: networkmapping1
    volumes.kubernetes.io/controller-managed-attach-detach: "true"
  creationTimestamp: 2017-06-08T06:18:15Z
  enable: true
  labels:
    beta.kubernetes.io/arch: amd64
    beta.kubernetes.io/os: linux
    kubernetes.io/hostname: multinet-1
    network.alpha.kubernetes.io/phynet1: eth1
    os.architecture: amd64
```

List of Physical Networks

```
SHA1000136564:/home/test # /opt/paas/kubernetes/kubectl --client-certificate=tls.crt --client-key=tls.key --certificate-authority=ca.crt -s
https://100.106.74.140:5443 get pn
NAME      TYPE         PVID      AGE
phynet1   overlay_l2   1         6d
```

List of Logical Networks

```
SHA1000136564:/home/test # /opt/paas/kubernetes/kubectl --client-certificate=tls.crt --client-key=tls.key --certificate-authority=ca.crt -s
https://100.106.74.140:5443 get net
NAME      PHYNET     TYPE         SUBNET          AGE
net1      phynet1    overlay_l2   122.20.0.0/16   6d
```

Example Usage

Deploy pod

```
root@root1-ThinkPad-T440p:/home/root1/app-yamls/new-crd-yamls# cat app-weave-flannel-multi.yaml | grep -e "^" -e "networks" -e "eth"
apiVersion: v1
kind: Pod
metadata:
  name: nginx-logicalnet-wv-flnl-multi5555
  labels:
    app: web
  annotations:
    cni: ""
    networks: net1:eth0,net2:eth4
spec:
  containers:
    - name: key-value-store
      image: busybox
      command : ["top"]
      imagePullPolicy: IfNotPresent
```

```
root@root1-ThinkPad-T440p:/home/root1/app-yamls/new-crd-yamls# kubectl create -f app-weave-flannel-multi.yaml
pod "nginx-logicalnet-wv-flnl-multi5555" created
root@root1-ThinkPad-T440p:/home/root1/app-yamls/new-crd-yamls# kubectl get pods | grep -e "^" -e "nginx-logicalnet-wv-flnl-multi5555"
NAME                                READY     STATUS    RESTARTS   AGE
nginx-logicalnet-wv-flnl-multi5555   1/1       Running   0          17s
```

Example Usage

Query pod

```
SHA1000136564:/home/test # /opt/paas/kubernetes/kubectl --client-certificate=tls.crt --client-key=tls.key --certificate-authority=ca.crt -s
https://100.106.74.140:5443 get pods -n multinet -o wide
NAME                    READY     STATUS    RESTARTS   AGE       IP                          NODE
fuxi-72bds              1/1       Running   0          6d        100.106.122.158             multinet-3
fuxi-qltmm              1/1       Running   0          6d        100.106.122.215             multinet-2
fuxi-x08dj              1/1       Running   0          5d        100.106.75.232              multinet-1
nginx                   1/1       Running   0          4m        172.16.0.99,122.20.0.99     multinet-1
```

```
root@karun-cni-dev:~/yamls/demo# kubectl exec -ti nginx-multiip-per-container ip a | highlight -w red+b '10.32.*' -w red+b 'eth1' -w green+b
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
3: eth0@if48337: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1400 qdisc noqueue state UP group default
    link/ether d6:76:c9:d5:46:7d brd ff:ff:ff:ff:ff:ff
    inet 10.244.0.167/32 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d476:c9ff:fed5:467d/64 scope link
       valid_lft forever preferred_lft forever
48338: eth1@if48339: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1376 qdisc noqueue state UP group default
    link/ether ca:5b:2b:e4:be:50 brd ff:ff:ff:ff:ff:ff
    inet 10.32.0.3/12 scope global eth1
       valid_lft forever preferred_lft forever
    inet6 fe80::c85b:2bff:fee4:be50/64 scope link
       valid_lft forever preferred_lft forever
```

More?

Code repository: https://github.com/Huawei-PaaS/CNI-Genie/

Watch demo videos:

- Physical network and logical network: https://asciinema.org/a/xU5JJEJwq11LS3yiqnlyJRCZh
- Multiple IPs per pod:
- https://asciinema.org/a/120338
- Co-existence of multiple plugins:
- https://asciinema.org/a/120279
- CNI-Genie admission control: https://asciinema.org/a/KLptT8j37JNjBTwkxZpgvkbui
- Network policy controller: https://asciinema.org/a/kn4J3PCDx0Hzj3Me7A19qrnsW

Thank you

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