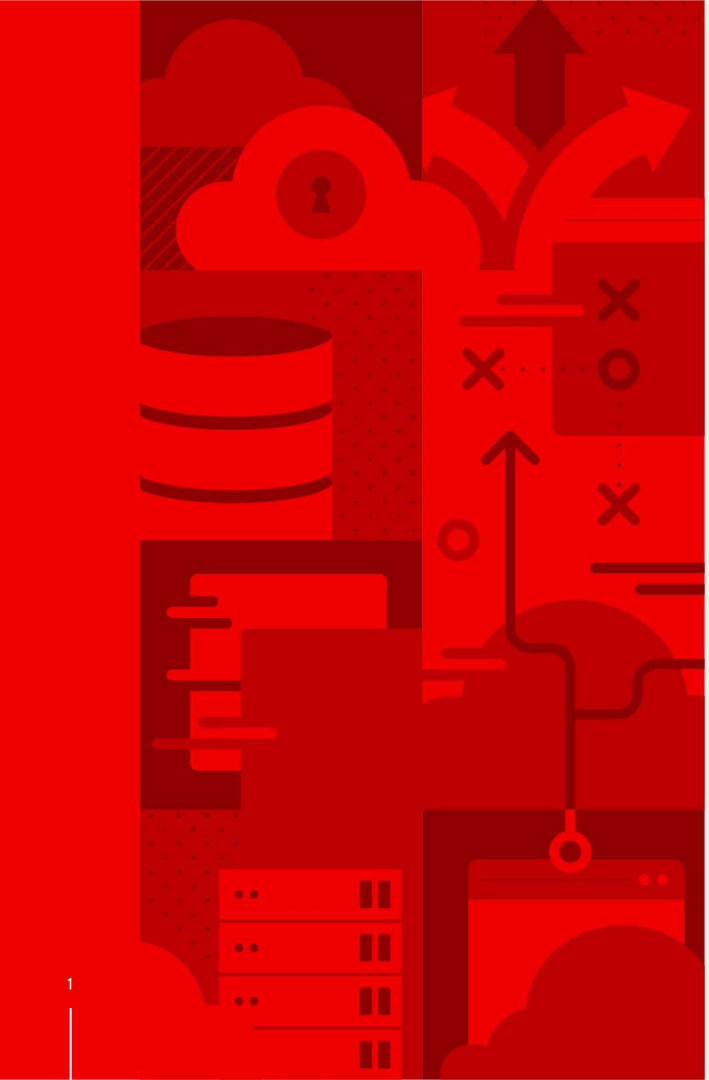


# OPENSHIFT CONTAINER PLATFORM

ARCHITECTURAL OVERVIEW

in linkedin.com/company/red-hat

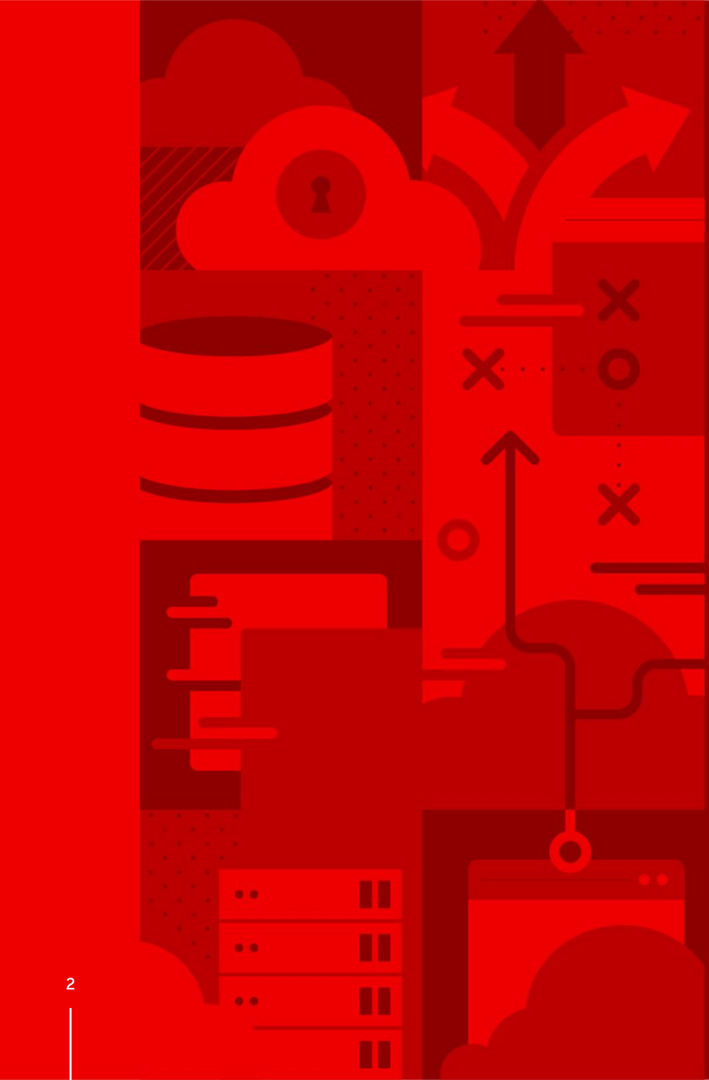
f facebook.com/redhatinc

youtube.com/user/RedHatVideos

twitter.com/RedHat

Alfred Bach
Principal Solution Architect
June 2021

Red Hat



# Functional overview

OPENSHIFT CONTAINER PLATFORM | Technical Value

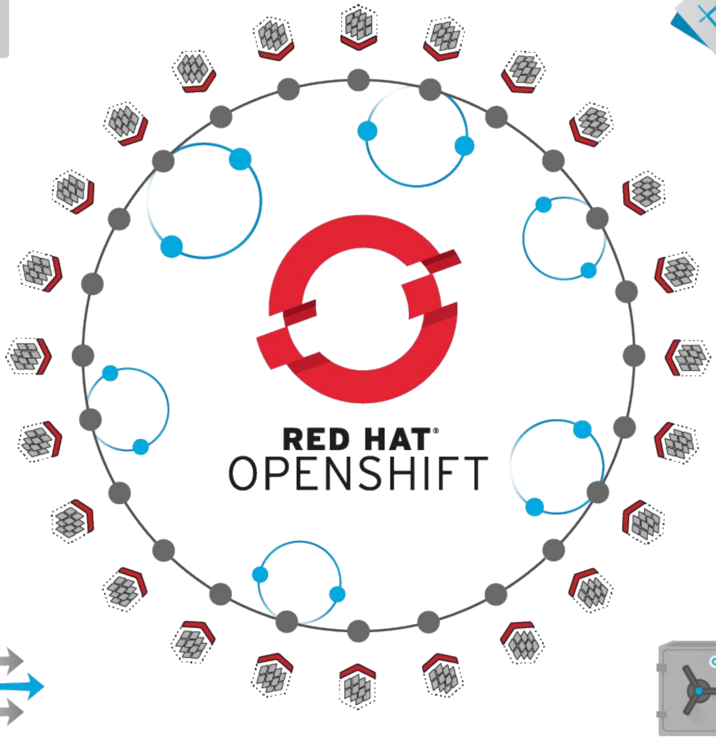
Self-Service

Multi-language

Automation

Collaboration

Multi-tenant



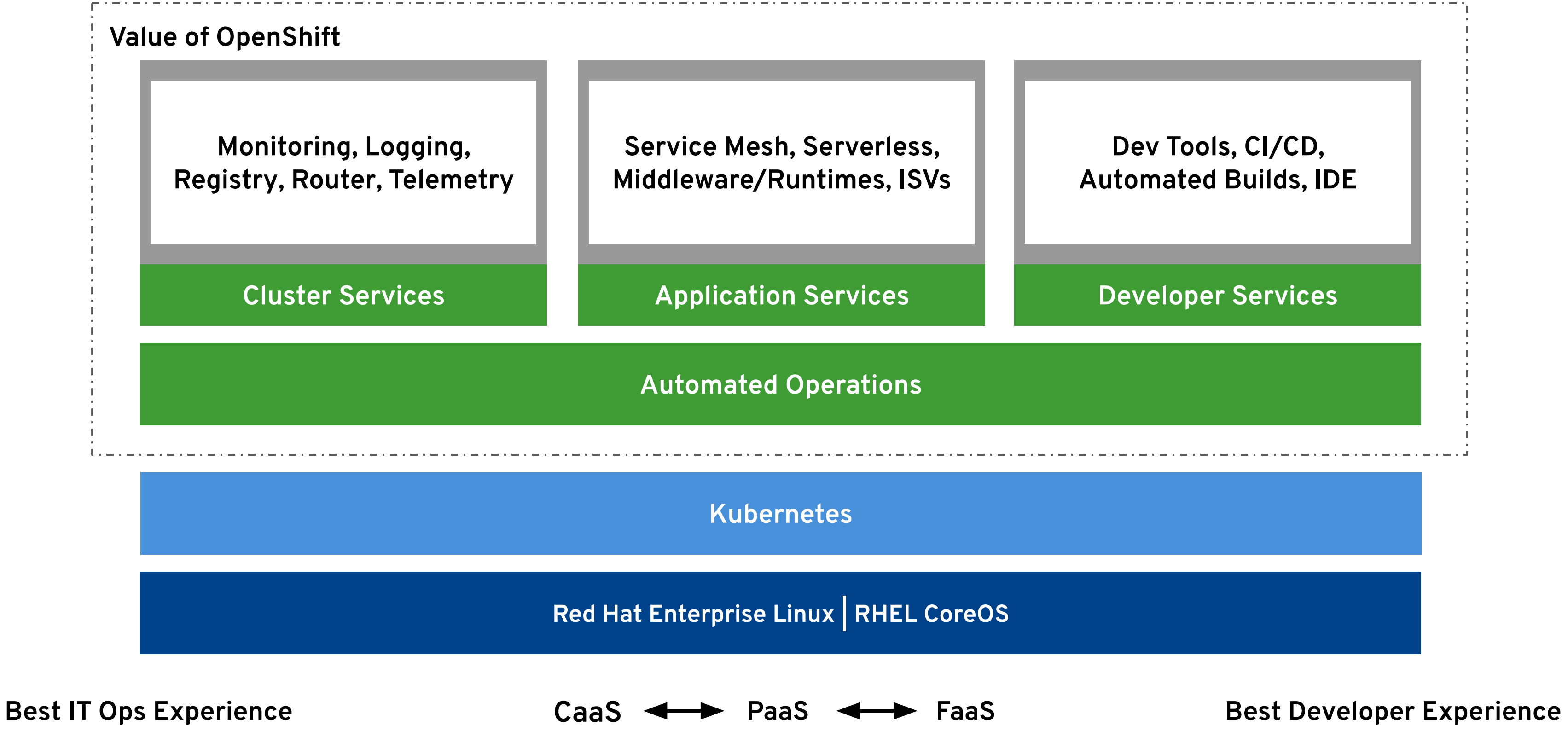
Standards-based

Web-scale

Open Source

Enterprise Grade

Secure



Value of OpenShift

Monitoring, Logging, Registry, Router, Telemetry

Cluster Services

Service Mesh, Serverless, Middleware/Runtimes, ISVs

Application Services

Dev Tools, CI/CD, Automated Builds, IDE

Developer Services

Automated Operations

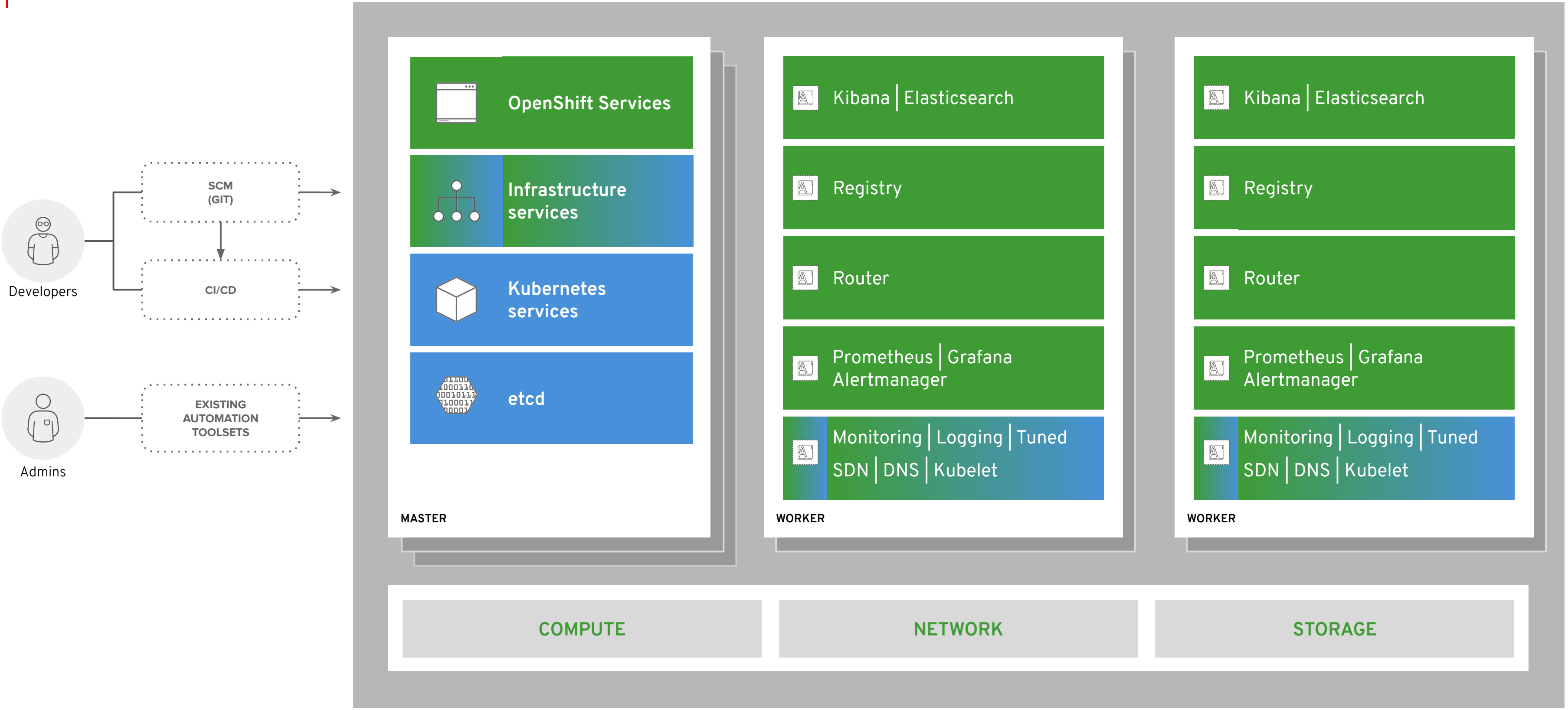
Kubernetes

Red Hat Enterprise Linux | RHEL CoreOS

Best IT Ops Experience

CaaS ⟷ PaaS ⟷ FaaS

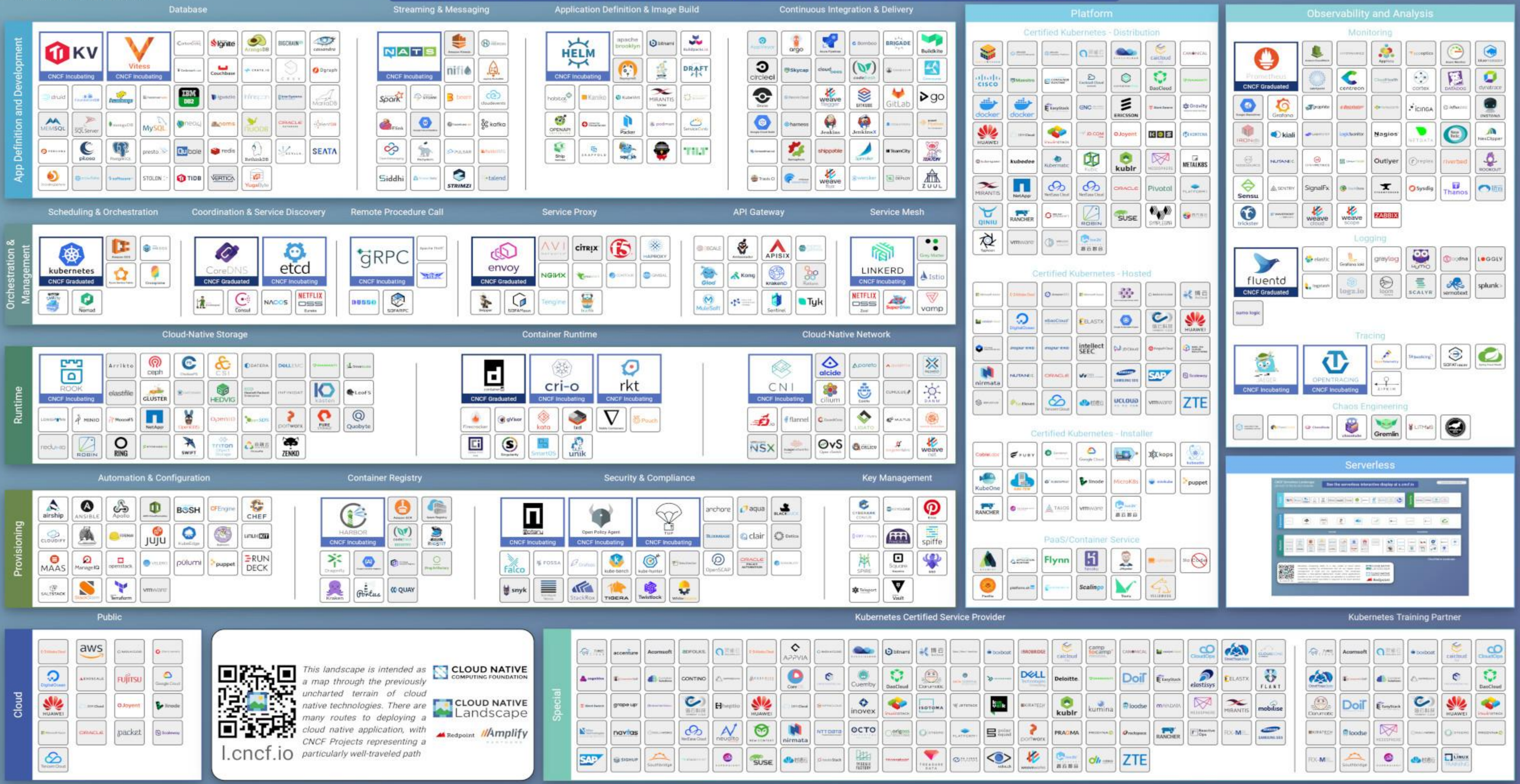
Best Developer Experience


Developers
SCM (GIT)
CI/CD
Admins
EXISTING AUTOMATION TOOLSETS
OpenShift Services
Infrastructure services
Kubernetes services
etcd
MASTER
Kibana | Elasticsearch
Registry
Router
Prometheus | Grafana Alertmanager
Monitoring | Logging | Tuned
SDN | DNS | Kubelet
WORKER
Kibana | Elasticsearch
Registry
Router
Prometheus | Grafana Alertmanager
Monitoring | Logging | Tuned
SDN | DNS | Kubelet
WORKER
COMPUTE
NETWORK
STORAGE

CNCF Cloud Native Landscape
2019-07-12T03:51:02Z 024e93b

Overwhelmed? Please see the CNCF Trail Map. That and the interactive landscape are at l.cncf.io

Greyed logos are not open source



App Definition and Development

Database

Streaming & Messaging

Application Definition & Image Build

Continuous Integration & Delivery

Orchestration & Management

Scheduling & Orchestration

Coordination & Service Discovery

Remote Procedure Call

Service Proxy

API Gateway

Service Mesh

Runtime

Cloud-Native Storage

Container Runtime

Cloud-Native Network

Provisioning

Automation & Configuration

Container Registry

Security & Compliance

Key Management

Platform

Certified Kubernetes - Distribution

Certified Kubernetes - Hosted

Certified Kubernetes - Installer

PaaS/Container Service

Observability and Analysis

Monitoring

Logging

Tracing

Chaos Engineering

Serverless

Cloud

Public

l.cncf.io

*This landscape is intended as a map through the previously uncharted terrain of cloud native technologies. There are many routes to deploying a cloud native application, with CNCF Projects representing a particularly well-traveled path*

Special

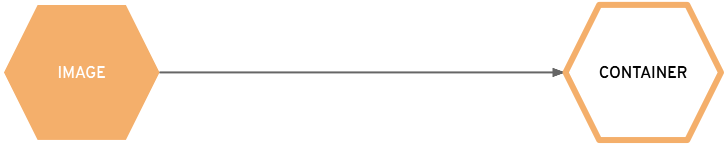
Kubernetes Certified Service Provider

Kubernetes Training Partner

# OpenShift and Kubernetes core concepts

# a container is the smallest compute unit

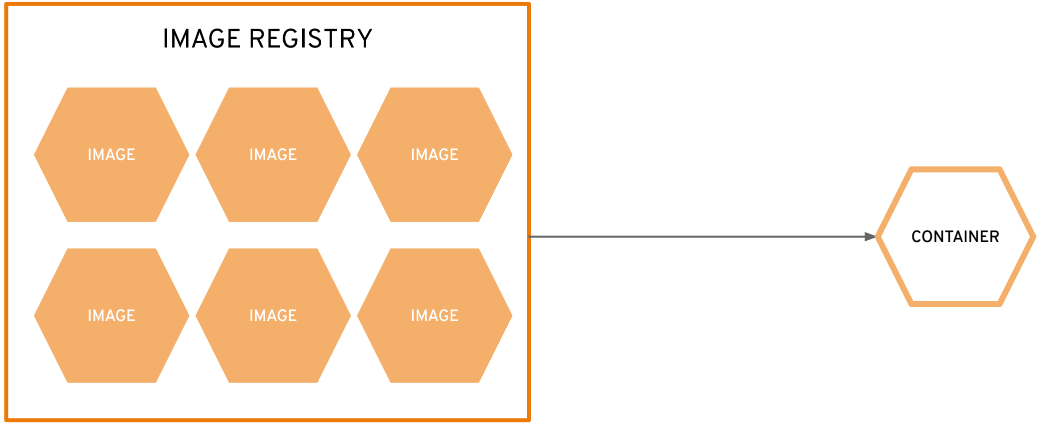
# containers are created from container images



BINARY

RUNTIME

# container images are stored in an image registry



# an image repository contains all versions of an image in the image registry

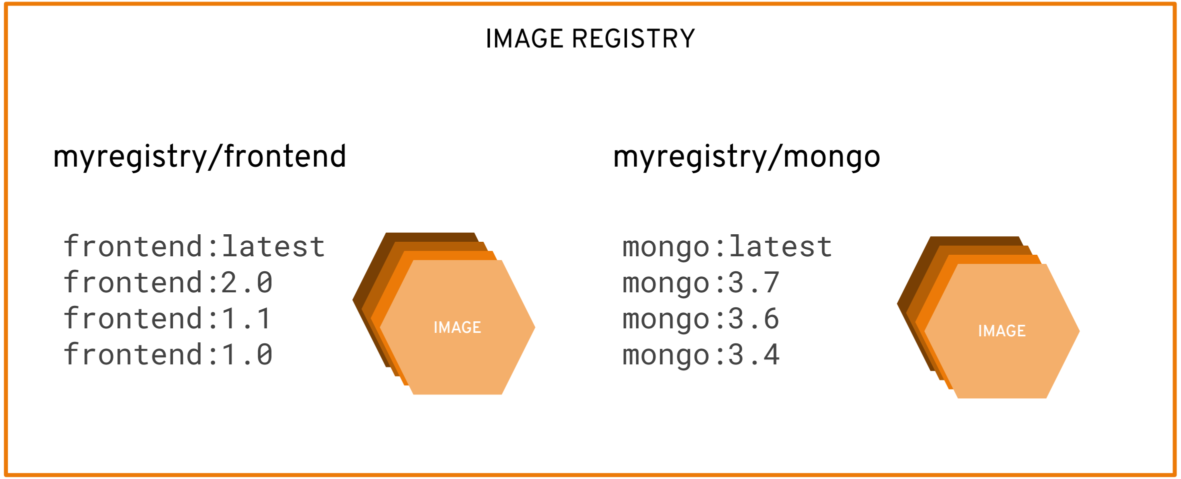


IMAGE REGISTRY

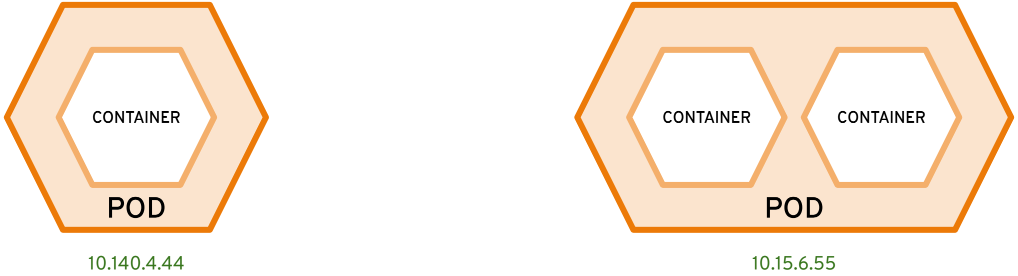
myregistry/frontend

```
frontend:latest
frontend:2.0
frontend:1.1
frontend:1.0
```

myregistry/mongo

```
mongo:latest
mongo:3.7
mongo:3.6
mongo:3.4
```

# containers are wrapped in pods which are units of deployment and management



# `ReplicationControllers` & `ReplicaSets` ensure a specified number of pods are running at any given time

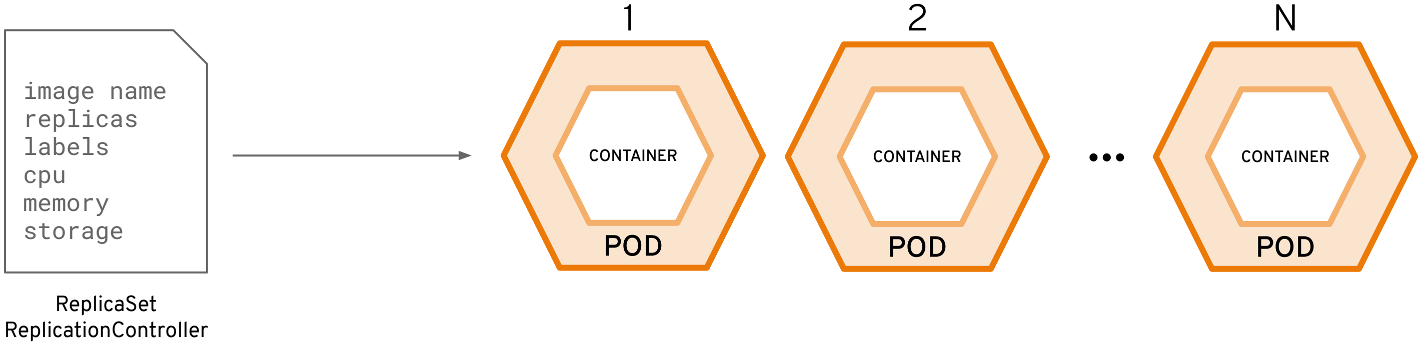
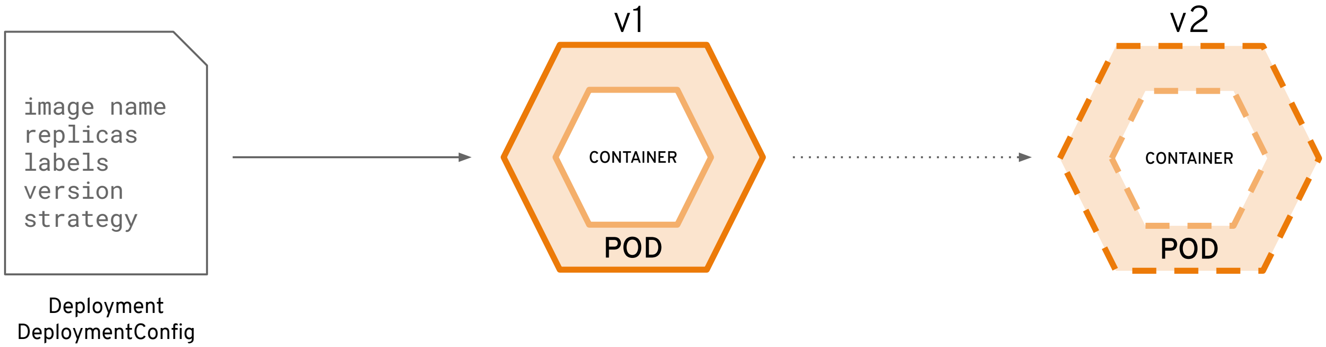


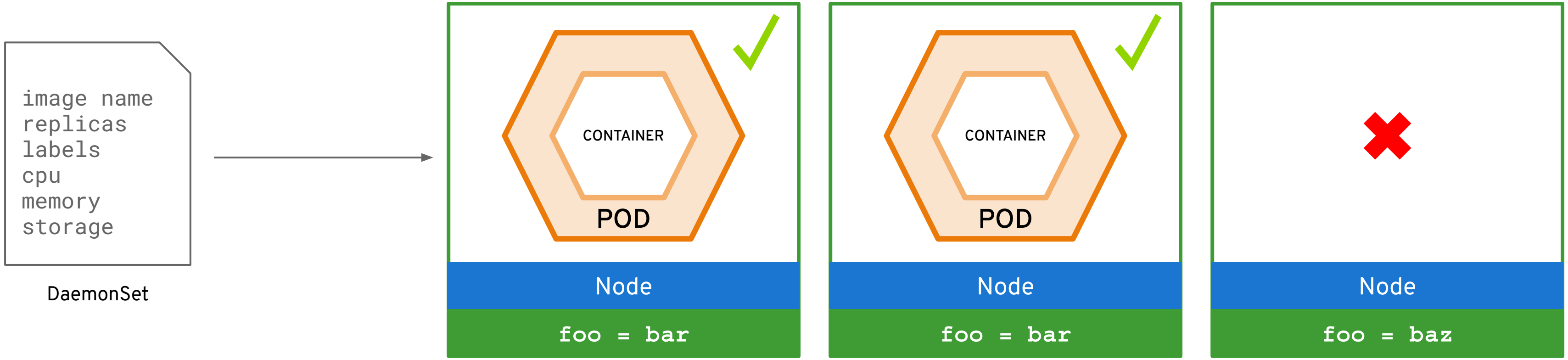
image name
replicas
labels
cpu
memory
storage

ReplicaSet
ReplicationController

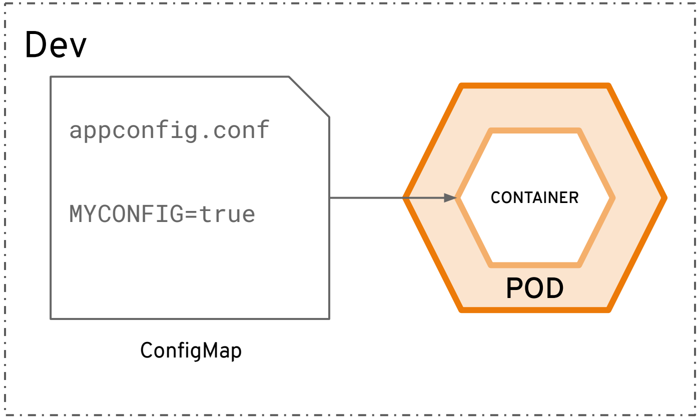
# `Deployments` and `DeploymentConfigurations` define how to roll out new versions of Pods



# a daemonset ensures that all (or some) nodes run a copy of a pod



# `configmaps` allow you to decouple configuration artifacts from image content



Dev

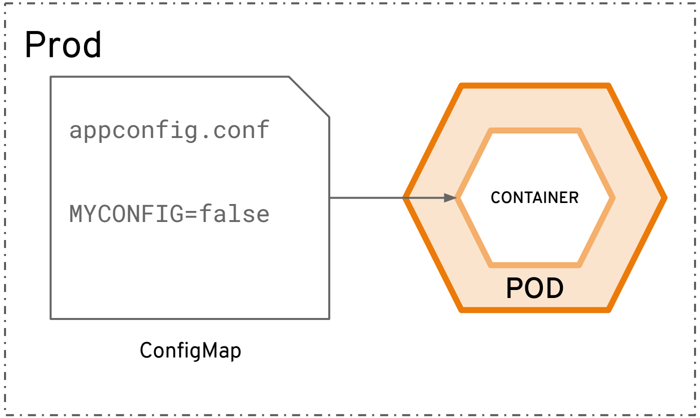
```
appconfig.conf

MYCONFIG=true
```

ConfigMap

CONTAINER

POD



Prod

```
appconfig.conf

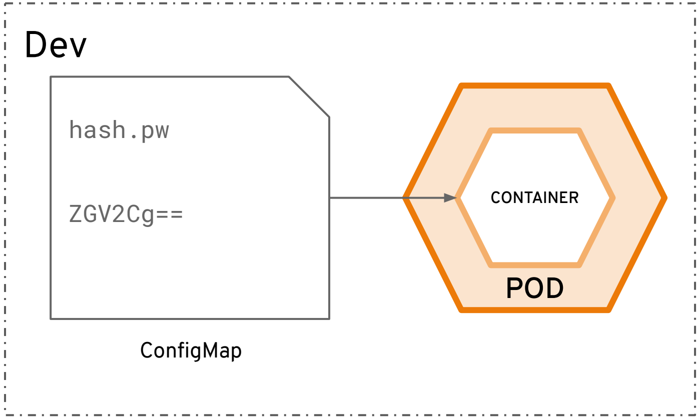
MYCONFIG=false
```

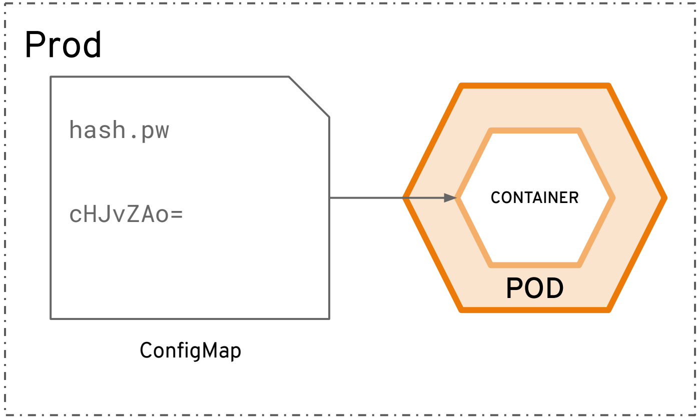
ConfigMap

CONTAINER

POD

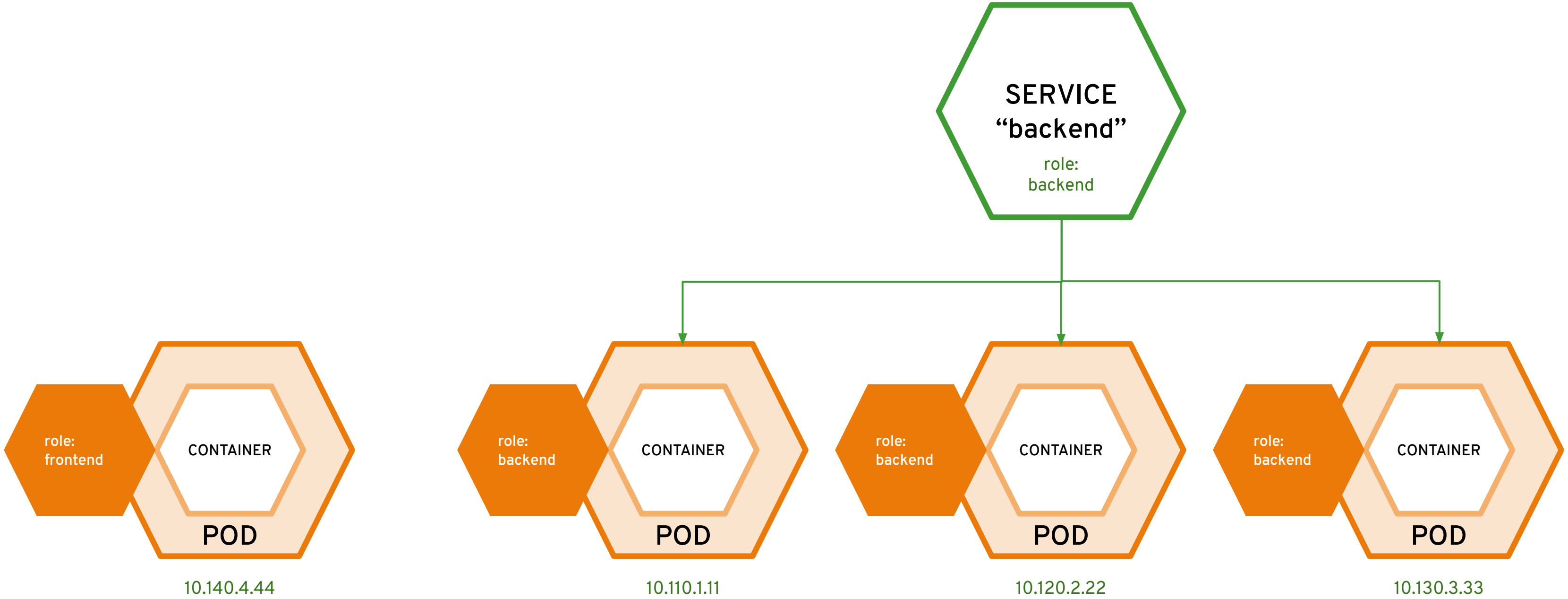
# `secrets` provide a mechanism to hold sensitive information such as passwords



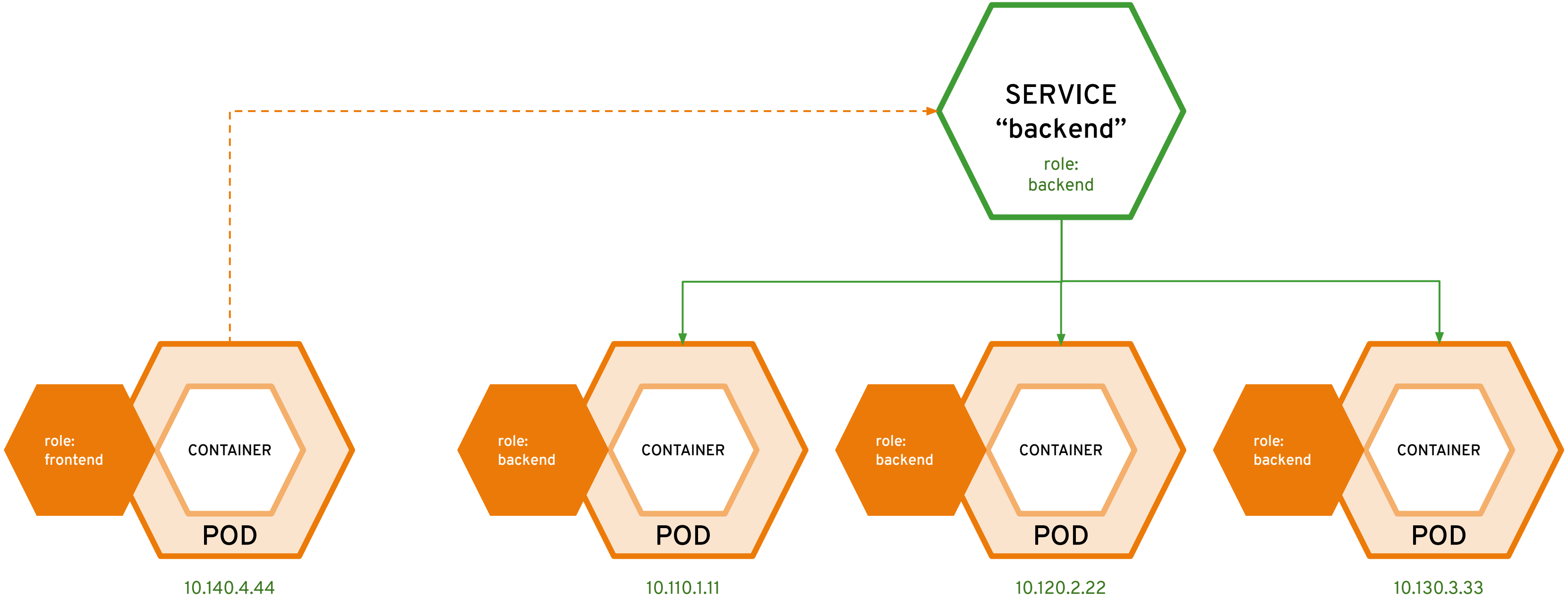


The etcd datastore can be encrypted for additional security
https://docs.openshift.com/container-platform/4.6/security/encrypting-etcd.html

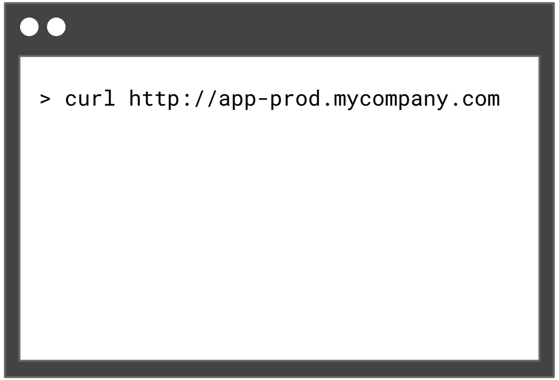
# services provide internal load-balancing and service discovery across pods



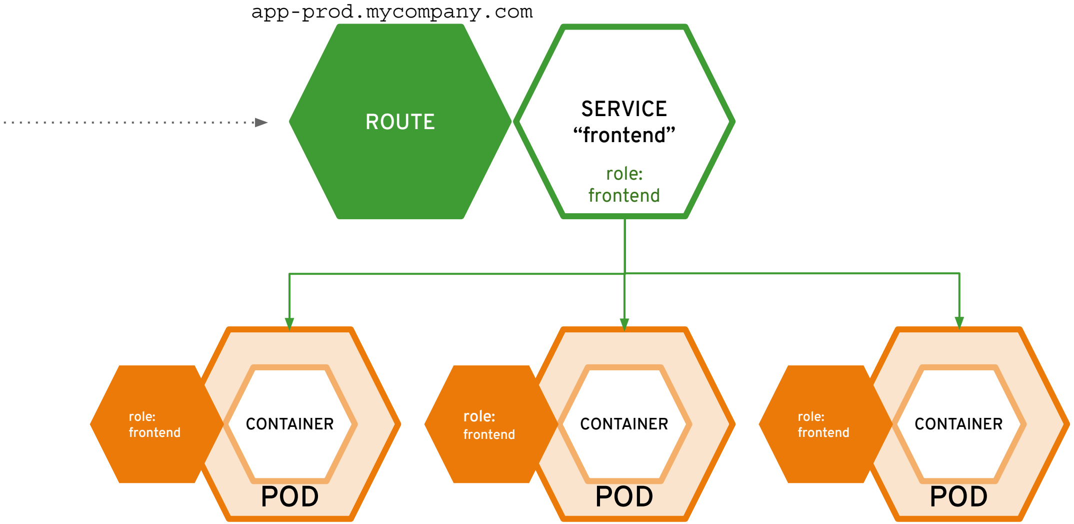
# apps can talk to each other via services



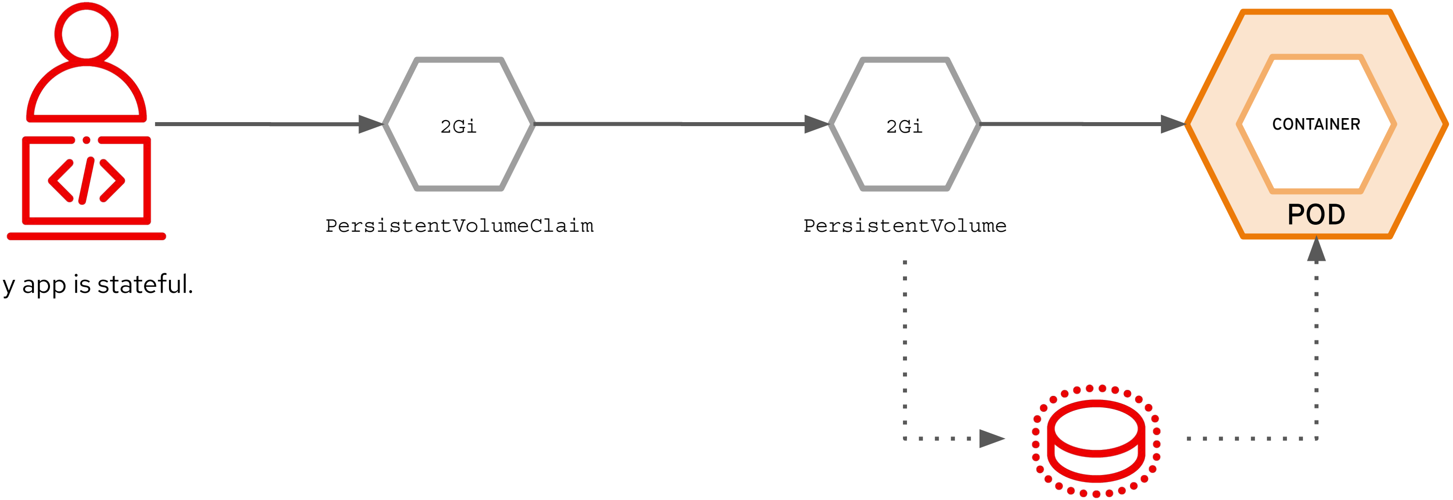
# `routes` make services accessible to clients outside the environment via real-world urls



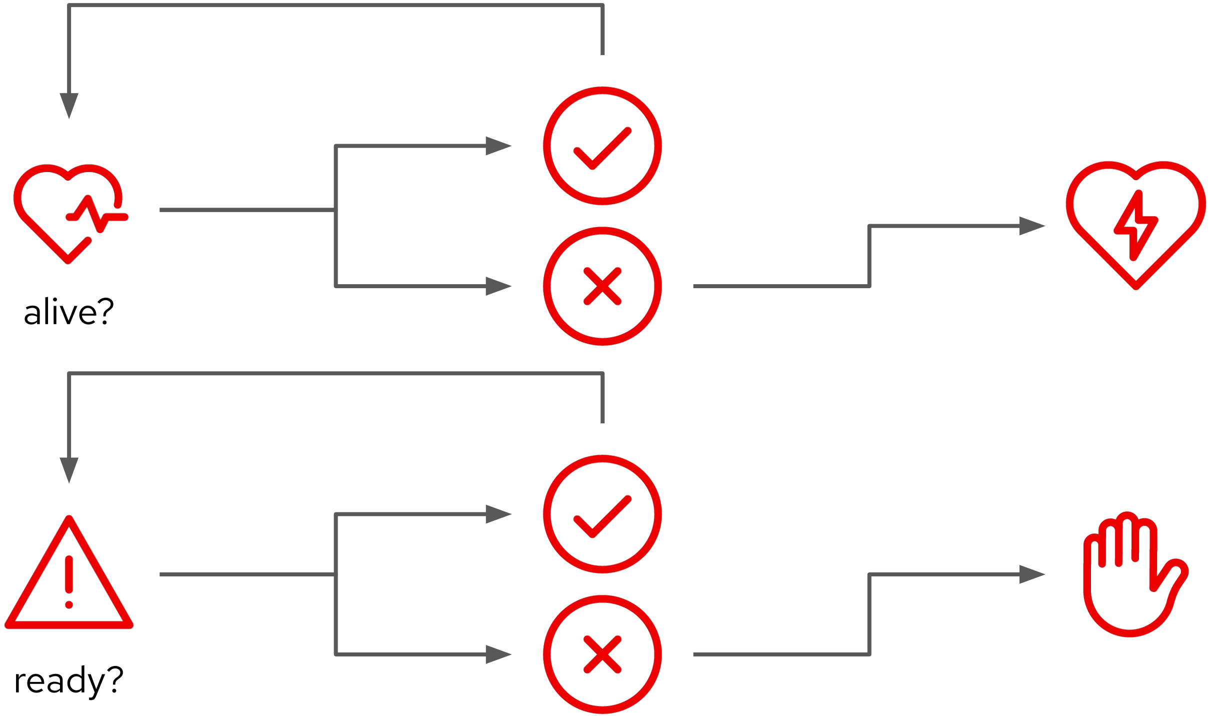
```
> curl http://app-prod.mycompany.com
```



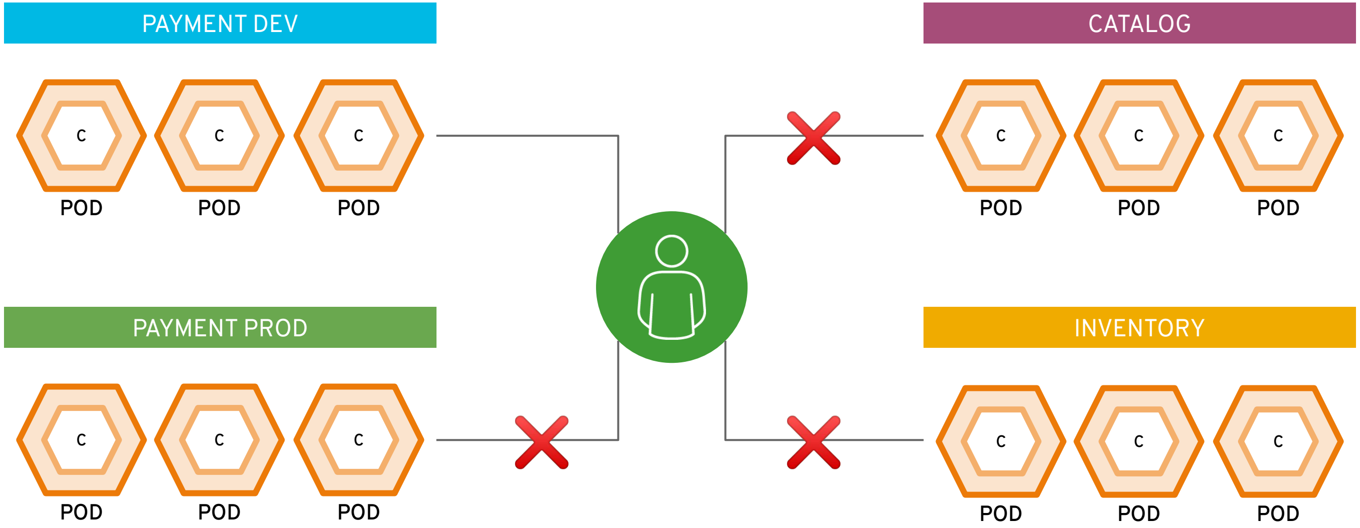
# Persistent Volume and Claims

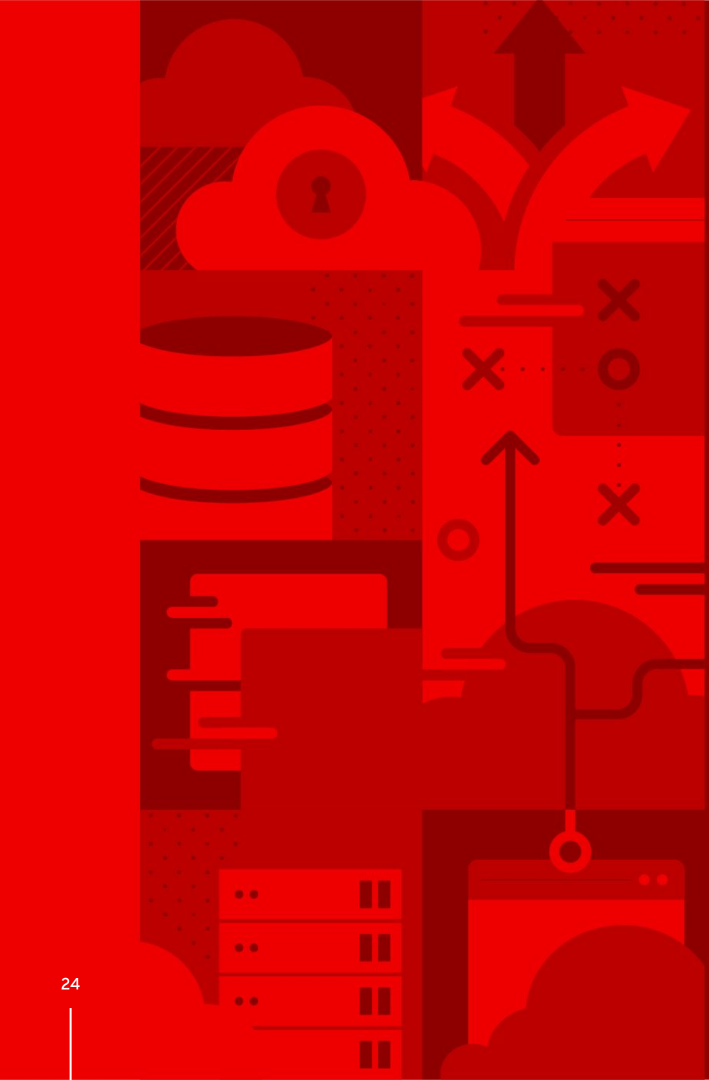


# Liveness and Readiness



# projects isolate apps across environments, teams, groups and departments





# OpenShift 4 Architecture

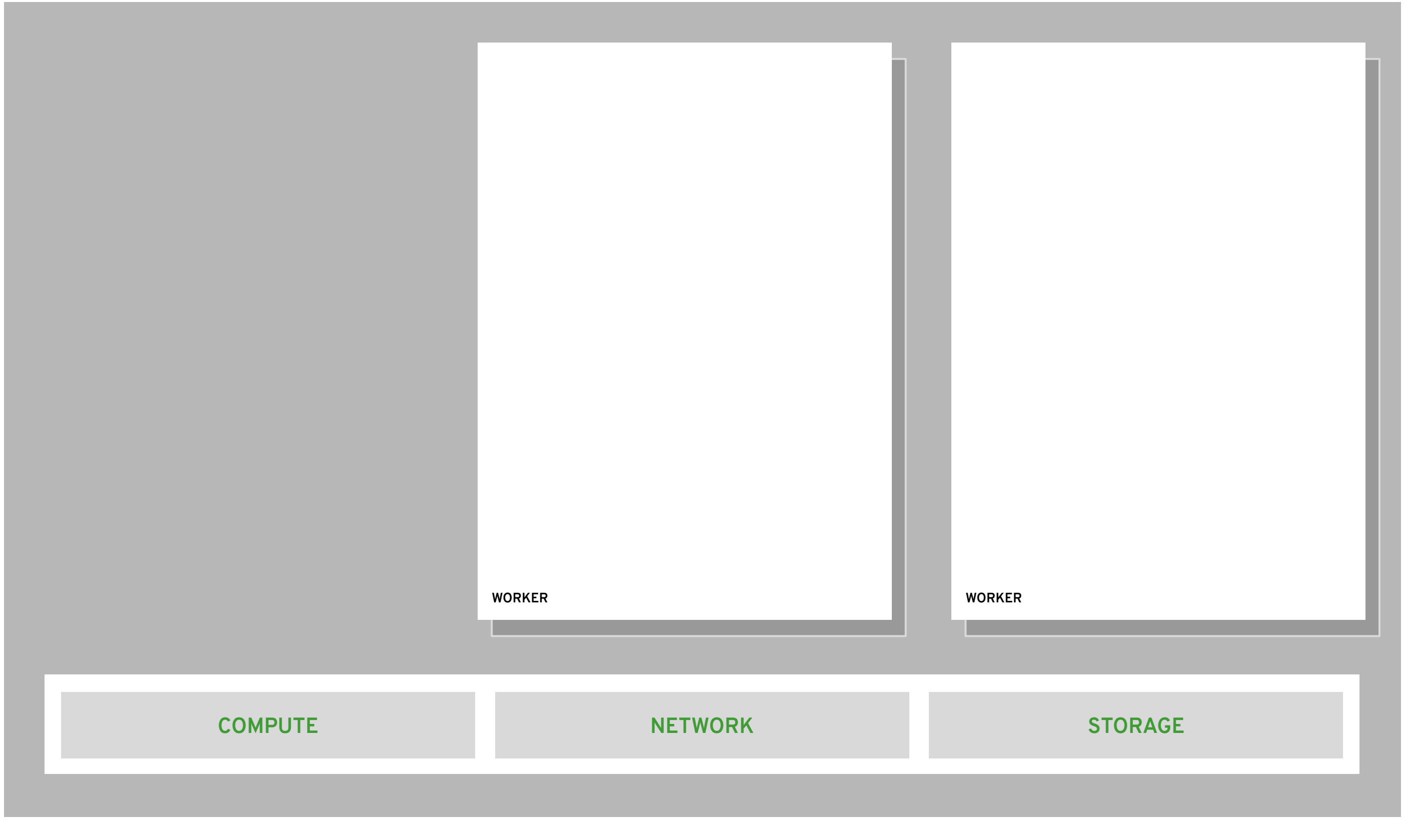
# your choice of infrastructure

COMPUTE

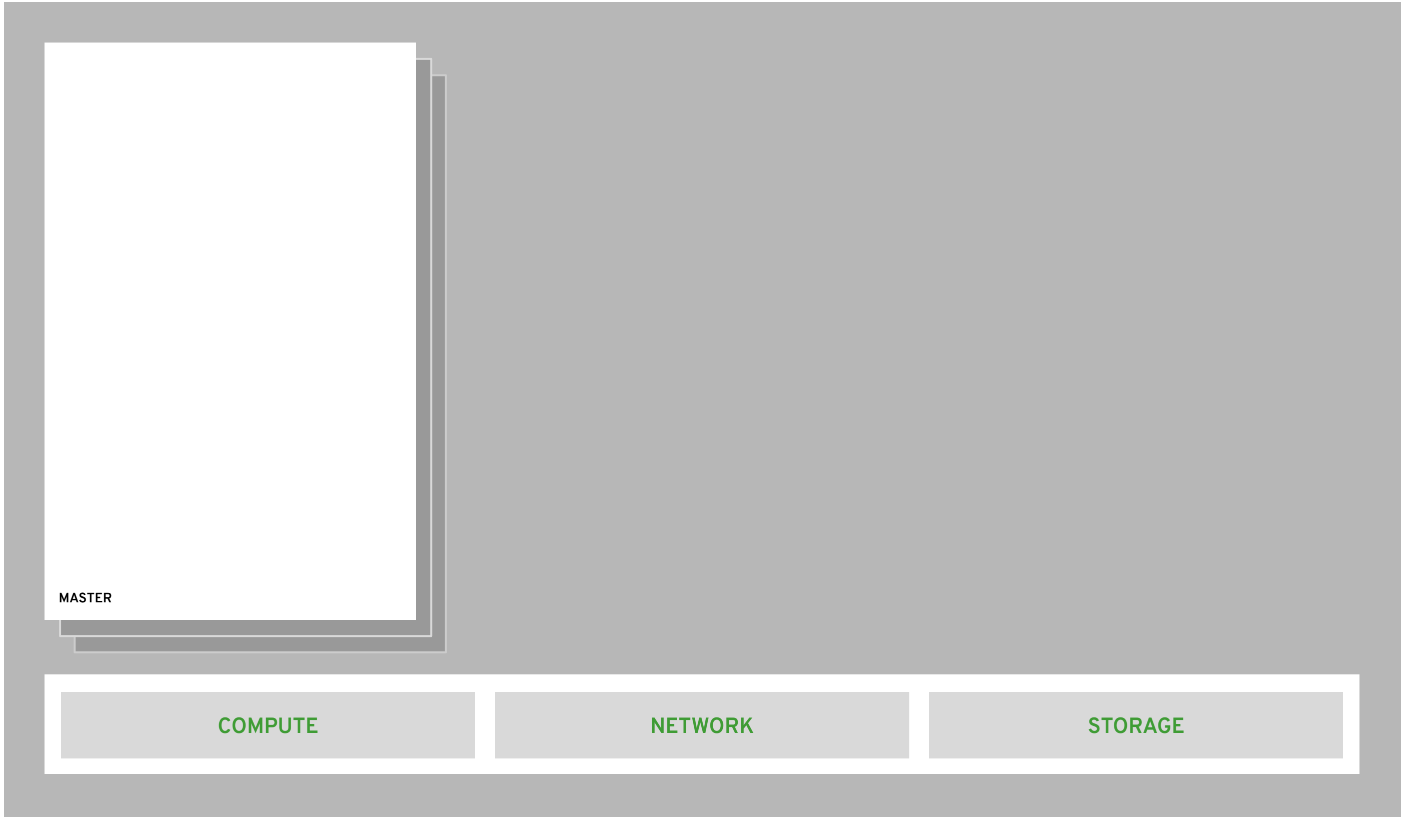
NETWORK

STORAGE

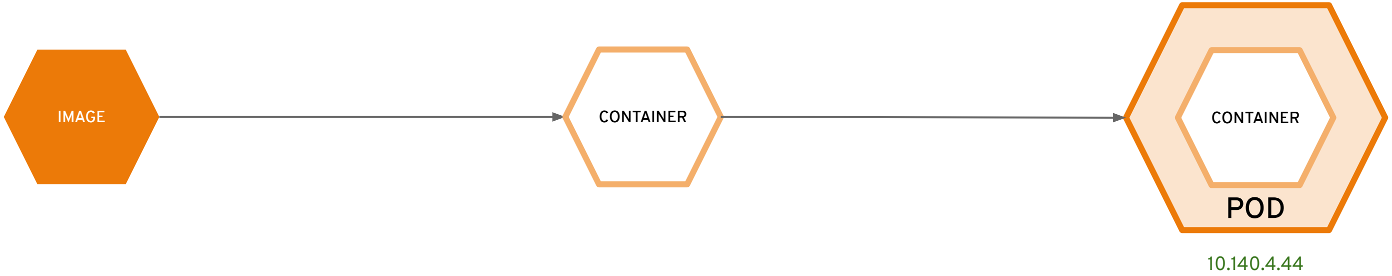
# workers run workloads



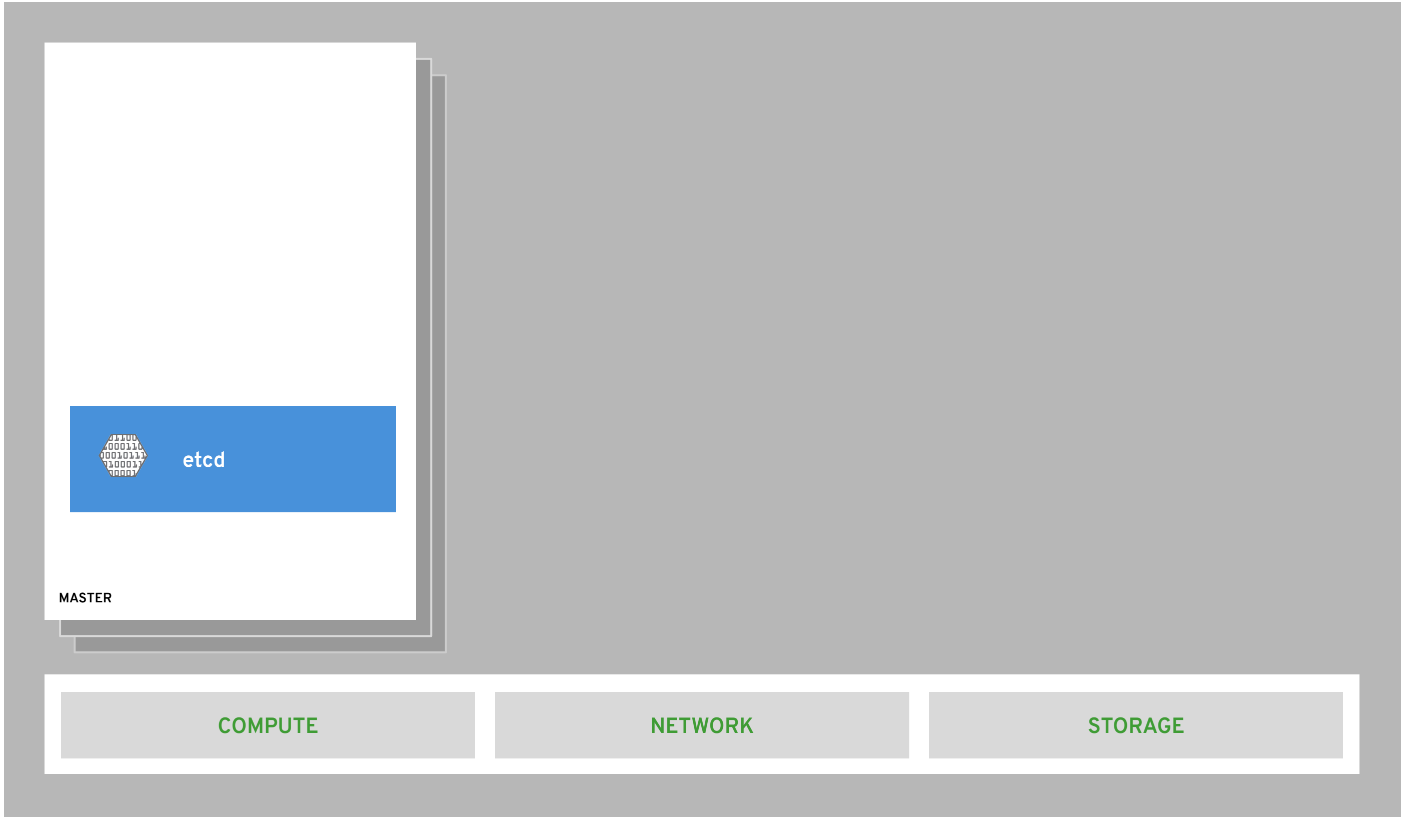
# masters are the control plane



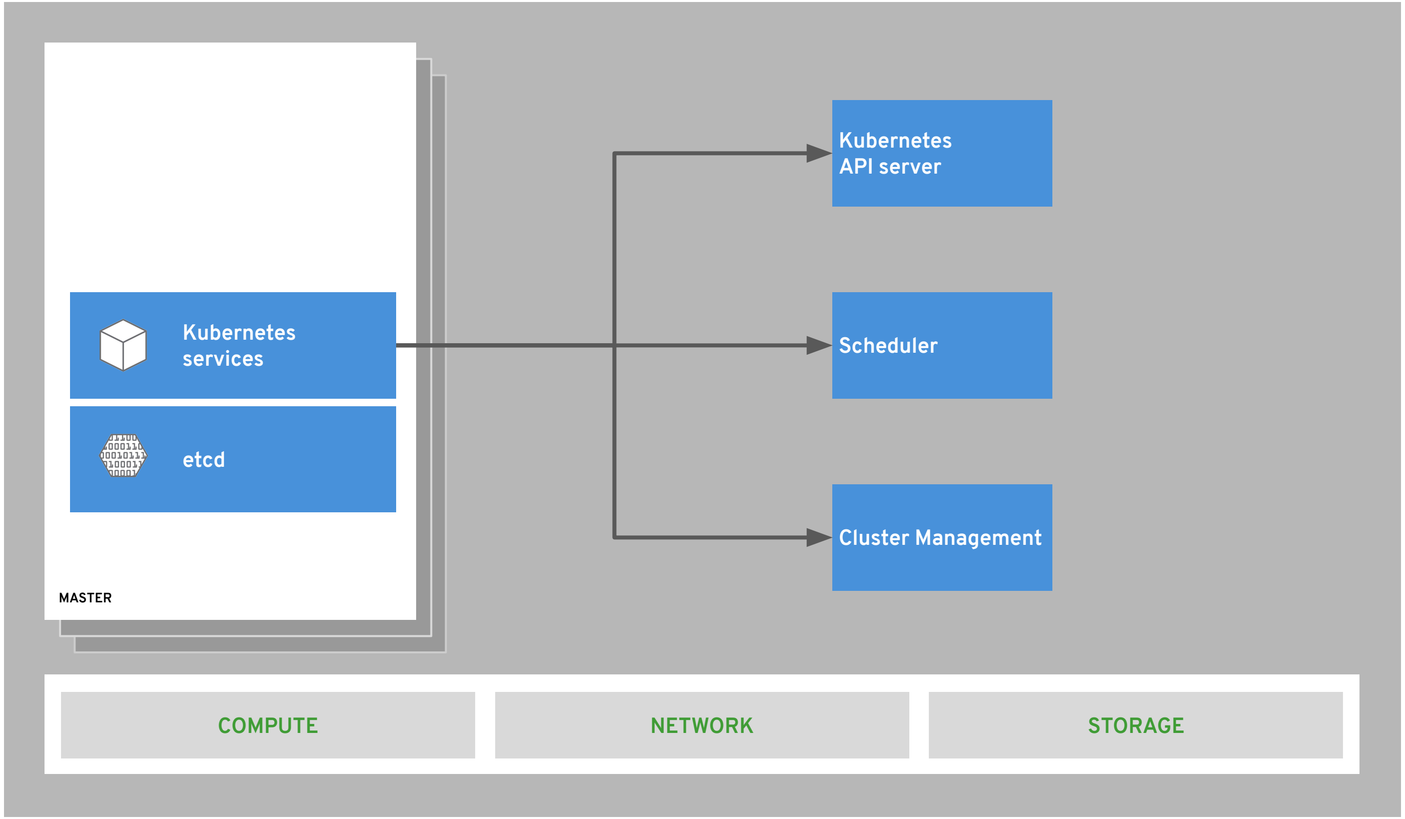
# everything runs in pods



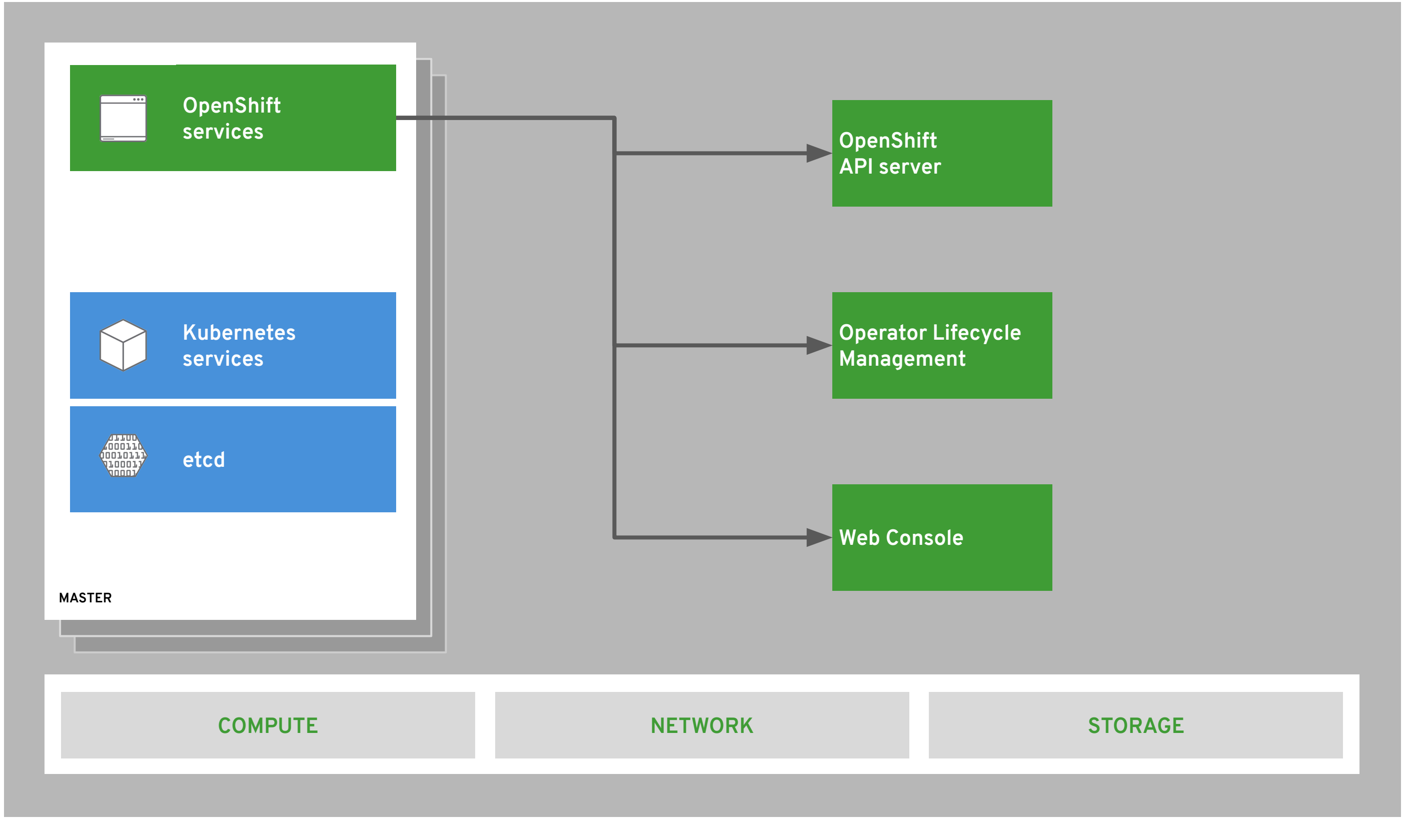
# state of everything



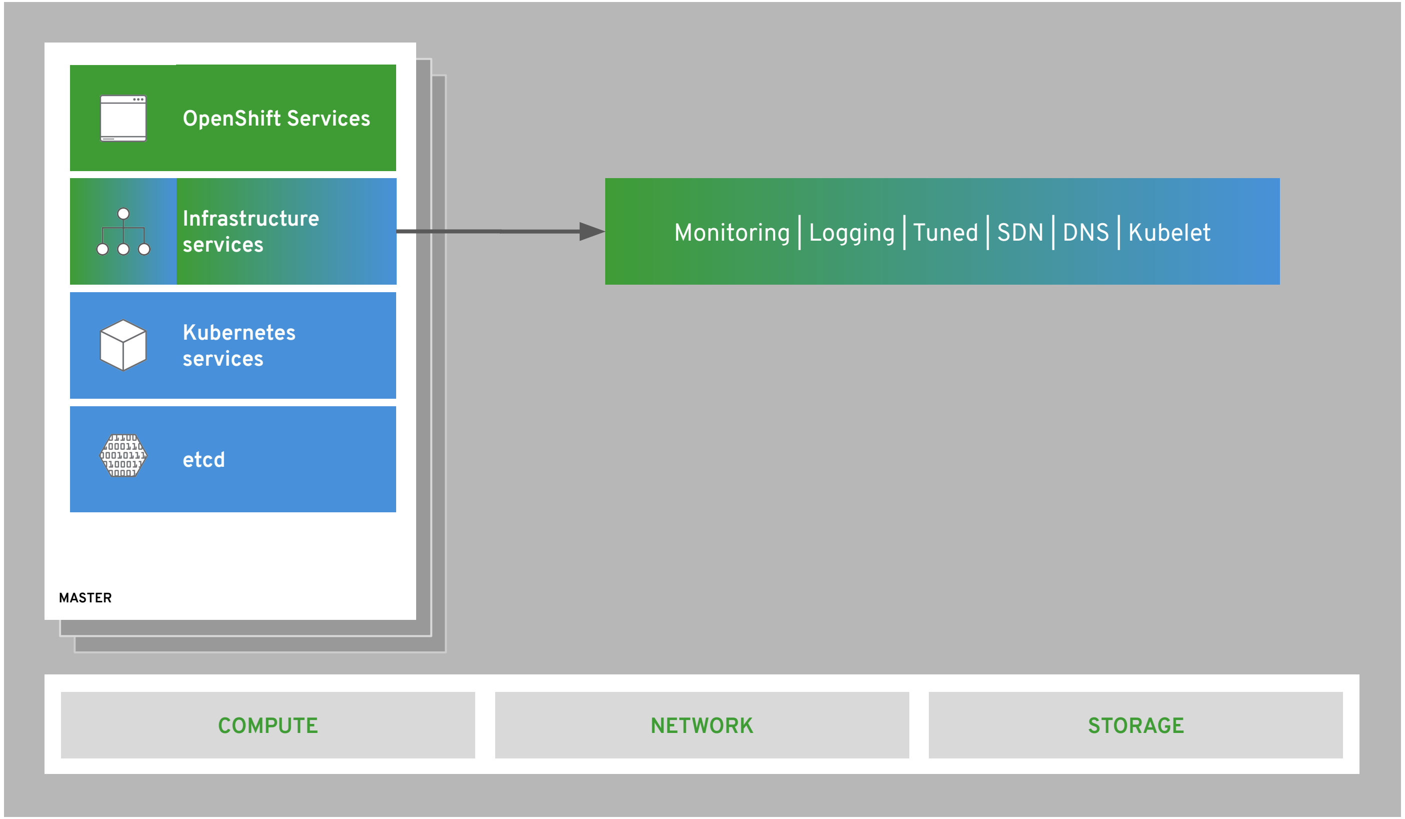
# core kubernetes components



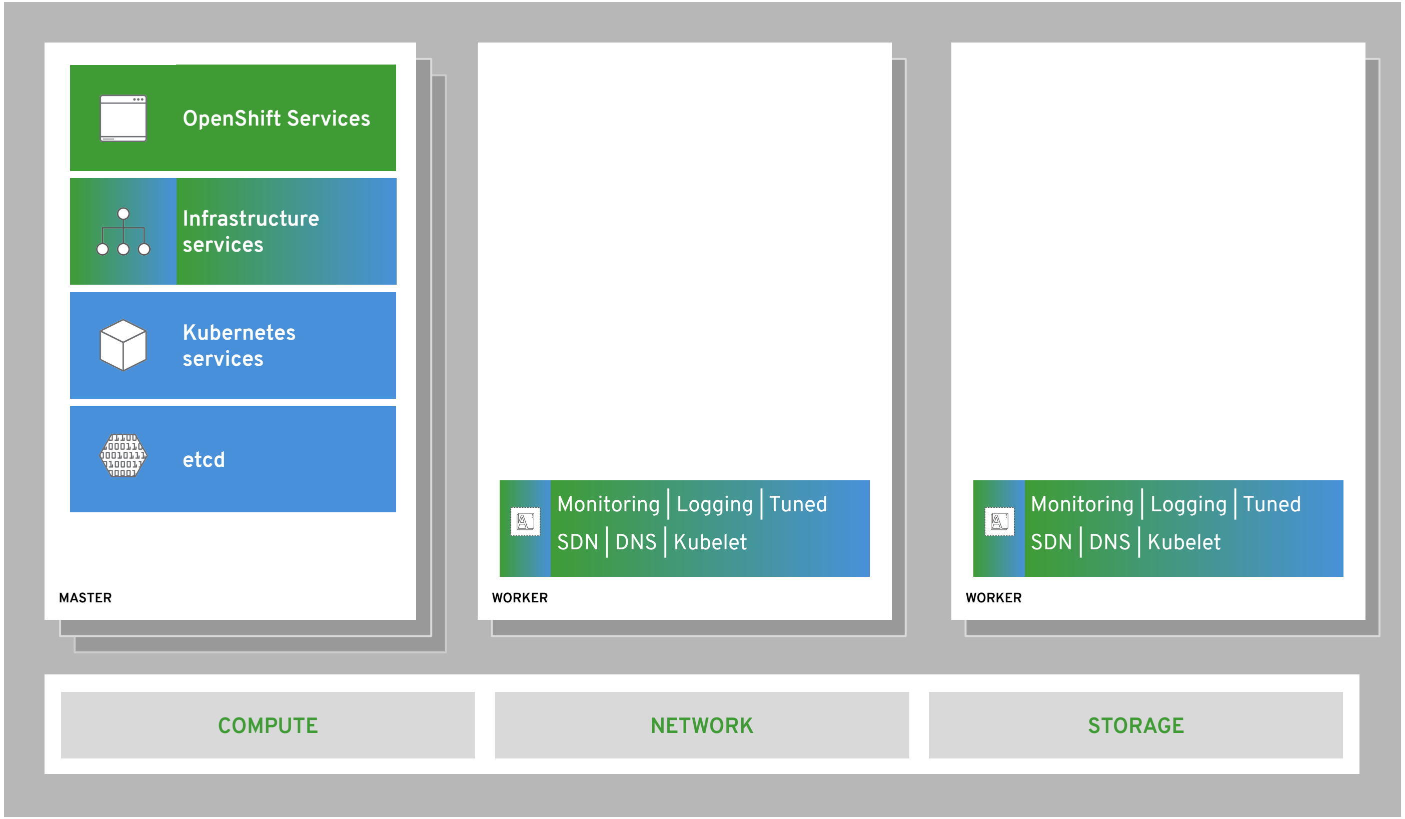
# core OpenShift components



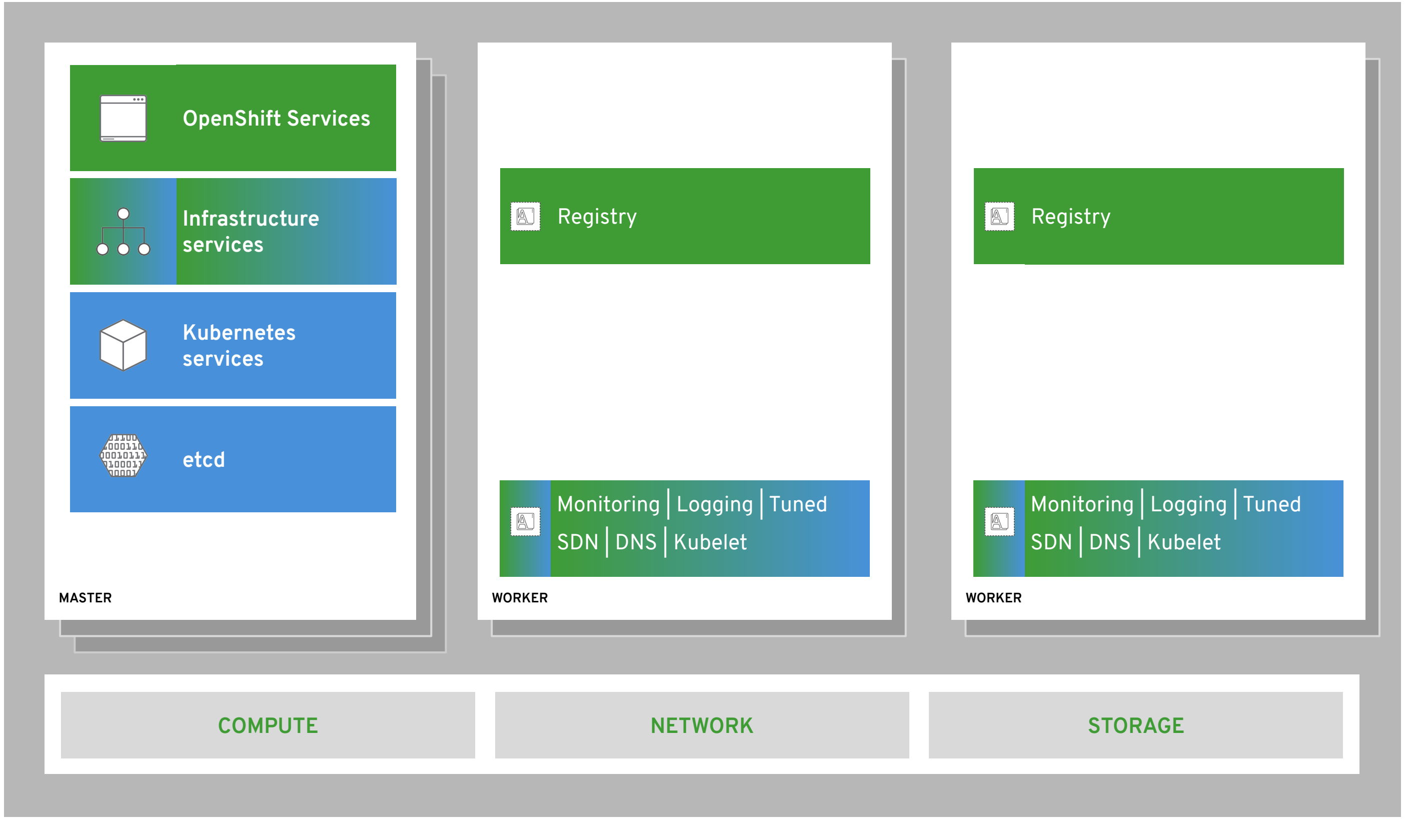
# internal and support infrastructure services



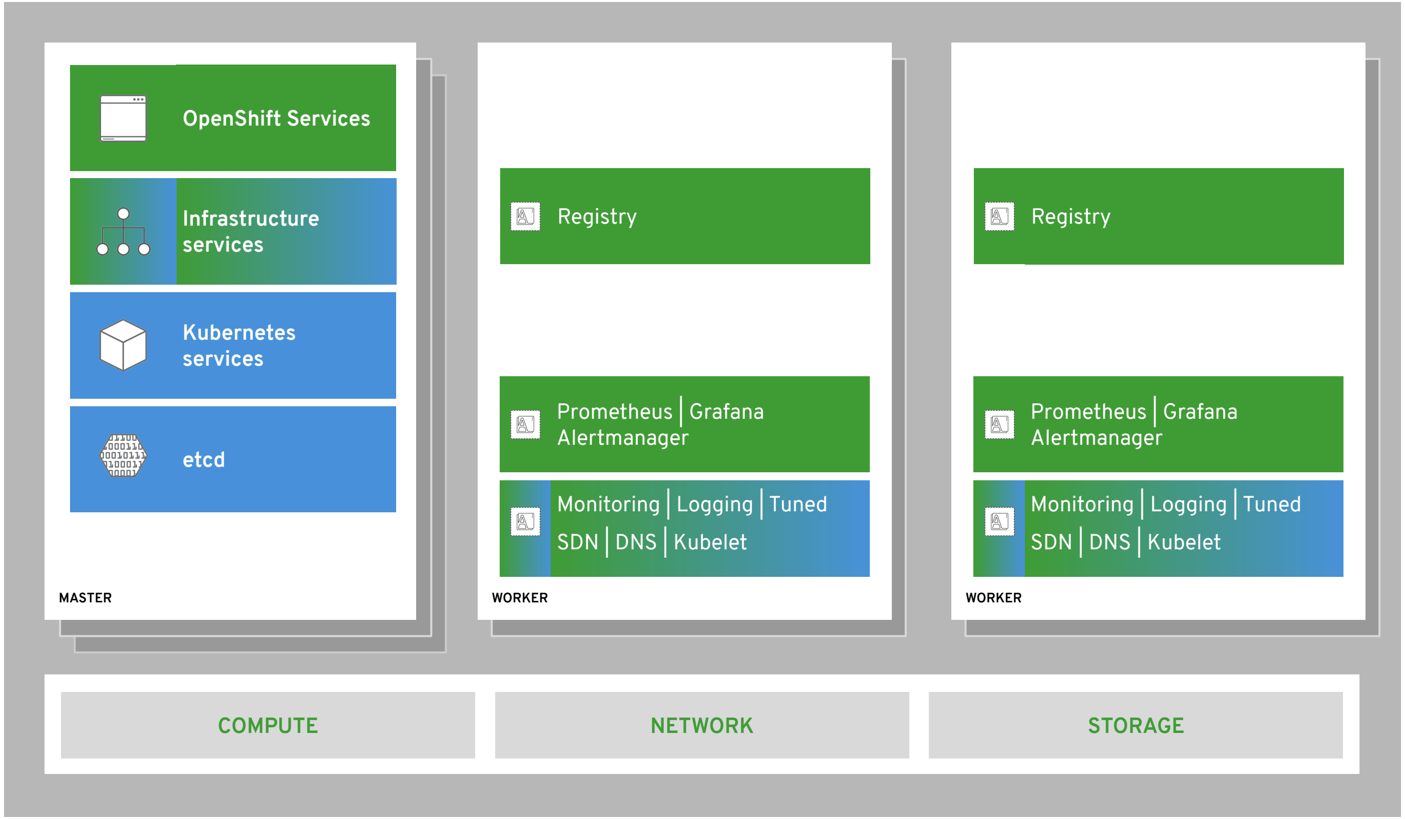
# run on all hosts



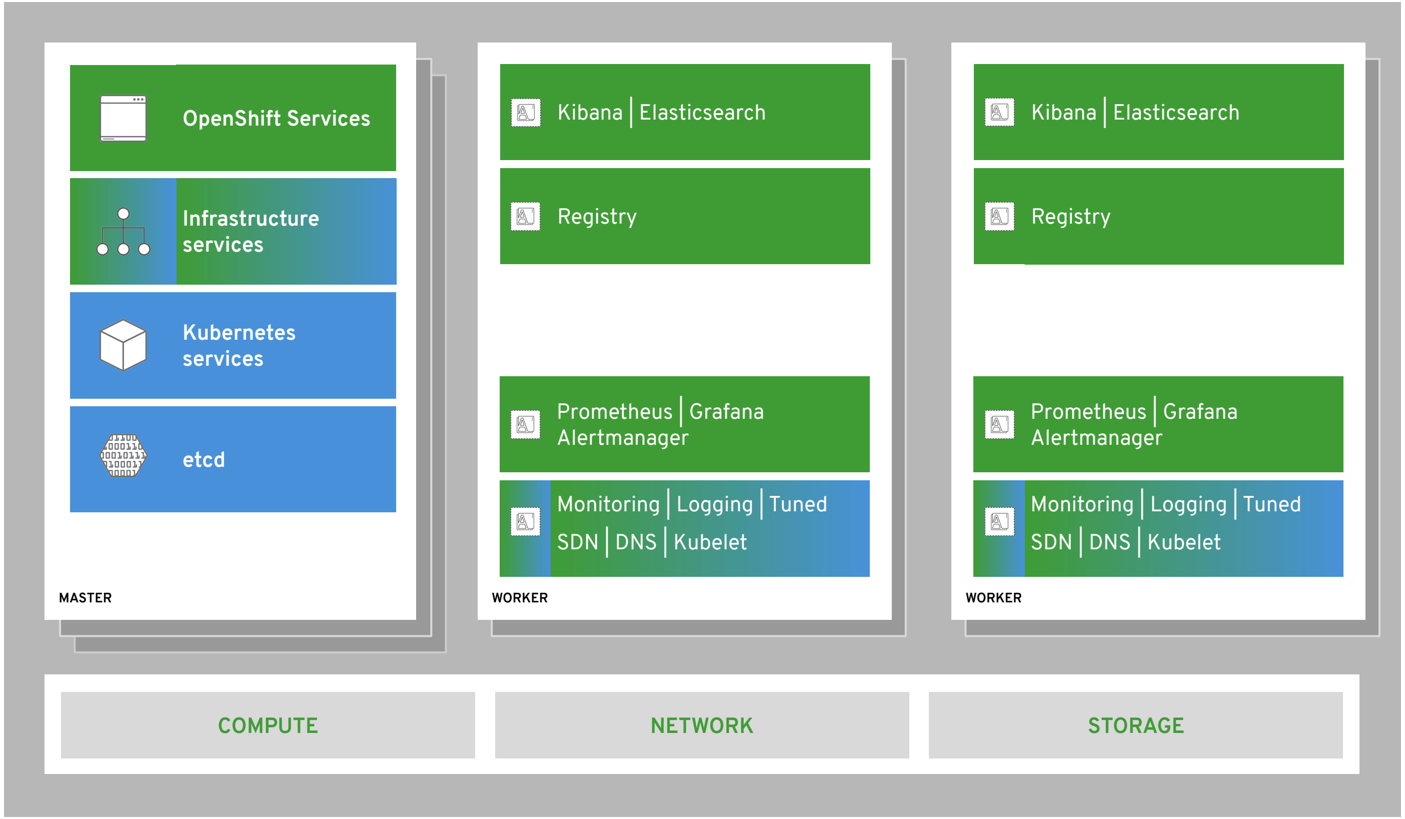
# integrated image registry



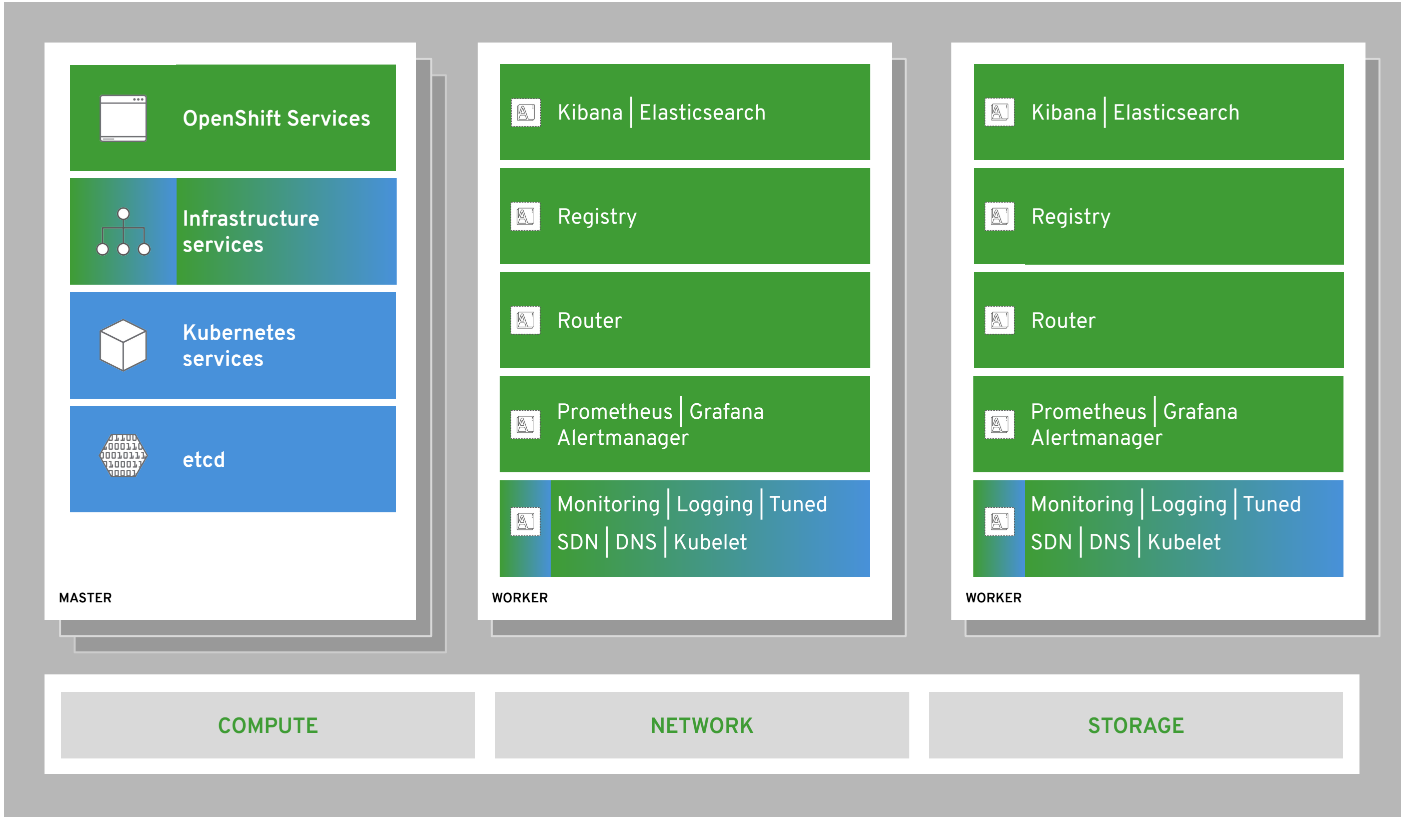
# cluster monitoring



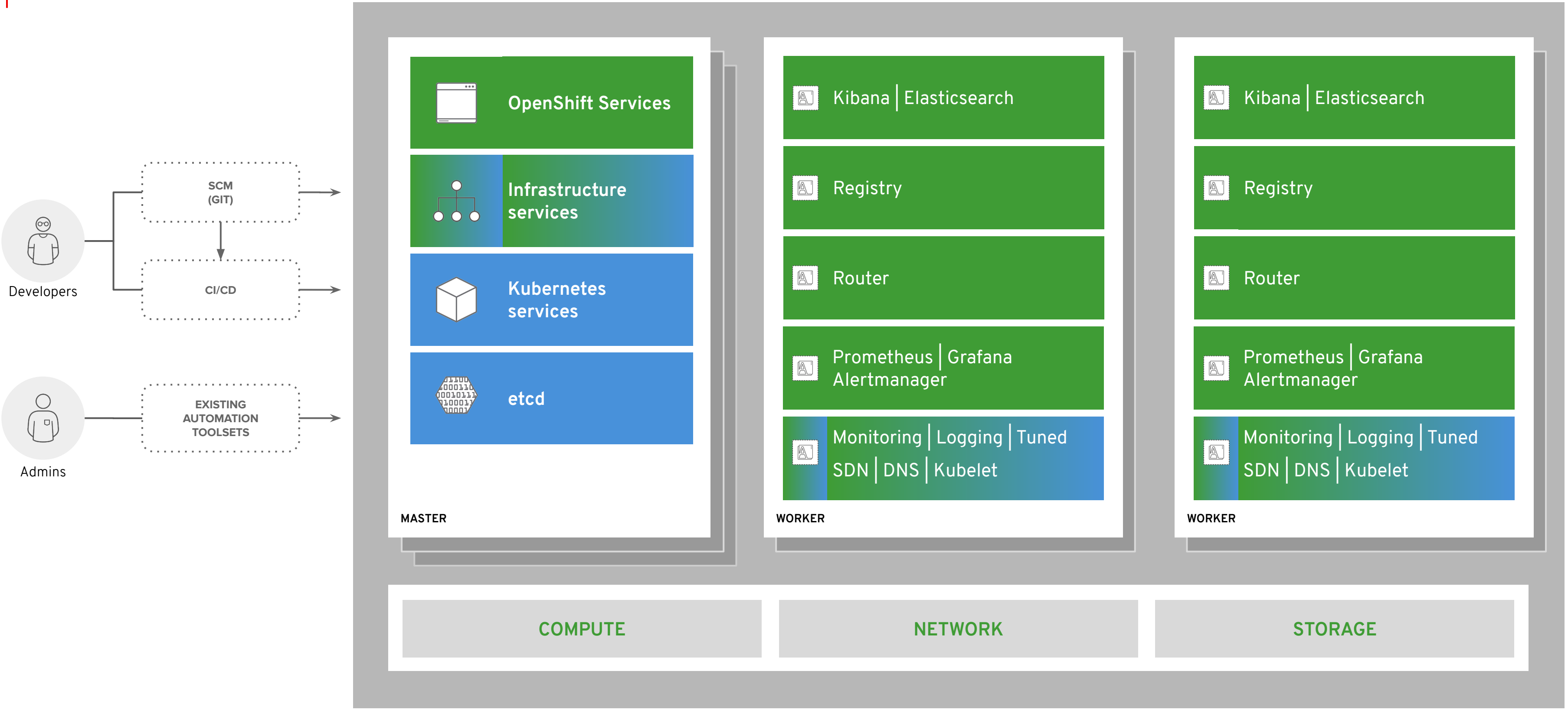
# log aggregation



# integrated routing



# dev and ops via web, cli, API, and IDE



# Networking

A pluggable model for

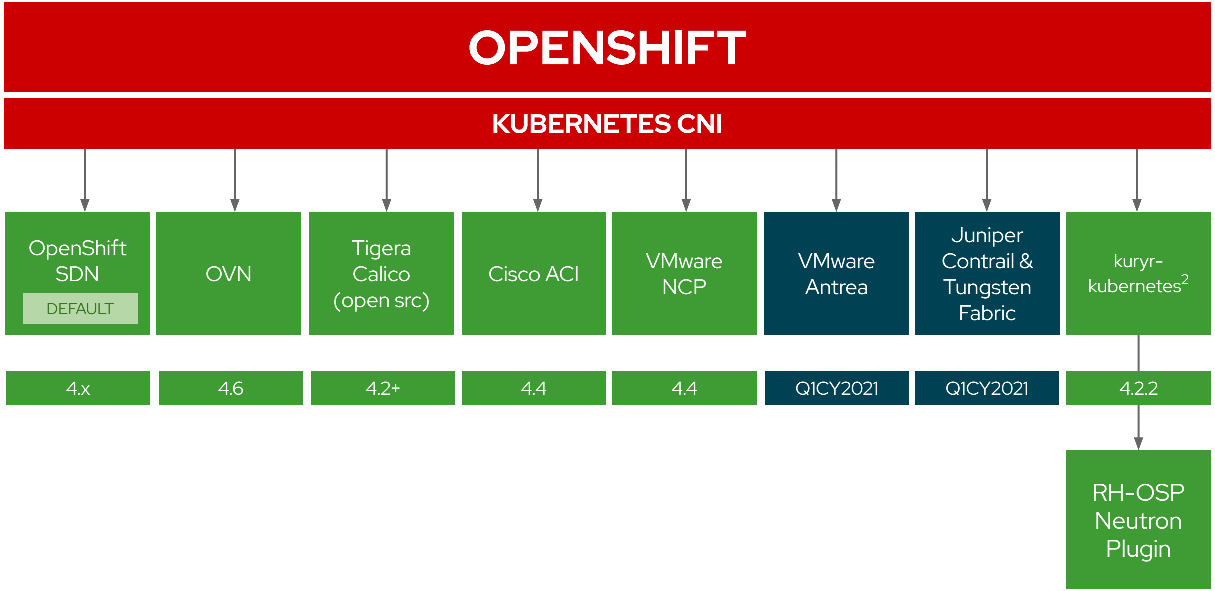
network interface

controls in kubernetes

# OpenShift Networking Plug-ins

3rd-party Kubernetes CNI plug-in certification primarily consists of:

1. Formalizing the partnership
2. Certifying the container(s)
3. Certifying the Operator
4. Successfully passing the same Kubernetes networking conformance tests that OpenShift uses to validate its own SDN



OPENSHIFT

KUBERNETES CNI

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| OpenShift SDN<br>DEFAULT | OVN | Tigera Calico (open src) | Cisco ACI | VMware NCP | VMware Antrea | Juniper Contrail & Tungsten Fabric | kuryr-kubernetes[2] |
| 4.x | 4.6 | 4.2+ | 4.4 | 4.4 | Q1CY2021 | Q1CY2021 | 4.2.2 |
| | | | | | | | RH-OSP Neutron Plugin |

Fully Supported | Tech Preview | Cert In-Progress | TBD

# OpenShift SDN

An Open

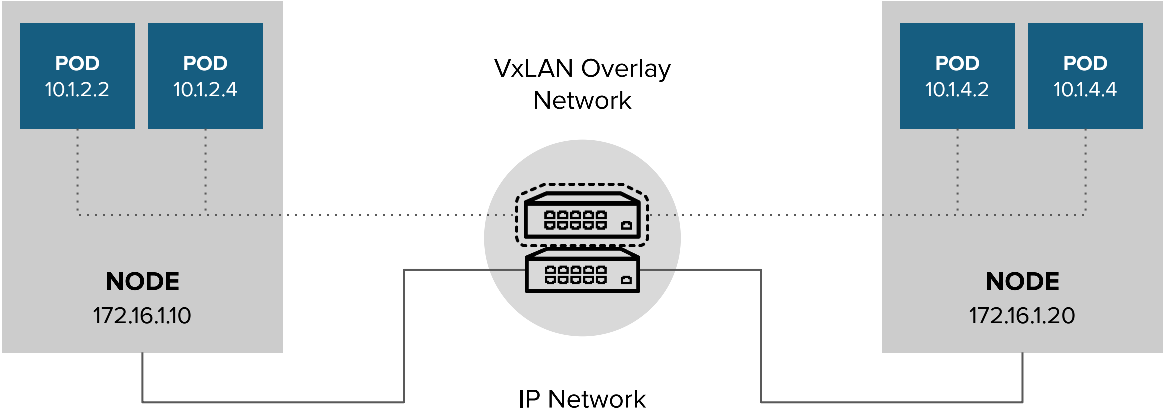
vSwitch-based

Software Defined

Network for

kubernetes

# OpenShift SDN high-level architecture



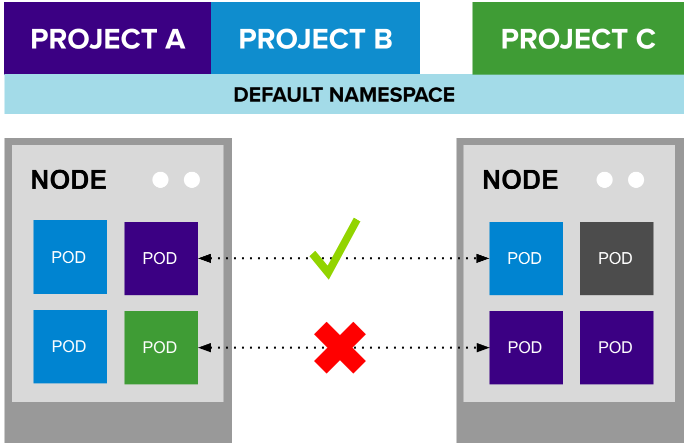
# OpenShift SDN “flavors”

## OPEN NETWORK (Default)

- All pods can communicate with each other across projects

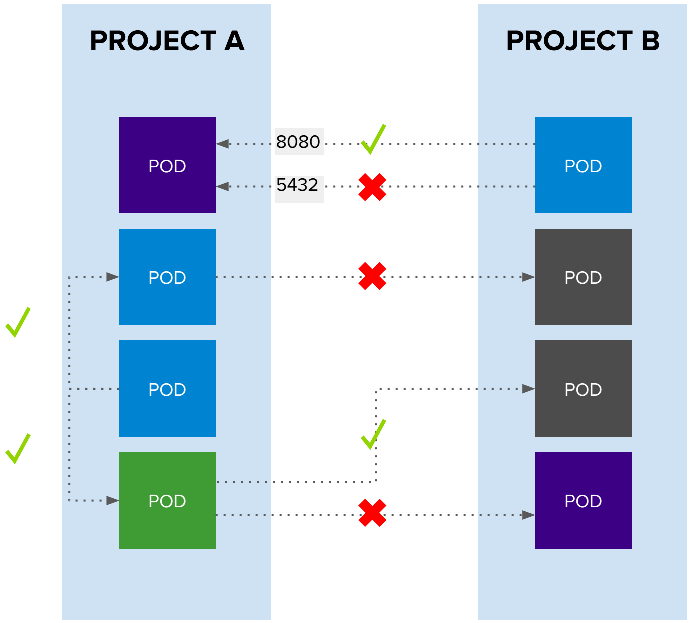
## MULTI-TENANT NETWORK

- Project-level network isolation
- Multicast support
- Egress network policies



Multi-Tenant Network

# NetworkPolicy



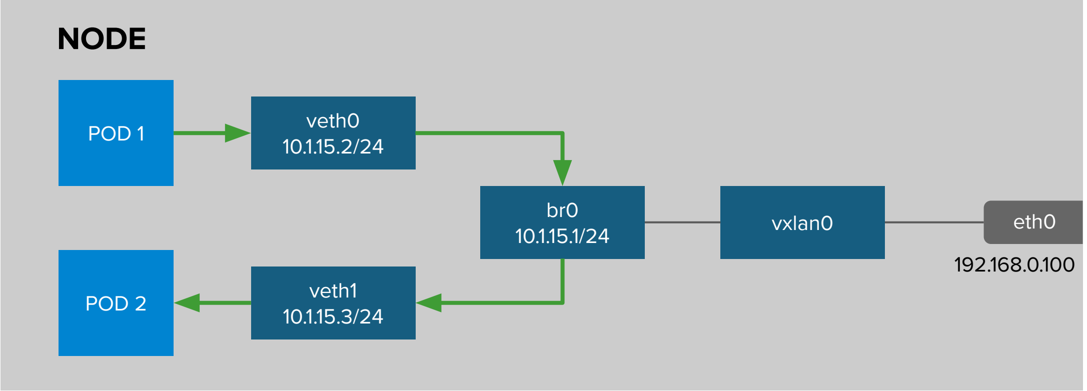
Example Policies

- 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
```

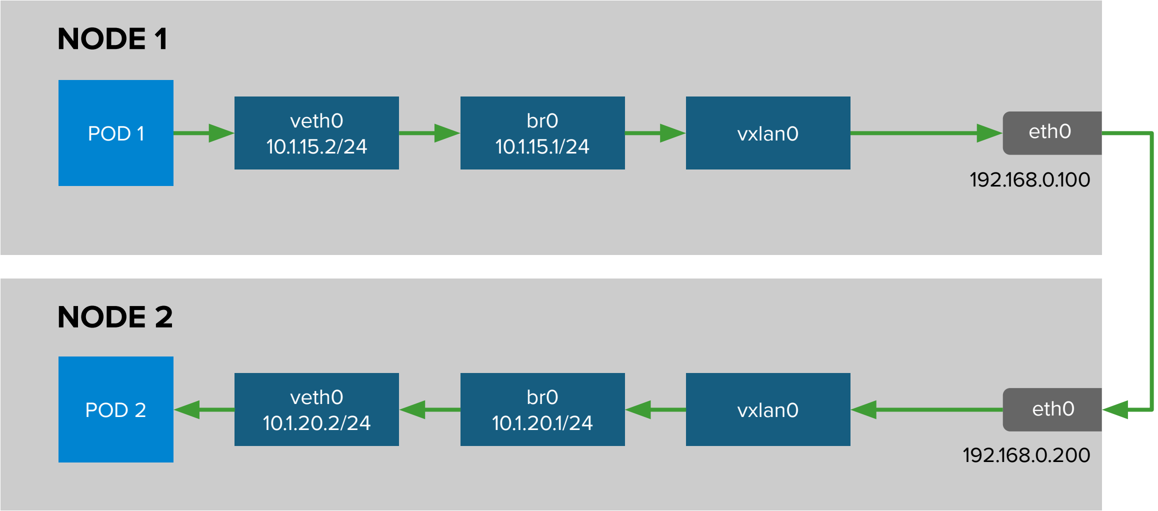
# OpenShift SDN packet flows

# container-container on same host



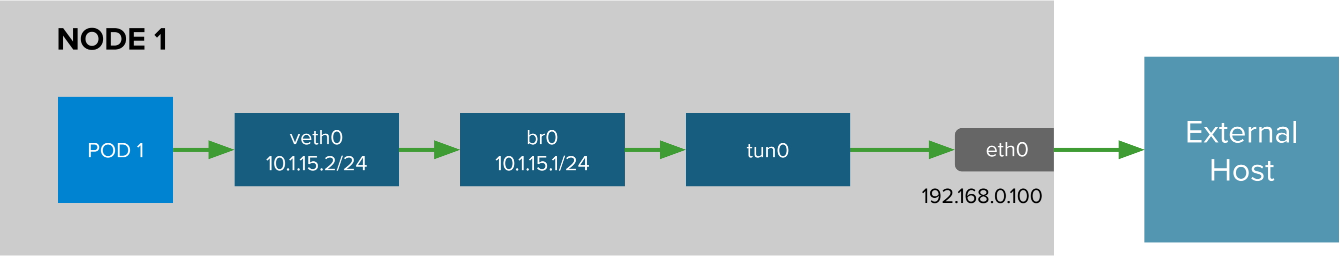
# OpenShift SDN packet flows

# container-container across hosts

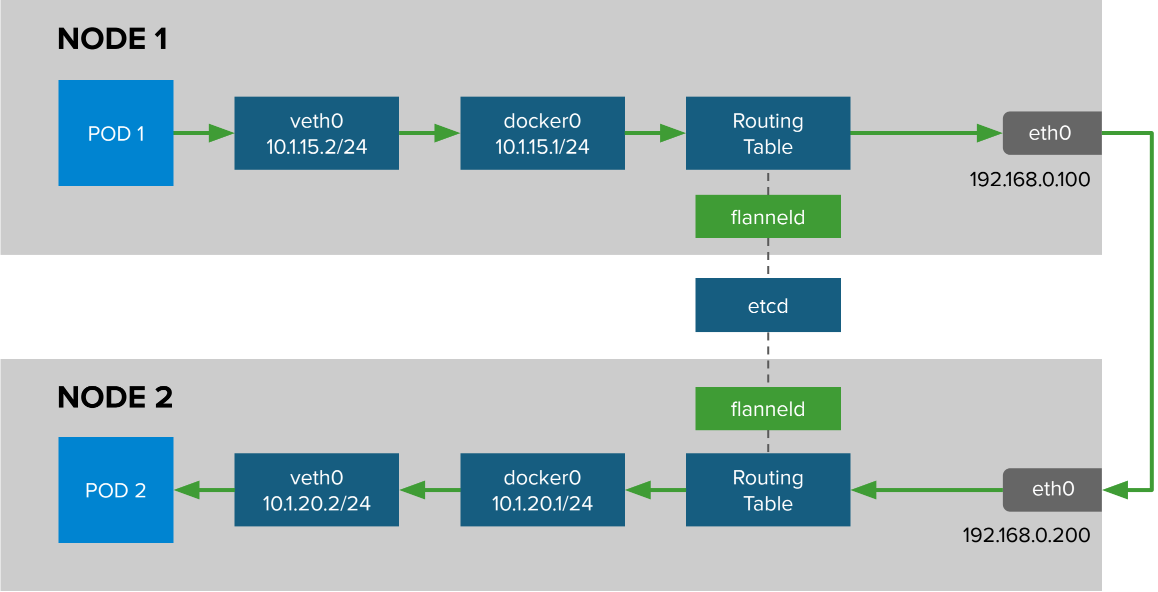


# OpenShift SDN packet flows

# container leaving the host



# Kuryr and OpenStack



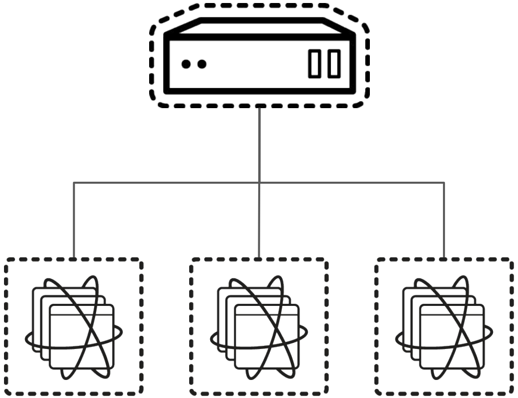
Flannel is minimally verified and is supported only and exactly as deployed in the OpenShift on OpenStack reference architecture https://access.redhat.com/articles/2743631

# routes and ingress

How traffic enters the cluster

# Routing and Load Balancing

- Pluggable routing architecture
  - HAProxy Router
  - F5 Router
- Multiple-routers with traffic sharding
- Router supported protocols
  - HTTP/HTTPS
  - WebSockets
  - TLS with SNI
- Non-standard ports via cloud load-balancers, external IP, and NodePort

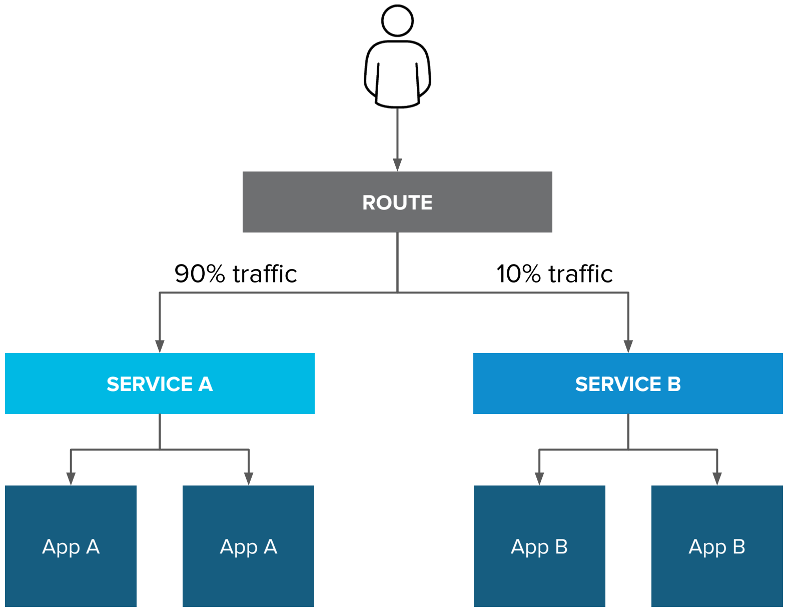


# Routes vs Ingress

| Feature | Ingress | Route |
|---|---|---|
| Standard Kubernetes object | X | |
| External access to services | X | X |
| Persistent (sticky) sessions | X | X |
| Load-balancing strategies (e.g. round robin) | X | X |
| Rate-limit and throttling | X | X |
| IP whitelisting | X | X |
| TLS edge termination | X | X |
| TLS re-encryption | X | X |
| TLS passthrough | X | X |
| Multiple weighted backends (split traffic) | | X |
| Generated pattern-based hostnames | | X |
| Wildcard domains | | X |

# Router-based deployment methodologies

Split Traffic Between Multiple Services For A/B Testing, Blue/Green and Canary Deployments

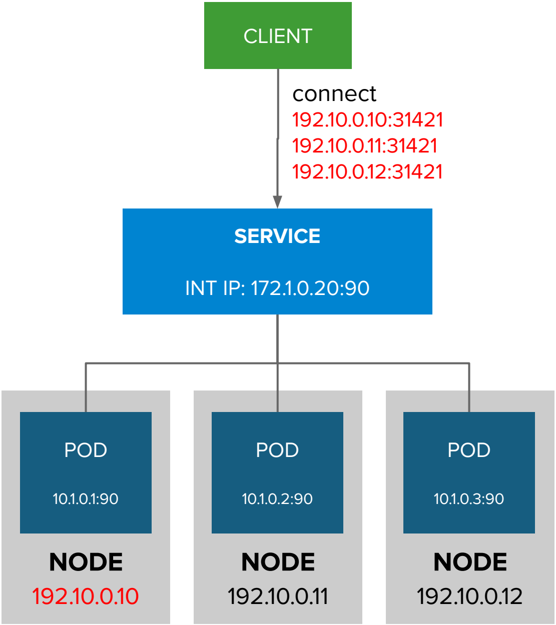


# Alternative methods for ingress

Different ways that traffic can enter the cluster without the router

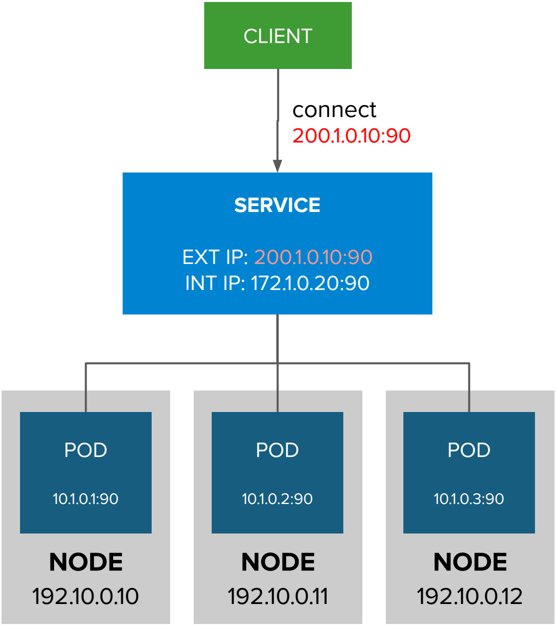
# Entering the cluster on a random port with service nodeports

- NodePort binds a service to a unique port on all the nodes
- Traffic received on any node redirects to a node with the running service
- Ports in 30K-60K range which usually differs from the service
- Firewall rules must allow traffic to all nodes on the specific port



# External traffic to a service on any port with external IP

- Access a service with an external IP on any TCP/UDP port, such as
  - Databases
  - Message Brokers
- Automatic IP allocation from a predefined pool using Ingress IP Self-Service
- IP failover pods provide high availability for the IP pool (fully supported in 4.8)



# Cluster DNS

An automated system

for providing hostname

resolution within

kubernetes

# CoreDNS

- Built-in internal DNS to reach services by a (fully qualified) hostname
- Split DNS is used with CoreDNS
    - CoreDNS answers DNS queries for internal/cluster services
    - Other defined “upstream” name servers serve the rest of the queries

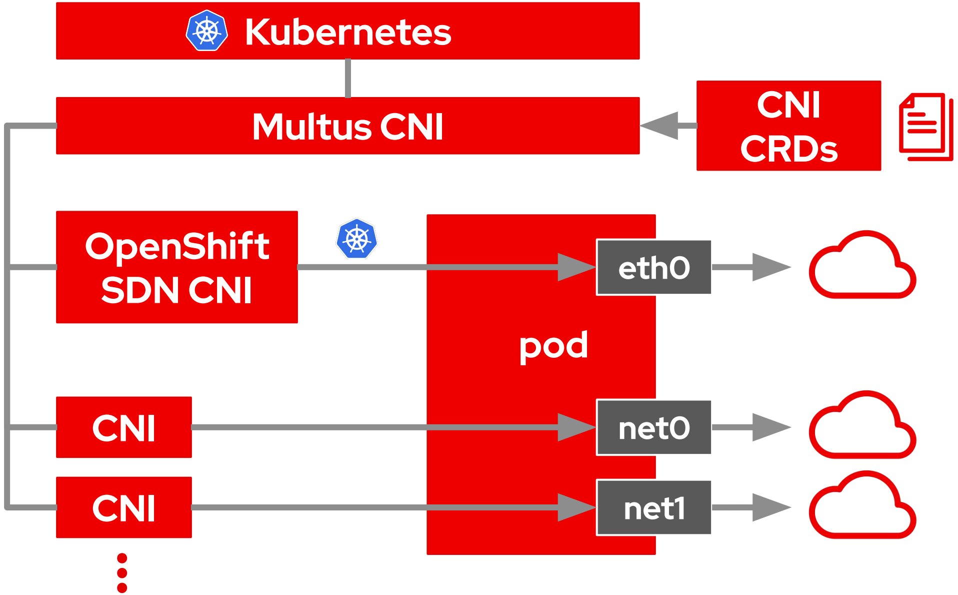
# Multus

A CNI plugin that provides multiple network interfaces for pods

# Multinetwork with Multus

The Multus CNI “meta plugin” for Kubernetes enables one to create multiple network interfaces per pod, and assign a CNI plugin to each interface created.

Additional networks and capability

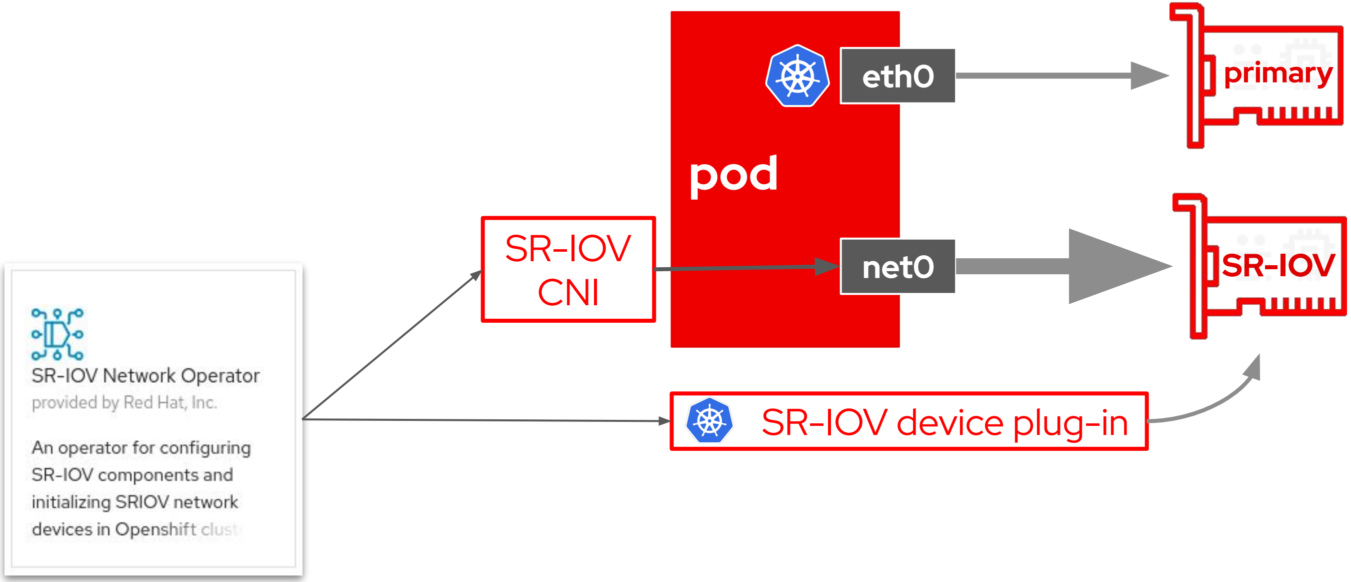


# Additional OpenShift-Supported Secondary CNI Plug-Ins

OpenShift 4.x Tested Integrations: Network Components and Plugins

- host device
- IPAM(dhcp)
- MACVLAN
- IPVLAN
- Bridge with VLAN
- Static IPAM
- DHCP IPAM
- Route Override
- whereabouts
- SR-IOV
- ...

# SR-IOV

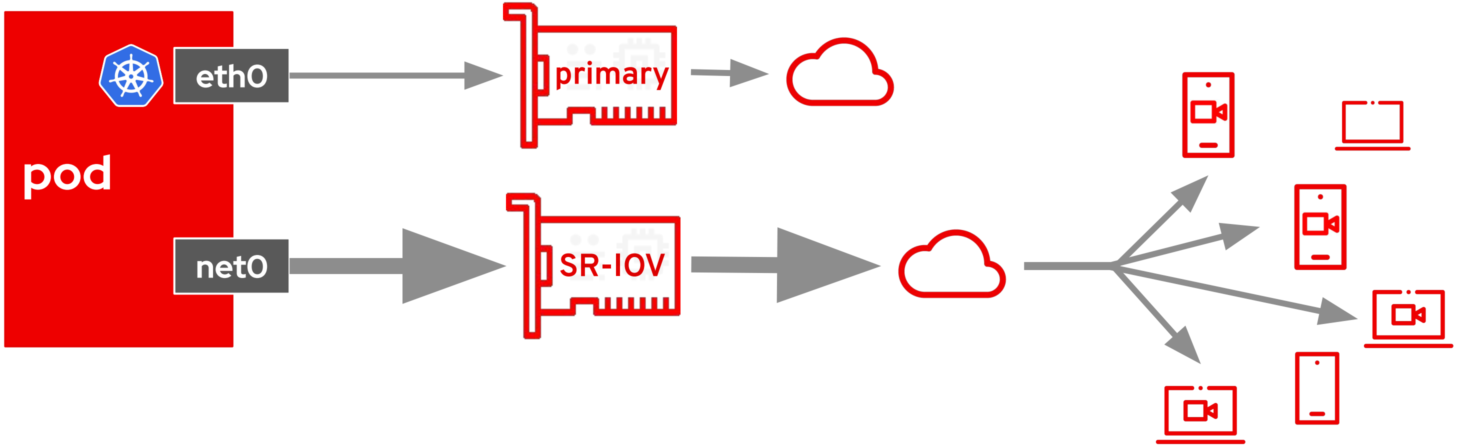


SR-IOV Network Operator

provided by Red Hat, Inc.

An operator for configuring SR-IOV components and initializing SRIOV network devices in Openshift clust

# High-performance multicast



# OpenShift Monitoring

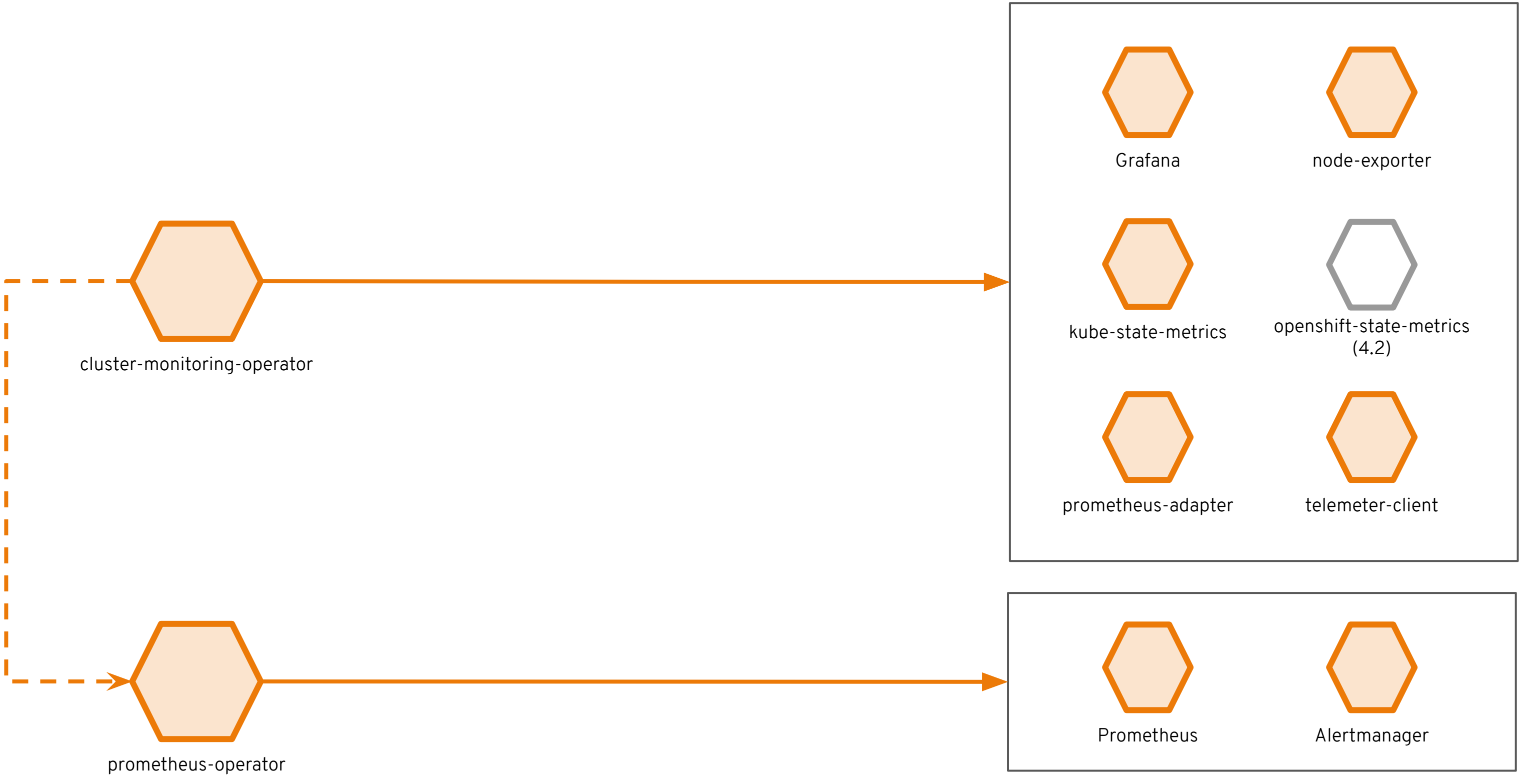
An integrated cluster monitoring and alerting stack

# OpenShift Cluster Monitoring

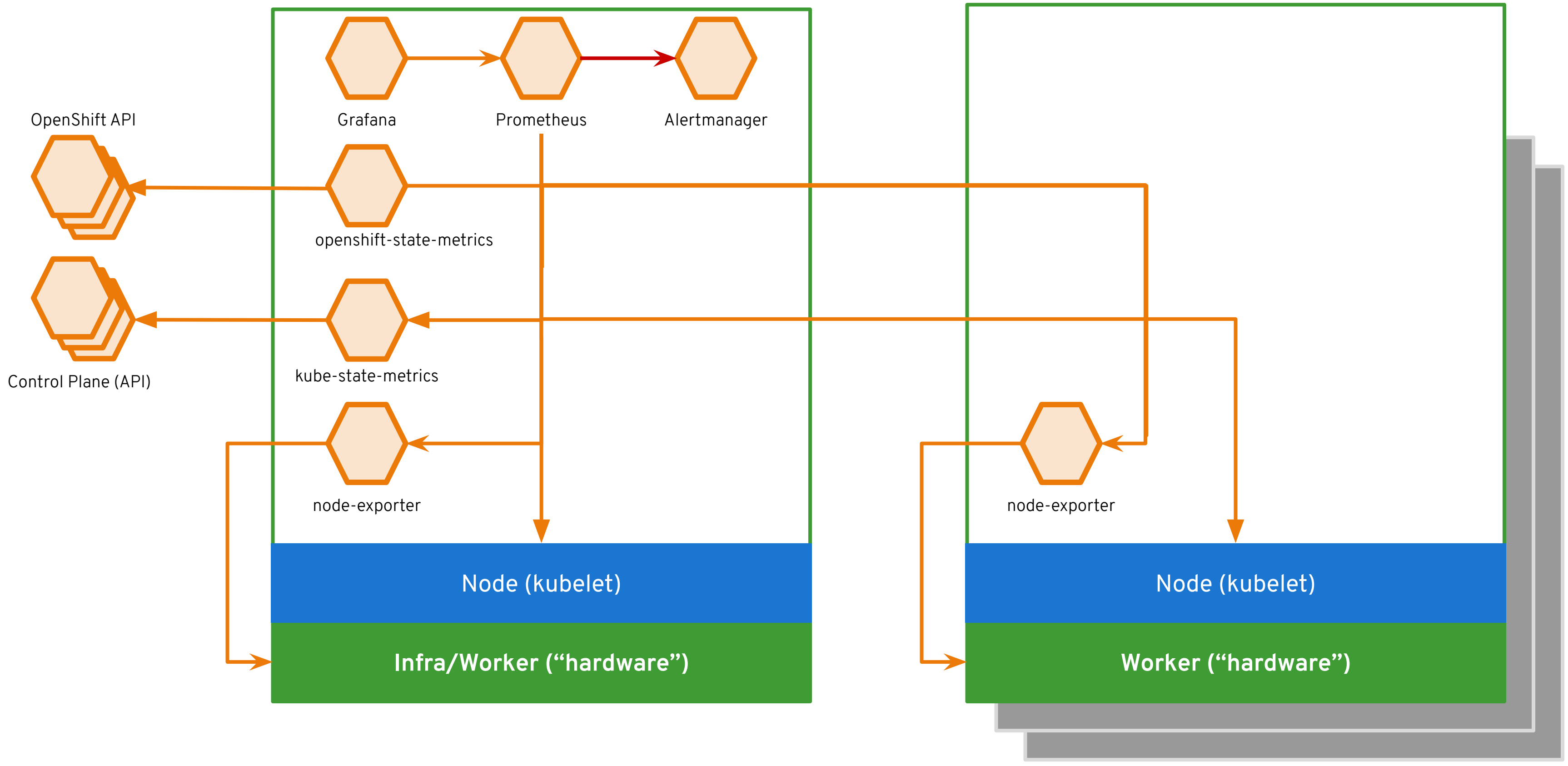
**Metrics collection and storage** via Prometheus, an open-source monitoring system time series database.

**Alerting/notification** via Prometheus' Alertmanager, an open-source tool that handles alerts send by Prometheus.

**Metrics visualization** via Grafana, the leading metrics visualization technology.


cluster-monitoring-operator
prometheus-operator
Grafana
node-exporter
kube-state-metrics
openshift-state-metrics
(4.2)
prometheus-adapter
telemeter-client
Prometheus
Alertmanager

# Prometheus, Grafana and Alertmanager Wiring



# OpenShift Logging

An integrated solution

for exploring and

corroborating

application logs

# Observability via log exploration and corroboration with EFK

## Components

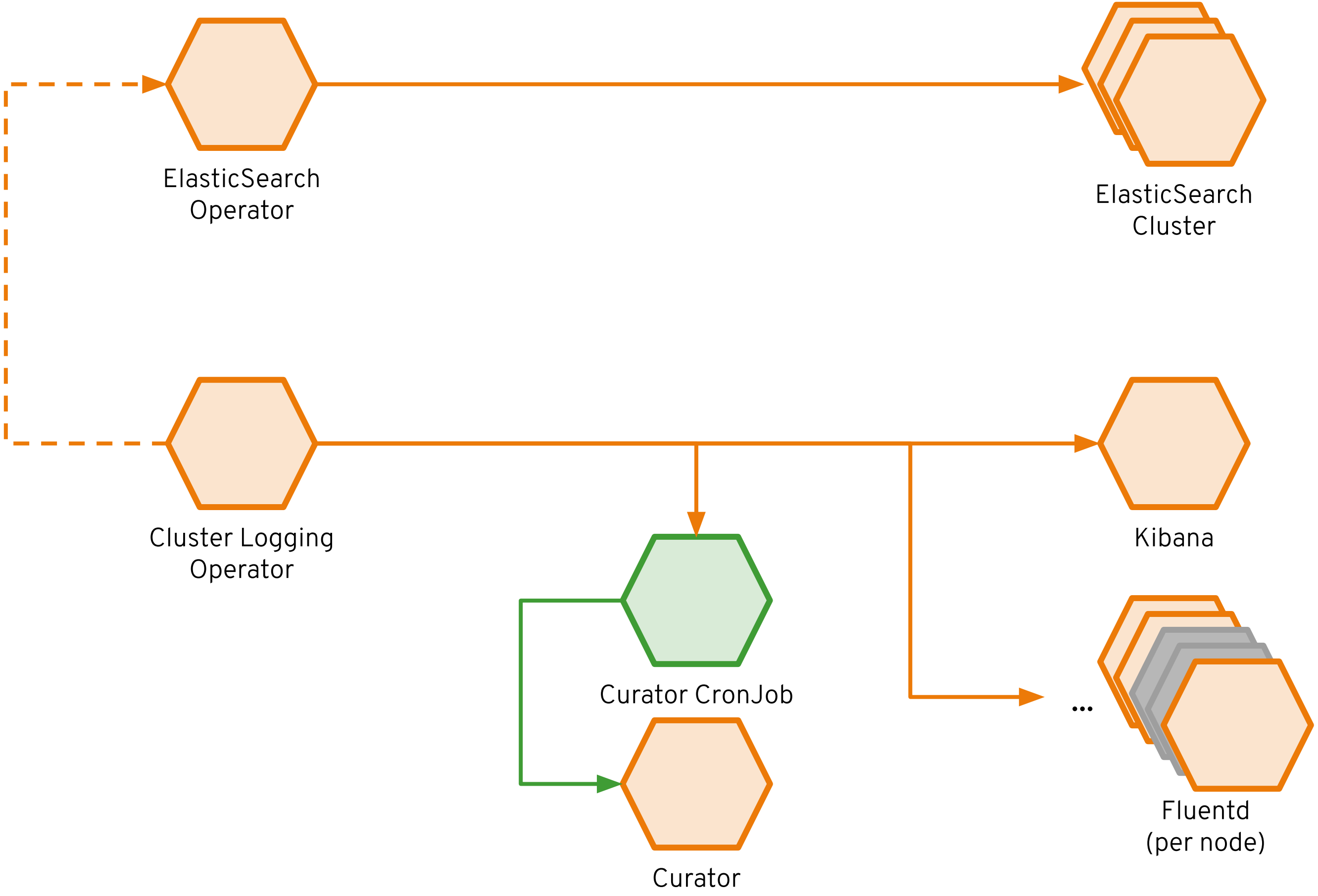
- **Elasticsearch:** a search and analytics engine to store logs
- **Fluentd:** gathers logs and sends to Elasticsearch.
- **Kibana:** A web UI for Elasticsearch.

## Access control

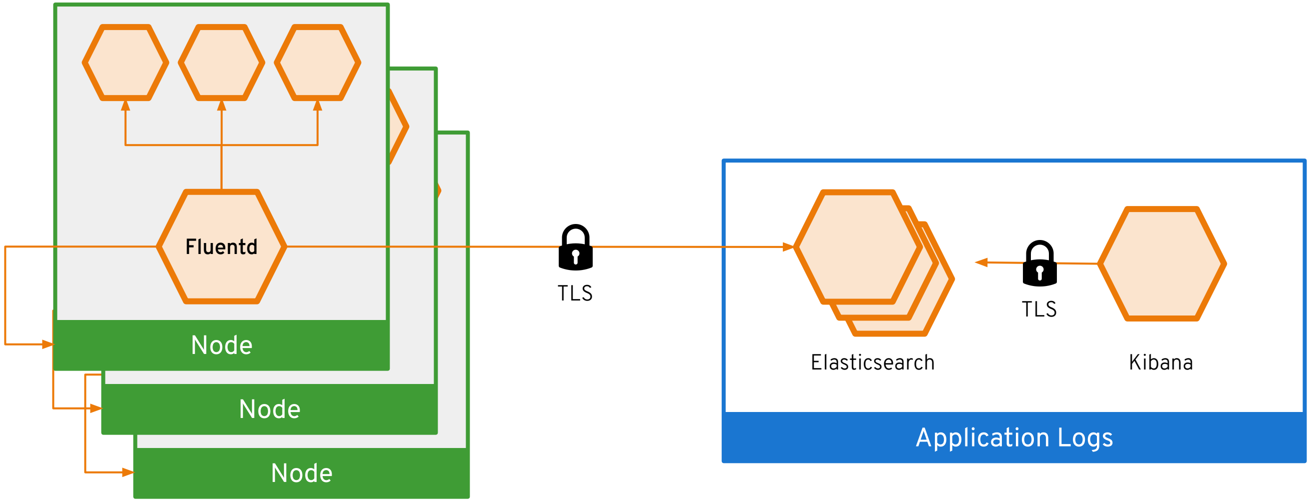
- Cluster administrators can view all logs
- Users can only view logs for their projects

## Ability to forward logs elsewhere

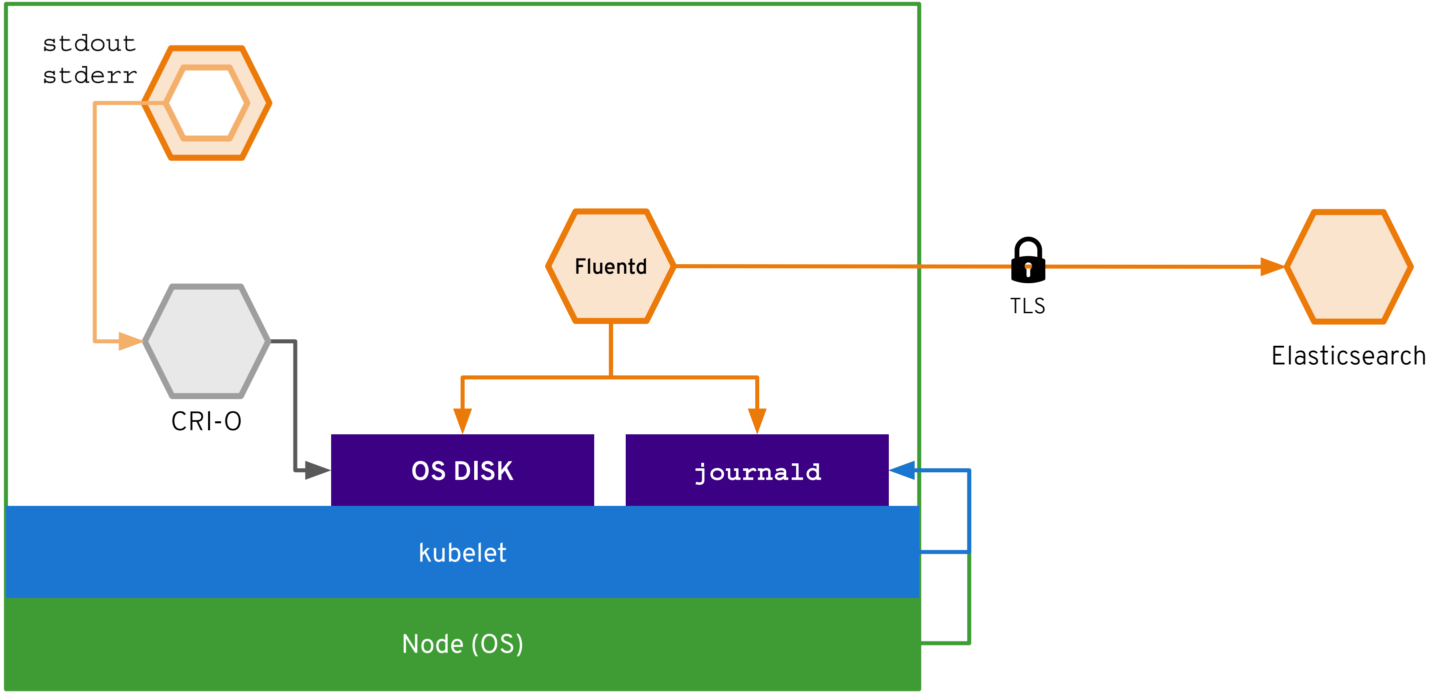
- External elasticsearch, Splunk, etc


ElasticSearch Operator
ElasticSearch Cluster
Cluster Logging Operator
Kibana
Curator CronJob
Curator
...
Fluentd (per node)

# Log data flow in OpenShift



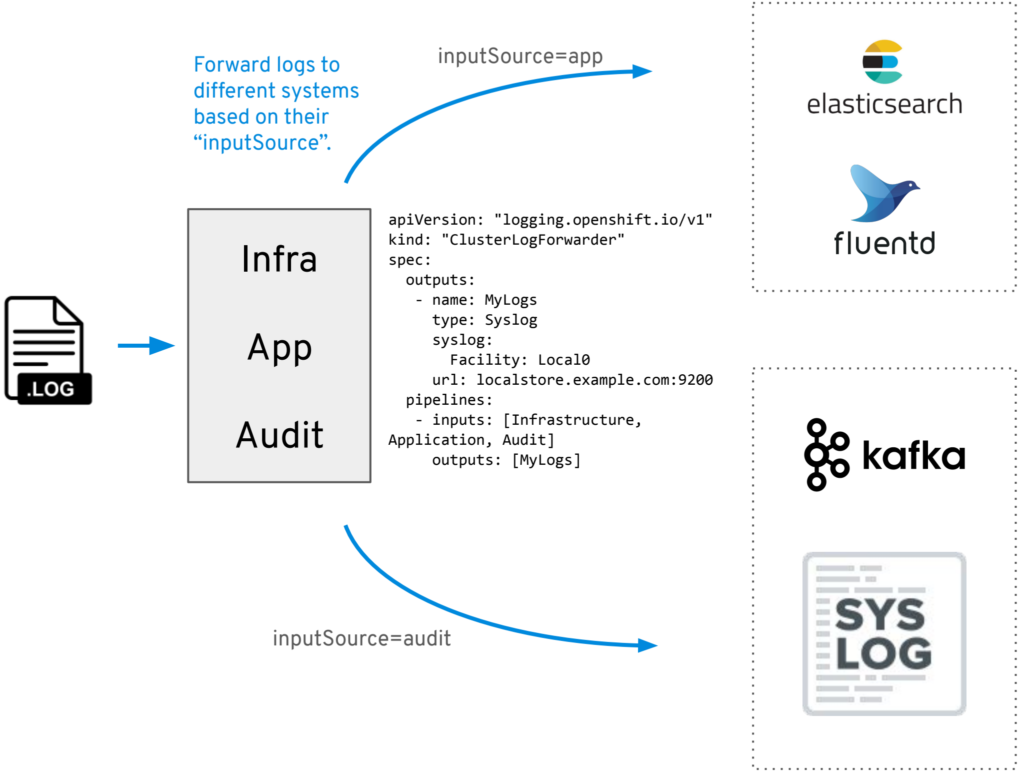
# Log data flow in OpenShift



# New log forwarding API (since 4.6)

**Abstract Fluentd configuration by introducing new log forwarding API to improve support and experience for customers.**

- Introducing a new, cluster-wide *ClusterLogForwarder* CRD (API) that replaces needs to configure log forwarding via Fluentd ConfigMap.
- The API helps to reduce probability to misconfigure Fluentd and helps bringing in more stability into the Logging stack.
- Features include: Audit log collection and forwarding, Kafka support, namespace- and source-based routing, tagging, as well as improvements to the existing log forwarding features (e.g. syslog RFC5424 support).

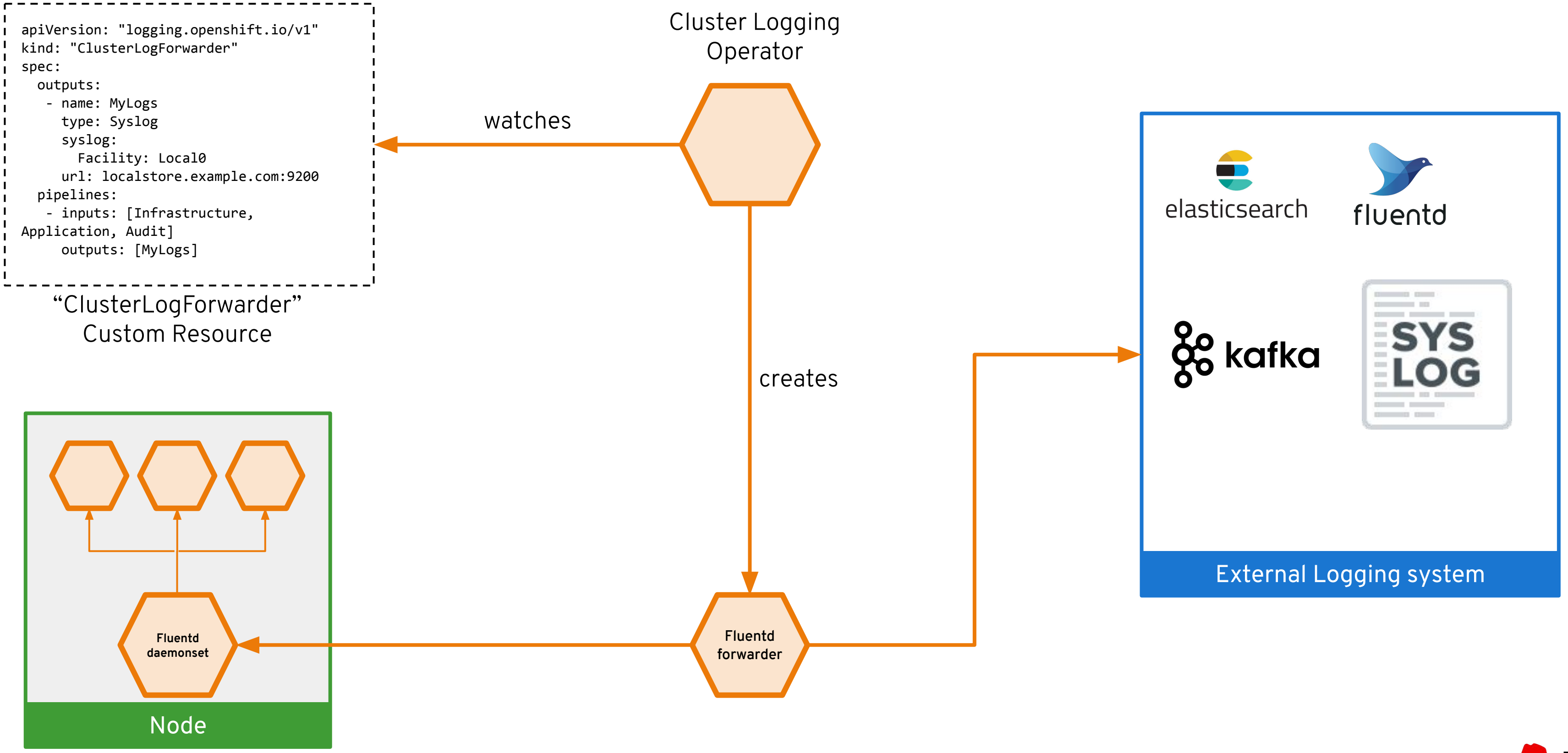


Forward logs to different systems based on their “inputSource”.

```
apiVersion: "logging.openshift.io/v1"
kind: "ClusterLogForwarder"
spec:
  outputs:
   - name: MyLogs
     type: Syslog
     syslog:
       Facility: Local0
     url: localstore.example.com:9200
  pipelines:
   - inputs: [Infrastructure,
Application, Audit]
     outputs: [MyLogs]
```

Product Manager: Christian Heidenreich

# Secure Log Forwarding to 3rd party



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apiVersion: "logging.openshift.io/v1"
kind: "ClusterLogForwarder"
spec:
  outputs:
   - name: MyLogs
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     syslog:
       Facility: Local0
     url: localstore.example.com:9200
  pipelines:
   - inputs: [Infrastructure,
Application, Audit]
     outputs: [MyLogs]
```

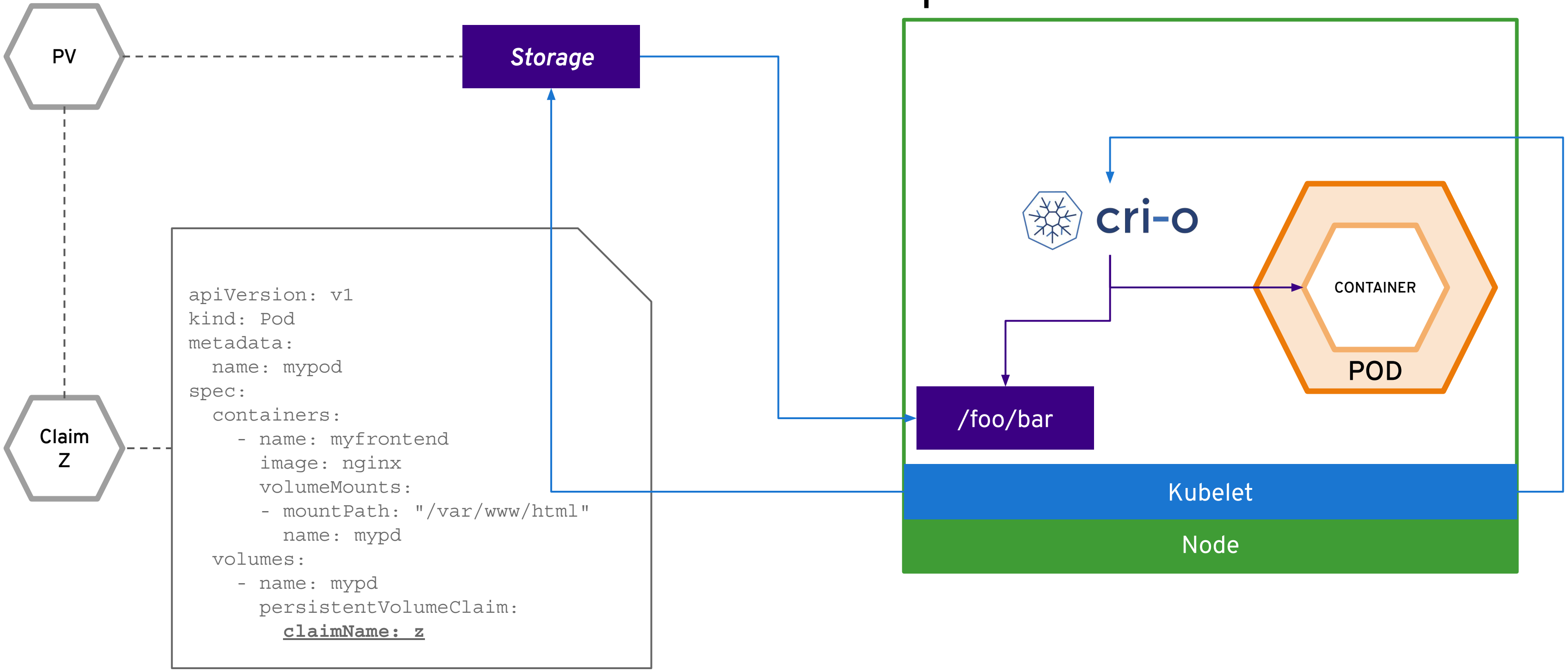
# Persistent Storage

Connecting real-world storage to your containers to enable stateful applications

# A broad spectrum of static and dynamic storage endpoints

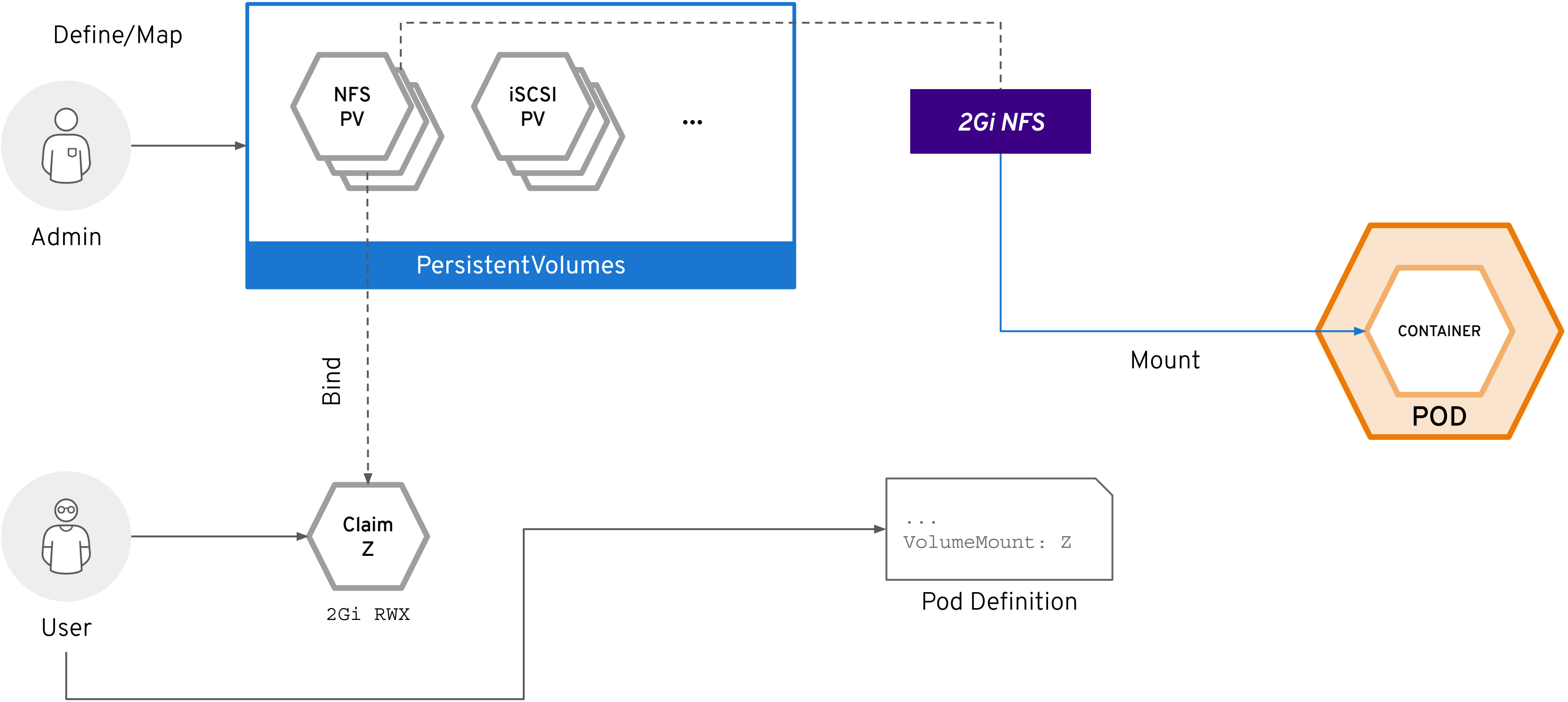
- NFS
- OpenStack Cinder
- iSCSI
- Azure Disk
- AWS EBS
- FlexVolume
- Raw Block
- Local Volumes
- Fiber Channel
- Azure File
- GCE Persistent Disk
- VMware vSphere VMDK
- Container Storage Interface (CSI)

# PV Consumption

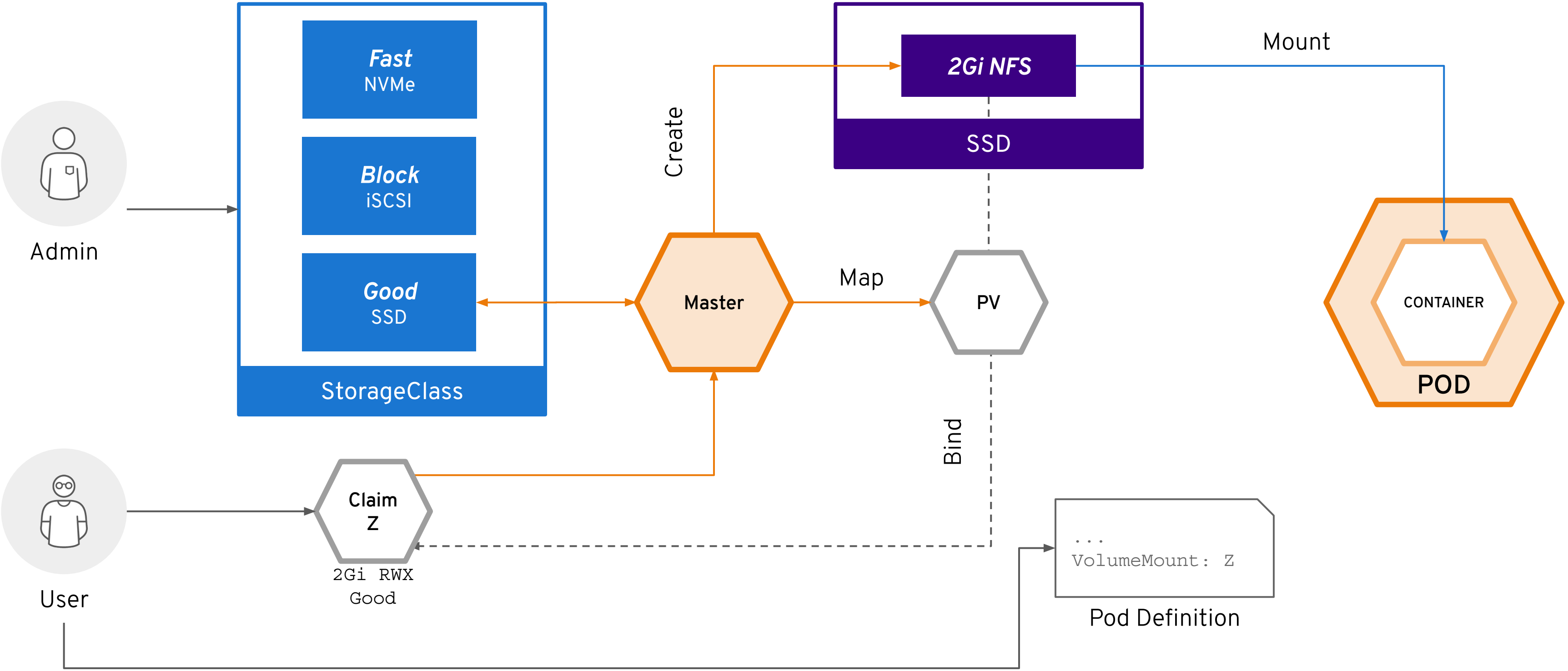


```
apiVersion: v1
kind: Pod
metadata:
  name: mypod
spec:
  containers:
    - name: myfrontend
      image: nginx
      volumeMounts:
      - mountPath: "/var/www/html"
        name: mypd
  volumes:
    - name: mypd
      persistentVolumeClaim:
        claimName: z
```

# Static Storage Provisioning

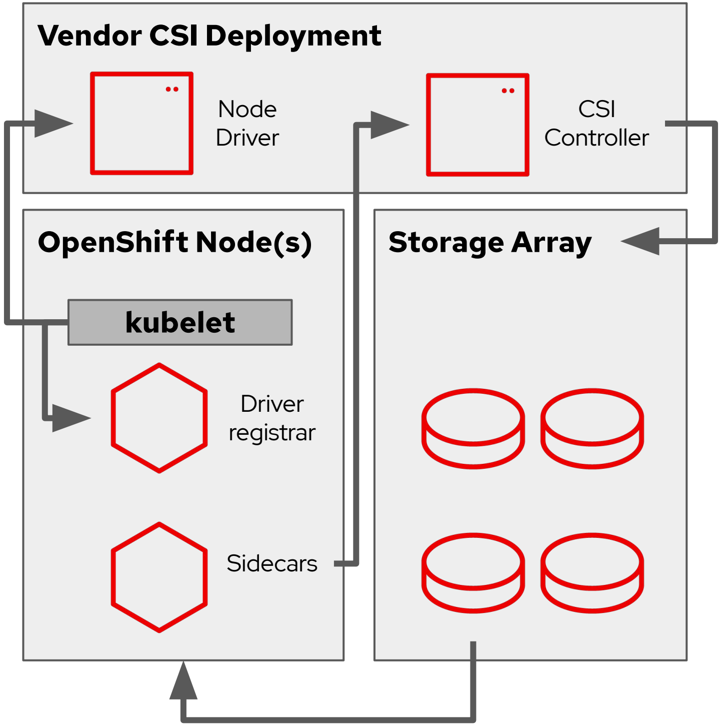


# Dynamic Storage Provisioning



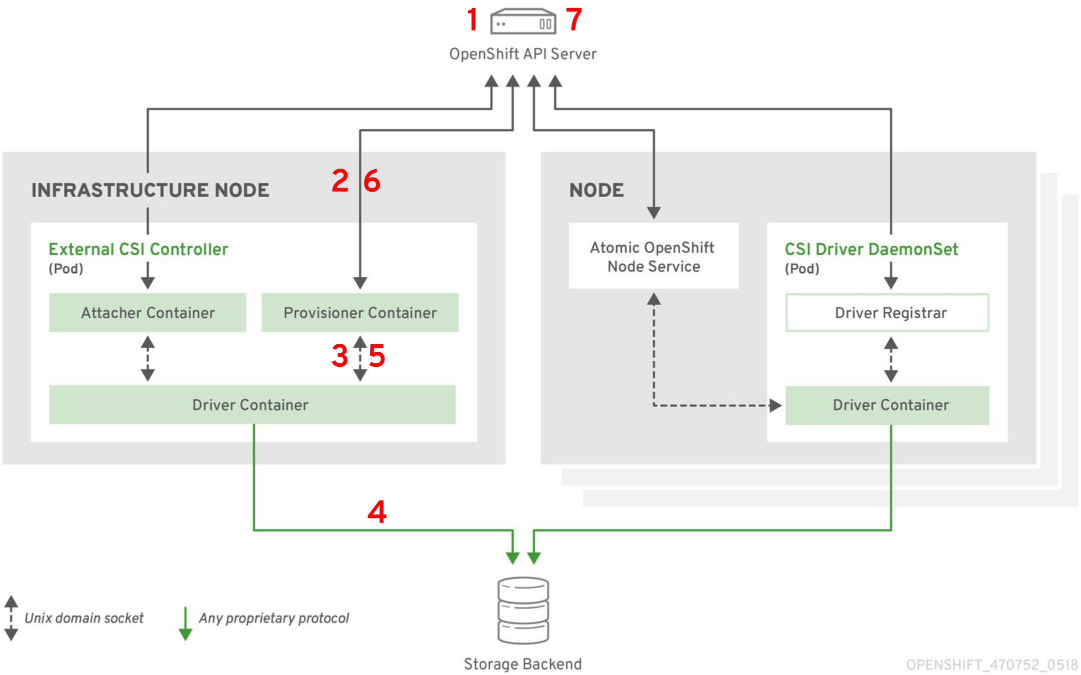
# CSI Driver Paradigm

- CSI drivers and logic are provided by storage vendors
  - Each implementation may be different based on the vendor
- Controller logic is deployed to the OpenShift cluster as an Operator, deployment, or even a standalone Pod(s)
  - Responsible for interfacing with storage device to create and manage volumes, snapshots, clones, etc.
  - Respond to events (create, delete PVC) for assigned StorageClass(es)
  - Sidecars assist with hooks for additional functionality - snapshots, resizing, etc.
- Each node hosts, via a DaemonSet, one or more CSI node plugin Pods for the driver
  - Kubelet requests the node plugin to mount/unmount volumes, format block devices if needed, etc.



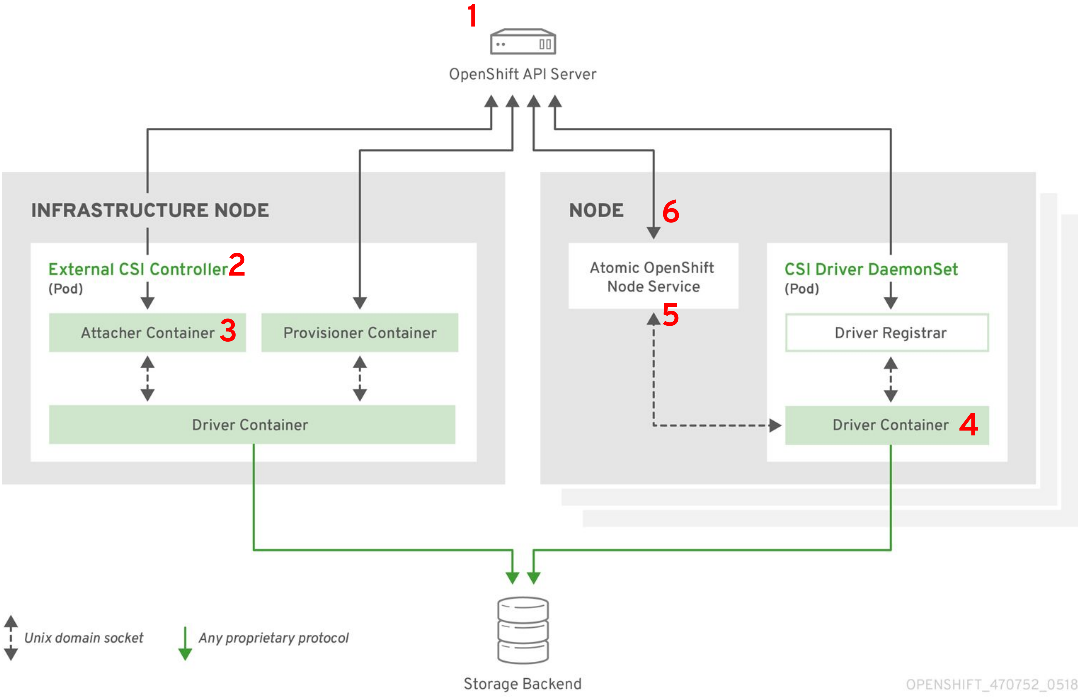
# CSI Dynamic Provisioning

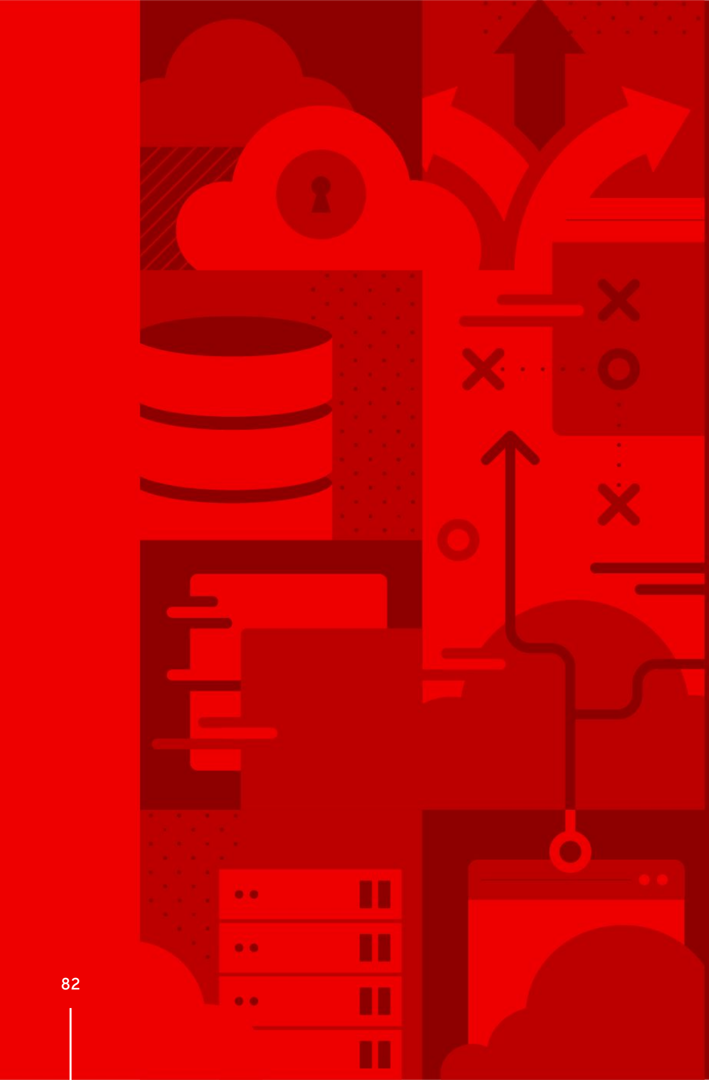
1. User creates a PVC
2. The external provisioner gets an event that a new PVC was created
3. The external provisioner initiates CreateVolume call to the CSI driver
4. The CSI driver talks to storage backend and creates a volume
5. The CSI driver returns a volume to the external provisioner
6. The external provisioner creates PV on API server
7. Kubernetes PV controller finishes the binding (PVC is Bound)



# CSI Volume Mounting

1. User instantiates a Pod with a PVC
2. The CSI controller is notified of a volume publish event via the attacher sidecar
3. The CSI controller takes any actions on the storage device to make the volume mountable, e.g. NFS export rules
4. The node driver stages the volume, taking action to prepare the volume to be used, e.g. formatting a non-raw block device
5. The node driver mounts the volume at the location requested by Kubelet
6. The volume is attached to the container, by Kubelet, as defined



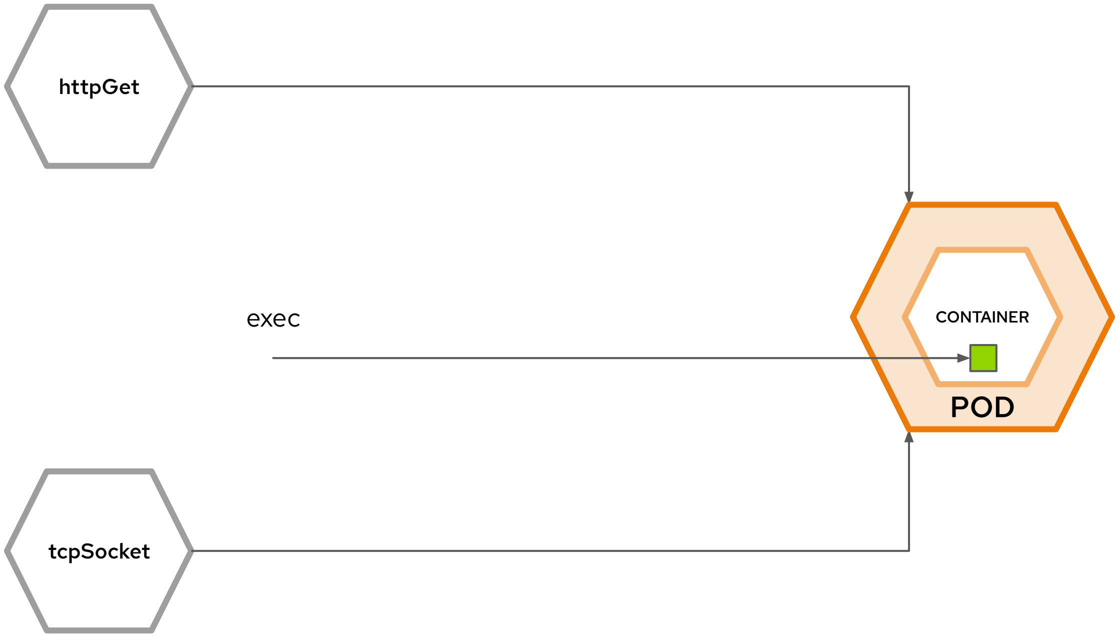


# Developer Experience

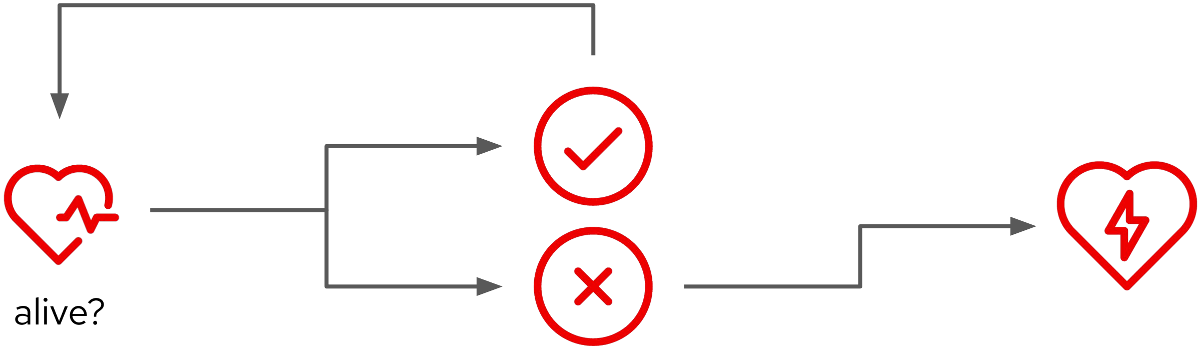
# Application Probes

Improving reliability and availability of applications via built-in probes

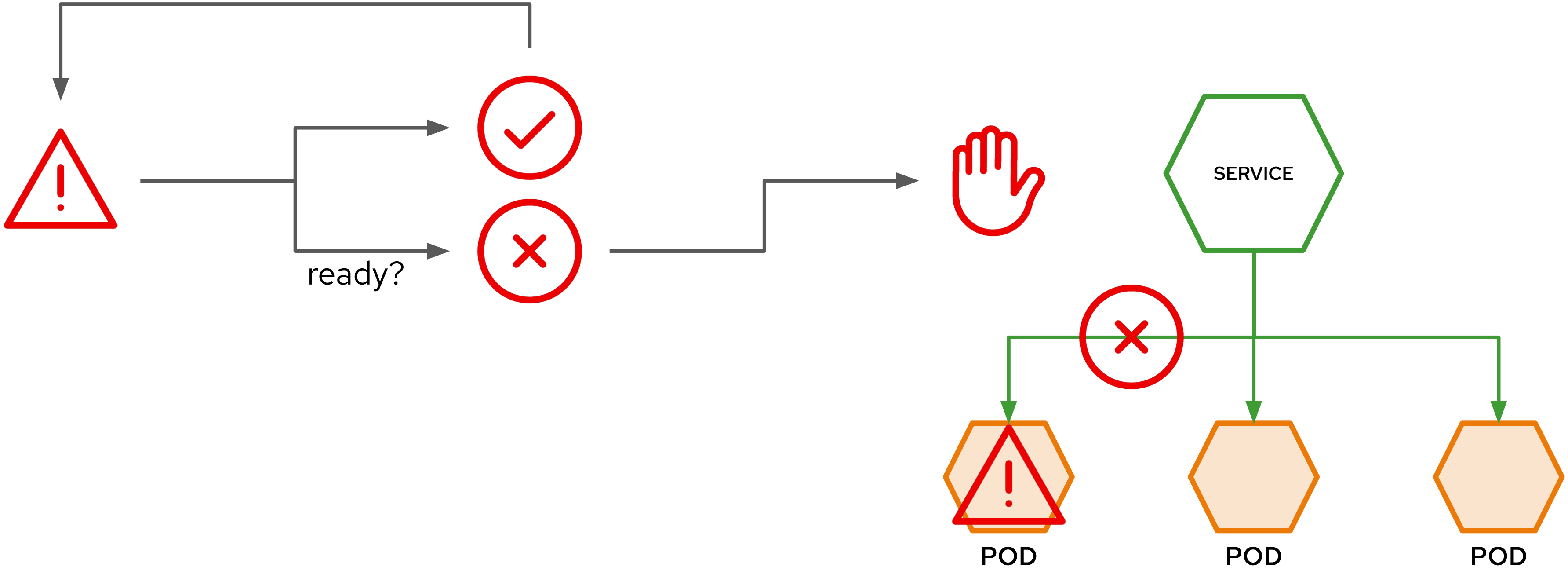
# Three Types: One Goal



# Liveness Probes



# Readiness Probes



# Important settings

`initialDelaySeconds`: How long to wait after the pod is launched to begin checking

`timeoutSeconds`: How long to wait for a successful connection (httpGet, tcpSocket only)

`periodSeconds`: How frequently to recheck

`failureThreshold`: How many consecutive failed checks before the probe is considered failed

# Build and Deploy Container Images

Tools and automation

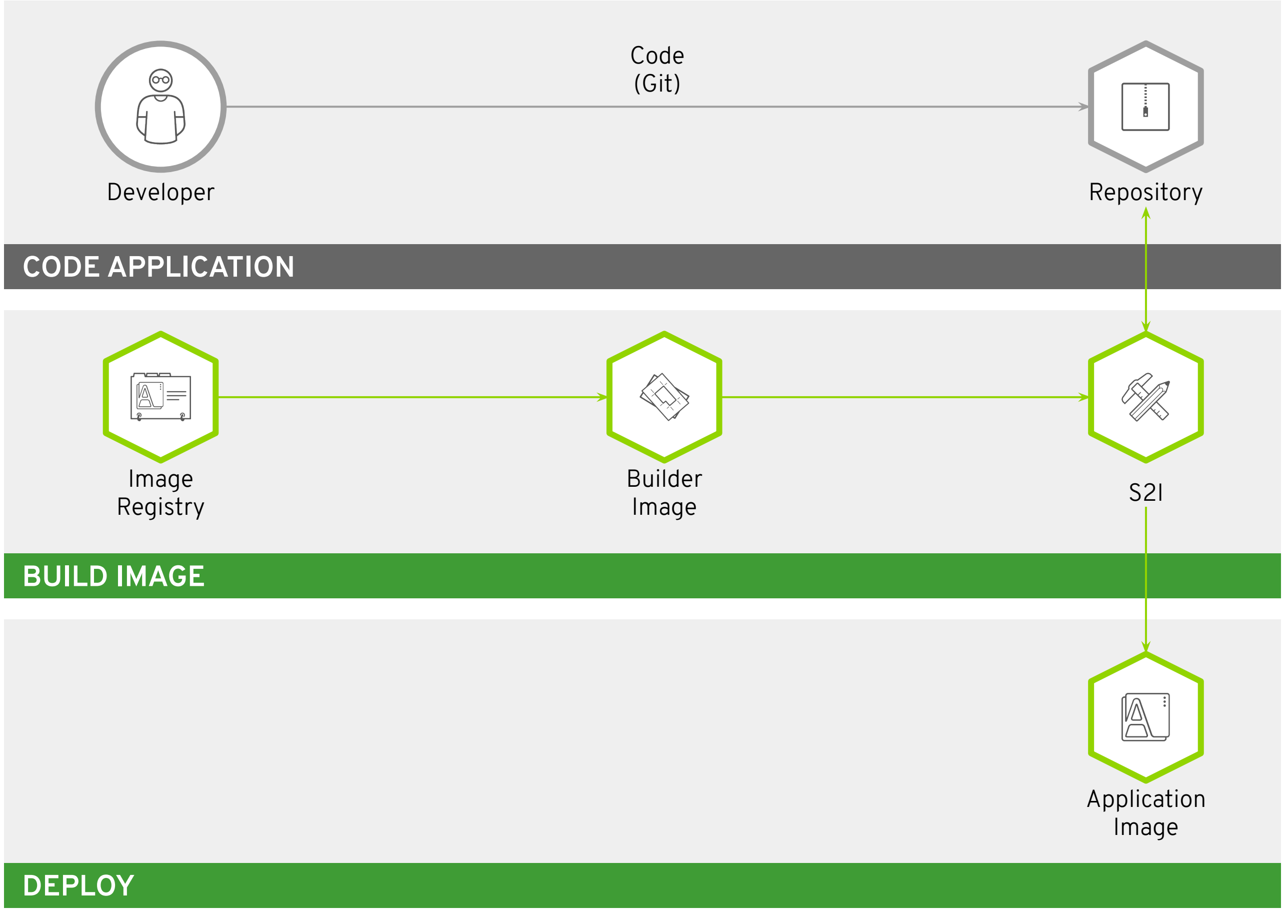
that makes developers

productive quickly

## DEPLOY YOUR SOURCE CODE

## DEPLOY YOUR APP BINARY

## DEPLOY YOUR CONTAINER IMAGE


Code
(Git)
Developer
Repository
CODE APPLICATION
Image
Registry
Builder
Image
S2I
BUILD IMAGE
Application
Image
DEPLOY

linkedin.com/company/red-hat

youtube.com/user/RedHatVideos

facebook.com/redhatinc

twitter.com/RedHat

Red Hat