
# Network Security for Apps on OpenShift

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# Agenda

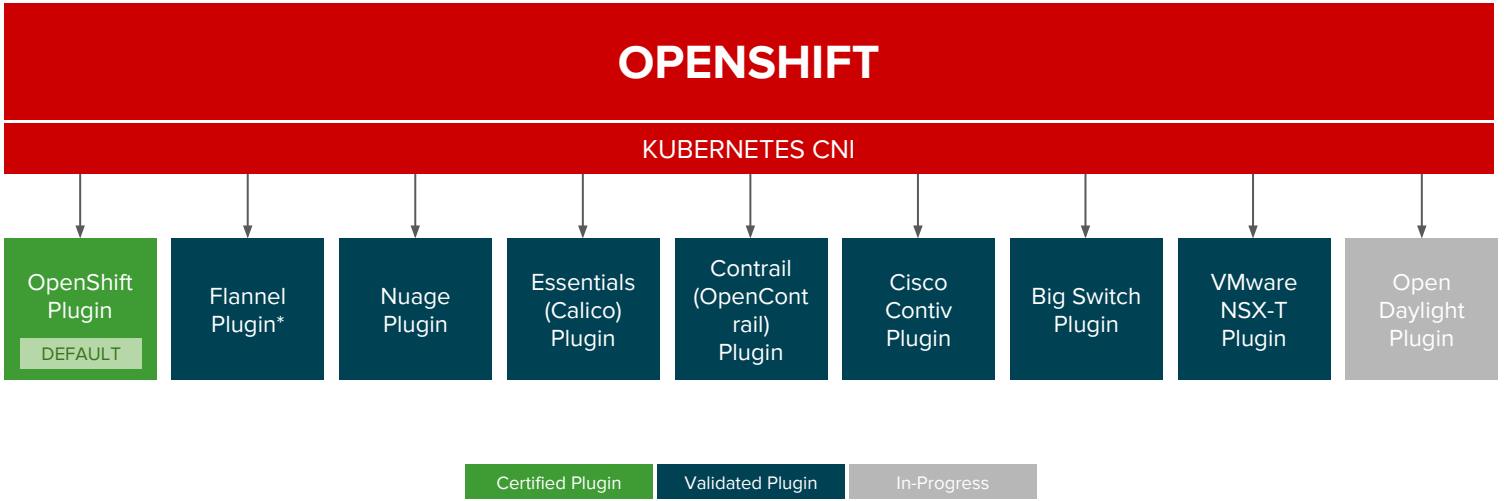
OpenShift SDN Overview

Typical network security questions for OpenShift

- Restricting traffic across tiers
- Handling network zones and isolation
- Securing Egress
- Securing Ingress
- Securing communications between OpenShift Nodes
- Application Network Security
- Upcoming changes in App Network Security with Istio

# OpenShift SDN Overview

# OpenShift uses CNI




* Flannel is minimally verified and is supported only and exactly as deployed in the OpenShift on OpenStack reference architecture

# OpenShift Networking

Software Defined Networking (SDN) for pod-pod communication

- Configures overlay network using Open vSwitch (OVS)
- Three types of plugins
  - **ovs-subnet** : flat network every pod can talk to every other pod
  - **ovs-multitenant**: project level isolation for pod-pod communication. Unique VNID per project

    You can join projects to get them the same VNID

    ‘default’ project (VNID 0) privileged to communicate with other pods

  - **ovs-networkpolicy**: fine-grained isolation using network policy objects

# OpenShift Installation Defaults

**Cluster network CIDR**: 10.128.0.0/14

Gives 32-14=18 bits or the ip address range of 10.128.0.0 - 10.131.255.255

**Host subnet length**: 9 bits (32-9=23)

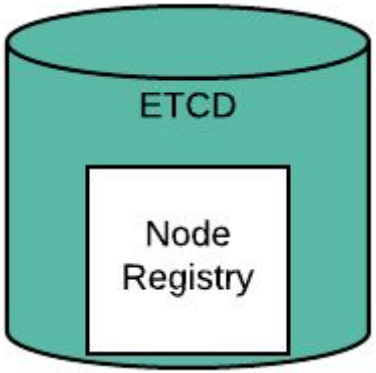
Subnet for each node is /23. Gets 512 ip addresses per node.

Leaves 9 bits for nodes ((32-9)-14=9). Allows $2^9$=512 subnets that can be assigned to nodes

**Subnets**: 10.128.0.0/23, 10.128.2.0/23, …10.131.254.0/23

**Master Portal Net** (services): 172.30.0.0/16

# OpenShift SDN manages Node Registry



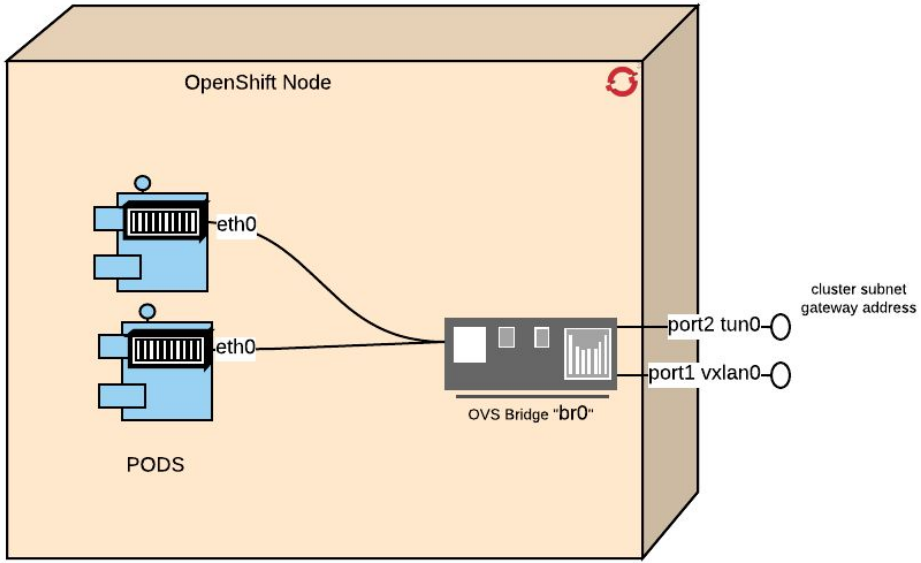

Master allocates a subnet to the node.

Node creation - Allocated subnet added to Node Registry

Node deletion - subnet removed from the Node Registry

On node creation,SDN registers the host with the SDN master

# OpenShift SDN configures network devices on Node




**br0** Pod containers attached to this ovs bridge device. Non subnet specific flow rules on br0

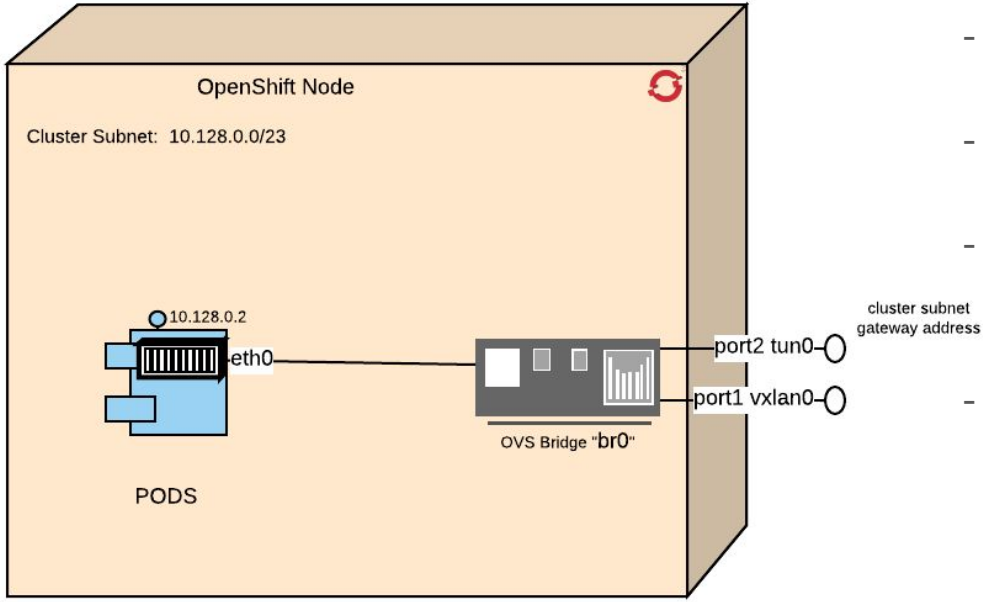
**tun0** For external network access via NAT. Cluster subnet gateway address assigned. Configures netfilter and routing rules.

**vxlan0** Access to other nodes. OVS VxLAN device

additional node added:

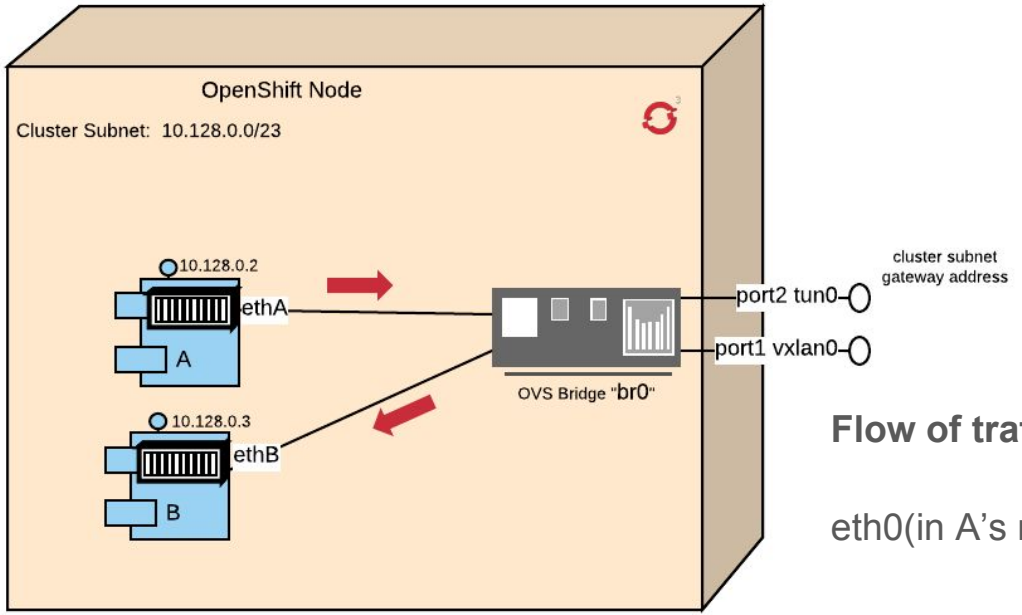
- Watch subnet updates from master
- Add OpenFlow rules on br0 to push traffic to the newly added subnet go to vxlan0

# OpenShift SDN Pod Creation




- Assigns an available ip address from the node's cluster subnet to the pod
- Attaches host side of pod's veth interface pair to br0
- Adds OpenFlow rules to OVS DB to route traffic addressed to the new pod to correct OVS port
- For ovs-multitenant, adds OpenFlow rules
  - to attach pod's VNID to outgoing traffic
  - allow traffic to pod when VNID matches

# Pod to Pod Traffic - Both pods on the same Node




**Flow of traffic**

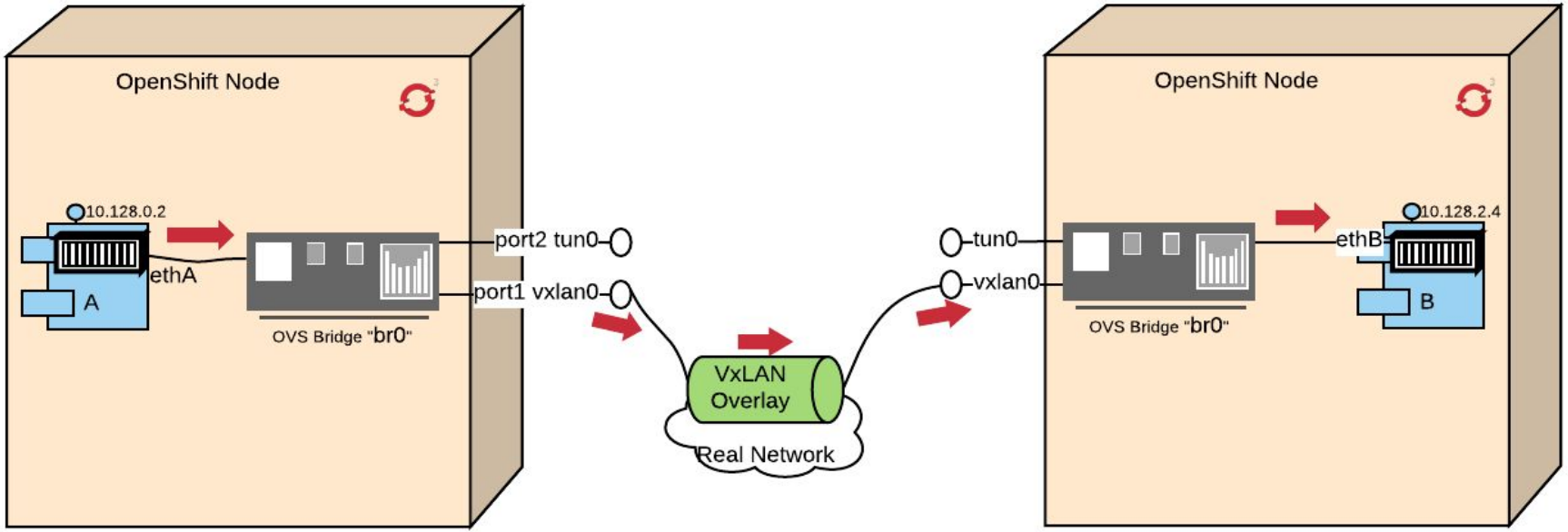
eth0(in A's netns) - vethA - br0 - vethB - eth0(in B's netns)

* Peer vEthernet device for container A is named ethA and for container B is named ethB

# Pod to Pod Traffic - Pods on two different Nodes

**Flow of traffic**

eth0(in A's netns) - vethA - br0 - vxlan0 - network - vxlan0 - br0- vethB - eth0(in B's netns)

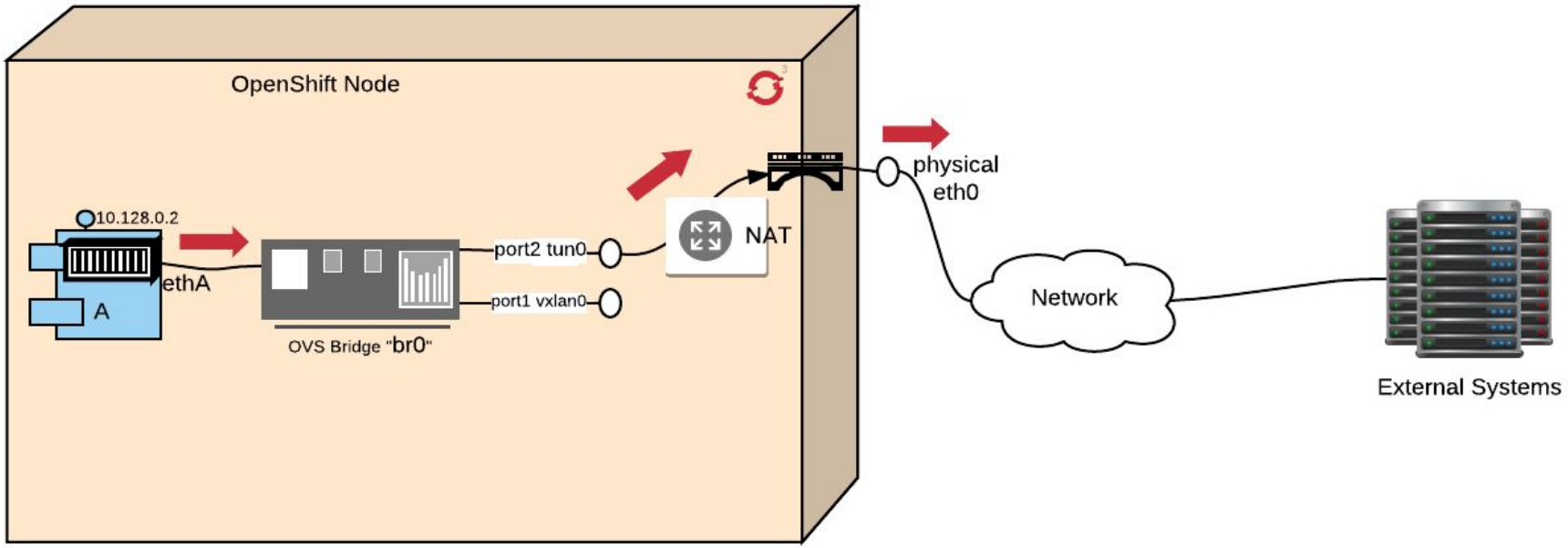



* Peer vEthernet device for container A is named ethA and for container B is named ethB

# Pod to External Systems outside OpenShift

**Flow of traffic**

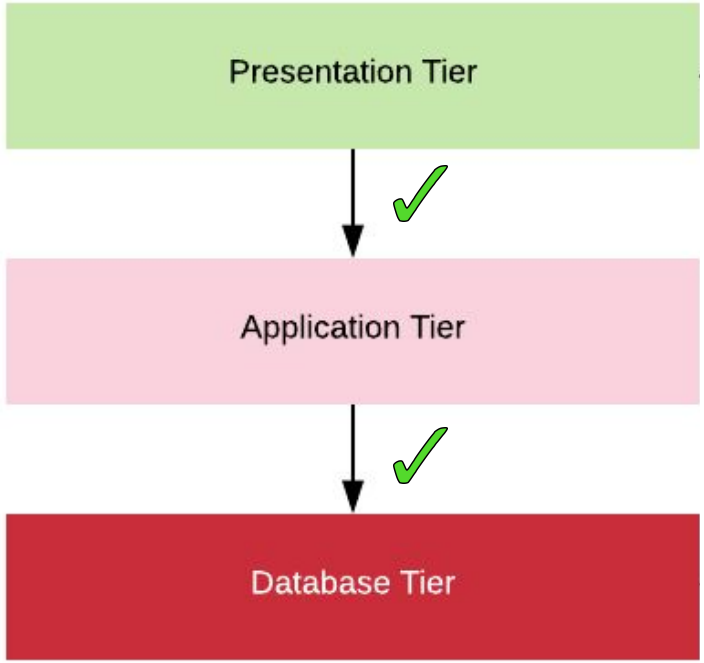
eth0(in A's netns) - vethA - br0 - tun0 - (NAT) - eth0(physical device) - Internet



# Typical Network Scenarios and OpenShift Solutions

# 1. Restricting traffic across tiers

# Traffic Restrictions Across Application Tiers




Allowed connections

Disallowed connections

In the world of OpenShift, how can we restrict traffic across Application Tiers?

# Network Policy Objects  - Introduction

Enables **Microsegmentation**

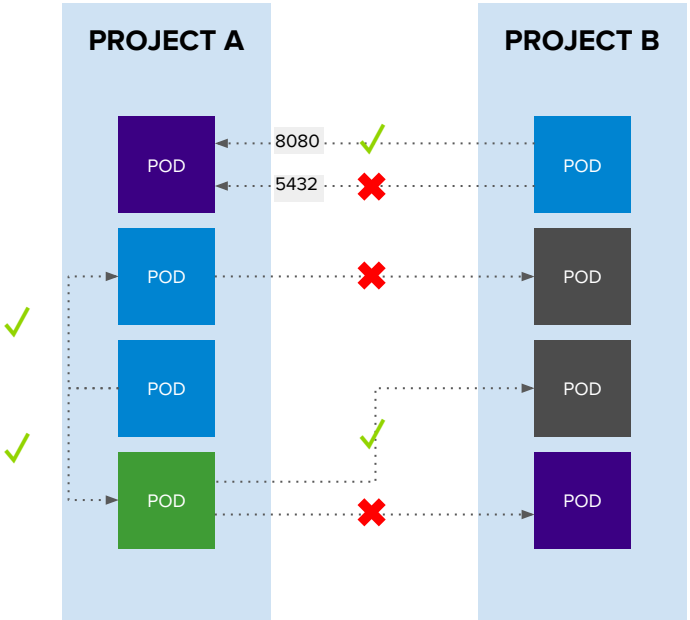
Allows configuring individual policies at the Pod Level

Apply to ingress traffic for pods and services

Allows restricting traffic between the pods within a project/namespace

Allows traffic to specific pods from other projects/namespaces

# Network Policy Objects

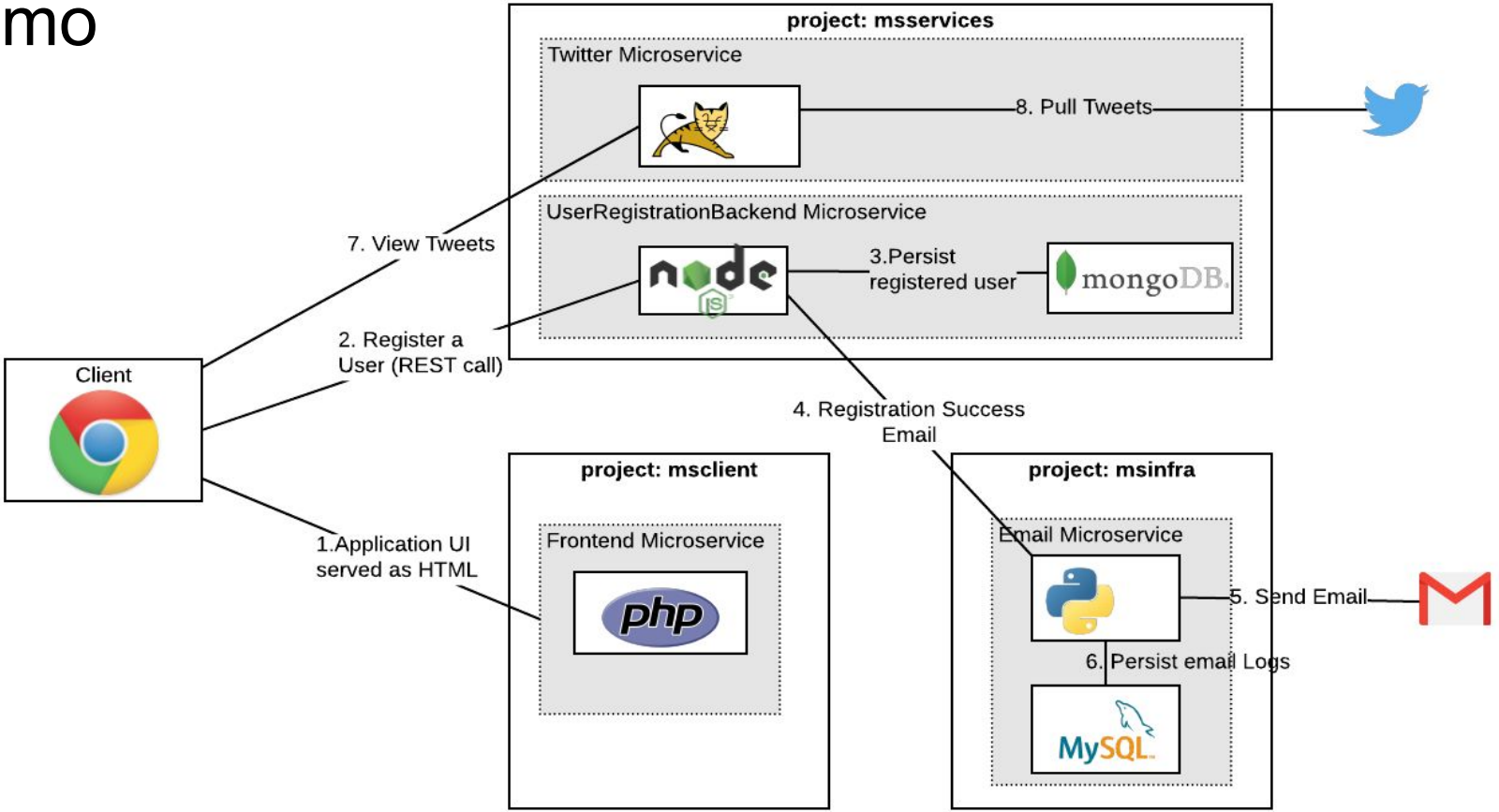



Example Policies

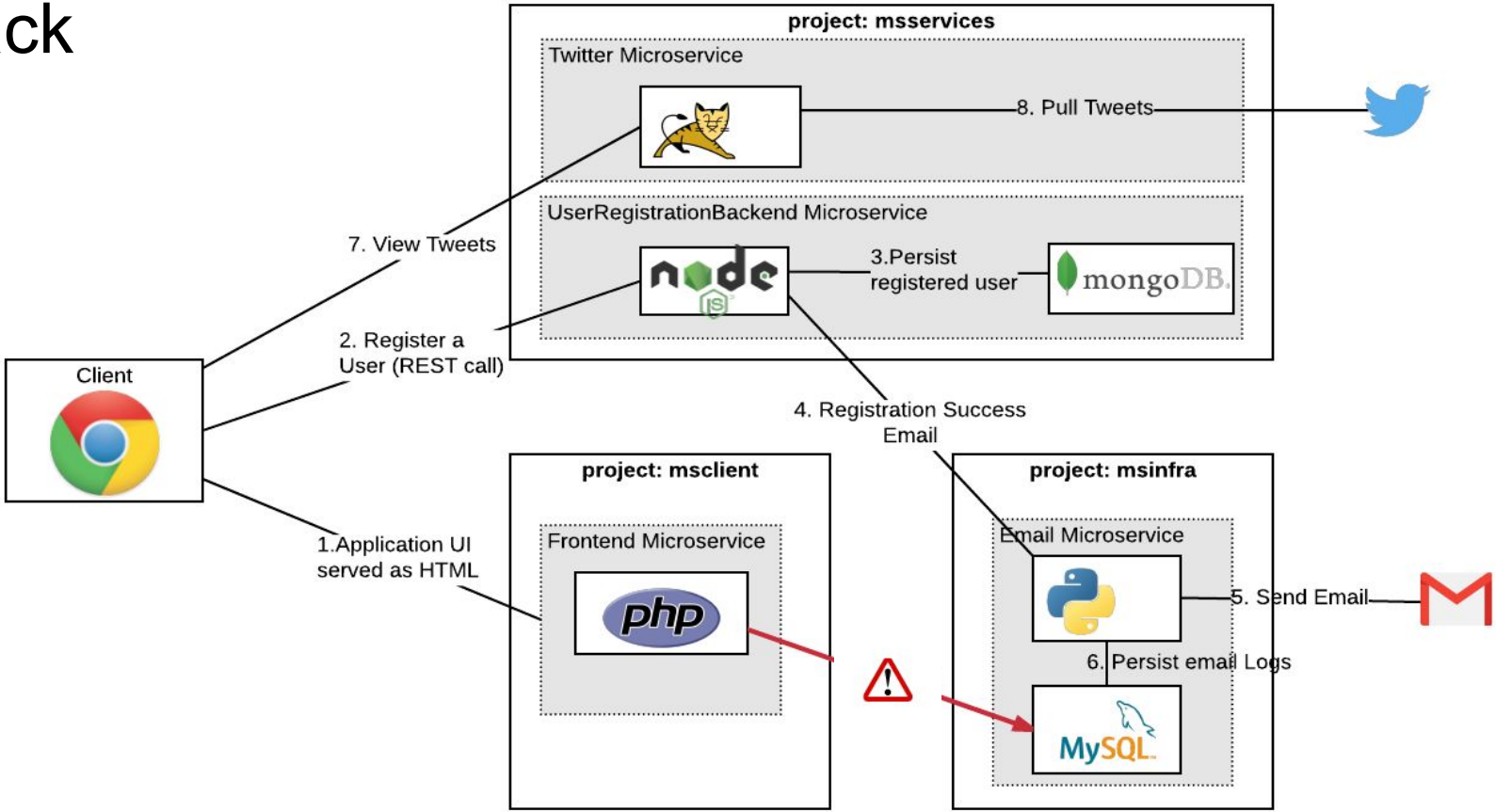
- Allow all traffic inside the project
- Allow traffic from green to gray
- Allow traffic to purple on 8080

```
apiVersion: extensions/v1beta1
kind: NetworkPolicy
metadata:
  name: allow-to-purple-on-8080
spec:
  podSelector:
    matchLabels:
      color: purple
  ingress:
  - ports:
    - protocol: tcp
      port: 8080
```

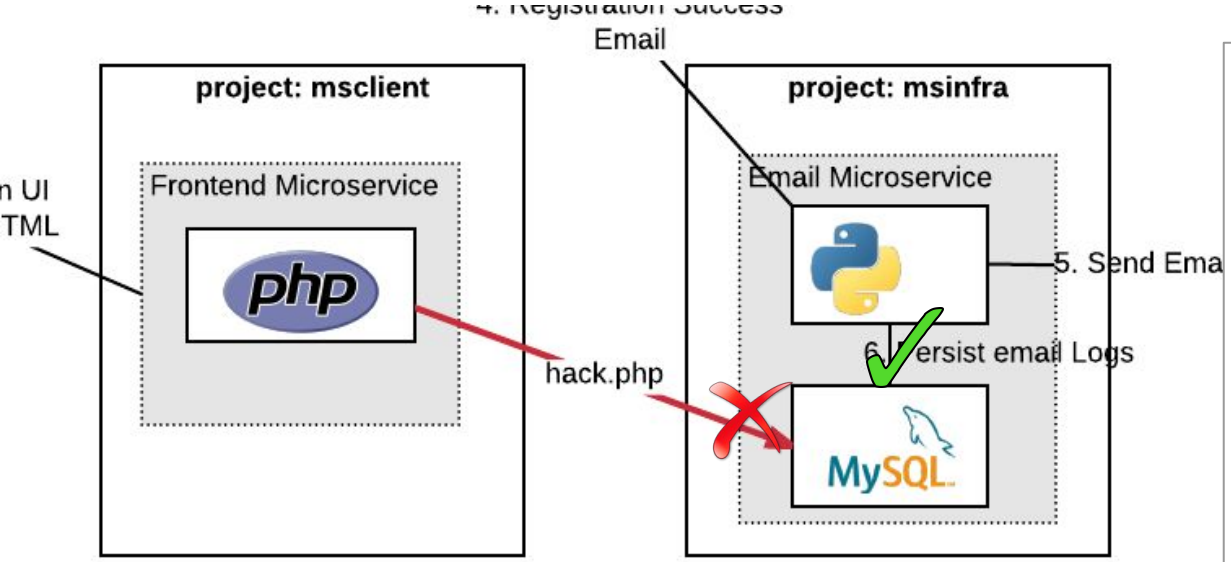
# Demo


project: msservices
Twitter Microservice
8. Pull Tweets
UserRegistrationBackend Microservice
3.Persist
registered user
mongoDB.
7. View Tweets
2. Register a
User (REST call)
Client
4. Registration Success
Email
project: msclient
Frontend Microservice
php
1.Application UI
served as HTML
project: msinfra
Email Microservice
5. Send Email
6. Persist email Logs
MySQL

# Hack


project: msservices
Twitter Microservice
8. Pull Tweets
UserRegistrationBackend Microservice
3.Persist
registered user
mongoDB.
7. View Tweets
2. Register a
User (REST call)
Client
4. Registration Success
Email
project: msclient
Frontend Microservice
php
1.Application UI
served as HTML
project: msinfra
Email Microservice
5. Send Email
6. Persist email Logs
MySQL

# Network Policy Objects to Rescue

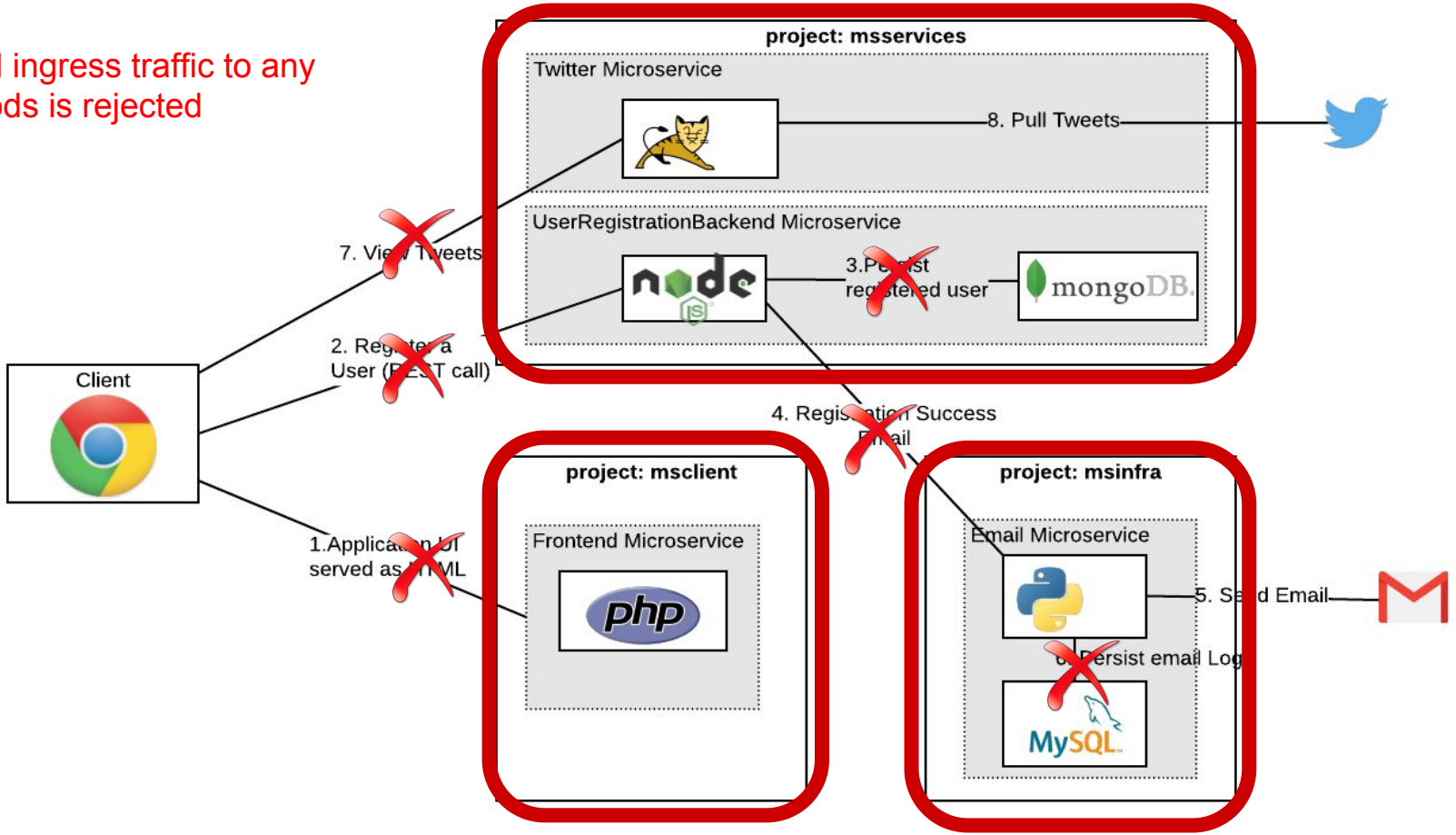



Allow MySQLDB connection from Email Service

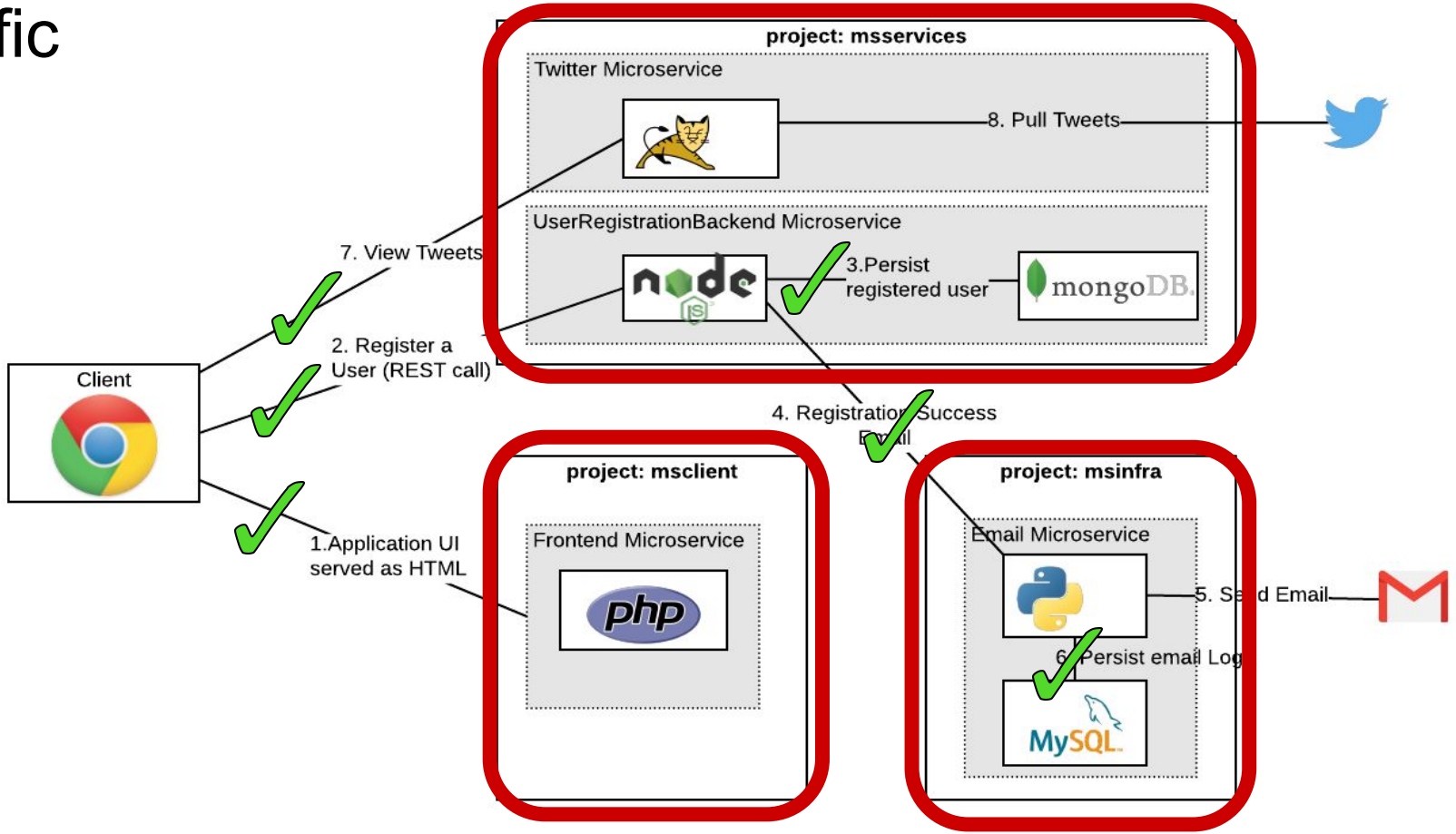
```
kind: NetworkPolicy
apiVersion: extensions/v1beta1
metadata:
  name: allow-3306
spec:
 podSelector:
   matchLabels:
     app: mysql
 ingress:
 - from:
   - podSelector:
       matchLabels:
         app: emailsvc
   ports:
   - protocol: TCP
     port: 3306
```

# Start with Default Deny

All ingress traffic to any pods is rejected

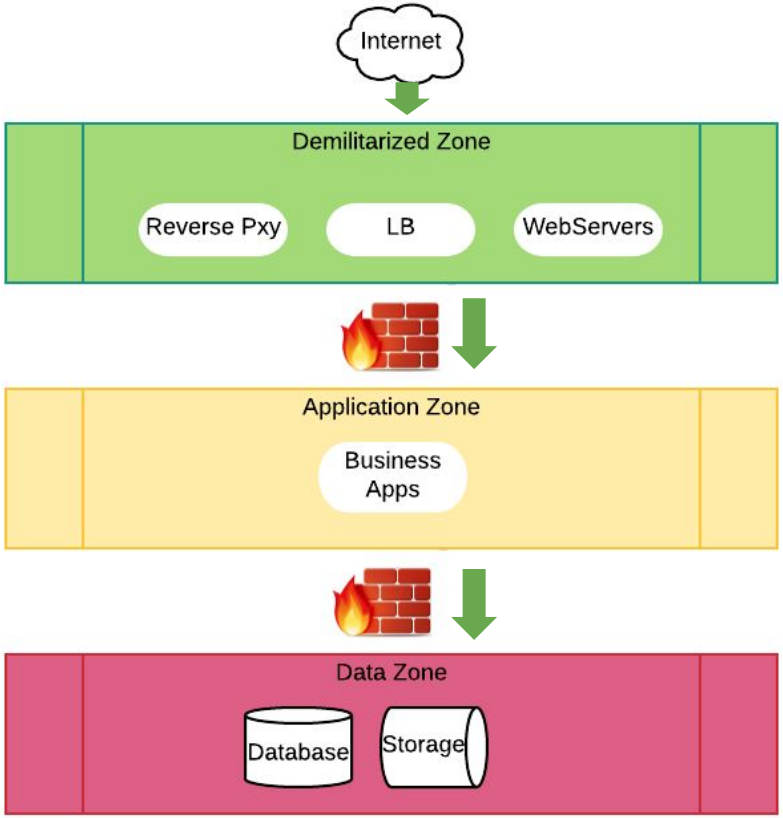


# Add Network Policies To Allow Specific Incoming Traffic



# 2. Isolating zones

# Network Zones separated by Firewalls




External traffic allowed to touch DMZ

Holes punched in firewalls to allow specific traffic from

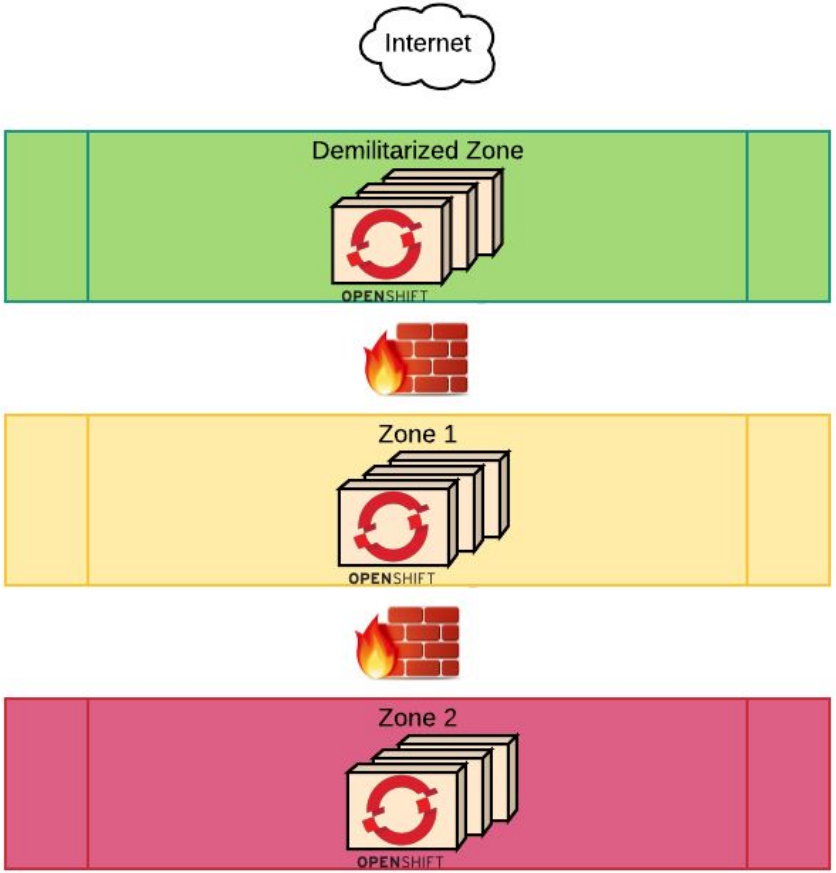
DMZ to Application Zone

and from

Application Zone to Data Zone

How do I setup OpenShift here?

# Option 1: OpenShift cluster per Zone

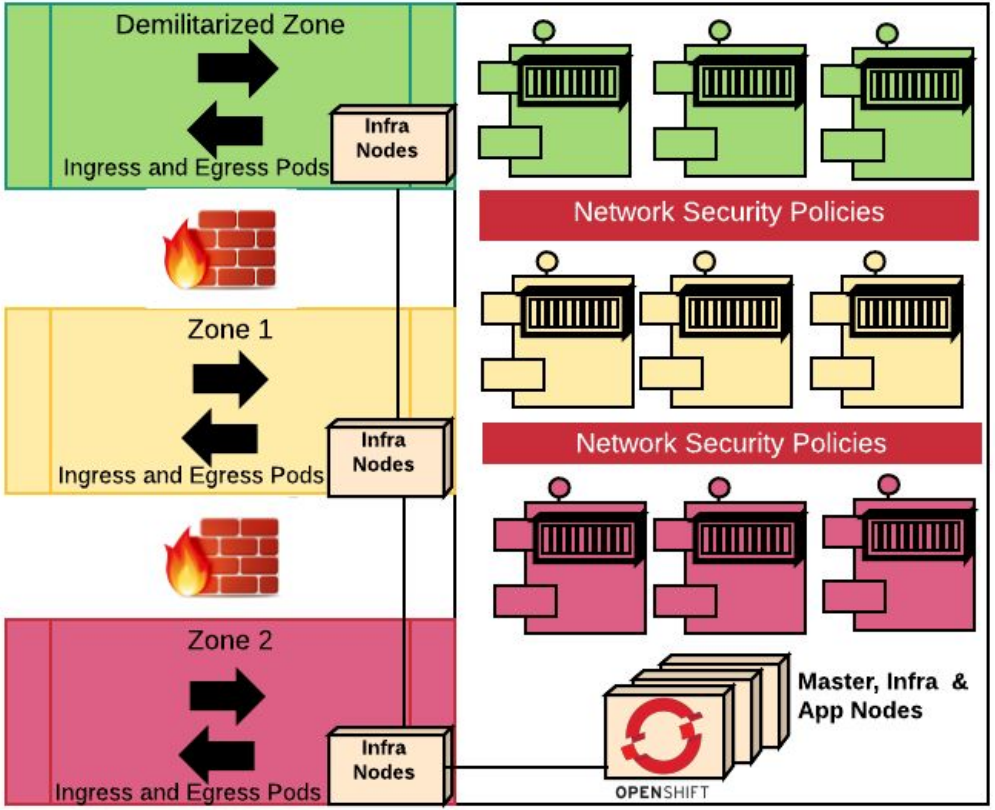



Useful to demonstrate compliance with Security Standards and Regulations

Additional actions needed to protect Master APIs, and other URLs in DMZ that are not supposed to be exposed to Internet

Cost of maintenance is high

# Option 2: OpenShift Cluster covering Multiple Zones



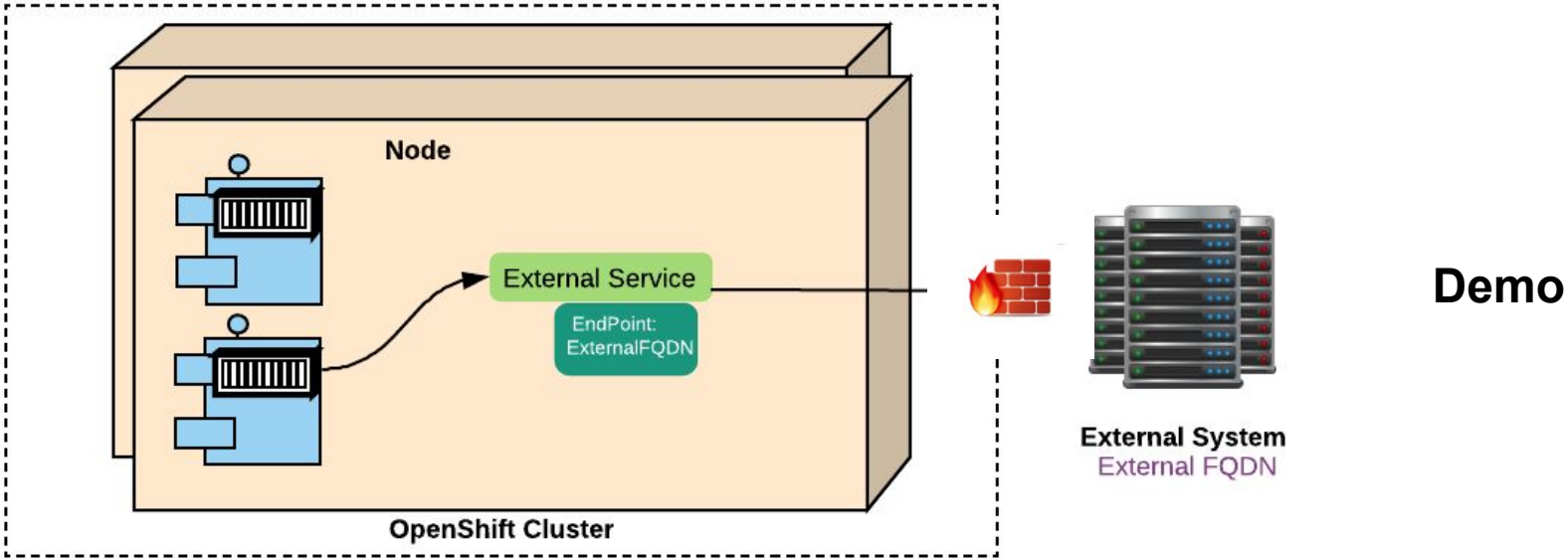

Application pods run on one OpenShift Cluster. Microsegmented with Network Security policies.

Infra Nodes in each zone run Ingress and Egress pods for specific zones

If required, physical isolation of pods to specific nodes is possible with node-selectors. But that defeats the purpose of a shared cluster. Microsegmentation with SDN is the way to go.

# 3. Securing Egress

# Connecting via External Service

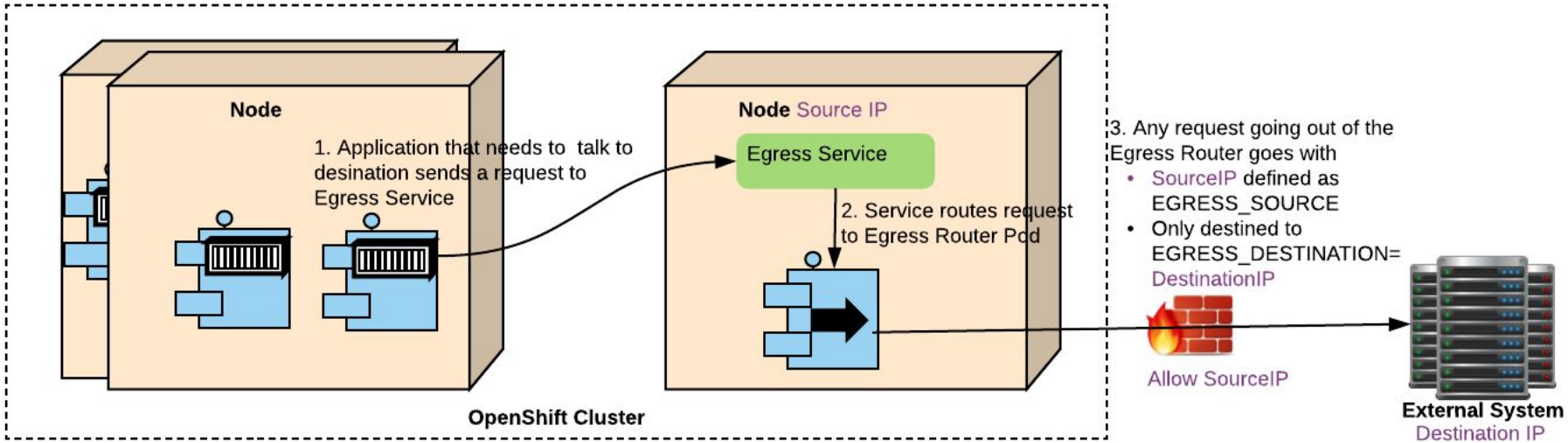



**Demo**

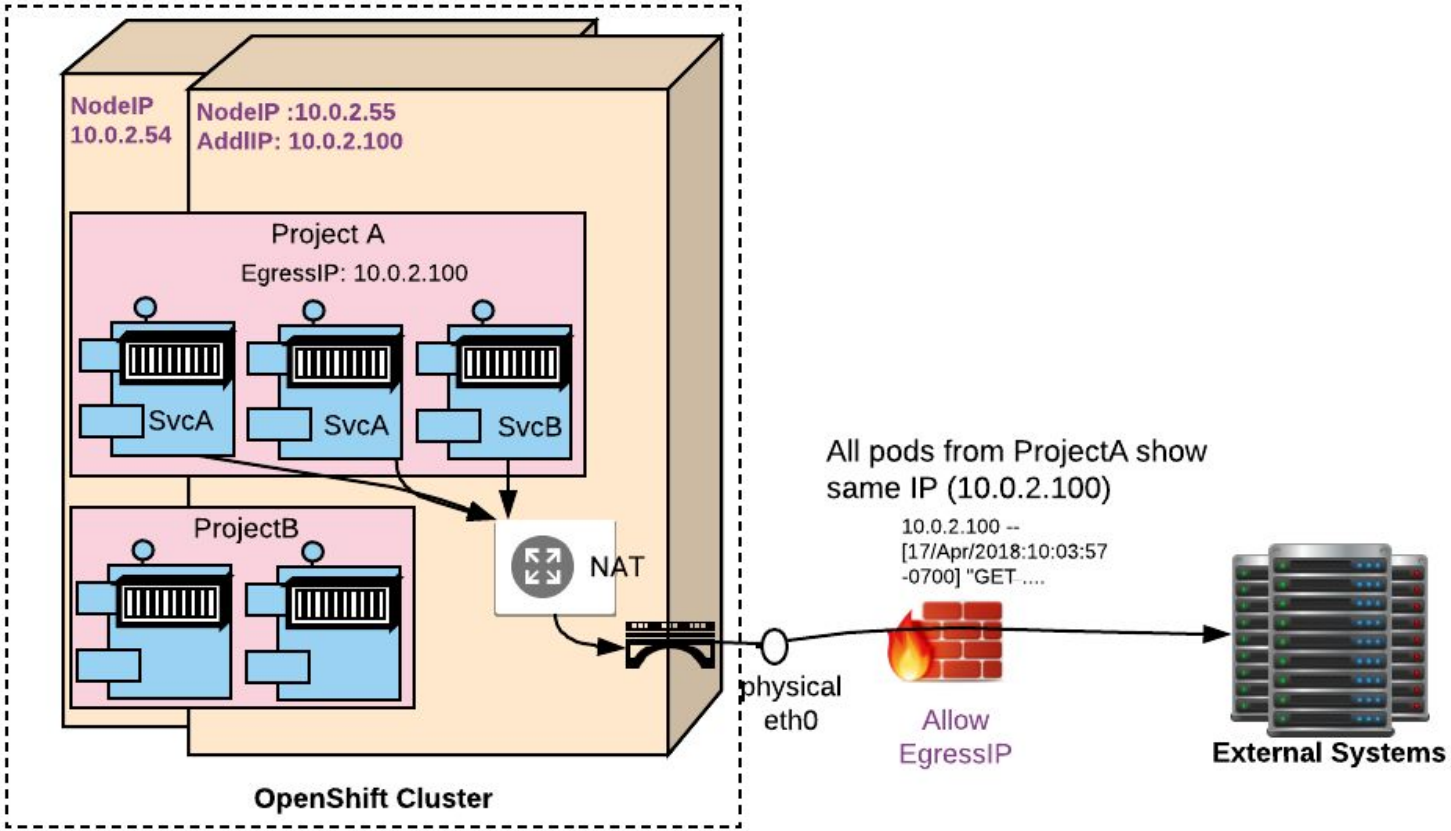
Application connecting to External System talks to an External Service whose Endpoint is set as Destination IP & Port
Or a Fully qualified domain name (FQDN) of the external system and port

But, what if we have a firewall in front of the External System that allows only Specific IPs?

# Connecting via Egress Router

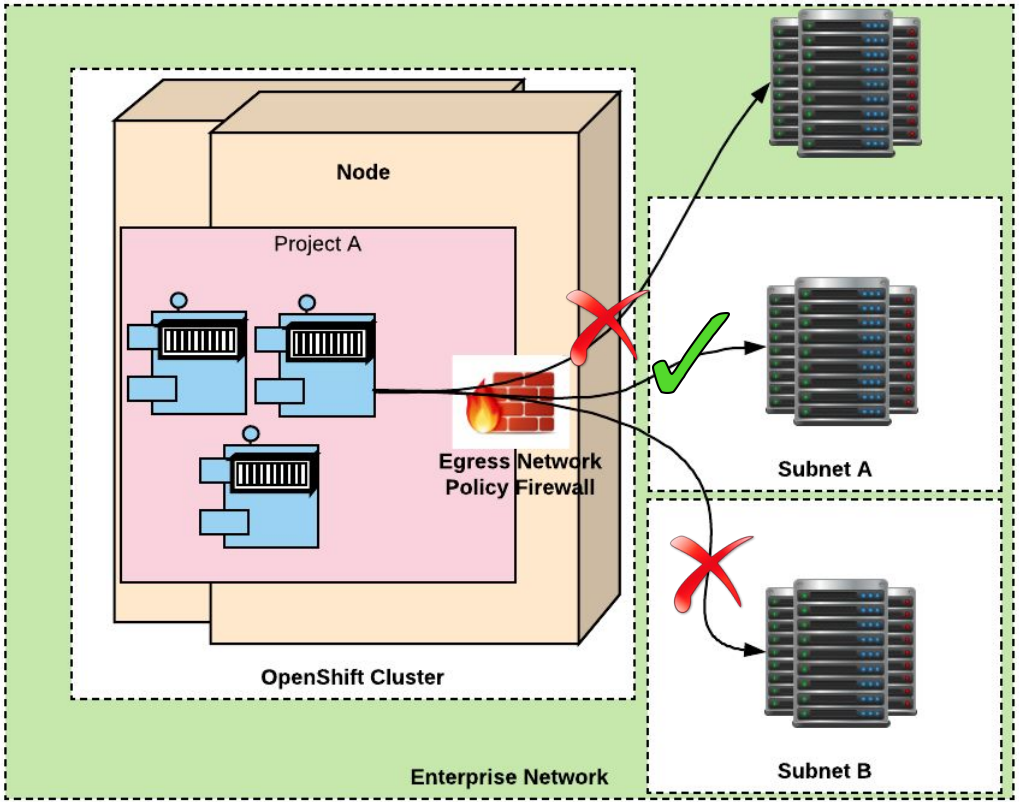


# Static IP for all traffic from a Project



# Egress Firewall to Limit Access

Cluster admin can limit the external addresses accessed by some or all pods




Examples:

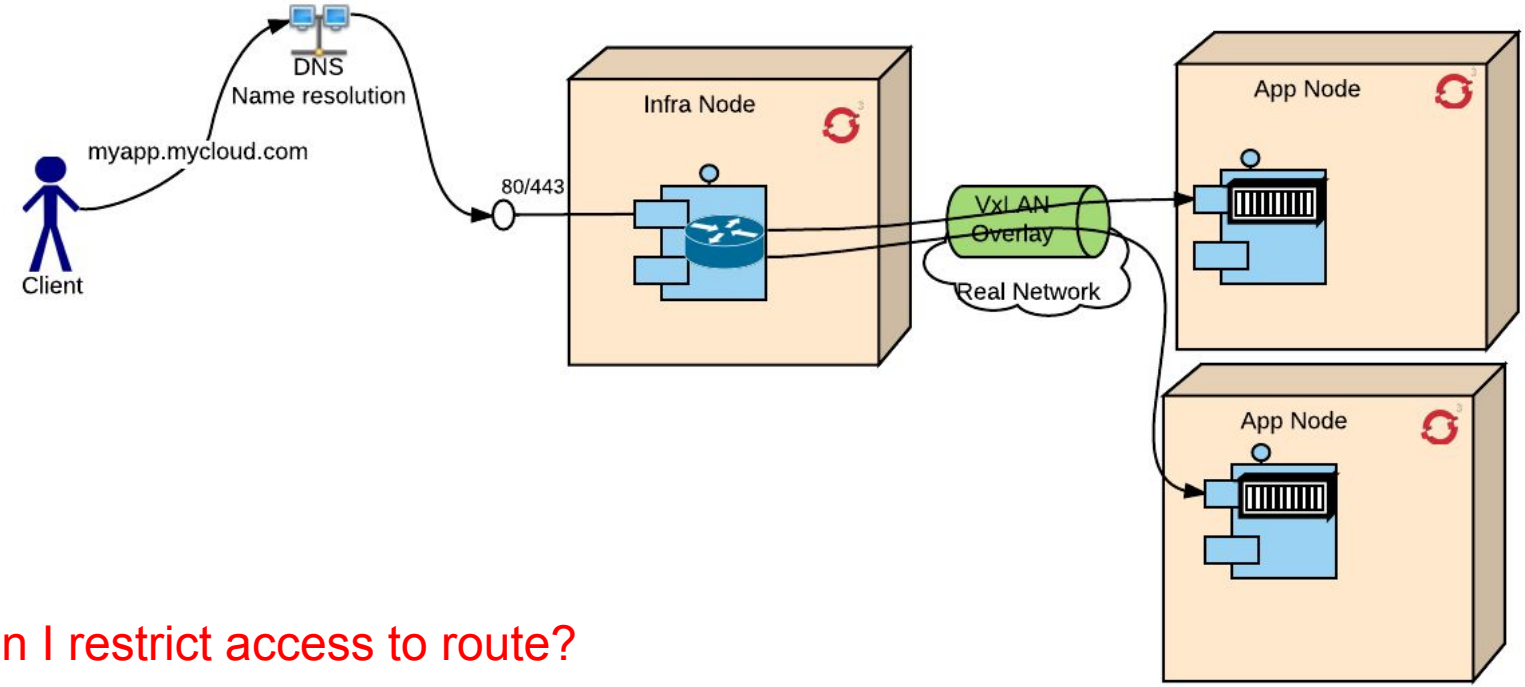
A pod can talk to hosts (outside OpenShift cluster) but cannot connect to public internet

A pod can talk to public internet, but cannot connect to hosts (outside OpenShift cluster)


A pod cannot reach specific subnets/hosts

# 4. Securing Ingress

# OpenShift Router as Ingress




Can I restrict access to route?

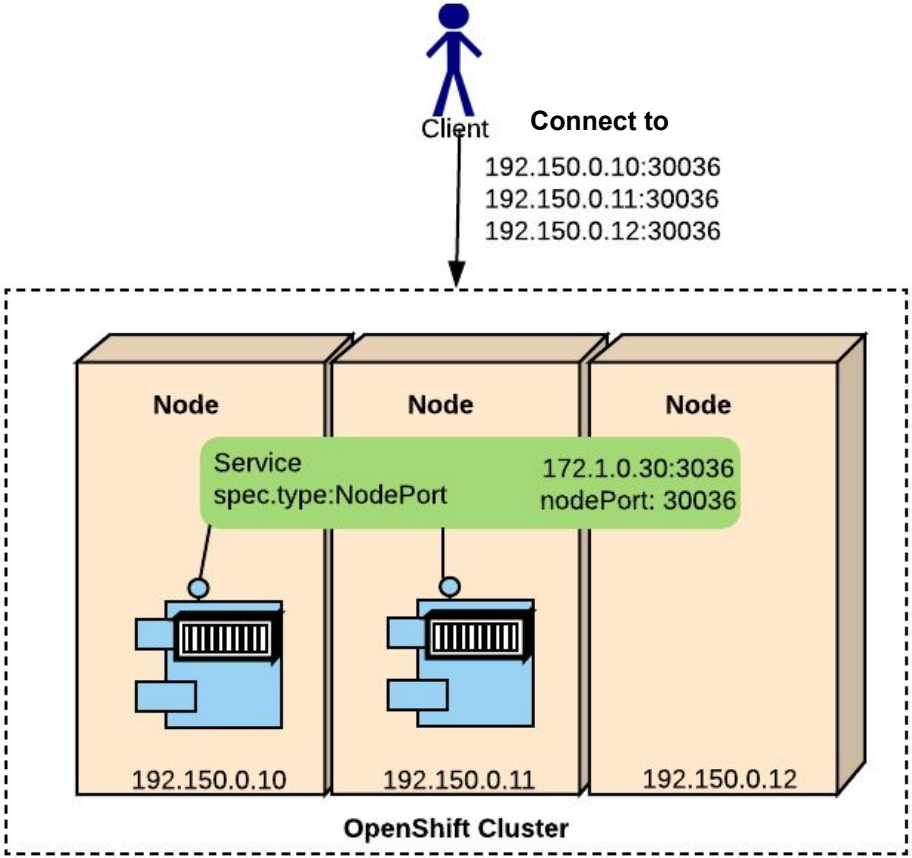
# Route Specific IP Whitelists

- Restrict access to a route to a select IP address(es)
- Annotate the route with the whitelisted/allowed IP addresses
- Connections from any other IPs are blocked

```
metadata:
  annotations:
    haproxy.router.openshift.io/ip_whitelist: 192.168.1.10 192.168.1.11
```

What about ingress traffic on ports that are not 80 or 443?

# Using NodePort as Ingress to Service




Binds service to a unique port on every node in the cluster

Port randomly assigned or optionally picked from port range 30000-32767

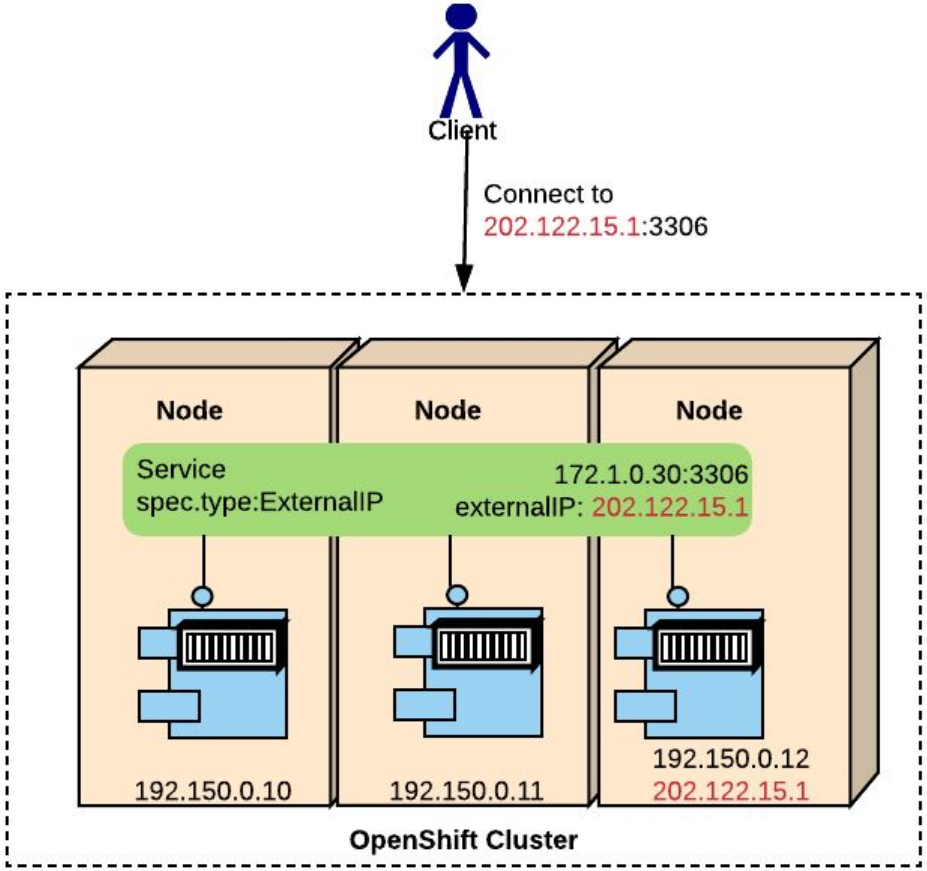
All nodes act as ingress point at the port assigned

Every node in the cluster redirects traffic to service service endpoints even if a corresponding pod is not running on that node

Firewall rules should not prevent nodes listening on these ports

Every exposed service uses up a port on all the nodes in a cluster. Are there alternatives?

# Assigning External IP to a Service with Ingress




Admin defines ExternalIP address range. Assigns these extra IPs to nodes.

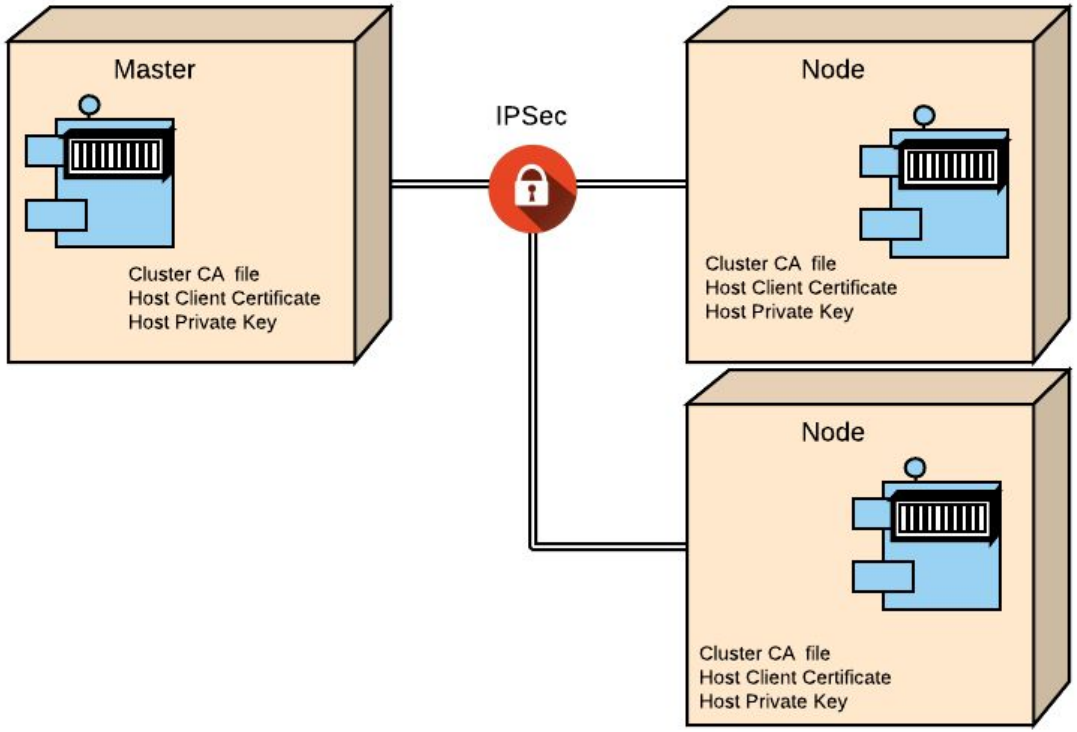
OpenShift assigns both internal IP and external IP to a service. Or a specific External IP can be chosen.

Node to which ExternalIP is assigned acts as the ingress point to the service.

ExternalIP can be a VIP. You can set up ipfailover to reassign VIP to other nodes. Ipfailover runs as a privileged pod and handles VIP assignment.

# 5. Securing communications between OpenShift nodes

# Secured Communications between Hosts

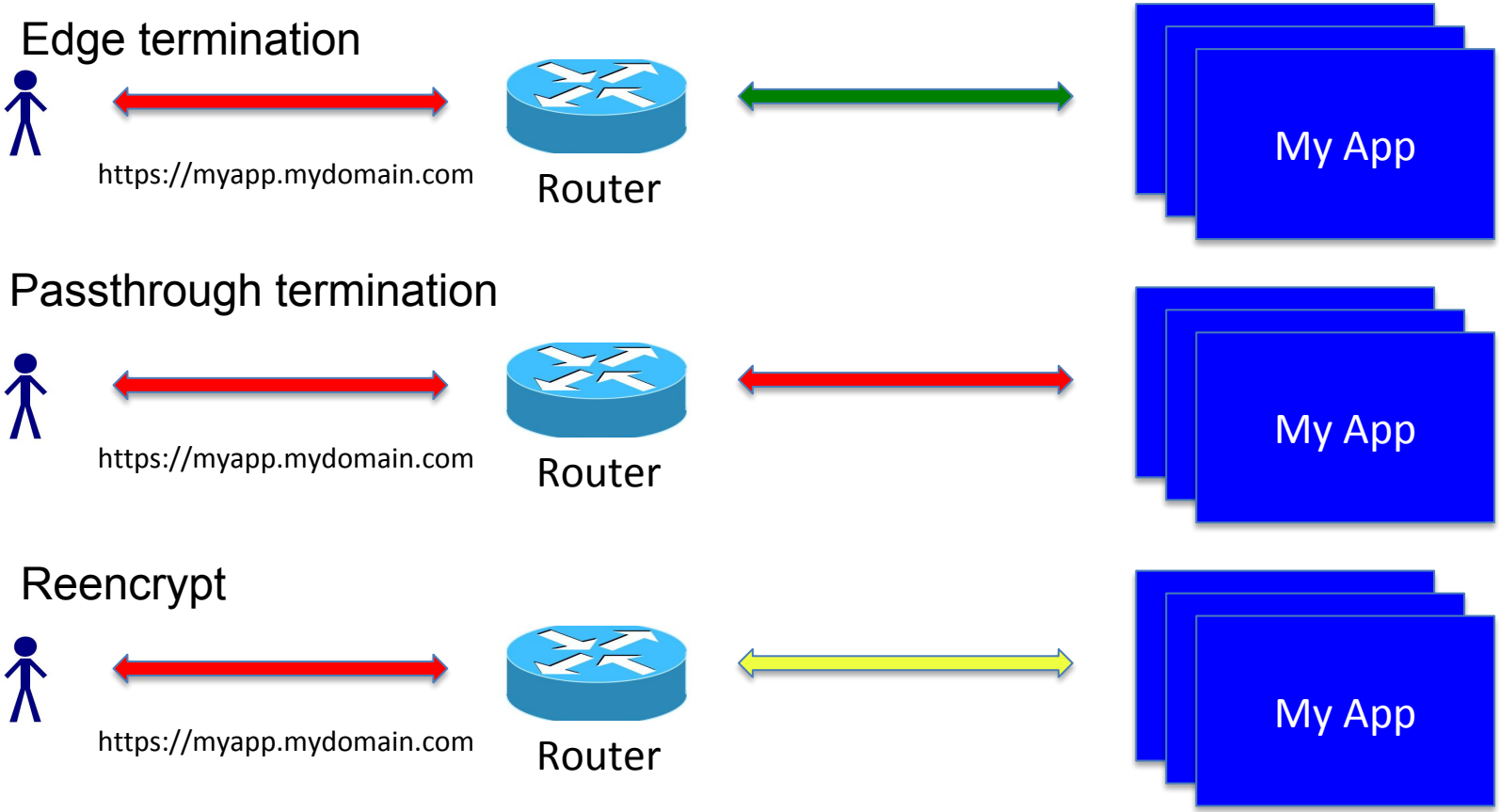



Secures cluster communications with IPsec

- Encryption between all Master and Node hosts (L3)
- Uses OpenShift CA and existing certificates
- Simple setup via policy defn
  - Groups (e.g. subnets)
  - Individual hosts

# 6. Security at Application Level

# SSL at Ingress (with OpenShift Routes)



# Layer 7 Application Security

Application specific monitoring East-West container traffic

Web Application Firewalls

Granular traffic control, Packet Inspections

Denial of Service, Ransomware, Viruses Detection and Mitigation

Runtime Security, Forensics, Incident capture, Audits, Alerts

Container runtime monitoring and

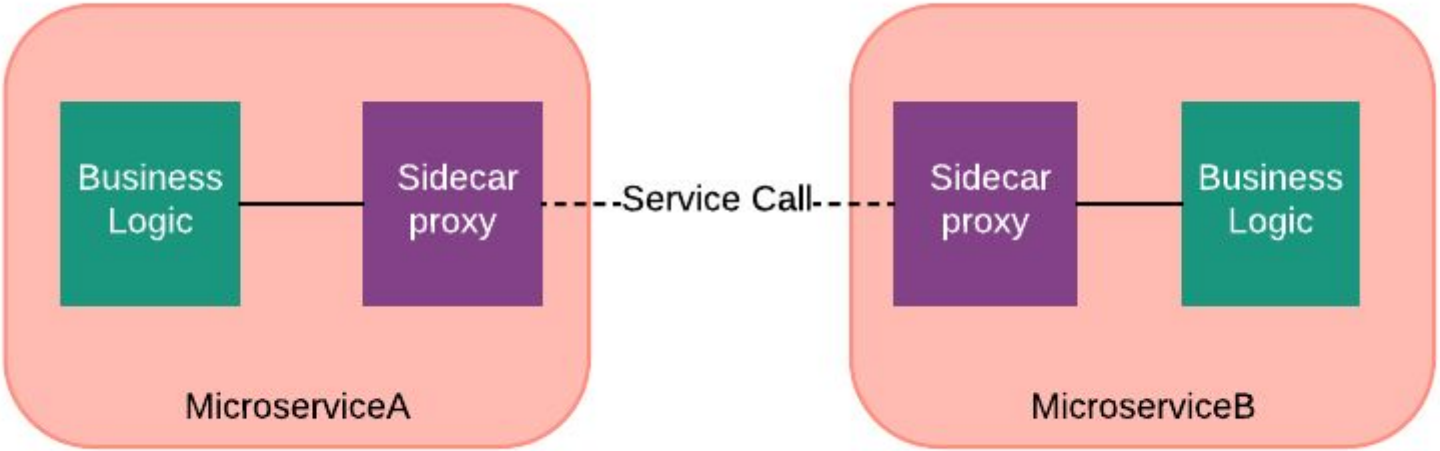
**Partner Solutions**





# 7. (Upcoming) Application network security with Istio

# Istio Concepts - Sidecar Proxy

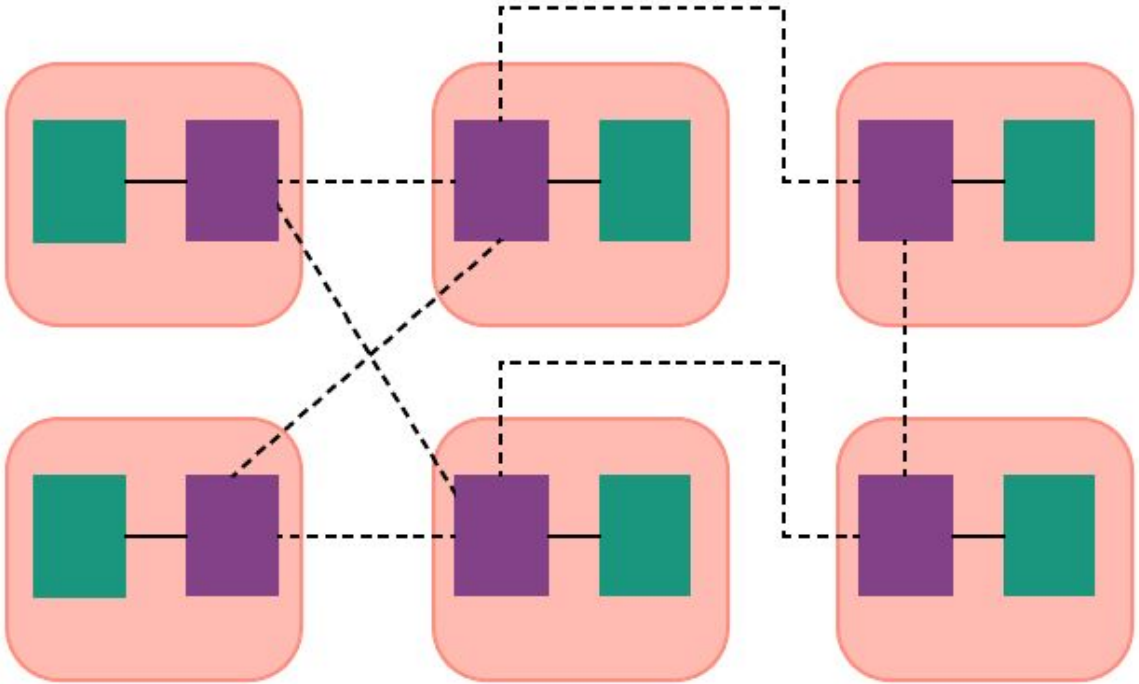



**SideCar Proxy**

- Intercepts all network communication between microservices
- Encapsulates Service Infrastructure code
- Application code (business logic) unaware of Sidecar proxy
- Examples - Linkerd, Envoy

# Istio Concepts - Service Mesh

**Network of Microservices**

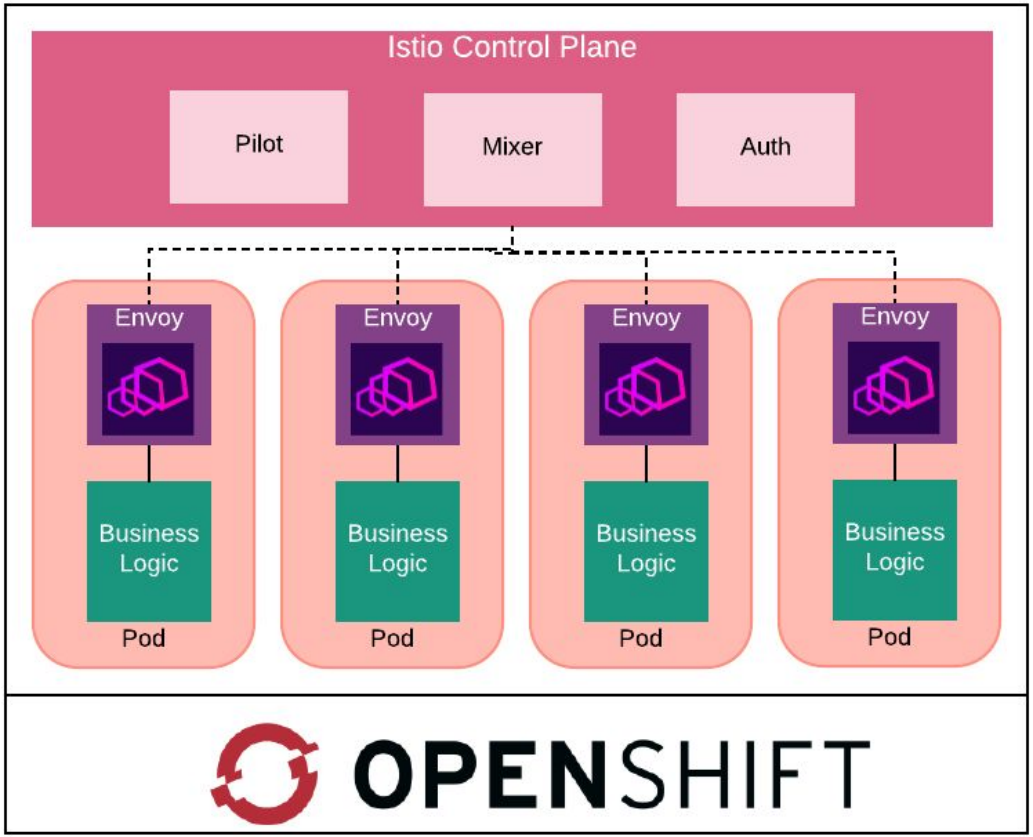


Service Mesh is a dedicated infrastructure layer to handle service-service communications

Typically implemented as an array of lightweight network proxies deployed alongside application code

Interconnected Proxies form a mesh network

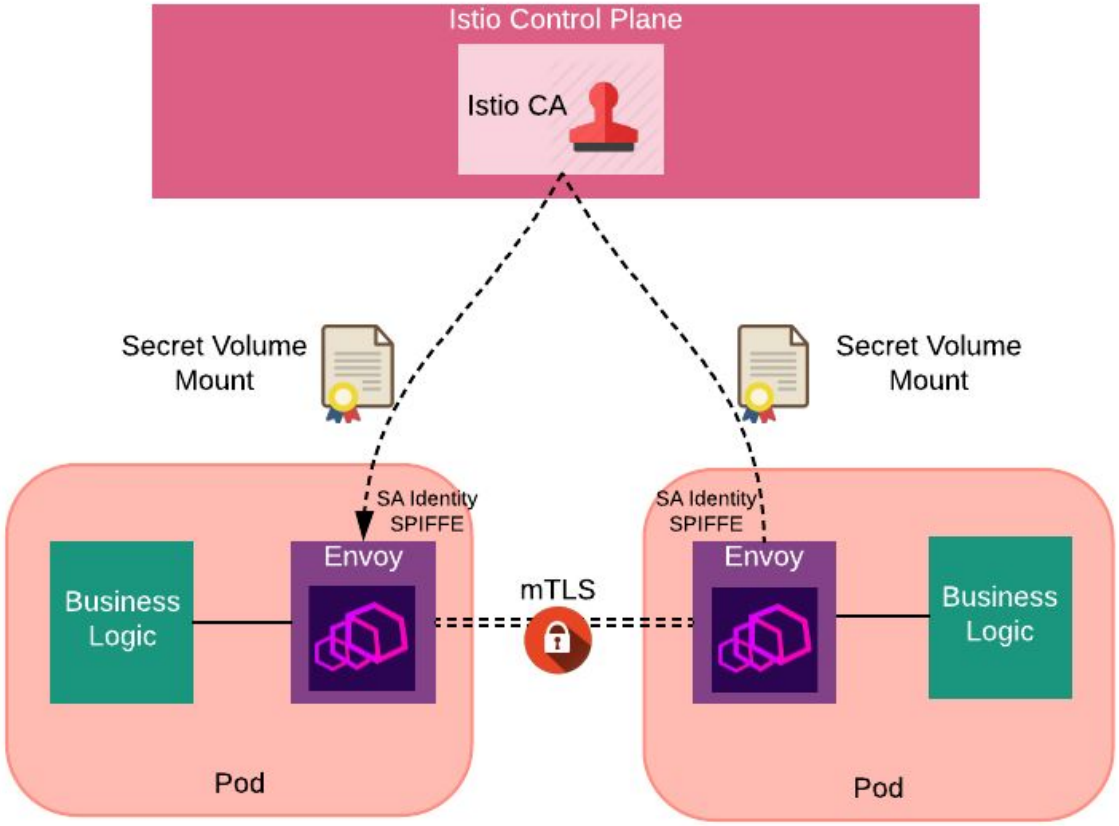
# Istio Service Mesh on OpenShift




Connect, Manage, and Secure Microservices, transparently

- Intelligent Routing
- Load Balancing
- Service Resilience
- Telemetry and Reporting
- Policy Enforcement
- Content based Filtering (Layer 7)
- mTLS between services
- East-West traffic control

# Application Traffic Encryption with Istio Auth (Future)




Uses Service Account as Identity. SPIFFE Id format

spiffe://<*domain*>/ns/<*namespace*>/sa/<*serviceaccount*>

Mutual TLS between sidecars

Istio CA

- Generate cert pair and SPIFFE key for each SA
- Distribute key and cert pairs
- Rotate keys and certs periodically
- Revoke key and cert when need

# Questions?


# THANK YOU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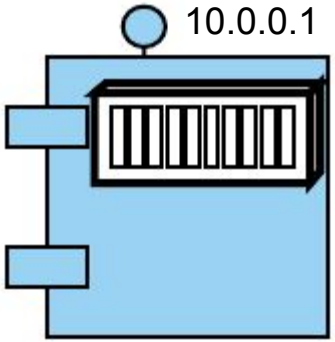
# Kubernetes/OpenShift
# Core Concepts

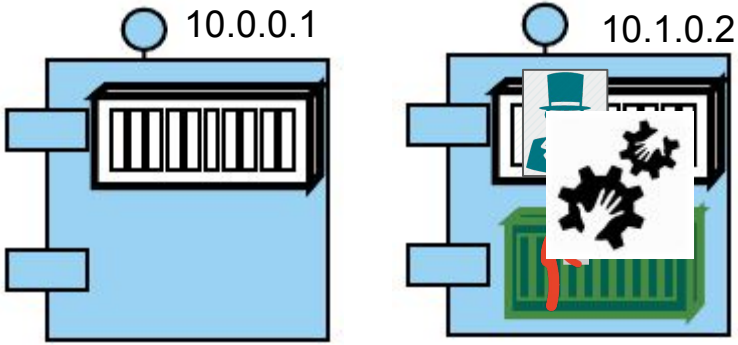
# Pods




Openshift/K8S runs containers in Pods. Pod is a wrapper

Each pod gets an IP address. Container adopts Pod's IP.

# Containers in Pods



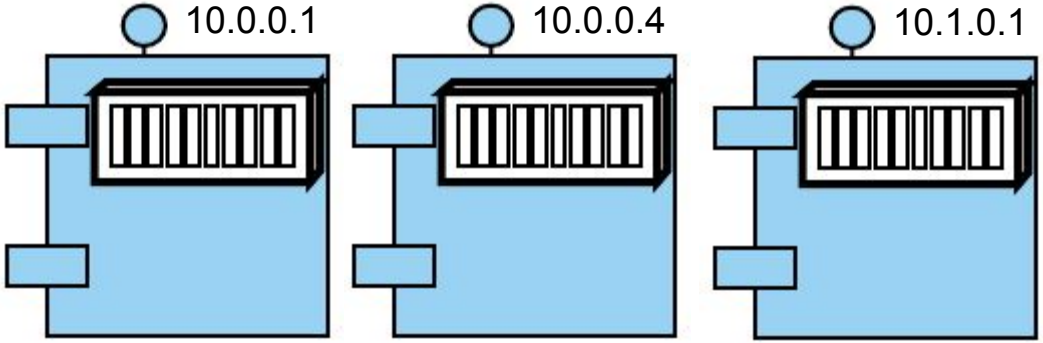

Some pods may have more than one container.. that's a special case though!!

Usually these containers are dependent like a master and slave or **side-car** pattern

And they have a very tight married relationship

All the containers in a pod die along with a pod.

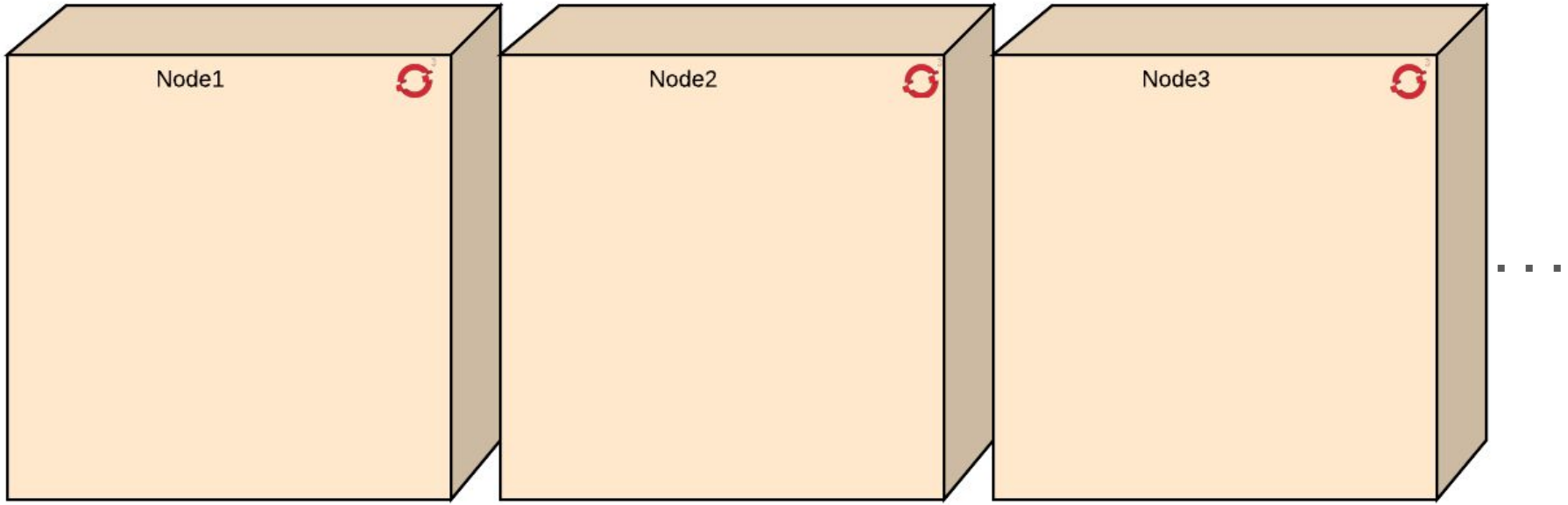
# Pod Scaling

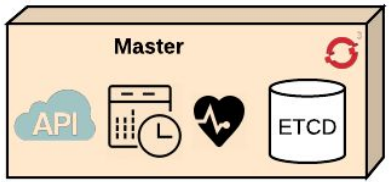



When you scale up your application, you are scaling up pods.

Each Pod has its own IP.

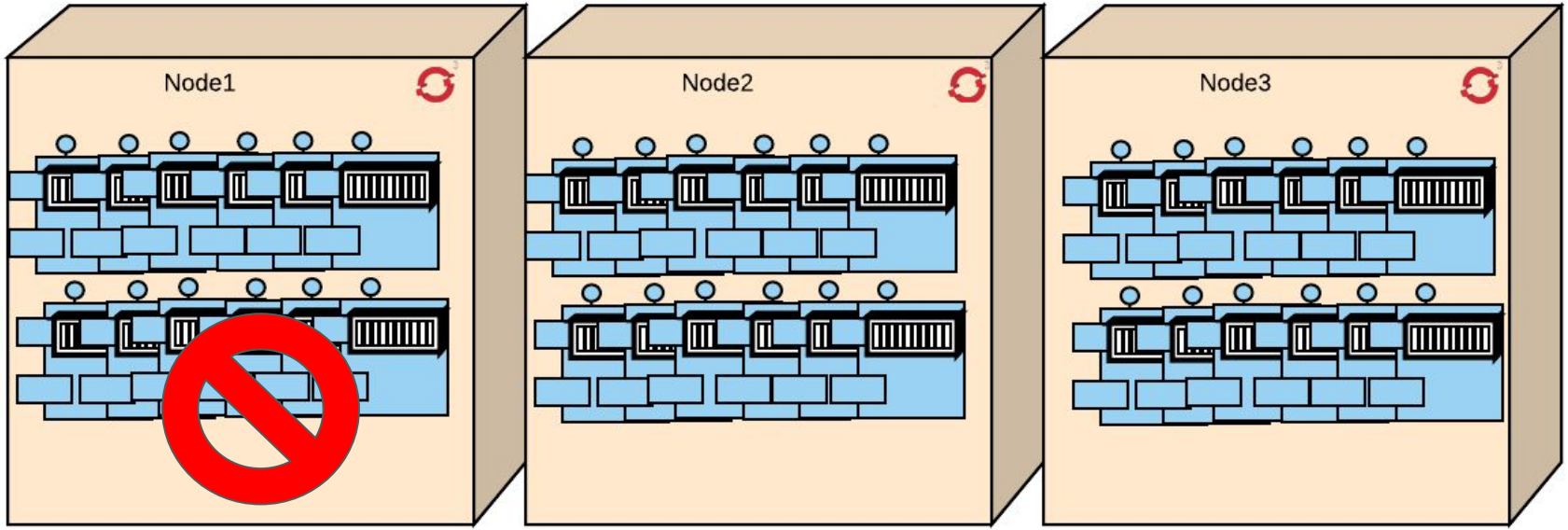
# Nodes




Nodes are the application hosts that make up a openshift/K8S cluster. They run docker and openshift. Master controls where the pods are deployed on the nodes, and ensures cluster health.

# High Availability

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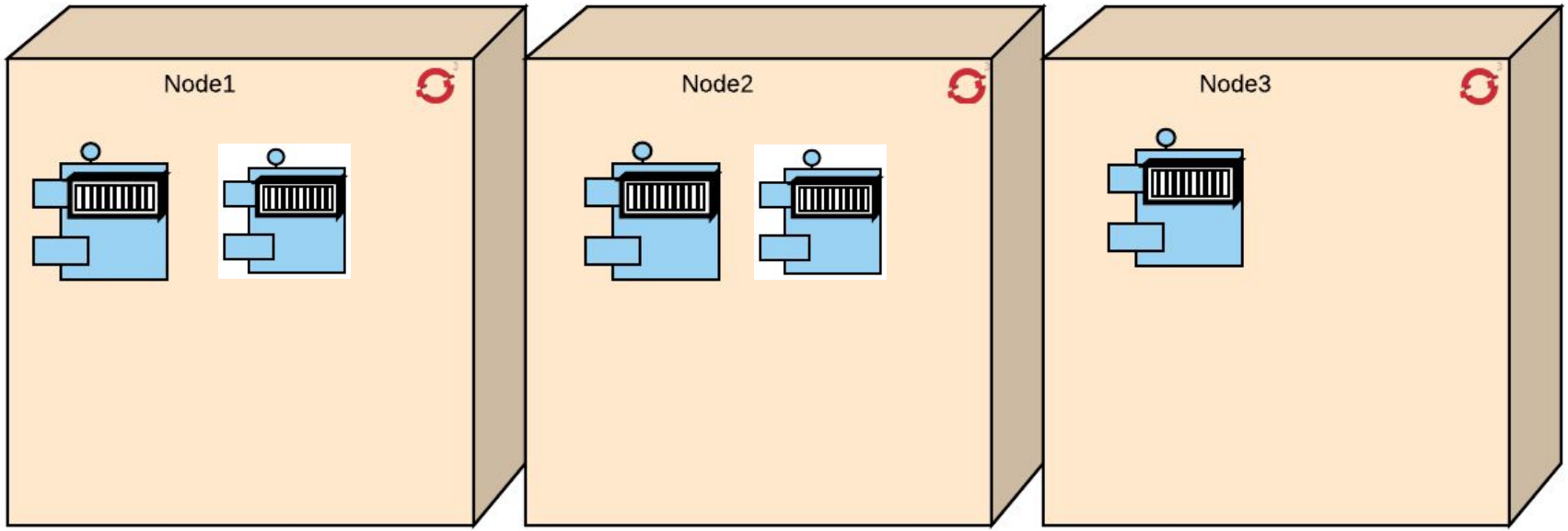
When you scale up, pods are distributed across nodes following scheduler policies defined by the administrator.

So even if a node fails, the application is still available

# Health Management

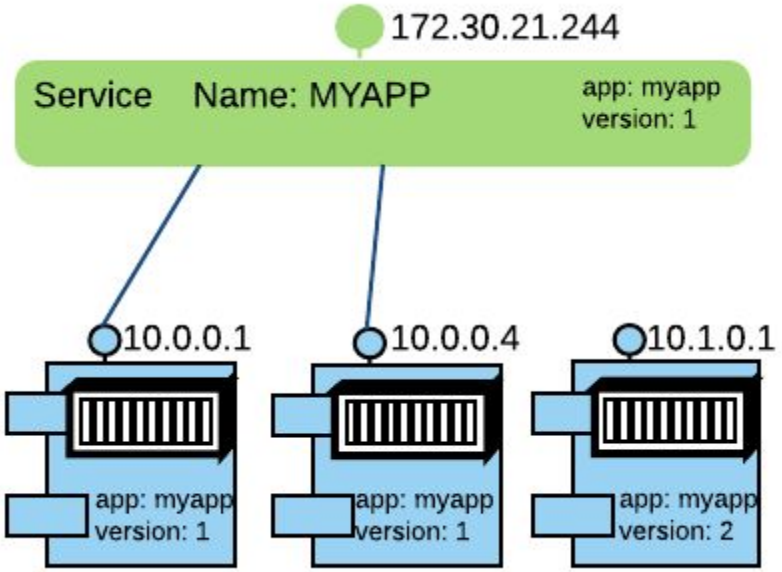



Not just that, if a pod dies for some reason, another pod will come in its place

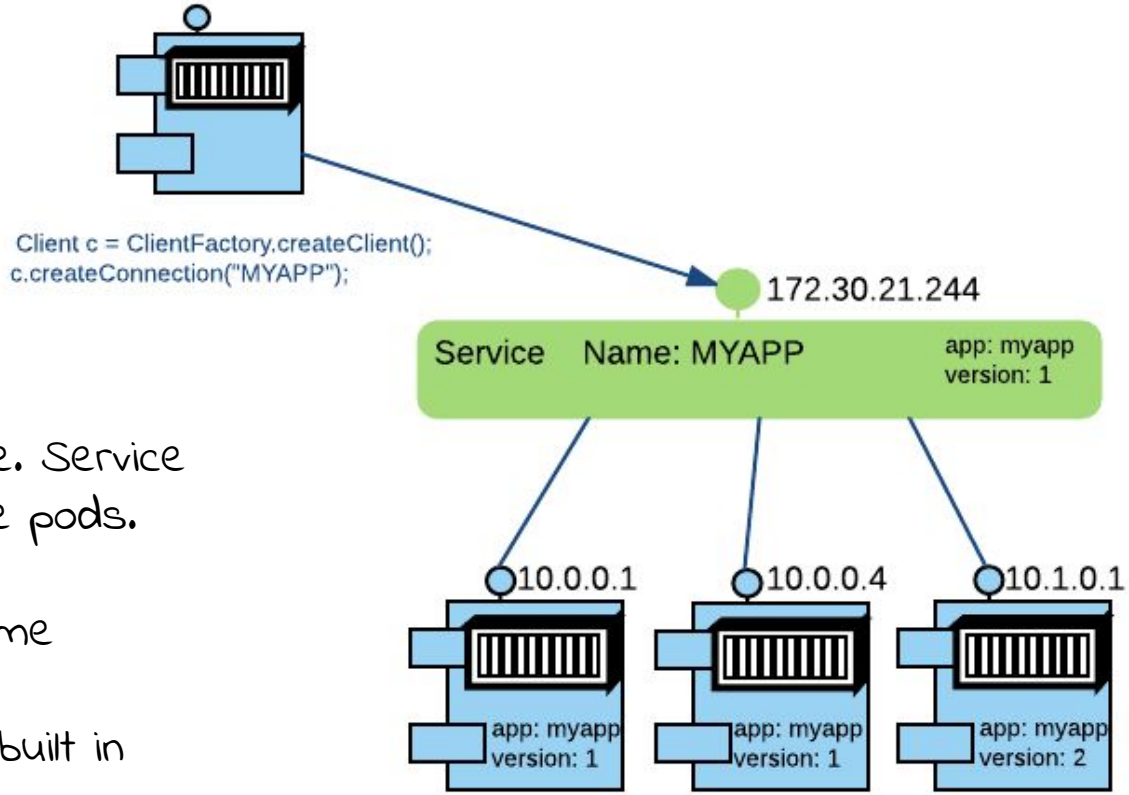
# Flexibility of architecture with Openshift/ K8S Services

Pods can be front-ended by a Service. Service is a proxy.. Every node knows about it. Service gets an IP

Service knows which pods to frontend based on the labels.



# Built-in Service Discovery

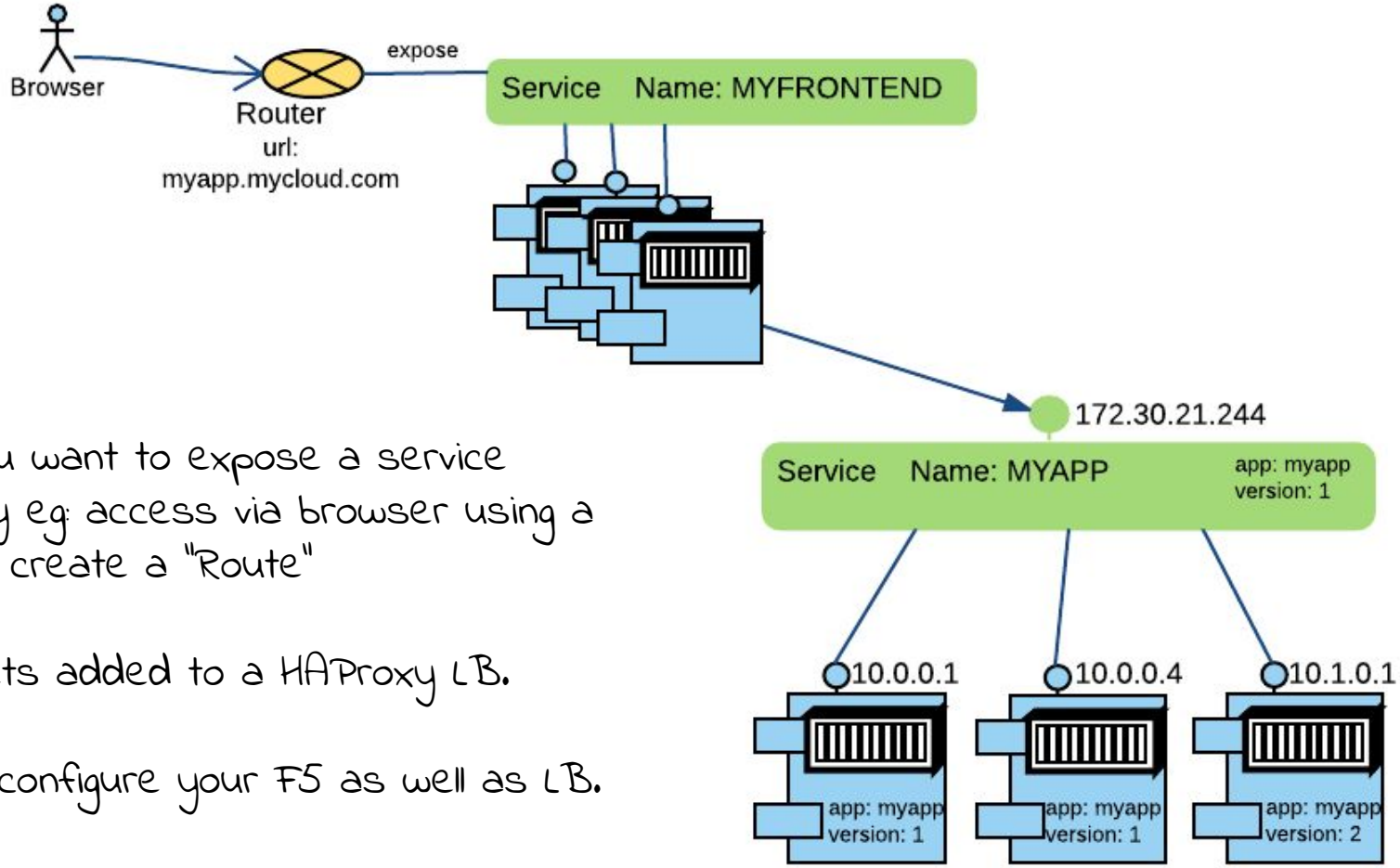



Clients can talk to the service. Service redirects the requests to the pods.

Service also gets a DNS Name

Client can discover service... built in service discovery!!

# Accessing your Application




When you want to expose a service externally eg: access via browser using a URL, you create a "Route"

Route gets added to a HAProxy LB.

You can configure your F5 as well as LB.