Tutorial: Kubernetes BGP True Load Balancer for Datacenters

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MetalLB

Abstract

- LoadBalancer is a highly sought-after Kubernetes service, but it lacks an out-of-the-box solution for on-premises clusters.
- This presents a challenge for operators who have limited options like "NodePort" that come with drawbacks for production environments.

Kind

CONTAINERlab

MetalLB

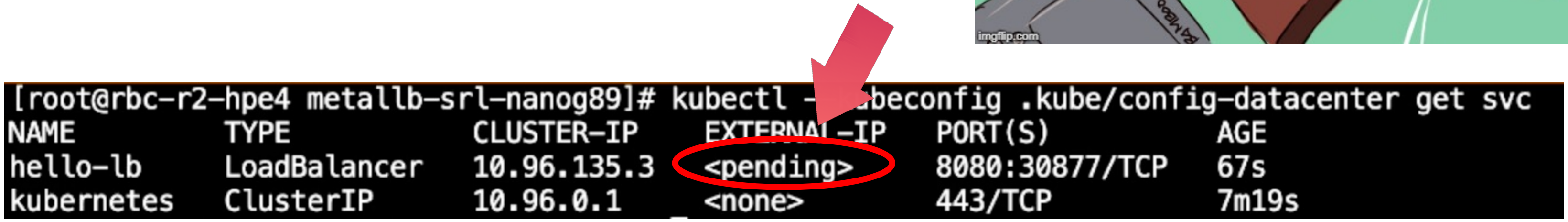
Abstract

- MetalLB comes to the rescue by seamlessly integrating with your Kubernetes cluster, providing a network load balancer implementation.
- By leveraging standard routing protocols and tight integration with your Datacenter Fabric, such as BGP and ECMP, MetalLB enables the creation of Load Balancer services in non-cloud environments.
- In this tutorial, we will guide you through building your own container-based lab to explore and experience MetalLB firsthand.

Kind CONTAINERlab MetalLB

Why should I care?

- Kubernetes does not offer, by default, an implementation of a Load Balancer service for on-premises clusters



```
[root@rbc-r2-hpe4 metallb-srl-nanog89]# kubectl --kubeconfig .kube/config-datacenter get svc
NAME         TYPE           CLUSTER-IP     EXTERNAL-IP   PORT(S)          AGE
hello-lb     LoadBalancer   10.96.135.3    <pending>     8080:30877/TCP   67s
kubernetes   ClusterIP      10.96.0.1      <none>        443/TCP          7m19s
```

What would I get here?

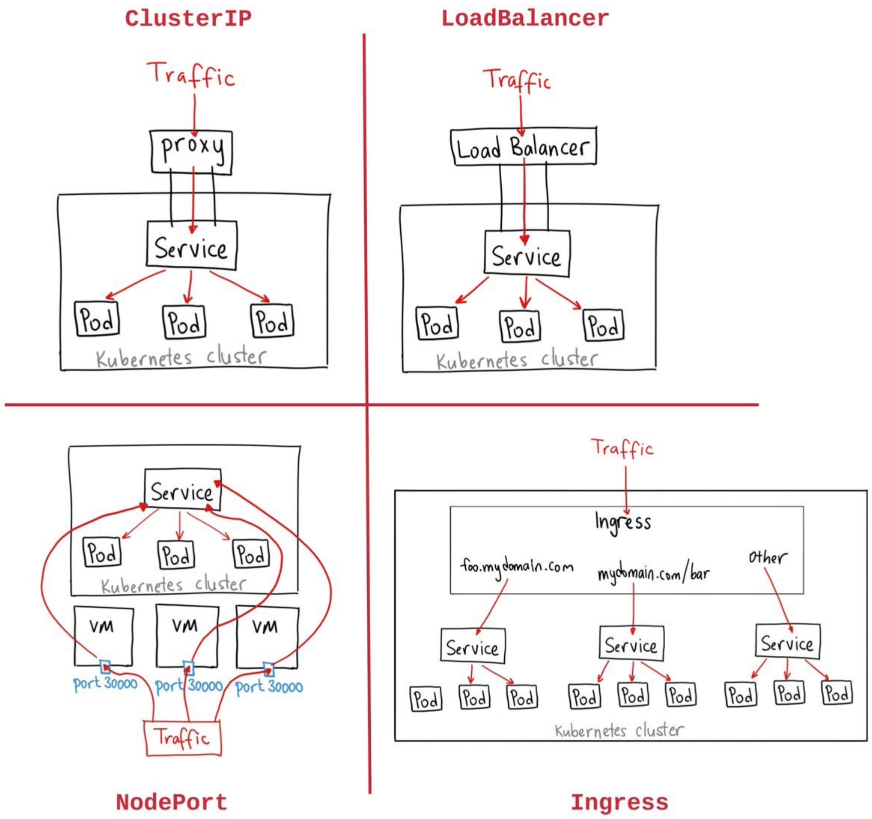
In this tutorial you will see:

- Intro
    - Kubernetes Load Balancer Services
    - MetalLB
    - Kubernetes Kind
- How to create a network lab using containerlab and Kind
- How to set up and test a BGP Load Balancer Services Between your Fabric and Kubernetes.
    - We'll walk around BGP and ECMP settings

K8s Native Services : What/Why?

- Each pod has its own IP address
- Pods are ephemeral – are destroy frequently

- Kubernetes Services
  - Stable IP address
  - Load-balancing
  - Within and outside cluster

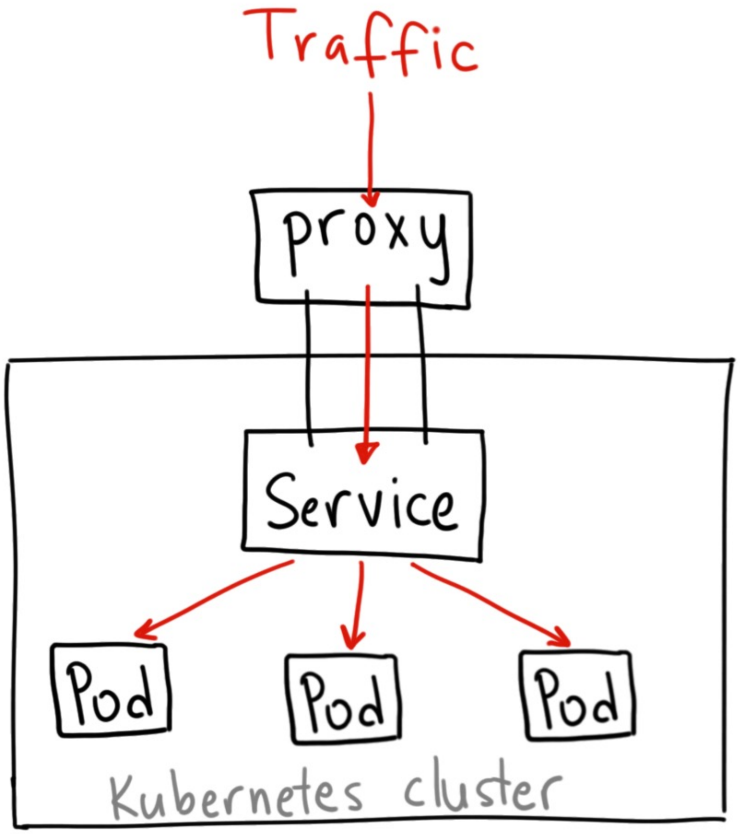


Source: https://medium.com/@kubernetes-advocate

K8s Native Services: ClusterIP

- Most common and default type
- Internal to the Cluster **only**
- Between backend/frontend pods

```
apiVersion: v1
kind: Service
metadata:
  name: "nginx-service"
  namespace: "default"
spec:
  ports:
    - port: 80
  type: ClusterIP
  selector:
    app: "nginx"
```

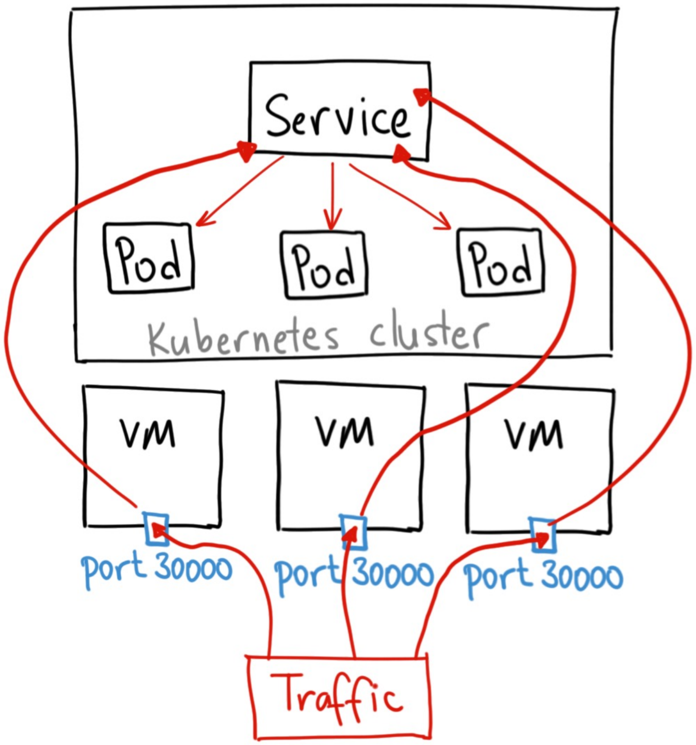


Source: https://medium.com/@kubernetes-advocate

K8s Native Services : NodePort

- 30000-32767 ports range.

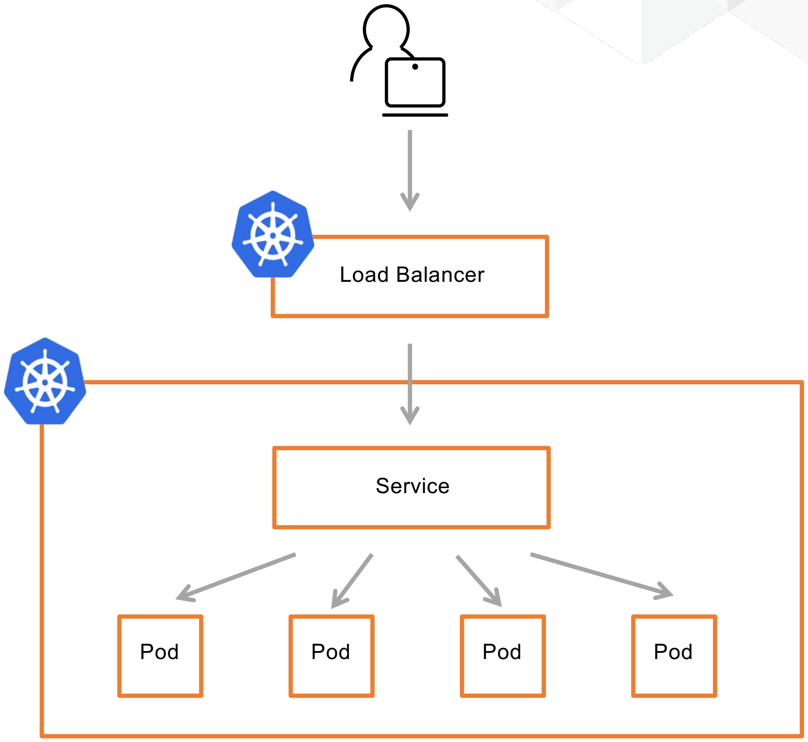
```
apiVersion: v1
kind: Service
metadata:
  name: "nginx-service"
  namespace: "default"
spec:
  ports:
    - port: 80
      nodePort: 30001
  type: NodePort
  selector:
    app: "nginx"
```



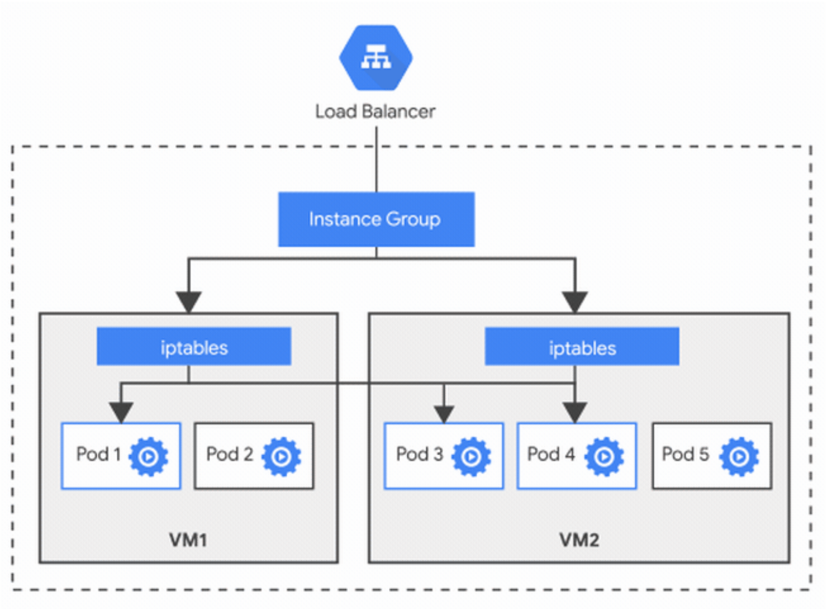
Source: https://medium.com/@kubernetes-advocate

K8s Native Services: Load Balancer

- Most popular Kubernetes Service
- Distributes network traffic among multiple Kubernetes Services.
  - Application Scalability
  - Containers are used more efficiently
  - Maximize the availability of your Services
- Elastic, Distributed and Easy to Orchestrate than physical/virtual appliances.
- In conjunction with an Ingress Controller. Can bring important benefits:
  - SSL Offload
  - App routing



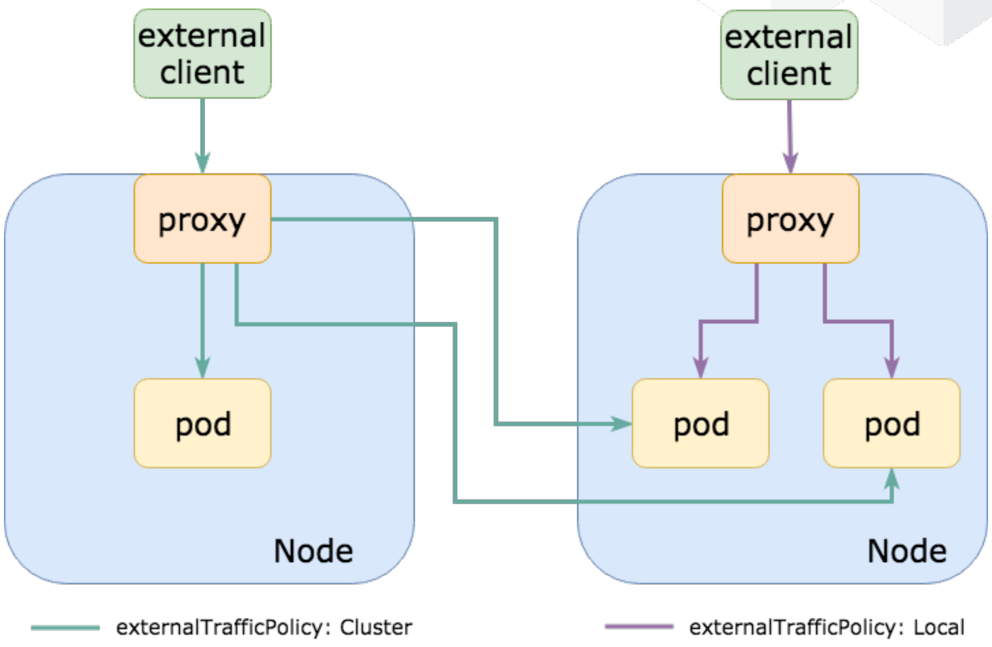
GKE Load Balancer Example



```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ilb-deployment
spec:
  replicas: 3
  selector:
    matchLabels:
      app: ilb-deployment
  template:
    metadata:
      labels:
        app: ilb-deployment
    spec:
      containers:
      - name: hello-app
        image: us-docker.pkg.dev/google-
samples/containers/gke/hello-app:1.0
```

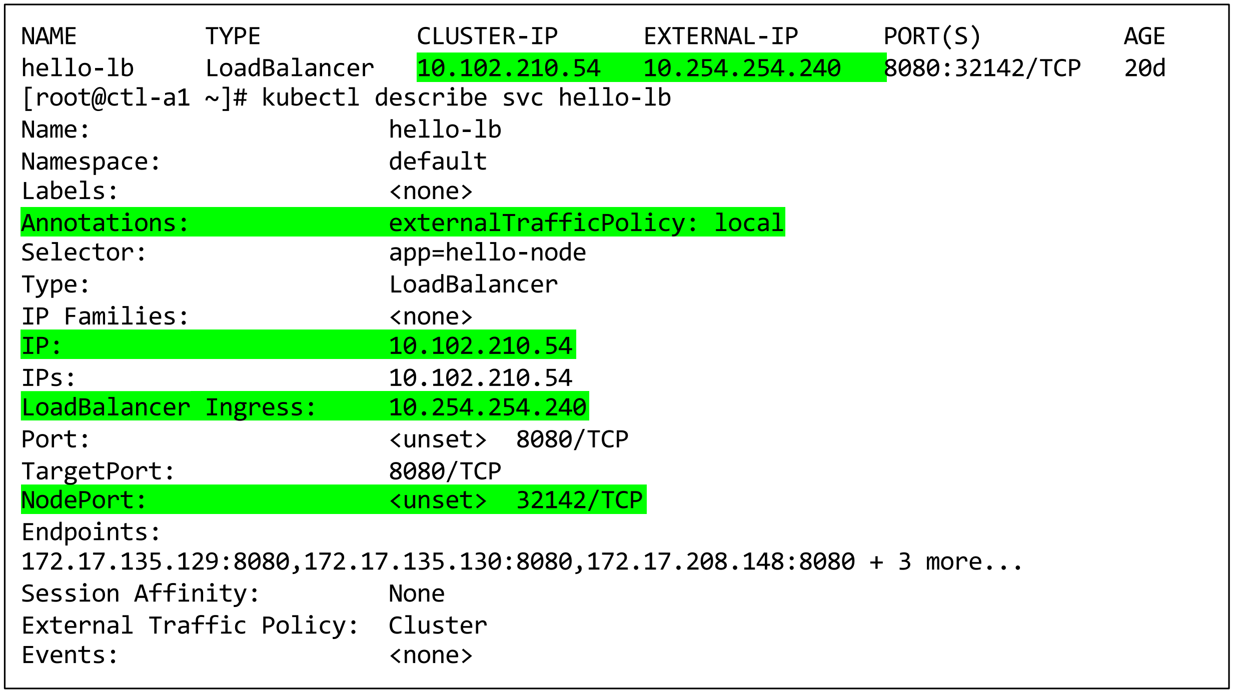
externalTrafficPolicy: Cluster or Local

- **externalTrafficPolicy** routes external traffic to node-local or cluster-wide endpoints.
- "Local" preserves the client source IP and avoids a second hop for LoadBalancer and NodePort type services.
- "Cluster" obscures the client source IP and may cause a second hop to another node.

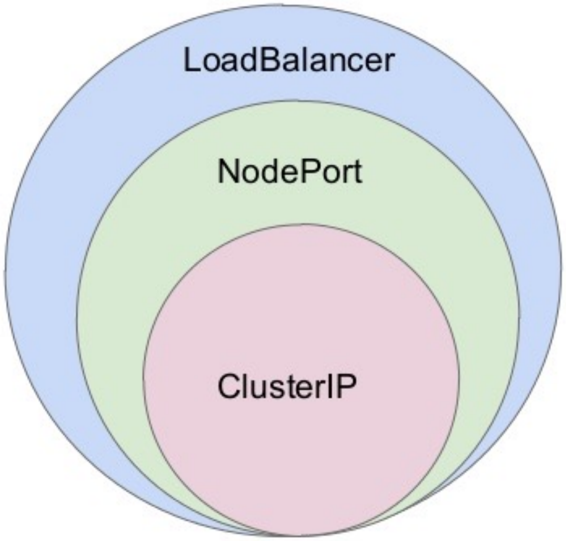


Proxy: iptables proxy rules for Service ExternalIPs or NodePort

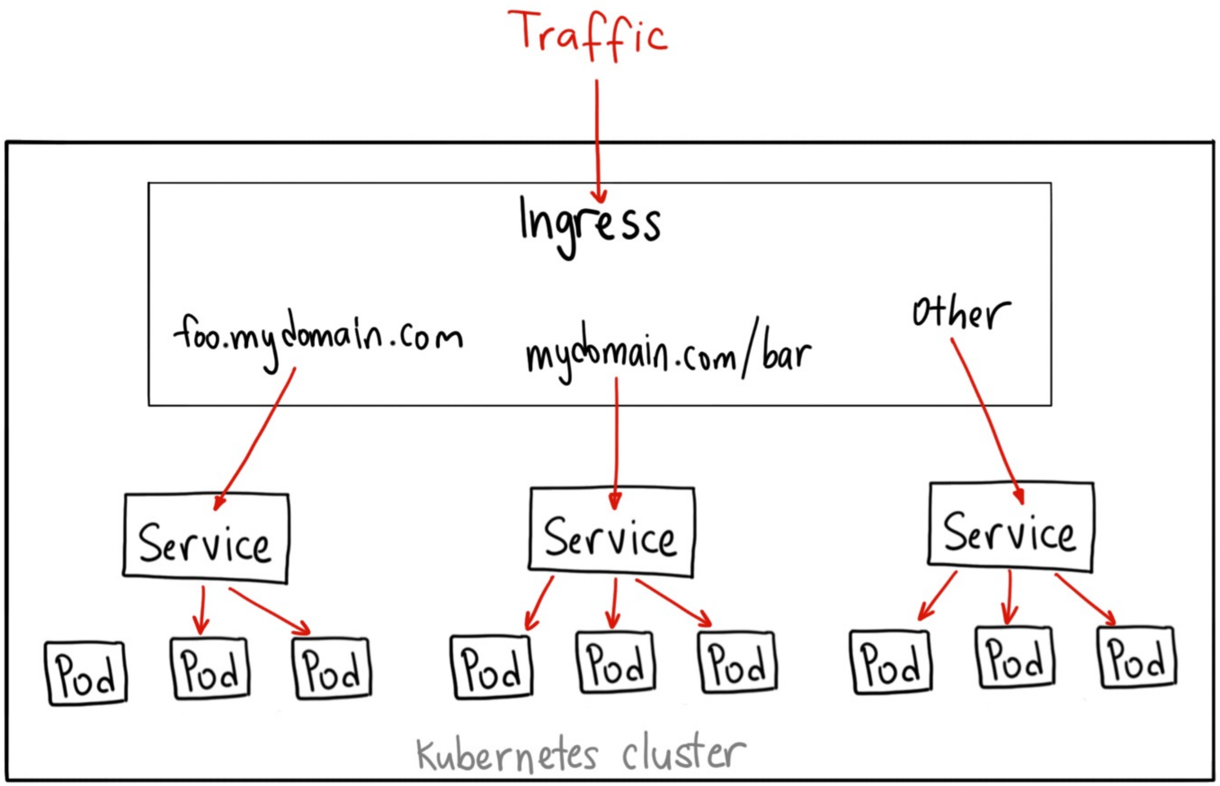
K8s Services: LoadBalancer



```
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP      PORT(S)          AGE
hello-lb     LoadBalancer   10.102.210.54   10.254.254.240   8080:32142/TCP   20d
[root@ctl-a1 ~]# kubectl describe svc hello-lb
Name:                     hello-lb
Namespace:                default
Labels:                   <none>
Annotations:              externalTrafficPolicy: local
Selector:                 app=hello-node
Type:                     LoadBalancer
IP Families:              <none>
IP:                       10.102.210.54
IPs:                      10.102.210.54
LoadBalancer Ingress:     10.254.254.240
Port:                     <unset>  8080/TCP
TargetPort:               8080/TCP
NodePort:                 <unset>  32142/TCP
Endpoints:
172.17.135.129:8080,172.17.135.130:8080,172.17.208.148:8080 + 3 more...
Session Affinity:         None
External Traffic Policy:  Cluster
Events:                   <none>
```



K8s Services : Ingress



Source: https://medium.com/@kubernetes-advocate

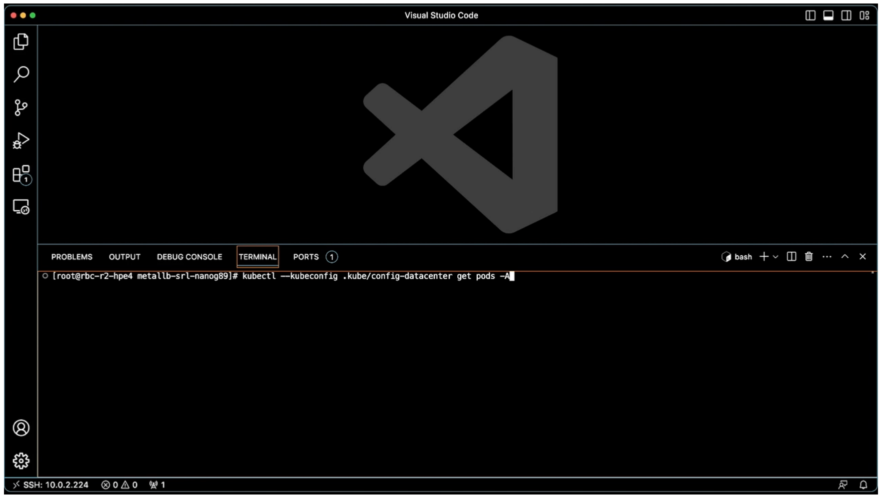
K8s Services : Ingress

```
apiVersion: v1
kind: Service
metadata:
  name: "nginx-1-service"
  namespace: "default"
spec:
  ports:
    - port: 80
  type: NodePort
  selector:
    app: "nginx-1"
---
apiVersion: v1
kind: Service
metadata:
  name: "nginx-2-service"
  namespace: "default"
spec:
  ports:
    - port: 80
  type: NodePort
  selector:
    app: "nginx-2"
```

```
---
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: "nginx-ingress"
  annotations:
    kubernetes.io/ingress.class: alb
    alb.ingress.kubernetes.io/scheme: internet-facing
  labels:
    app: "nginx"
spec:
  rules:
  - http:
      paths:
      - path: /svc1.html
        backend:
          serviceName: "nginx-1-service"
          servicePort: 80
      - path: /svc2.html
        backend:
          serviceName: "nginx-2-service"
          servicePort: 80
```

Why should I care?

- Kubernetes does not offer, by default, an implementation of it for on-premises clusters



```
[root@rbc-r2-hpe4 metallb-srl-nanog89]# kubectl —-kubeconfig .kube/config-datacenter get pods -A
```

K8s Apps providing Load Balancing capabilities (on-premises)

NGNIX Ingress Controller

- SSL termination, load balancing, path-based routing, and traffic control
- Large and active community
- Extensive documentation

Traefik

- Automatic configuration, dynamic routing, SSL certificate management, and multiple service discovery mechanisms
- Ease of use

HAProxy

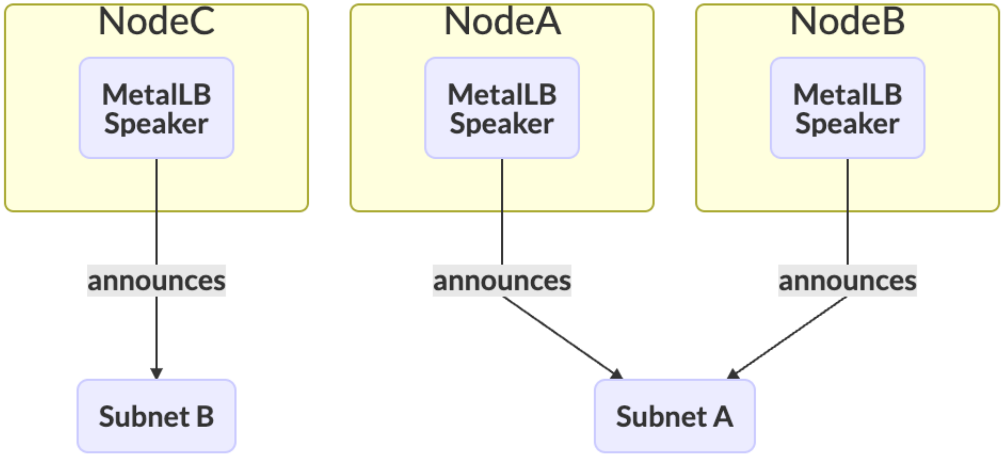
- Widely-used load balancer
- Robust performance and scalability

MetalLB

- **LoadBalancer service type**
- Simple and flexible
- Popular in on-premises and bare metal environments.

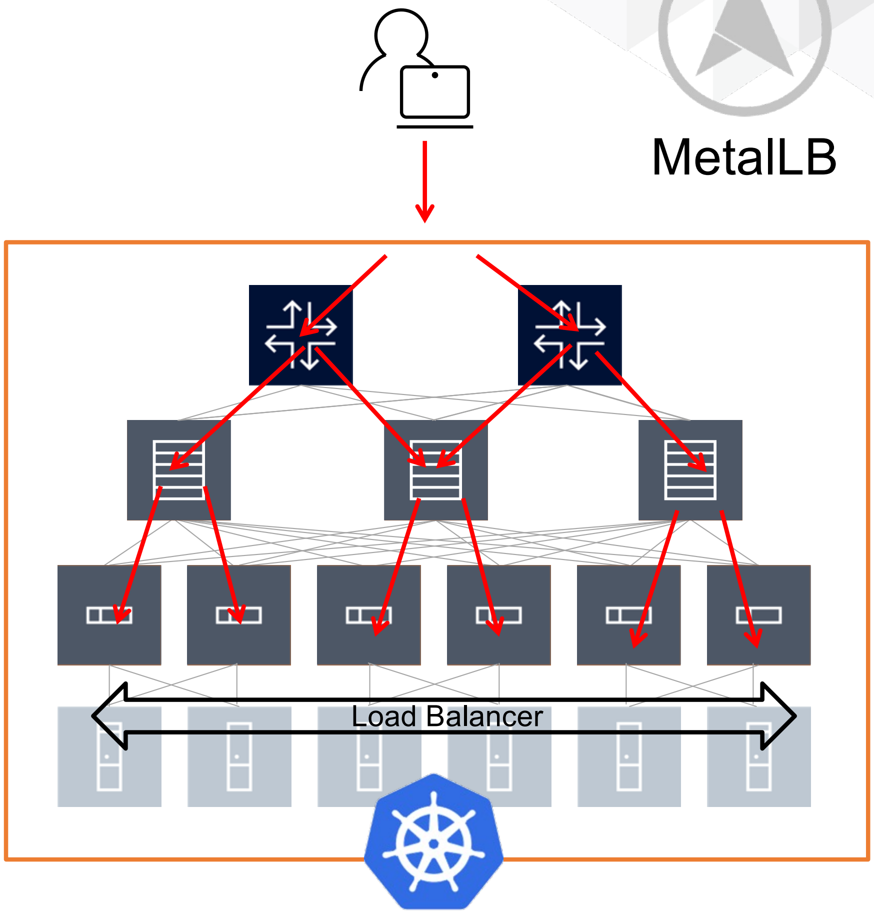
MetalLB: Layer2 Configuration

- In L2 mode, only one node is elected to announce the IP from.
- Normally, all the nodes where a Speaker is running are eligible for any given IP.
- There can be scenarios where only a subset of the nodes are exposed to a given network, so it can be useful to limit only those nodes as potential entry points for the service IP.
- This is achieved by using the node selector in the L2Advertisement CR.



BGP Mode K8s Load Balancer

- BGP-based leaf-switch implements stateless load balancing
  - Add Ingress for Stateful
- No Bottlenecks.
  - BGP brings distribution across the Network.
- Resilient
  - Fast failover
  - BFD support (Experimental and no included in this demo)
- Enables True Load Balancing via ECMP
- Traffic control: Cluster vs Local



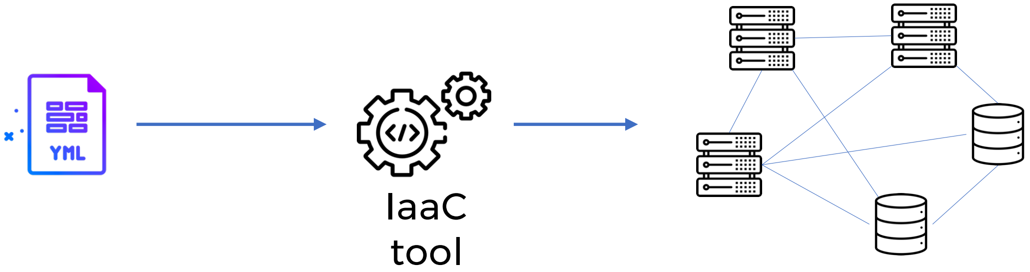
Yep! Another element in the network

The moment you realize Kubernetes will be another element in the network (a BGP peer for the leaf switches)

Demo Setup

Clab: Bringing declarativeness to networking labs

IT

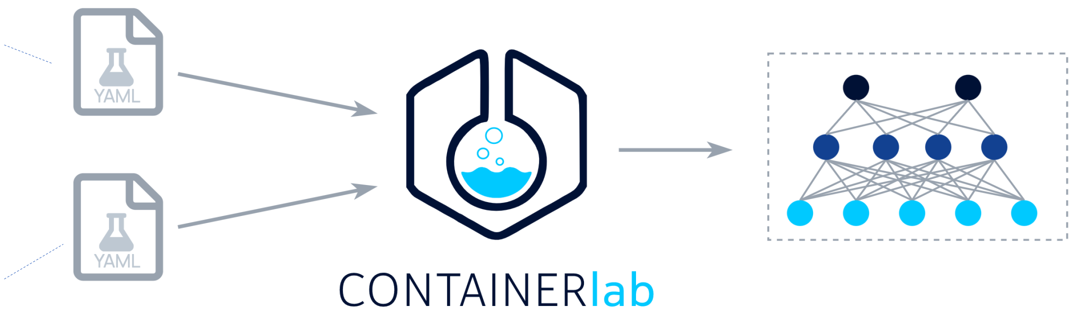


Network Labs

```
name: mylab

topology:
  nodes:
          :
          :

  links:
   -      :
```



Containerlab: Installation

Installation commands for Fedora33

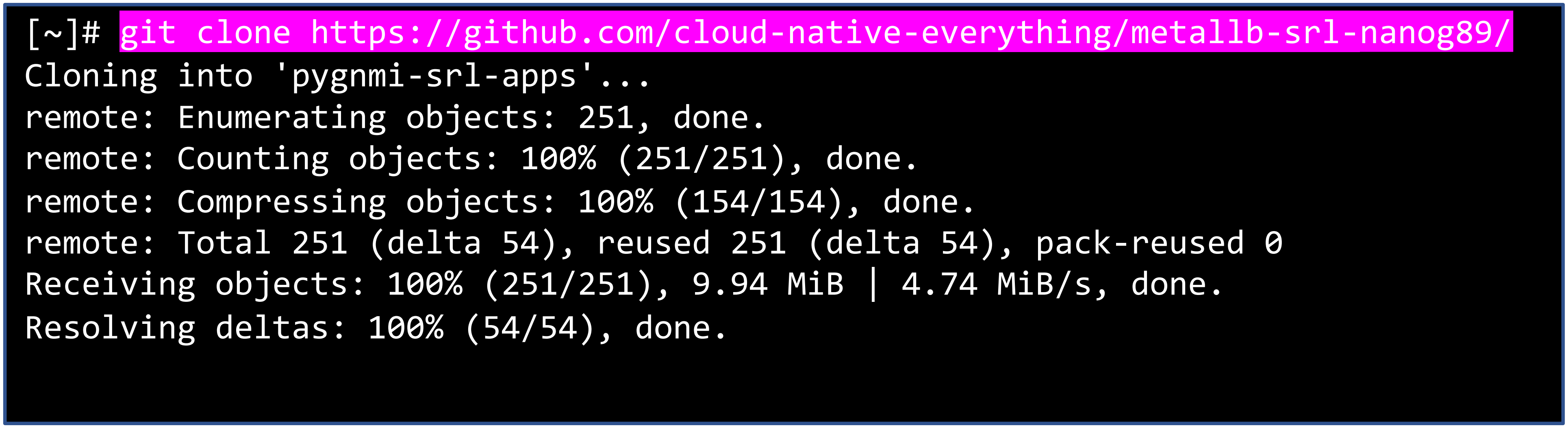
```
# Install docker
sudo dnf -y install docker
sudo systemctl start docker
sudo systemctl enable docker

# Install containerlab
bash -c "$(curl -sL https://get.containerlab.dev)"
```

https://containerlab.dev/install/

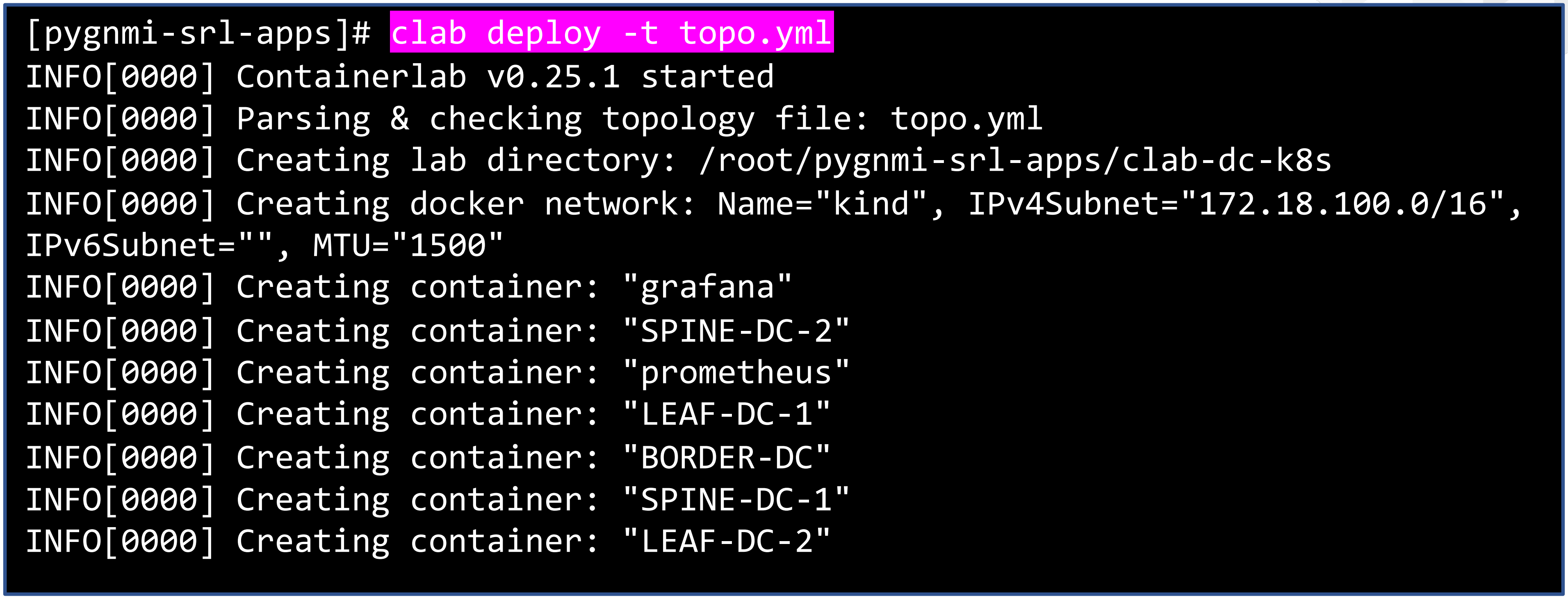
Using git repo for this tutorial

https://github.com/cloud-native-everything/metallb-srl-nanog89/



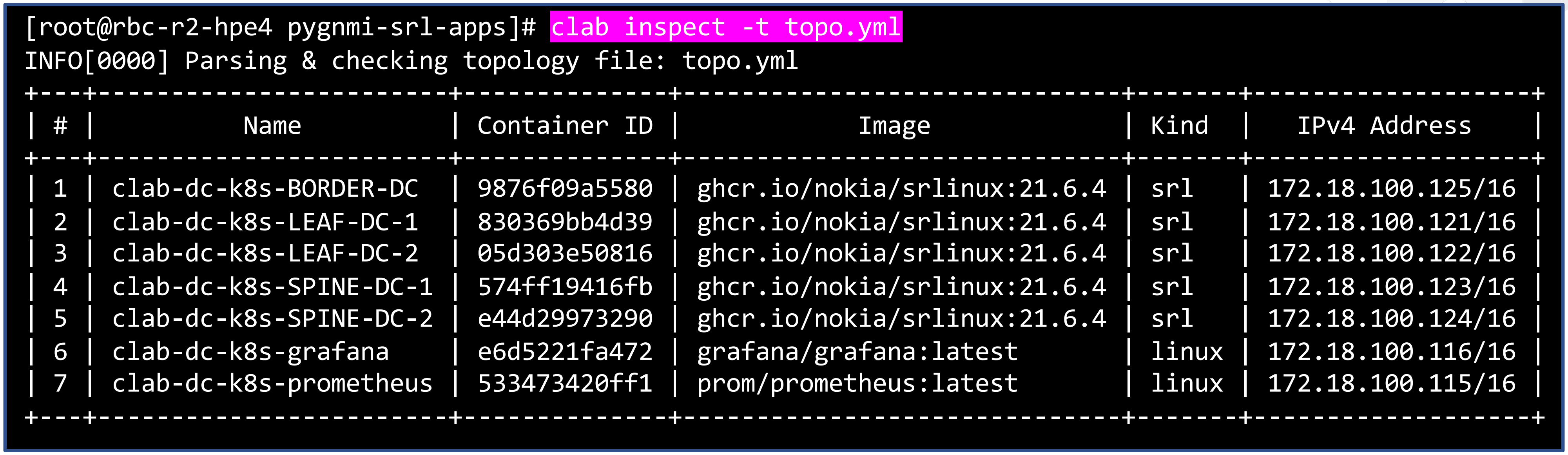
```
[~]# git clone https://github.com/cloud-native-everything/metallb-srl-nanog89/
Cloning into 'pygnmi-srl-apps'...
remote: Enumerating objects: 251, done.
remote: Counting objects: 100% (251/251), done.
remote: Compressing objects: 100% (154/154), done.
remote: Total 251 (delta 54), reused 251 (delta 54), pack-reused 0
Receiving objects: 100% (251/251), 9.94 MiB | 4.74 MiB/s, done.
Resolving deltas: 100% (54/54), done.
```

Creating the lab



```
[pygnmi-srl-apps]# clab deploy -t topo.yml
INFO[0000] Containerlab v0.25.1 started
INFO[0000] Parsing & checking topology file: topo.yml
INFO[0000] Creating lab directory: /root/pygnmi-srl-apps/clab-dc-k8s
INFO[0000] Creating docker network: Name="kind", IPv4Subnet="172.18.100.0/16",
IPv6Subnet="", MTU="1500"
INFO[0000] Creating container: "grafana"
INFO[0000] Creating container: "SPINE-DC-2"
INFO[0000] Creating container: "prometheus"
INFO[0000] Creating container: "LEAF-DC-1"
INFO[0000] Creating container: "BORDER-DC"
INFO[0000] Creating container: "SPINE-DC-1"
INFO[0000] Creating container: "LEAF-DC-2"
```

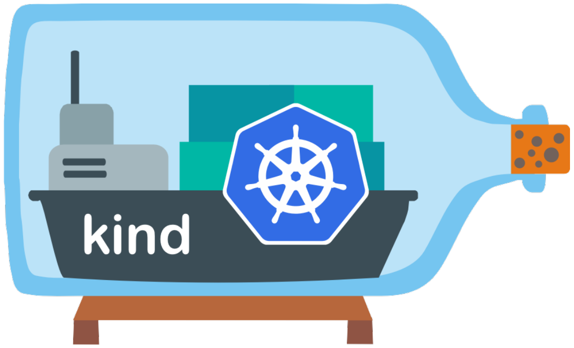
Inspecting the lab



```
[root@rbc-r2-hpe4 pygnmi-srl-apps]# clab inspect -t topo.yml
INFO[0000] Parsing & checking topology file: topo.yml
+---+-------------------------+--------------+--------------------------------+-------+-------------------+
| # |          Name           | Container ID |             Image              | Kind  |   IPv4 Address    |
+---+-------------------------+--------------+--------------------------------+-------+-------------------+
| 1 | clab-dc-k8s-BORDER-DC   | 9876f09a5580 | ghcr.io/nokia/srlinux:21.6.4 | srl   | 172.18.100.125/16 |
| 2 | clab-dc-k8s-LEAF-DC-1   | 830369bb4d39 | ghcr.io/nokia/srlinux:21.6.4 | srl   | 172.18.100.121/16 |
| 3 | clab-dc-k8s-LEAF-DC-2   | 05d303e50816 | ghcr.io/nokia/srlinux:21.6.4 | srl   | 172.18.100.122/16 |
| 4 | clab-dc-k8s-SPINE-DC-1  | 574ff19416fb | ghcr.io/nokia/srlinux:21.6.4 | srl   | 172.18.100.123/16 |
| 5 | clab-dc-k8s-SPINE-DC-2  | e44d29973290 | ghcr.io/nokia/srlinux:21.6.4 | srl   | 172.18.100.124/16 |
| 6 | clab-dc-k8s-grafana     | e6d5221fa472 | grafana/grafana:latest         | linux | 172.18.100.116/16 |
| 7 | clab-dc-k8s-prometheus  | 533473420ff1 | prom/prometheus:latest         | linux | 172.18.100.115/16 |
+---+-------------------------+--------------+--------------------------------+-------+-------------------+
```

Kind Kubernetes

- Local Kubernetes clusters using Docker container “nodes”.
- Designed for testing Kubernetes.
- Requirements:
  - go (1.17+)
  - Uses docker for node instances



https://github.com/kubernetes-sigs/kind/

NANOG™

Install K8s Kind

- You can install kind with:

```
go install sigs.k8s.io/kind@v0.18.0
```

- This will put kind in $(go env GOPATH)/bin.
  - You may need to add that directory to your $PATH as shown here if you encounter the error kind: command not found after installation.
- Kind uses docker for node instances
- Once you have docker running you can create a cluster with:

```
kind create cluster
```

Kind config

- For this demo we'll use 2 workers and one controller
- Use “`kind load`” to upload images for apps and metallb after cluster is created
  - Unless you want to setup a private registry

```
[~/kind]# cat cluster_datacenter.yaml
---
kind: Cluster
apiVersion: kind.x-k8s.io/v1alpha4
nodes:
  - role: control-plane
  - role: worker
  - role: worker
```

Connecting K8s Cluster to Clab

- You can use

`clab tools veth`

- This containerlab tool helps you to connect containers after the lab is created like for example connecting leaf switches to K8s worker nodes.

We got your back

- We have included an app (go lang) that you can use to deploy the lab and the Kubernetes clusters
- Load images
- Connect elements
- Still under development
  - Contributions are welcome

We got your back

- You can use “srklab” to deploy everything

```
./srklab start -c
srklab.yml
```

- All details of the configuration are in srklab.yml file

```
# this is the info clab tool will use to
interconnect clusters and containerlab instances
links:
- k8sNode: "datacenter-worker:e1-1"
      clabNode: "clab-dc-k8s-LEAF-DC-1:e1-10"
      k8sIpv4: "192.168.101.101/24"
      k8sIpv4Gw: "192.168.101.1"
    - k8sNode: "datacenter-worker2:e1-1"
      clabNode: "clab-dc-k8s-LEAF-DC-2:e1-10"
      k8sIpv4: "192.168.101.102/24"
      k8sIpv4Gw: "192.168.101.1"
```

We got your back

- You can use “srklab” to deploy everything

`./srklab start -c srklab.yml`

- All details of the configuration are in srklab.yml file

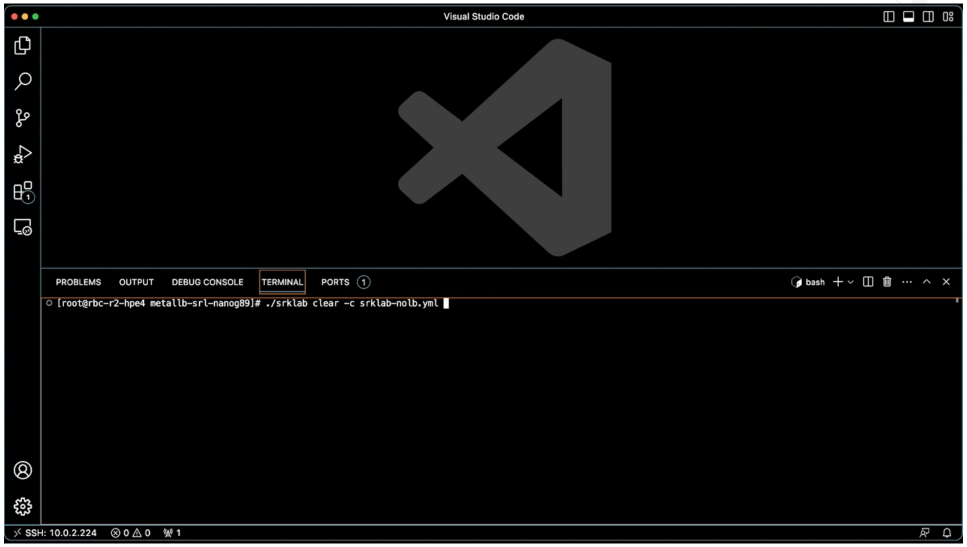
```
network: "kind"
prefix: "172.18.0.0/16"
clabTopology: "/root/srklab/topo.yml"
clusters:
- name: "datacenter"
      kubeconfig: "/root/.kube/config-datacenter"
      config: "/root/srklab/kind/cluster_datacenter.yaml"
      image: "enc-kind-worker:v1.22.2"
      imagesToLoad:
        - image: alpine:latest
        - image: python:latest
        - image: quay.io/metallb/speaker:v0.12.1
        - image: quay.io/metallb/controller:v0.12.1
      resources:
        - app: "/root/srklab//metallb/metallb-namespace.yaml"
        - app: "/root/srklab//metallb/metallb-manifest.yaml"
        - app: "/root/srklab//metallb/metallb-bgp-setup.yaml"
        - app: "/root/srklab/app/hello-app-python-datacenter.yaml"
        - app: "/root/srklab/app/hello-app-lb-datacenter.yaml"
```

Starting the lab

- You can use “srklab” to deploy everything

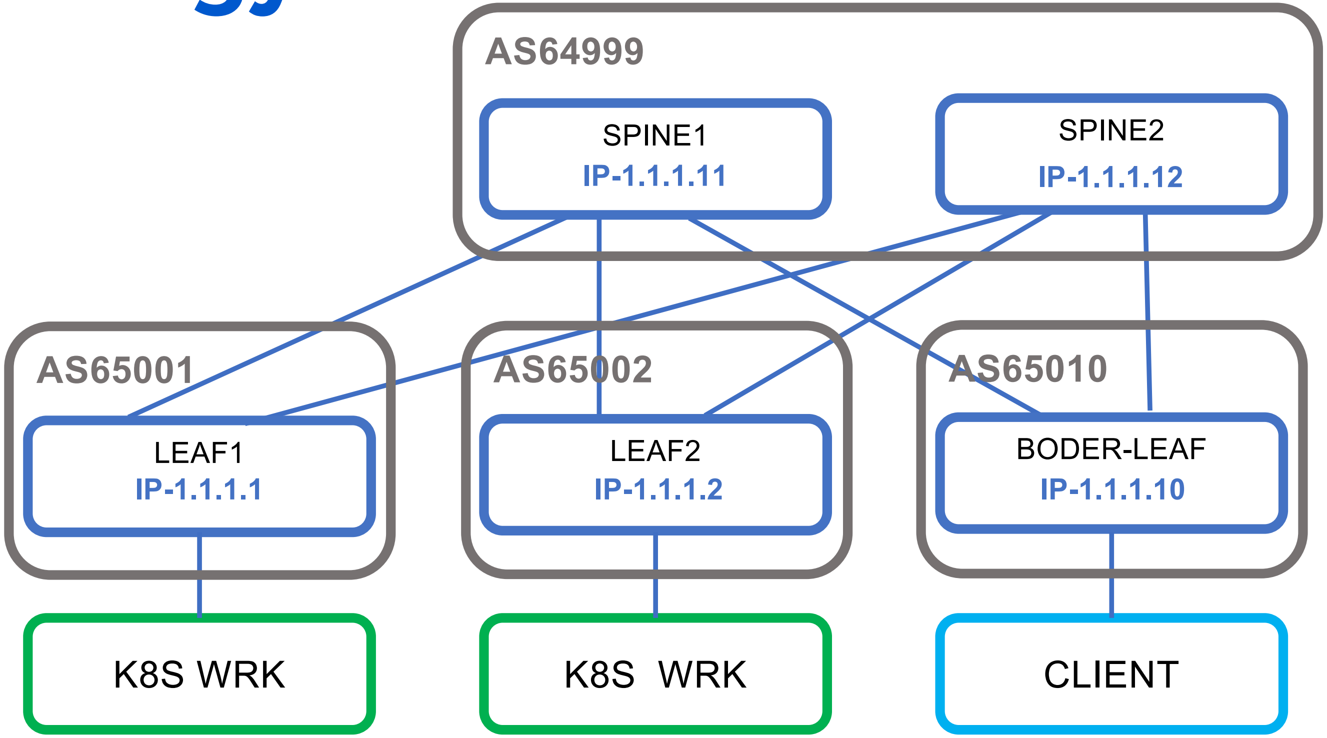
```
./srklab start -c srklab-nolb.yml
```

- Removing app load balancer setup from configuration file

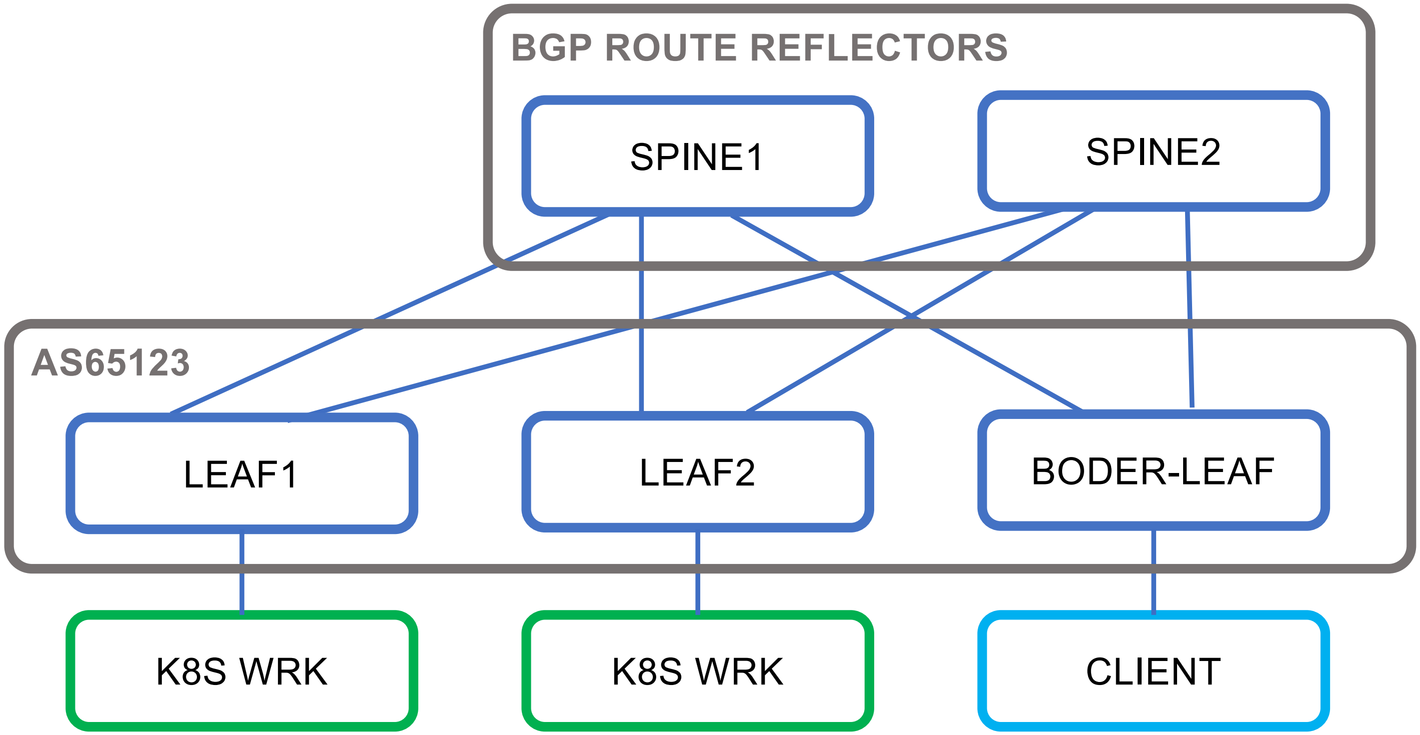


```
○ [root@rbc-r2-hpe4 metallb-srl-nanog89]# ./srklab clear -c srklab-nolb.yml
```

Lab Topology: eBGP Underlay Topology

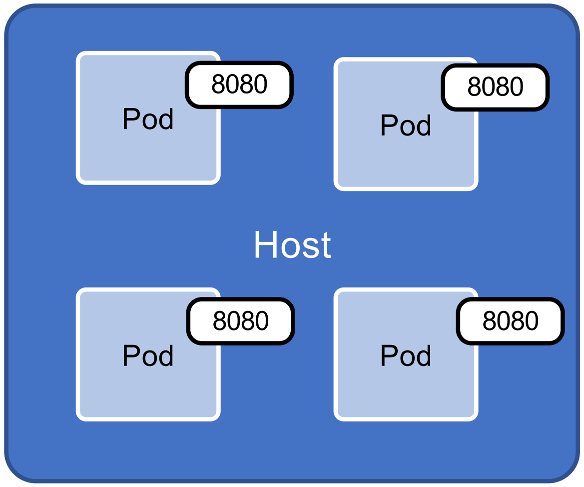


Lab Topology: iBGP EVPN Overlay



Pods and Containers

- Every Pod has a unique IP address
- IP address reachable from all other Pods in the K8s cluster

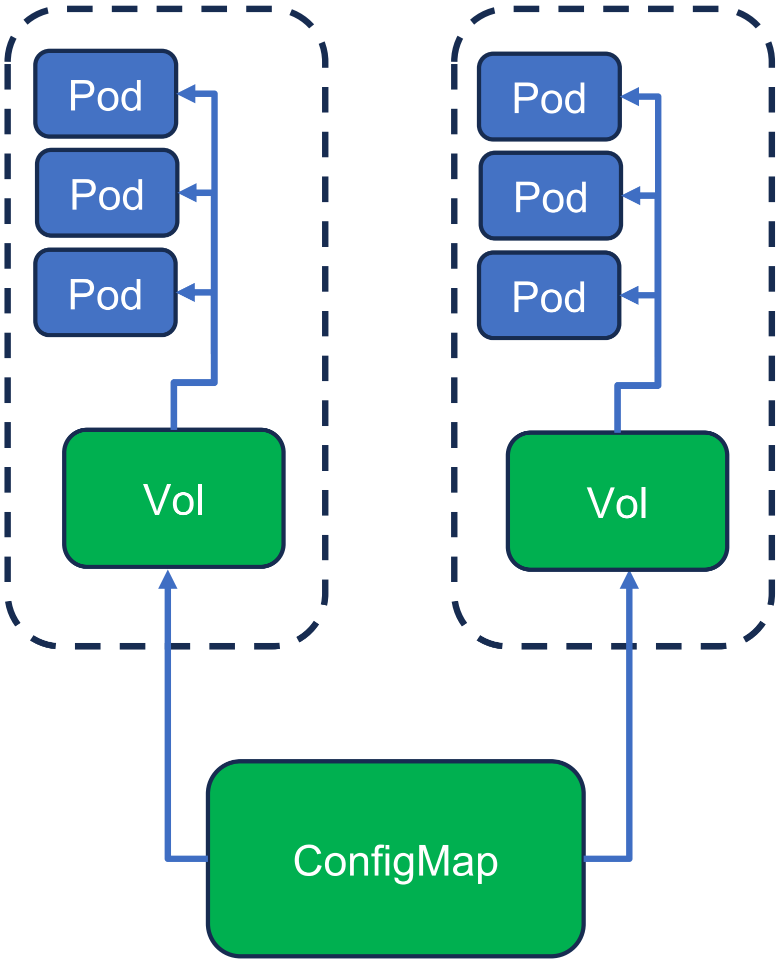


No conflicts

```
apiVersion: v1
kind: Pod
metadata:
  name: postgress
  labels:
    app: postgress
spec:
  containers:
    - name: postgress
      image: postgress:9.6.17
      ports:
       - containerPort: 80
       env:
       - name: POSTGRESS_PASSWORD
           value: “pwd”
```

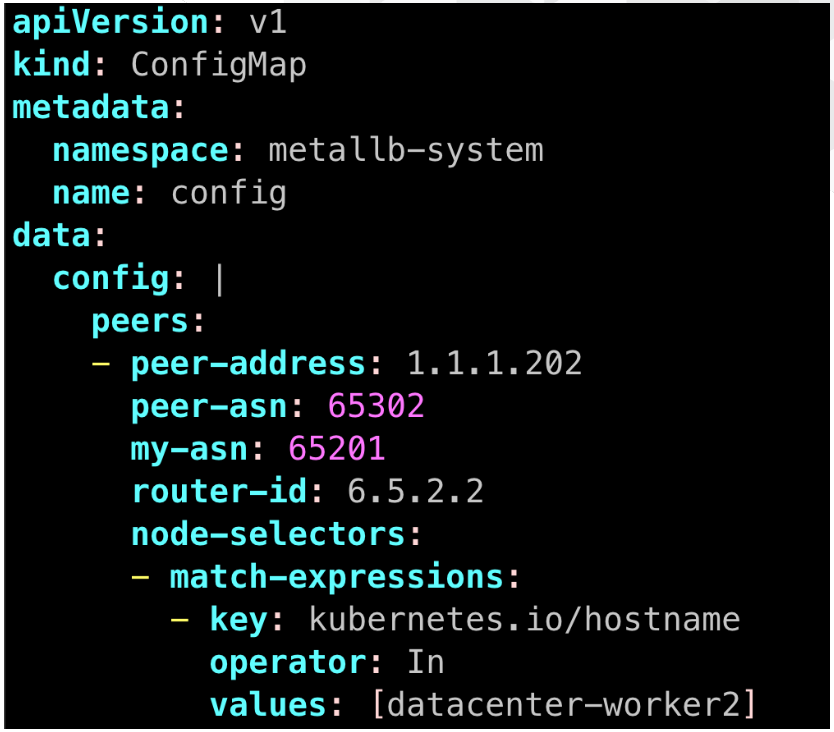
ConfigMap

- An API object
- Non-confidential data in key-value pairs
- Pods can consume ConfigMaps
  - Environment variables
  - Command-line arguments
  - **Configuration files in a volume**

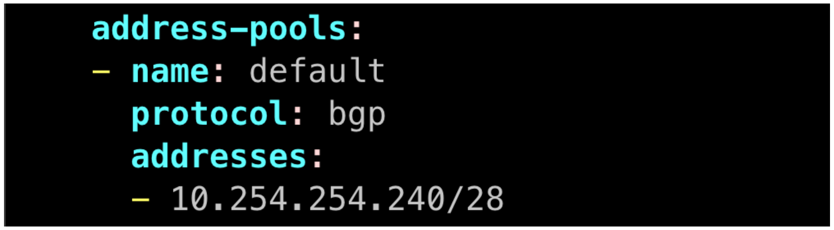


MetalLB BGP setup

- Setting up ConfigMap
  - Currently using CRDs
- BGP Peers (EVPN Subnet)
- Local and peer ASN
- Address Pool
- Speakers



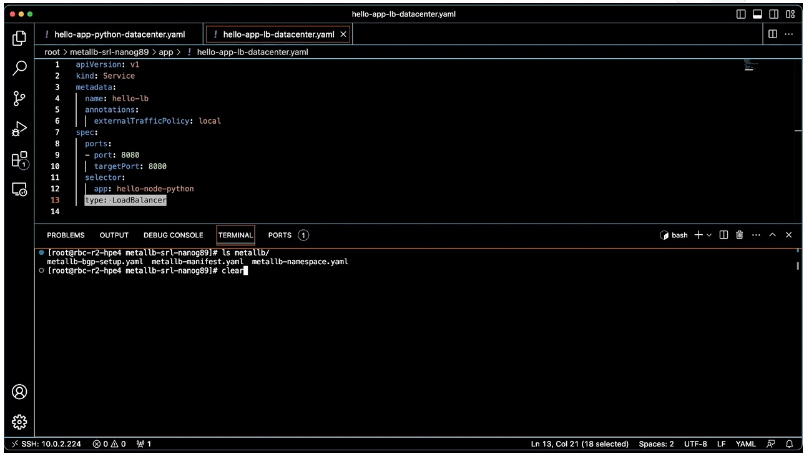
```
apiVersion: v1
kind: ConfigMap
metadata:
  namespace: metallb-system
  name: config
data:
  config: |
    peers:
    - peer-address: 1.1.1.202
      peer-asn: 65302
      my-asn: 65201
      router-id: 6.5.2.2
      node-selectors:
      - match-expressions:
        - key: kubernetes.io/hostname
          operator: In
          values: [datacenter-worker2]
```



```
    address-pools:
    - name: default
      protocol: bgp
      addresses:
      - 10.254.254.240/28
```

MetalLB BGP setup

- Setting up ConfigMap
  - Currently using CRDs
- BGP Peers (EVPN Subnet)
- Local and peer ASN
- Address Pool
- Speakers

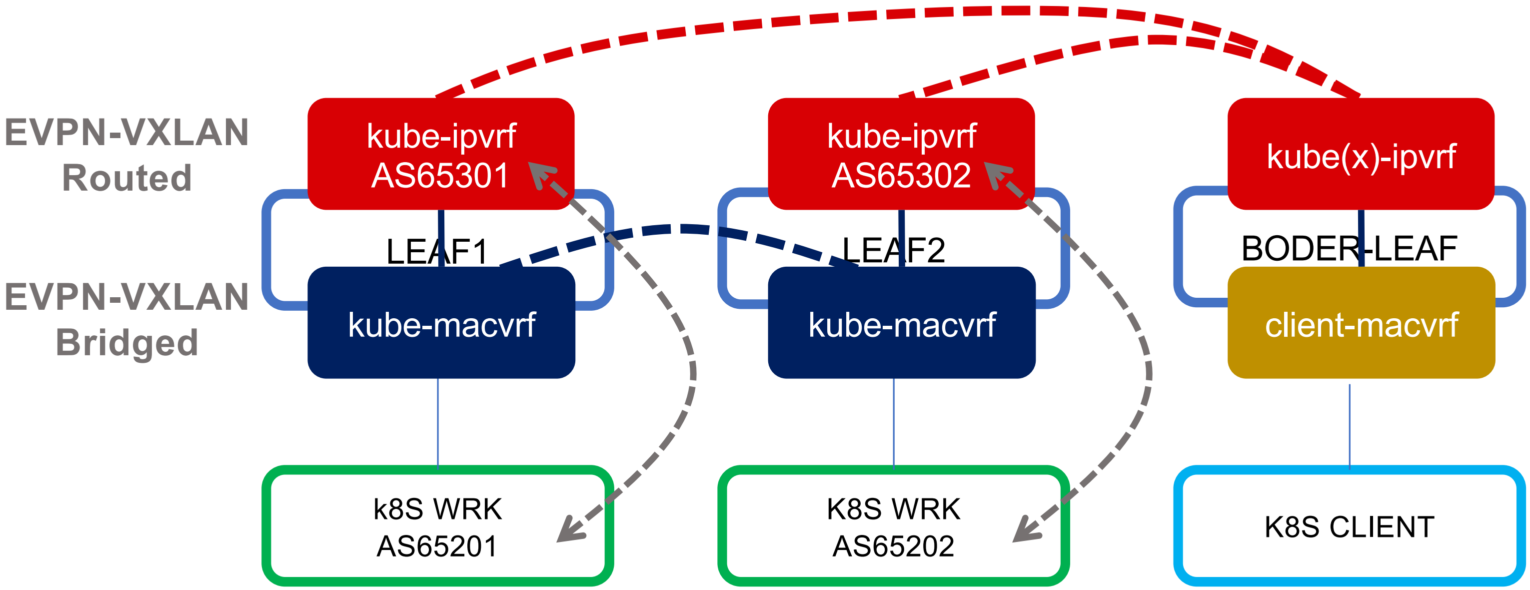


```
apiVersion: v1
kind: Service
metadata:
  name: hello-lb
  annotations:
    externalTrafficPolicy: local
spec:
  ports:
  - port: 8080
    targetPort: 8080
  selector:
    app: hello-node-python
  type: LoadBalancer

```

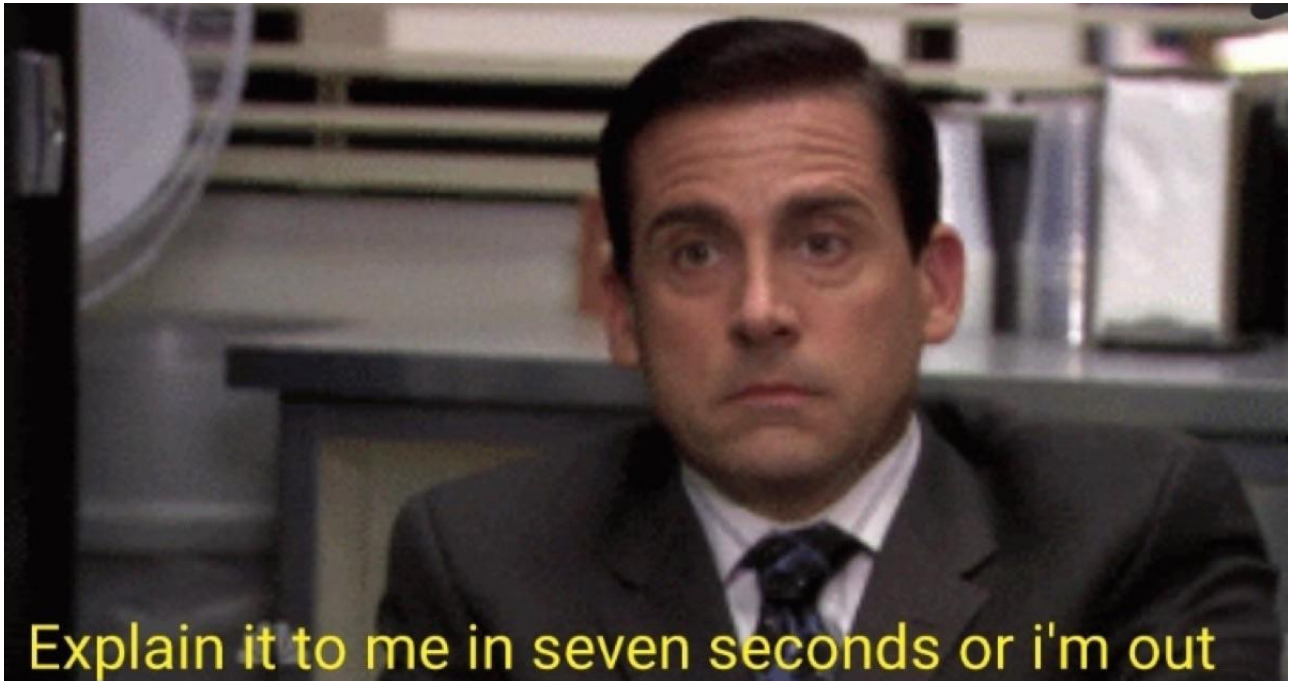
```
[root@rbc-r2-hpe4 metallb-srl-nanog89]# ls metallb/
metallb-bgp-setup.yaml  metallb-manifest.yaml  metallb-namespace.yaml
[root@rbc-r2-hpe4 metallb-srl-nanog89]# clear
```

Lab Topology: iBGP EVPN Overlay



Python Simple HTTP Server

- Stateless Simple HTTP Python App



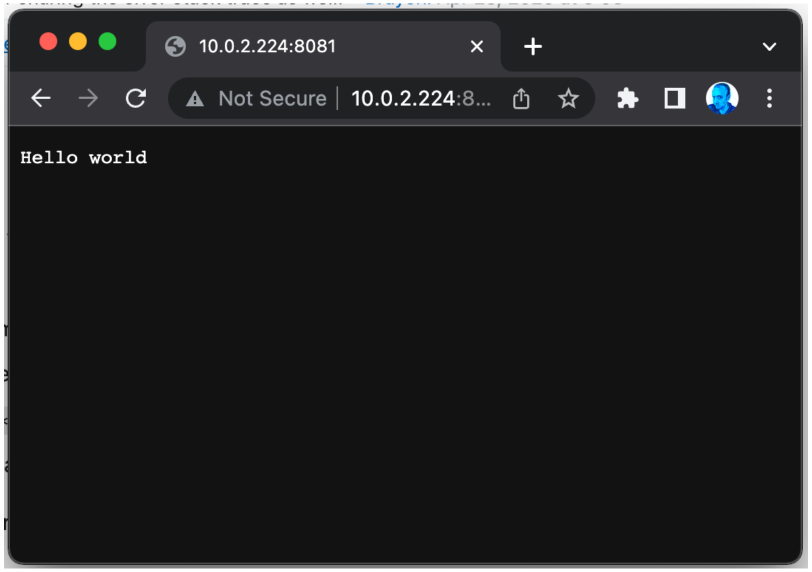
Python Simple HTTP Server

- Stateless Simple HTTP Python App

```
import os
from http.server import HTTPServer, BaseHTTPRequestHandler
class SimpleHTTPRequestHandler(BaseHTTPRequestHandler):
  def do_GET(self):
    self.send_response(200)
    self.send_header("Content-type", "text/html")
    self.end_headers()
    self.wfile.write(bytes("Hello world\n", "utf8"))
port = int(os.environ['HTTP_APP_PORT'])
httpd = HTTPServer(('0.0.0.0’, 8081), SimpleHTTPRequestHandler)
httpd.serve_forever()
```

Python Simple HTTP Server

- Stateless Simple HTTP Python App



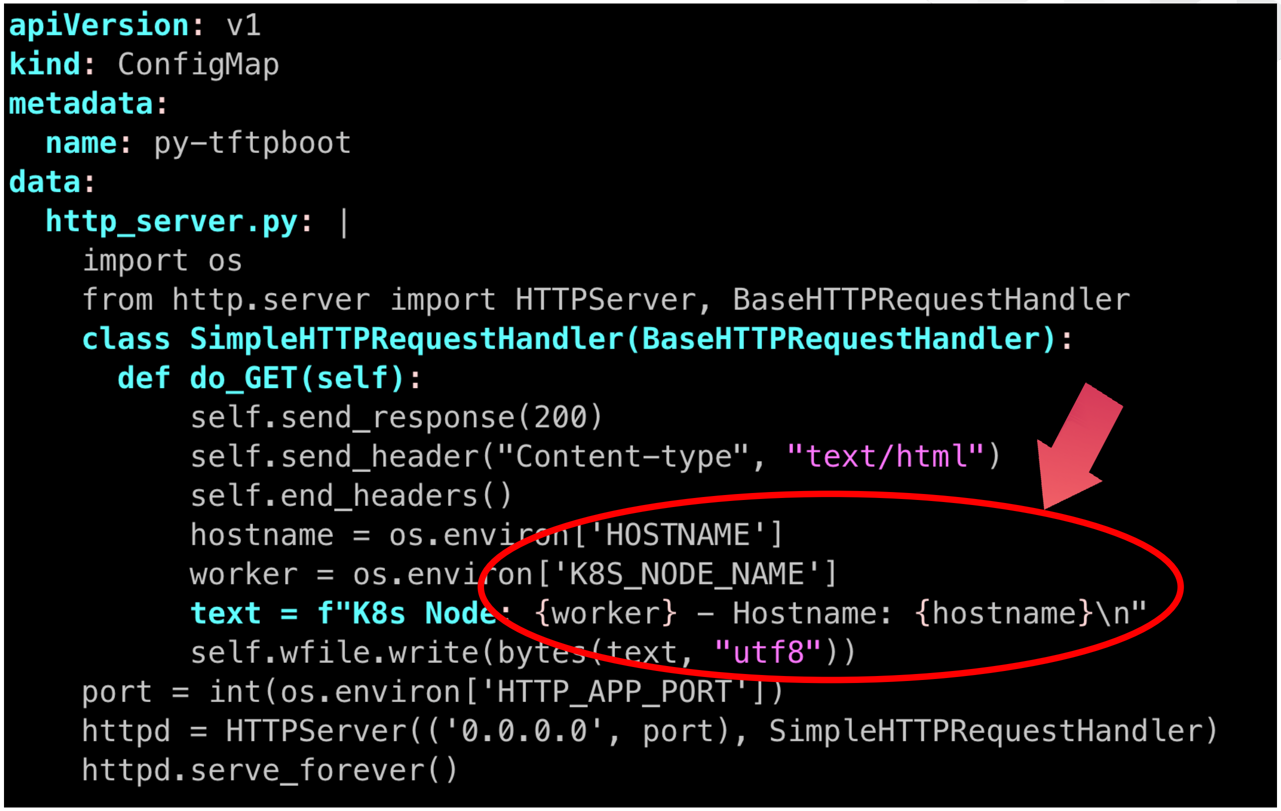
```
Hello world
```

OR

```
[root@]# curl http://localhost:8081
Hello world
[root@]#
```

Python Simple HTTP Server

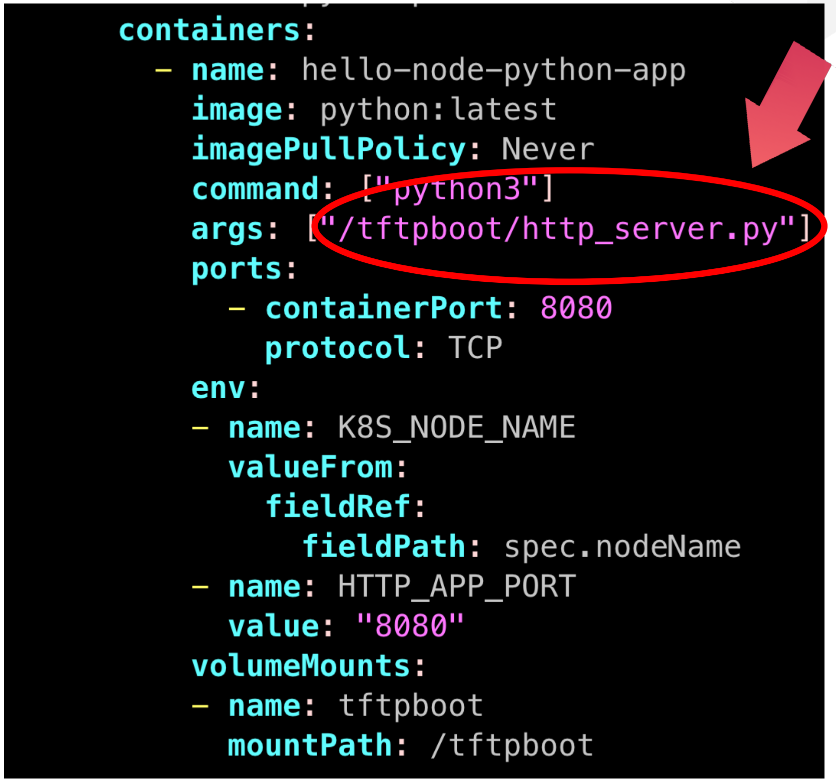
- Stateless Simple HTTP Python App
- Test Load Balancer Services
- Exposes K8s Worker hostname and Pod Hostname



```
apiVersion: v1
kind: ConfigMap
metadata:
  name: py-tftpboot
data:
  http_server.py: |
    import os
    from http.server import HTTPServer, BaseHTTPRequestHandler
    class SimpleHTTPRequestHandler(BaseHTTPRequestHandler):
      def do_GET(self):
          self.send_response(200)
          self.send_header("Content-type", "text/html")
          self.end_headers()
          hostname = os.environ['HOSTNAME']
          worker = os.environ['K8S_NODE_NAME']
          text = f"K8s Node: {worker} - Hostname: {hostname}\n"
          self.wfile.write(bytes(text, "utf8"))
    port = int(os.environ['HTTP_APP_PORT'])
    httpd = HTTPServer(('0.0.0.0', port), SimpleHTTPRequestHandler)
    httpd.serve_forever()
```

Hello Node App

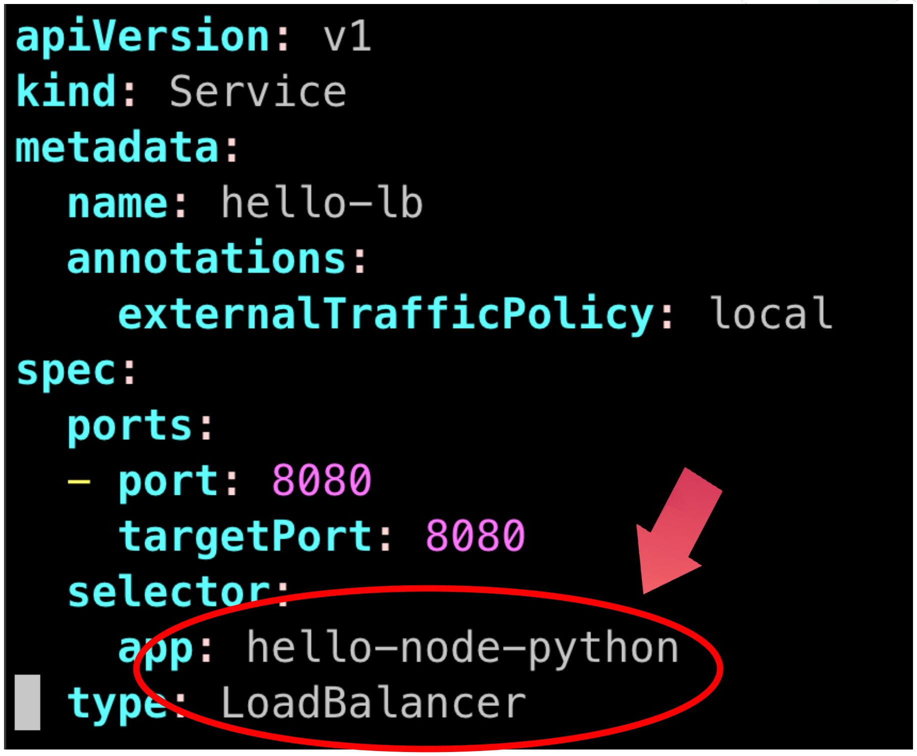
```
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello-node-py-deploy
spec:
  selector:
    matchLabels:
      app: hello-node-python
  replicas: 4
  template:
    metadata:
      labels:
        app: hello-node-python
    spec:
      volumes:
      - name: tftpboot     # The na
        configMap:
          name: py-tftpboot
```



```
      containers:
       - name: hello-node-python-app
         image: python:latest
         imagePullPolicy: Never
         command: ["python3"]
         args: ["/tftpboot/http_server.py"]
         ports:
          - containerPort: 8080
            protocol: TCP
         env:
         - name: K8S_NODE_NAME
           valueFrom:
             fieldRef:
               fieldPath: spec.nodeName
         - name: HTTP_APP_PORT
           value: "8080"
         volumeMounts:
         - name: tftpboot
           mountPath: /tftpboot
```

Exposing Hello Node Replicas

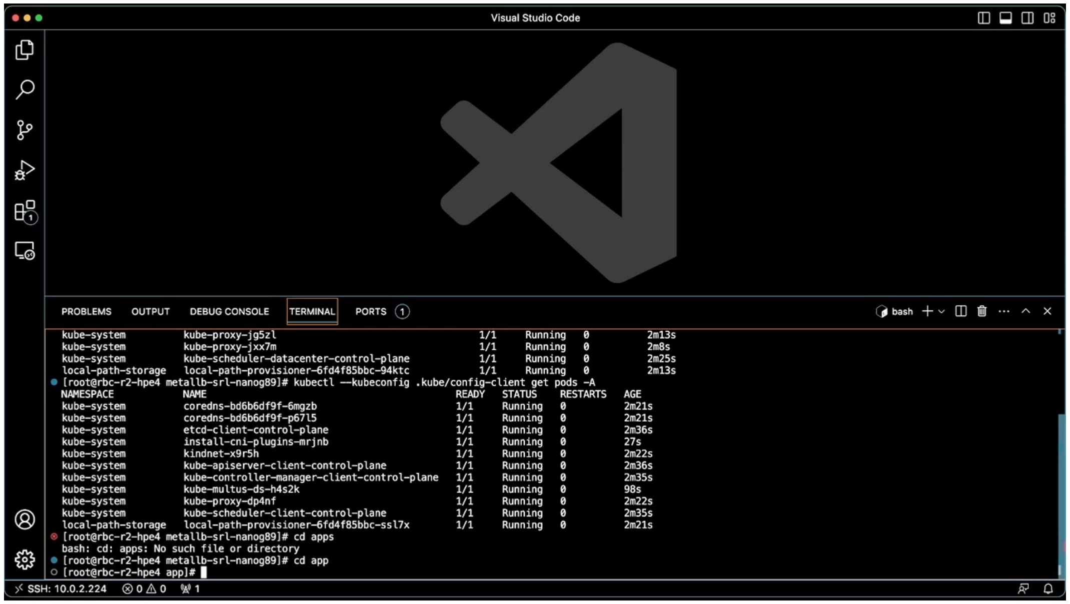
- Exposing Deployment via Service Load Balancer
- External Traffic Policy: Local



```
apiVersion: v1
kind: Service
metadata:
  name: hello-lb
  annotations:
    externalTrafficPolicy: local
spec:
  ports:
  - port: 8080
    targetPort: 8080
  selector:
    app: hello-node-python
  type: LoadBalancer
```

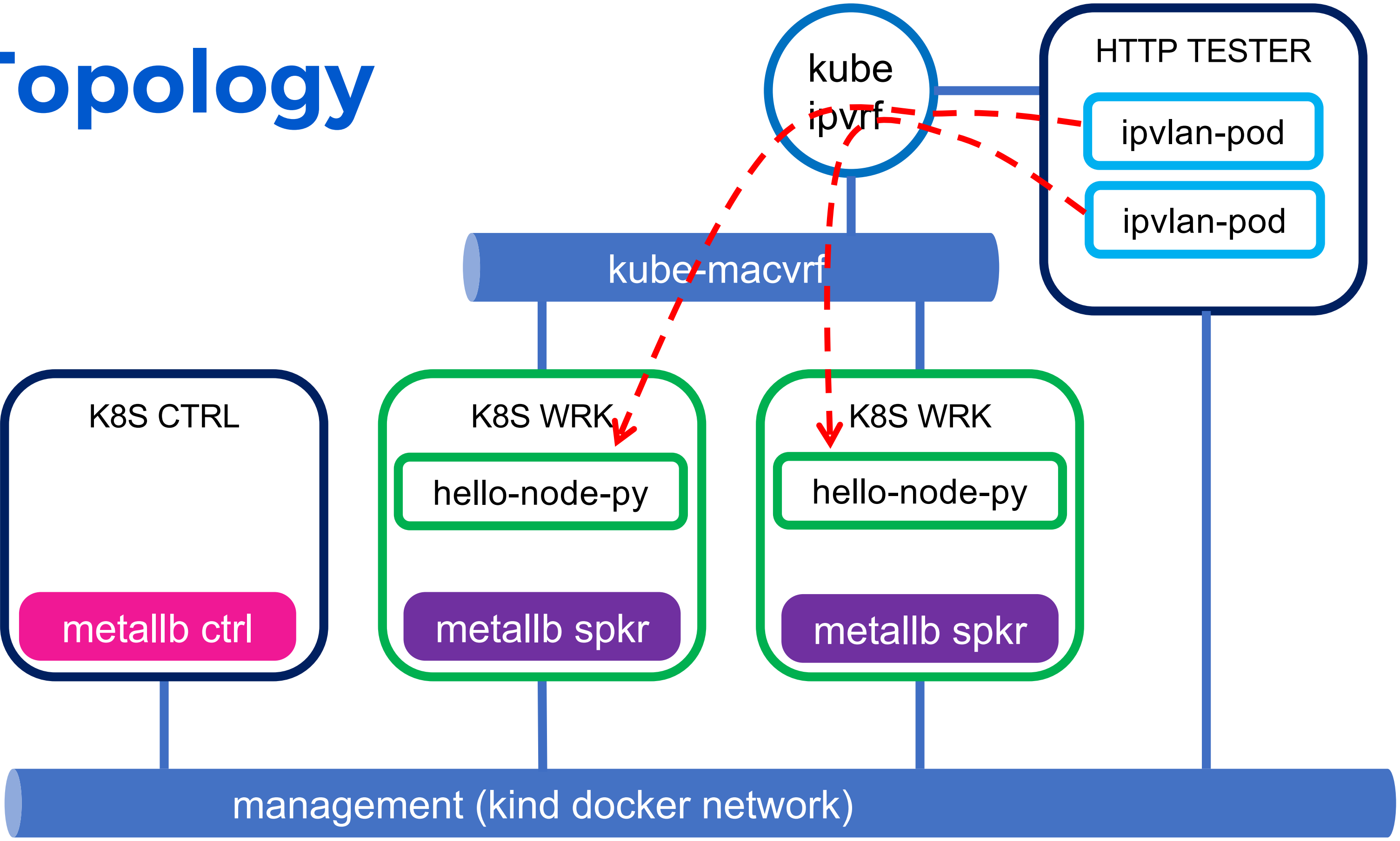
Simple Python HTTP Server

- Stateless Python App to test Load Balancer Services
- Exposes K8s Worker hostname and Pod Hostname

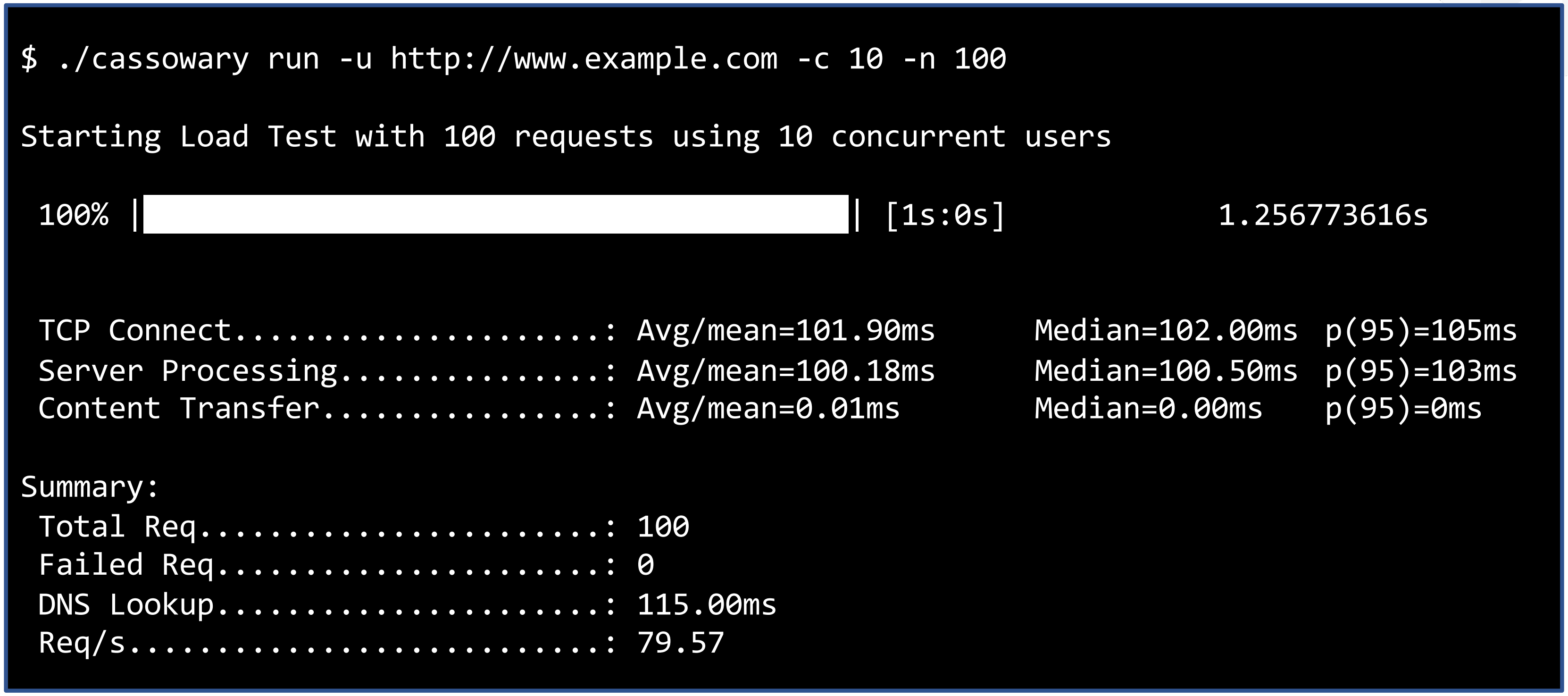


```
kube-system          kube-proxy-jg5zl                                    1/1     Running   0           2m13s
kube-system          kube-proxy-jxx7m                                    1/1     Running   0           2m8s
kube-system          kube-scheduler-datacenter-control-plane             1/1     Running   0           2m25s
local-path-storage   local-path-provisioner-6fd4f85bbc-94ktc             1/1     Running   0           2m13s
[root@rbc-r2-hpe4 metallb-srl-nanog89]# kubectl --kubeconfig .kube/config-client get pods -A
NAMESPACE            NAME                                          READY   STATUS    RESTARTS   AGE
kube-system          coredns-bd6b6df9f-6mgzb                       1/1     Running   0          2m21s
kube-system          coredns-bd6b6df9f-p67l5                       1/1     Running   0          2m21s
kube-system          etcd-client-control-plane                     1/1     Running   0          2m36s
kube-system          install-cni-plugins-mrjnb                     1/1     Running   0          27s
kube-system          kindnet-x9r5h                                 1/1     Running   0          2m22s
kube-system          kube-apiserver-client-control-plane           1/1     Running   0          2m36s
kube-system          kube-controller-manager-client-control-plane  1/1     Running   0          2m35s
kube-system          kube-multus-ds-h4s2k                          1/1     Running   0          98s
kube-system          kube-proxy-dp4nf                              1/1     Running   0          2m22s
kube-system          kube-scheduler-client-control-plane           1/1     Running   0          2m35s
local-path-storage   local-path-provisioner-6fd4f85bbc-ssl7x       1/1     Running   0          2m21s
[root@rbc-r2-hpe4 metallb-srl-nanog89]# cd apps
bash: cd: apps: No such file or directory
[root@rbc-r2-hpe4 metallb-srl-nanog89]# cd app
[root@rbc-r2-hpe4 app]# 
```

Lab Topology



HTTP Tester Cassowary



```
$ ./cassowary run -u http://www.example.com -c 10 -n 100

Starting Load Test with 100 requests using 10 concurrent users

 100% |████████████████████████████████████████| [1s:0s]            1.256773616s


 TCP Connect.....................: Avg/mean=101.90ms     Median=102.00ms  p(95)=105ms
 Server Processing...............: Avg/mean=100.18ms     Median=100.50ms  p(95)=103ms
 Content Transfer................: Avg/mean=0.01ms       Median=0.00ms    p(95)=0ms

Summary:
 Total Req.......................: 100
 Failed Req......................: 0
 DNS Lookup......................: 115.00ms
 Req/s...........................: 79.57
```

NANOG™

https://github.com/rogerwelin/cassowary

Kubernetes Deploy with IPVLAN

```
    spec:
      containers:
        - name: ipvlan-1001-alpine-1
          image: pinrojas/cassowary:0.33
          imagePullPolicy: Never
          command:
          - /bin/sh
          - -c
          - |
            until false; do cassowary run -u http://10.254.254.240:8080 -c 4 -n 4 -p pushsvc-cust1-to-dc:9091; sleep 2; done
          env:
          - name: K8S_NODE_NAME
            valueFrom:
              fieldRef:
                fieldPath: spec.nodeName
```

https://github.com/rogerwelin/cassowary

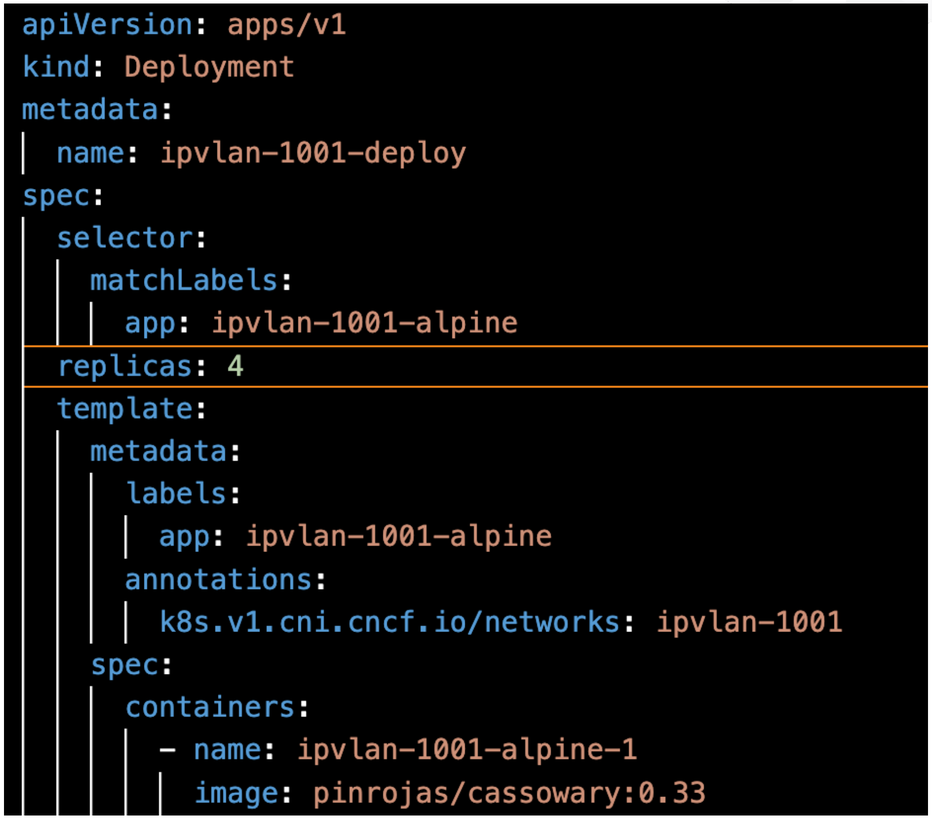
Load Balancing Hashing (Border Leaf)

- We defined Hashing “Source IP” in the Border Leaf for ECMP

```
--{ + running }--[  ]--
A:BORDER-DC# info /system load-balancing
    system {
        load-balancing {
            hash-options {
                source-address true
            }
        }
    }
--{ + running }--[  ]--
A:BORDER-DC#
```

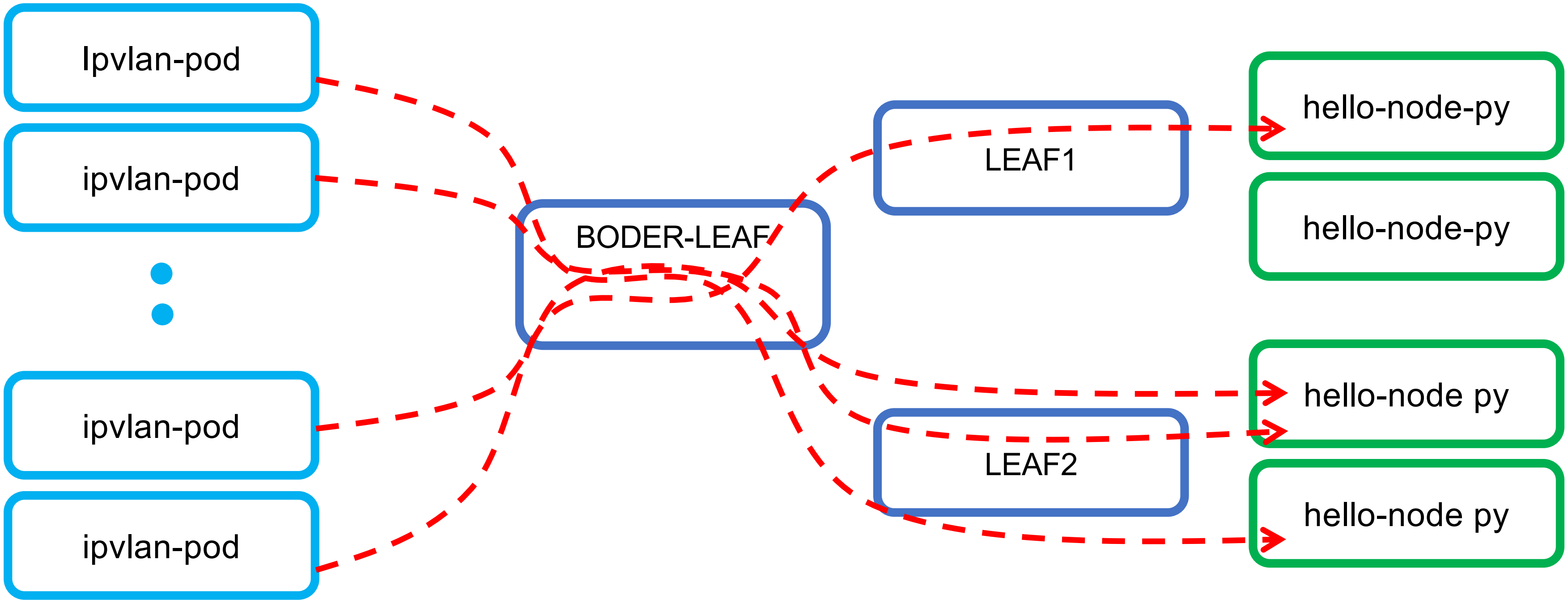
Load Balancing Hashing (Border Leaf)

- We defined Hashing “Source IP” in the Border Leaf for ECMP
- Add more replicas to the client app

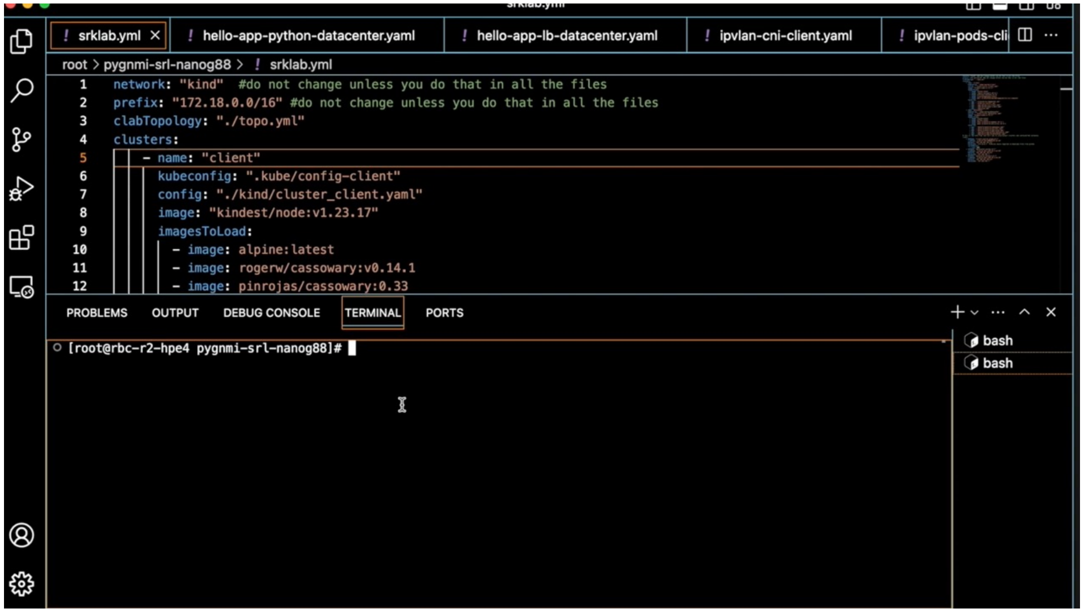


```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ipvlan-1001-deploy
spec:
  selector:
    matchLabels:
      app: ipvlan-1001-alpine
  replicas: 4
  template:
    metadata:
      labels:
        app: ipvlan-1001-alpine
      annotations:
        k8s.v1.cni.cncf.io/networks: ipvlan-1001
    spec:
      containers:
        - name: ipvlan-1001-alpine-1
          image: pinrojas/cassowary:0.33
```

Lab Topology



Navigating the lab components



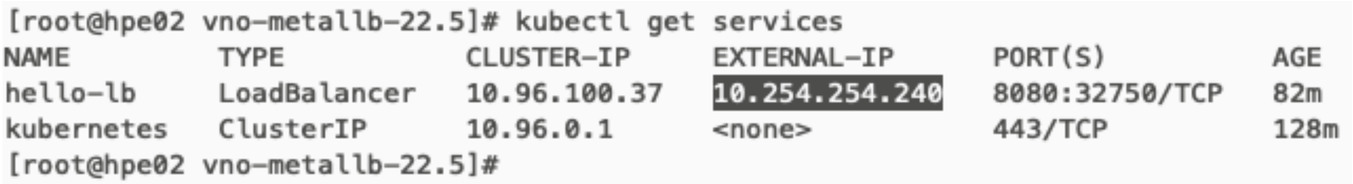
```yaml
network: "kind"  #do not change unless you do that in all the files
prefix: "172.18.0.0/16" #do not change unless you do that in all the files
clabTopology: "./topo.yml"
clusters:
  - name: "client"
    kubeconfig: ".kube/config-client"
    config: "./kind/cluster_client.yaml"
    image: "kindest/node:v1.23.17"
    imagesToLoad:
      - image: alpine:latest
      - image: rogerw/cassowary:v0.14.1
      - image: pinrojas/cassowary:0.33
```

```
[root@rbc-r2-hpe4 pygnmi-srl-nanog88]#
```

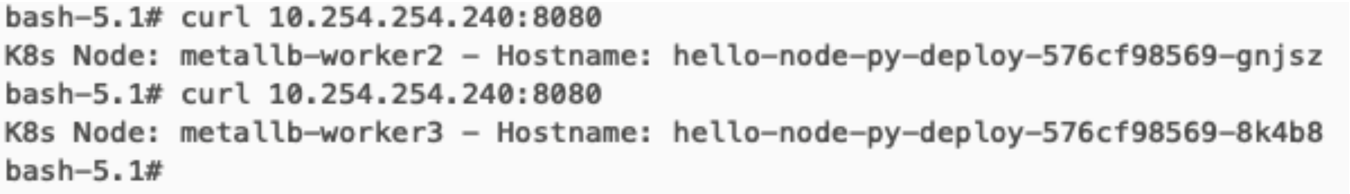
Testing Load Balancer

Testing Load Balancer

- We’ll show a test of the Load Balancer using curl command from the Kubernetes “client” connected to the border leaf



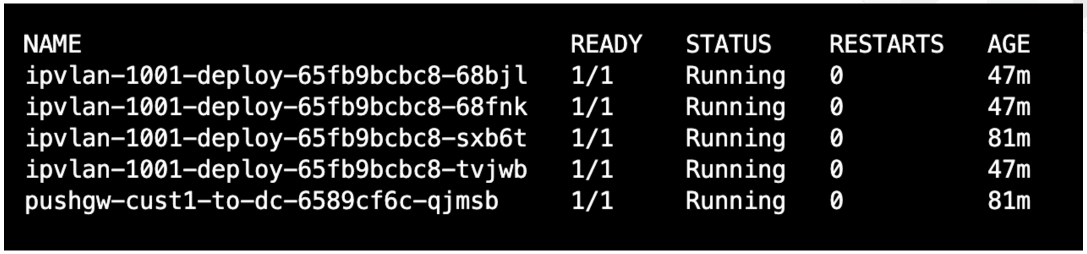
```
[root@hpe02 vno-metallb-22.5]# kubectl get services
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP       PORT(S)          AGE
hello-lb     LoadBalancer   10.96.100.37    10.254.254.240    8080:32750/TCP   82m
kubernetes   ClusterIP      10.96.0.1       <none>            443/TCP          128m
[root@hpe02 vno-metallb-22.5]#
```



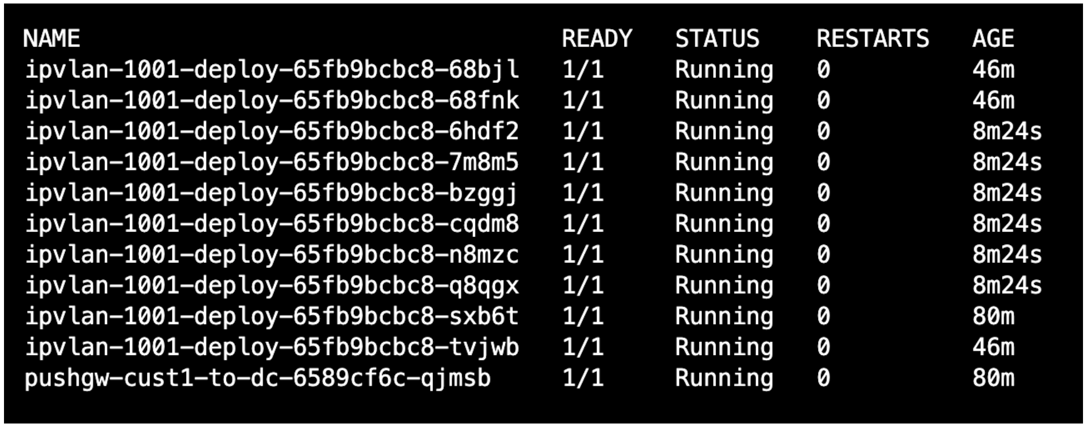
```
bash-5.1# curl 10.254.254.240:8080
K8s Node: metallb-worker2 - Hostname: hello-node-py-deploy-576cf98569-gnjsz
bash-5.1# curl 10.254.254.240:8080
K8s Node: metallb-worker3 - Hostname: hello-node-py-deploy-576cf98569-8k4b8
bash-5.1#
```

Load Balancing Hashing (Border Leaf)

- We defined Hashing "Source IP" in the Border Leaf (ECMP)
- Hashing algorithms are platform-specific and are considered proprietary
- In this demo we can **ADD** more replicas to the client app



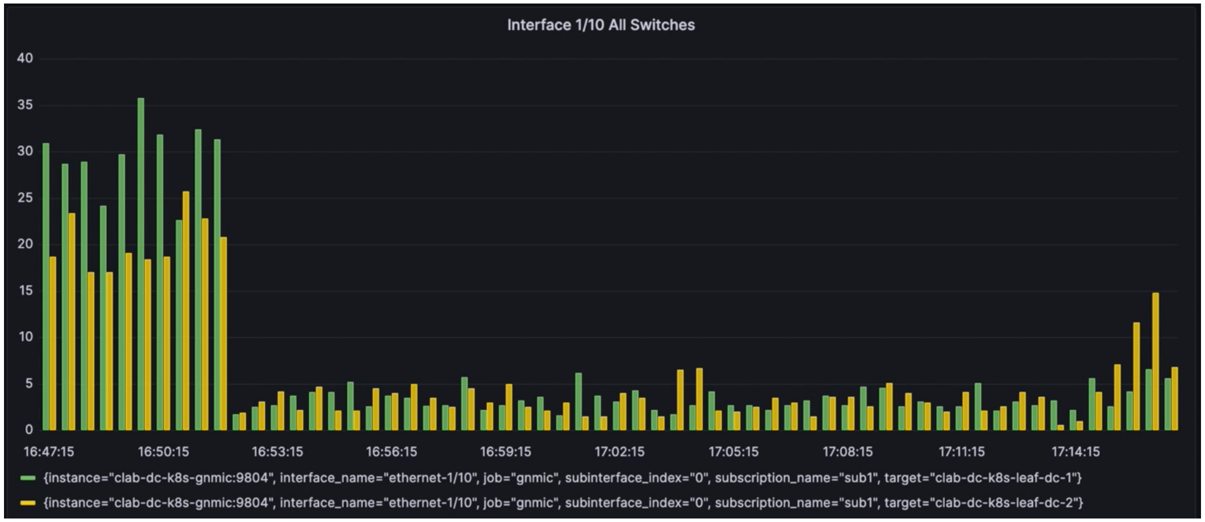
```
NAME                                 READY   STATUS    RESTARTS   AGE
ipvlan-1001-deploy-65fb9bcbc8-68bjl  1/1     Running   0          47m
ipvlan-1001-deploy-65fb9bcbc8-68fnk  1/1     Running   0          47m
ipvlan-1001-deploy-65fb9bcbc8-sxb6t  1/1     Running   0          81m
ipvlan-1001-deploy-65fb9bcbc8-tvjwb  1/1     Running   0          47m
pushgw-cust1-to-dc-6589cf6c-qjmsb    1/1     Running   0          81m
```



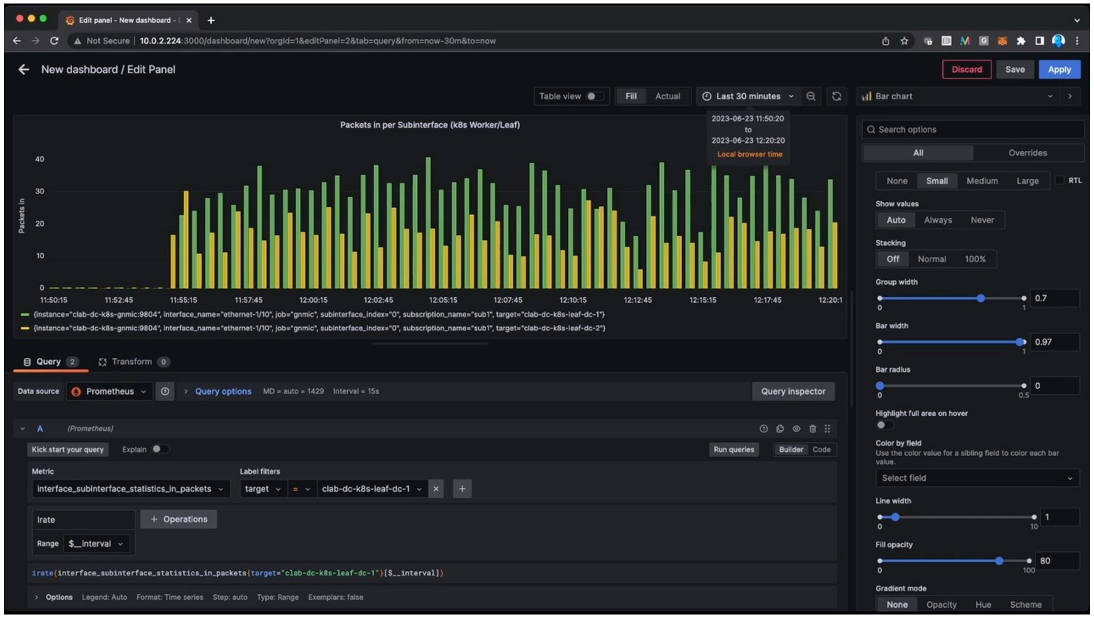
```
NAME                                 READY   STATUS    RESTARTS   AGE
ipvlan-1001-deploy-65fb9bcbc8-68bjl  1/1     Running   0          46m
ipvlan-1001-deploy-65fb9bcbc8-68fnk  1/1     Running   0          46m
ipvlan-1001-deploy-65fb9bcbc8-6hdf2  1/1     Running   0          8m24s
ipvlan-1001-deploy-65fb9bcbc8-7m8m5  1/1     Running   0          8m24s
ipvlan-1001-deploy-65fb9bcbc8-bzggj  1/1     Running   0          8m24s
ipvlan-1001-deploy-65fb9bcbc8-cqdm8  1/1     Running   0          8m24s
ipvlan-1001-deploy-65fb9bcbc8-n8mzc  1/1     Running   0          8m24s
ipvlan-1001-deploy-65fb9bcbc8-q8qgx  1/1     Running   0          8m24s
ipvlan-1001-deploy-65fb9bcbc8-sxb6t  1/1     Running   0          80m
ipvlan-1001-deploy-65fb9bcbc8-tvjwb  1/1     Running   0          46m
pushgw-cust1-to-dc-6589cf6c-qjmsb    1/1     Running   0          80m
```

Load Balancing Hashing (Border Leaf)

- Grafana shows how we can control forwarding distribution from the Border Leaf
- Stats are collected via GNMIc
- Prometheus pulls data directly from GNMIc server



Demo: Testing Load Balancer



2023-06-23 11:50:20
to
2023-06-23 12:20:20
Local browser time

- {instance="clab-dc-k8s-gnmic:9804", interface_name="ethernet-1/10", job="gnmic", subinterface_index="0", subscription_name="sub1", target="clab-dc-k8s-leaf-dc-1"}
- {instance="clab-dc-k8s-gnmic:9804", interface_name="ethernet-1/10", job="gnmic", subinterface_index="0", subscription_name="sub1", target="clab-dc-k8s-leaf-dc-2"}

Data source: Prometheus
Query options: MD = auto = 1429, Interval = 15s

A (Prometheus)

Metric: interface_subinterface_statistics_in_packets
Label filters: target = clab-dc-k8s-leaf-dc-1
Irate, Range: $__interval

```
irate(interface_subinterface_statistics_in_packets{target="clab-dc-k8s-leaf-dc-1"}[$__interval])
```

Options: Legend: Auto, Format: Time series, Step: auto, Type: Range, Exemplars: false

None | **Small** | Medium | Large ☐ RTL
Show values: **Auto** | Always | Never
Stacking: **Off** | Normal | 100%
Group width: 0.7 (0–1)
Bar width: 0.97 (0–1)
Bar radius: 0 (0–0.5)
Highlight full area on hover: ○
Color by field: Use the color value for a sibling field to color each bar value. Select field
Line width: 1 (0–10)
Fill opacity: 80 (0–100)
Gradient mode: **None** | Opacity | Hue | Scheme

Tips: Forcing multiple routes

- Reject any exchange of EVPN router type 5 between all LEAF switches and BORDER Leaf

```
routing-policy {
       policy evpn-type5 {
           statement 10 {
               match {
                   prefix-set metallb-pool
                   bgp {
                       evpn {
                           route-type [
                               5
                           ]
                       }
                   }
               }
               action {
                   reject {
                   }
               }
           }
```

Final Words

In this tutorial we have seen:

- How to create a network lab using containerlab and Kind Kubernetes
- How to set up and test a BGP Load Balancer Services Between your Fabric and Kubernetes
- How we can control load distribution via Load Balancing Hashing Algorithm at the Border Leaf

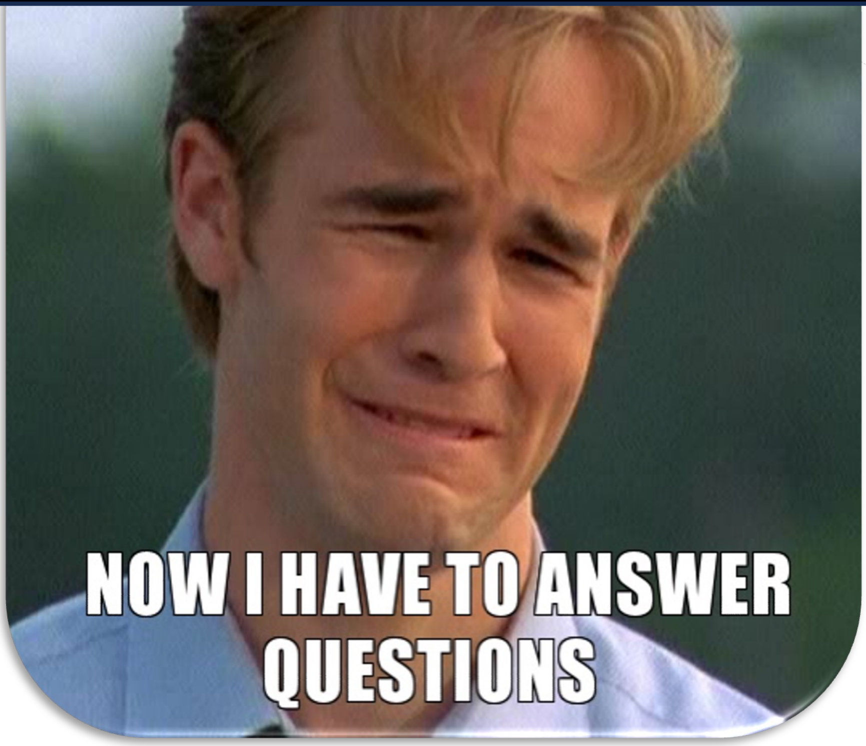
Additional resources

- Getting Started with Modern Time Series Database and Grafana – Damien Garros
  - https://youtu.be/lzppzWGRHGo
- Containerlab - running networking labs with Docker UX – Roman and Karim
  - https://youtu.be/qigCla1qY3k
- gNMIc - an intuitive gNMI CLI and a feature-rich telemetry collector - Karim
  - https://youtu.be/v3CL2vrGD_8
- Tutorial: Kubernetes 101 for Network Professionals
  - https://youtu.be/n2kgApcXij0

Thanks!

bio.site/pinrojas

DONE WITH MY PRESENTATION



Additional Slides

MetalLB

- MetalLB aims to redress this imbalance by offering a network load balancer implementation that integrates with standard network equipment
- MetalLB implements a FRR Mode that uses an FRR container as the backend for handling BGP sessions. It provides features that are not available with the native BGP implementation, such as pairing BGP sessions with BFD sessions, and advertising IPV6 addresses.
- Despite being less battle tested than the native BGP implementation, the FRR mode is currently used by those users that require either BFD or IPV6, and it is the only supported method in the MetalLB version distributed with OpenShift. The long term plan is to make it the only BGP implementation available in MetalLB.