AWB Bootcamp
Red Hat OpenShift and IBM Cloud Paks

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IBM

Agenda

Day 2 (Architecture and Installation)

- OpenShift 4.3 Architecture
- OpenShift 4.3 Common Cluster Architectures
- OpenShift Container Security
- OpenShift DNS
- OpenShift Authentication
- OpenShift Container Networking
- OpenShift Storage
- OpenShift 4.3 Installation
- OpenShift Day2

OpenShift 4.3 Architecture

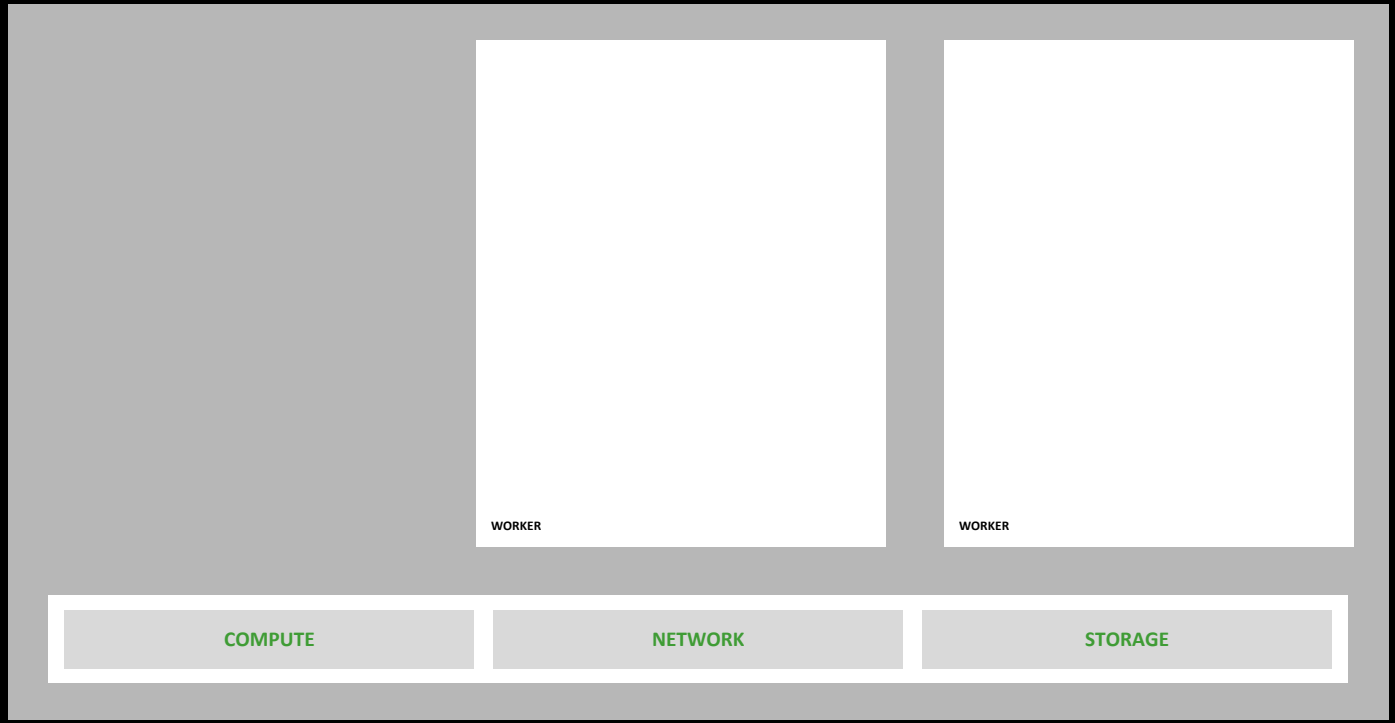
You choose the infrastructure

COMPUTE

NETWORK

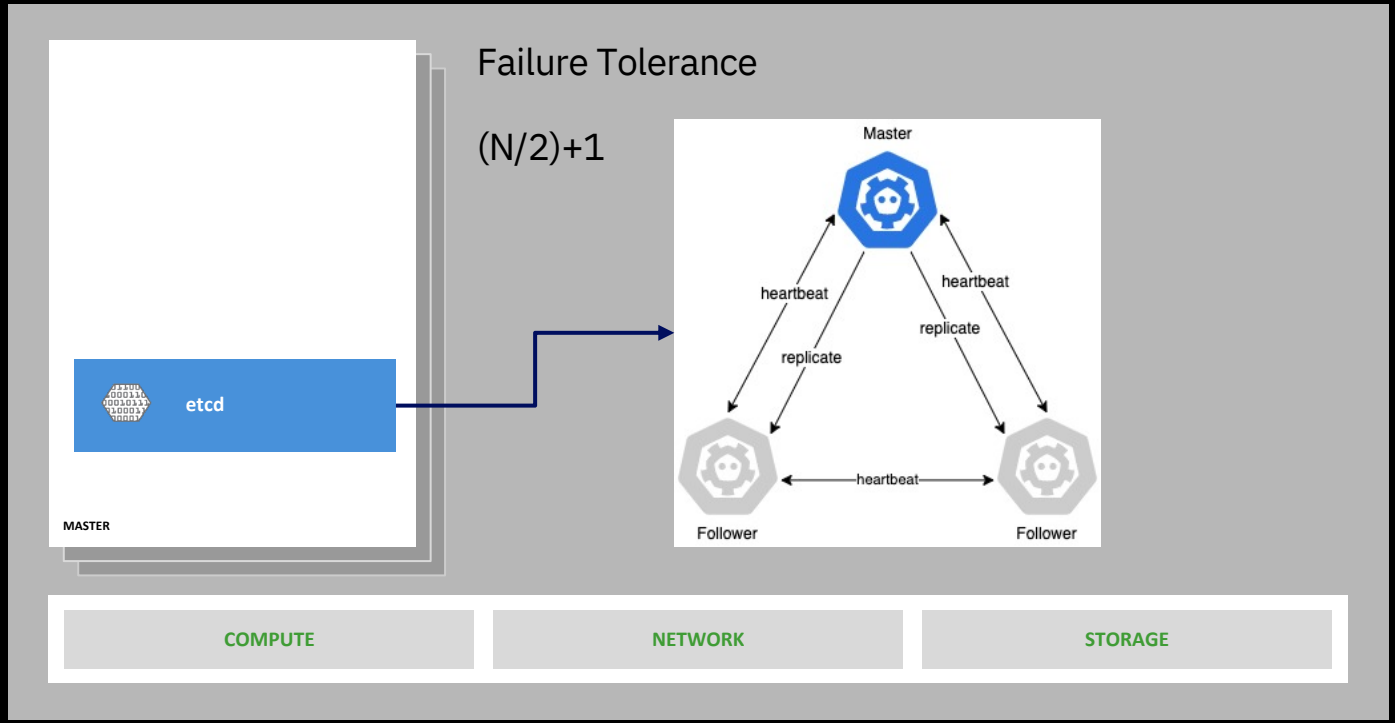
STORAGE

Workers run workloads

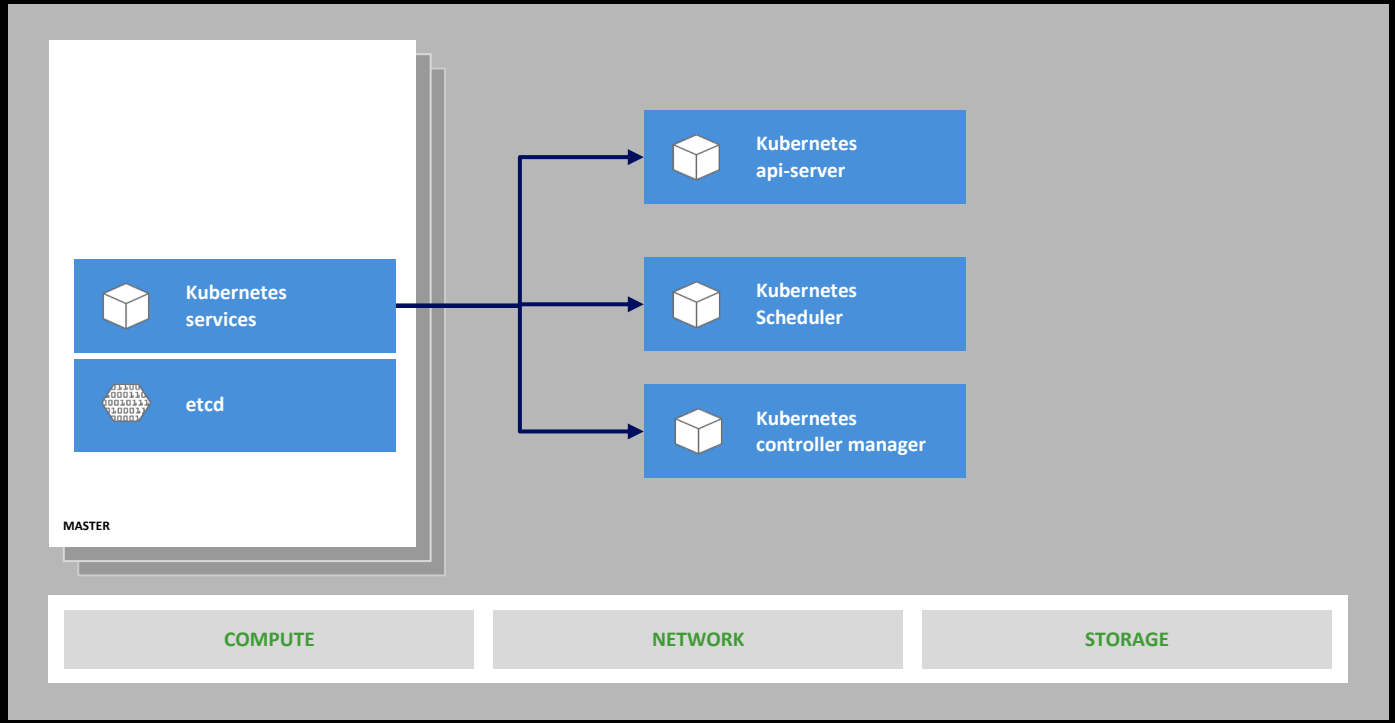


Masters are the control plane

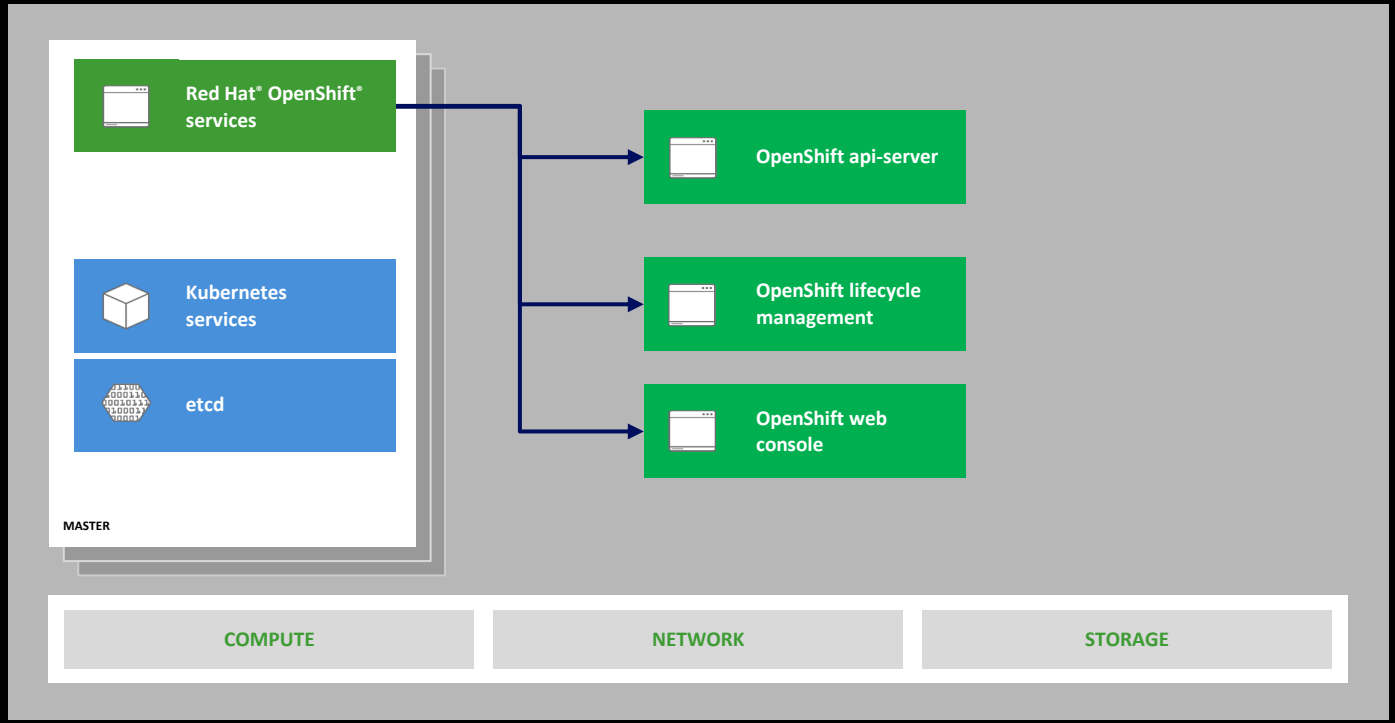
etcd stores the state of everything



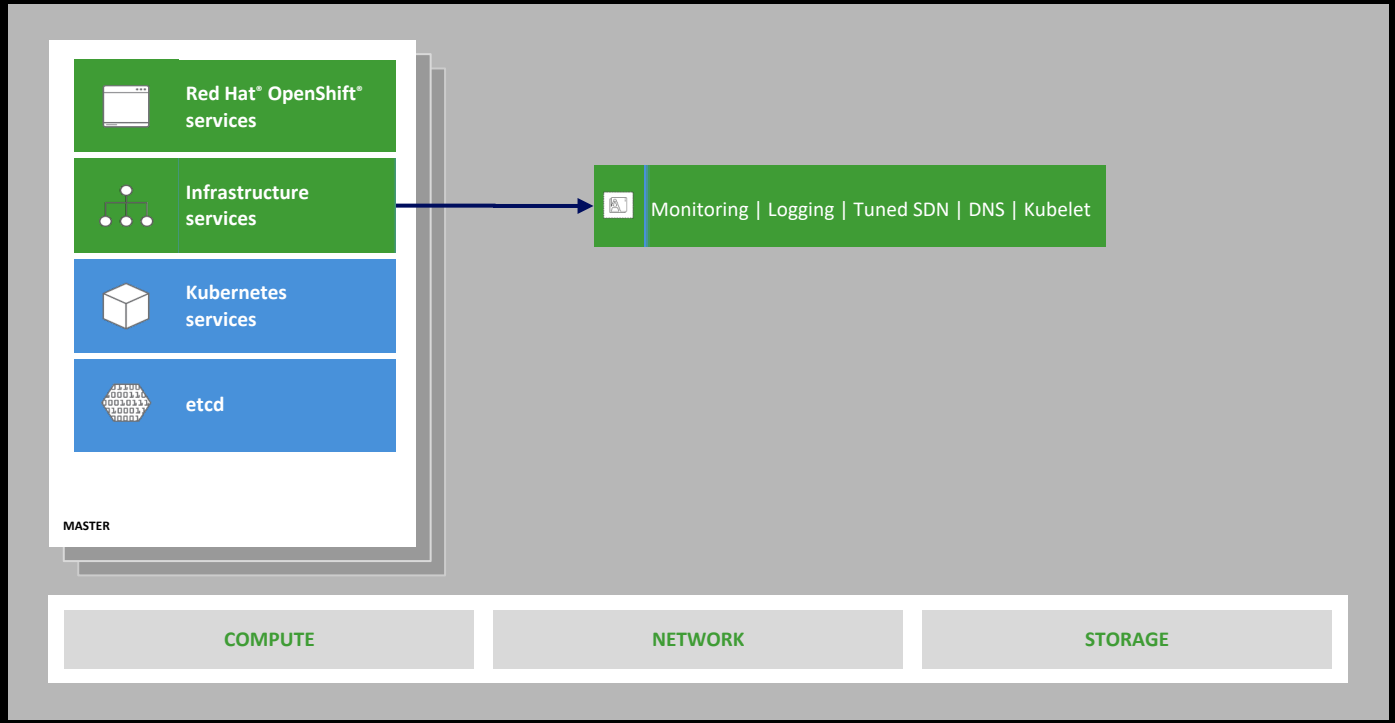
Core Kubernetes components



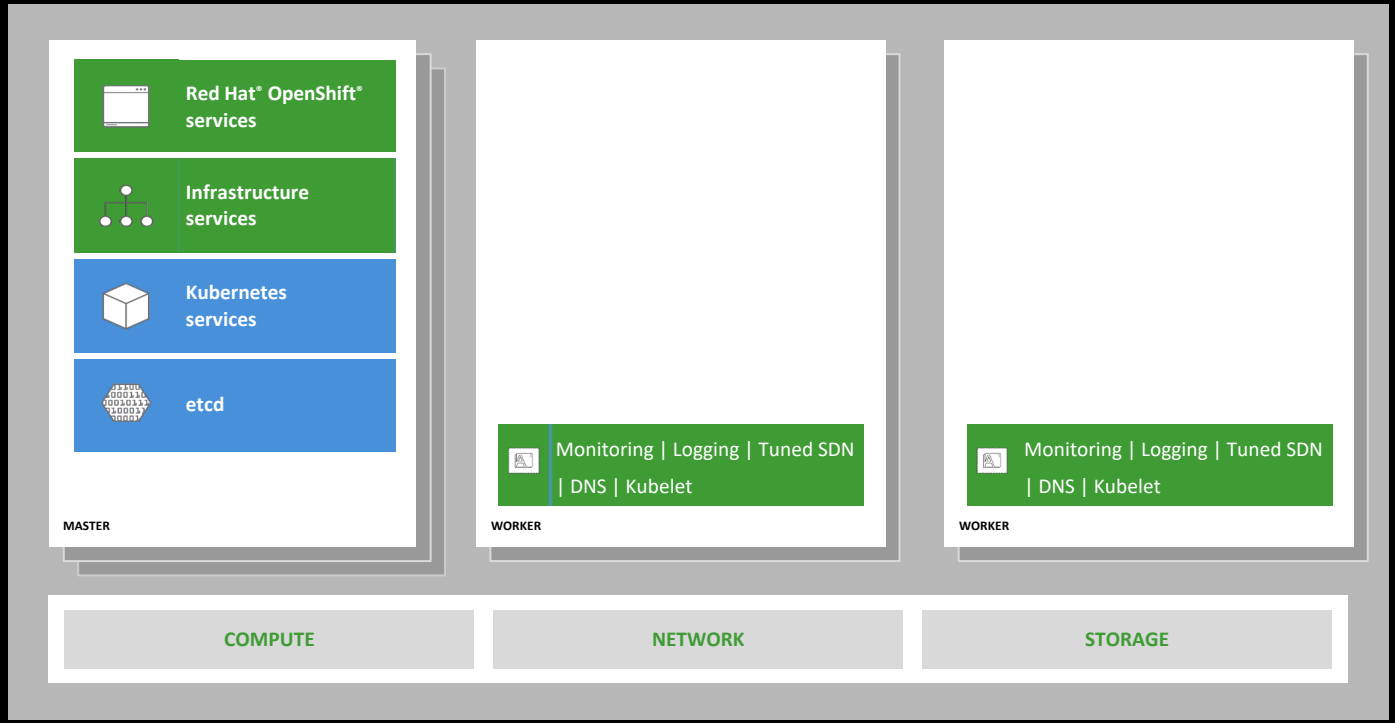
Core OpenShift components



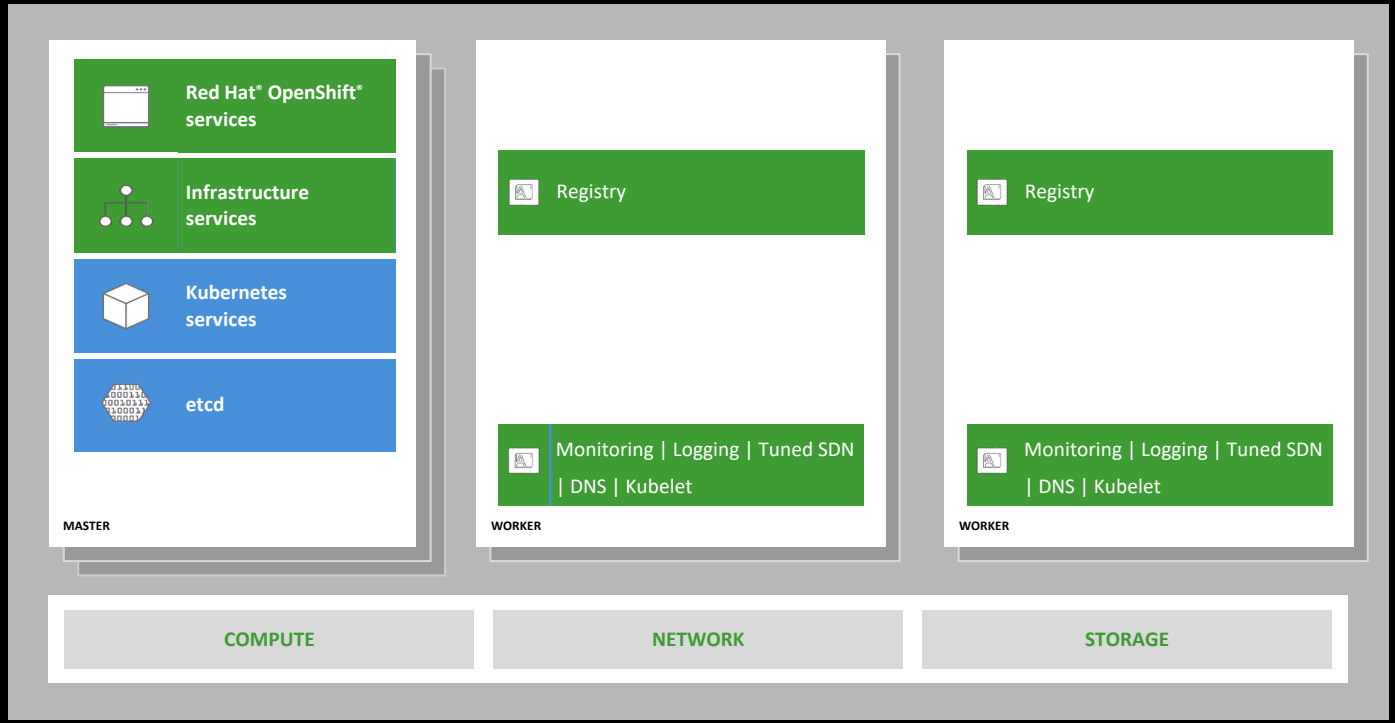
Internal and support infrastructure services



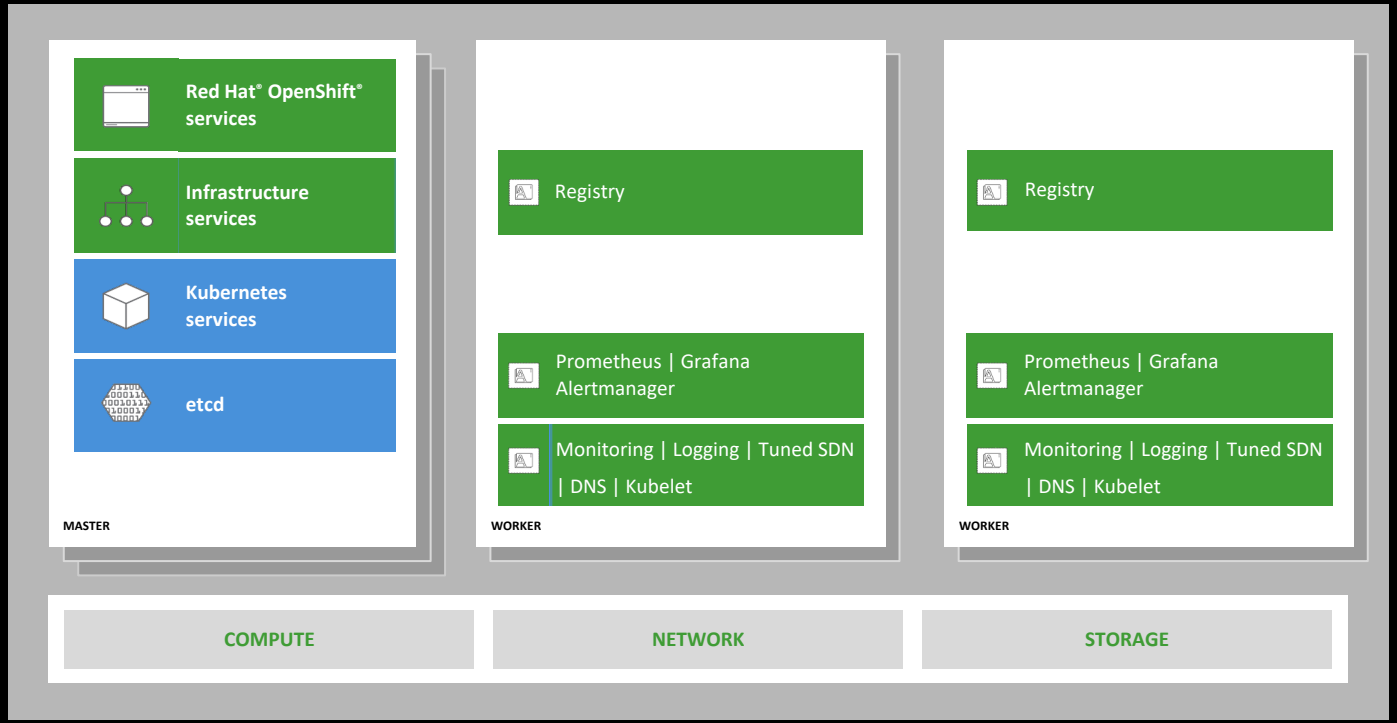
Runs on all hosts



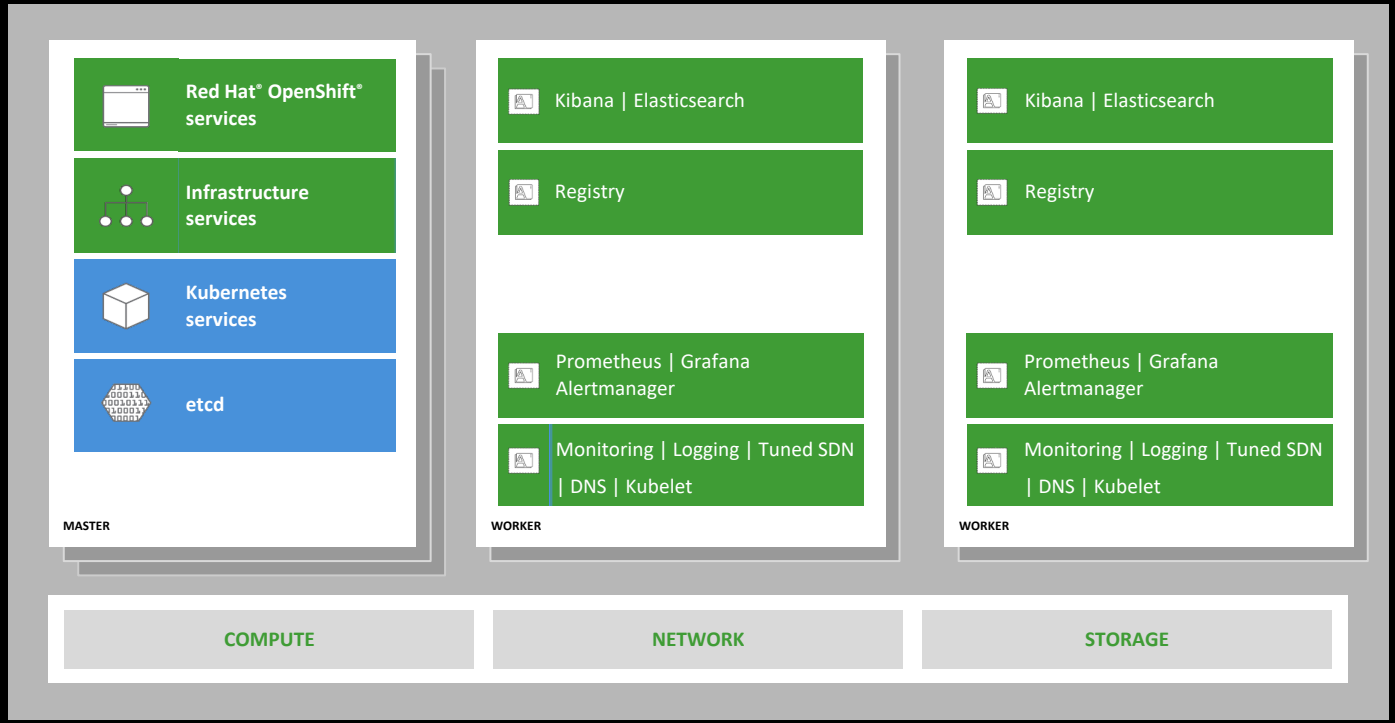
Integrated image registry



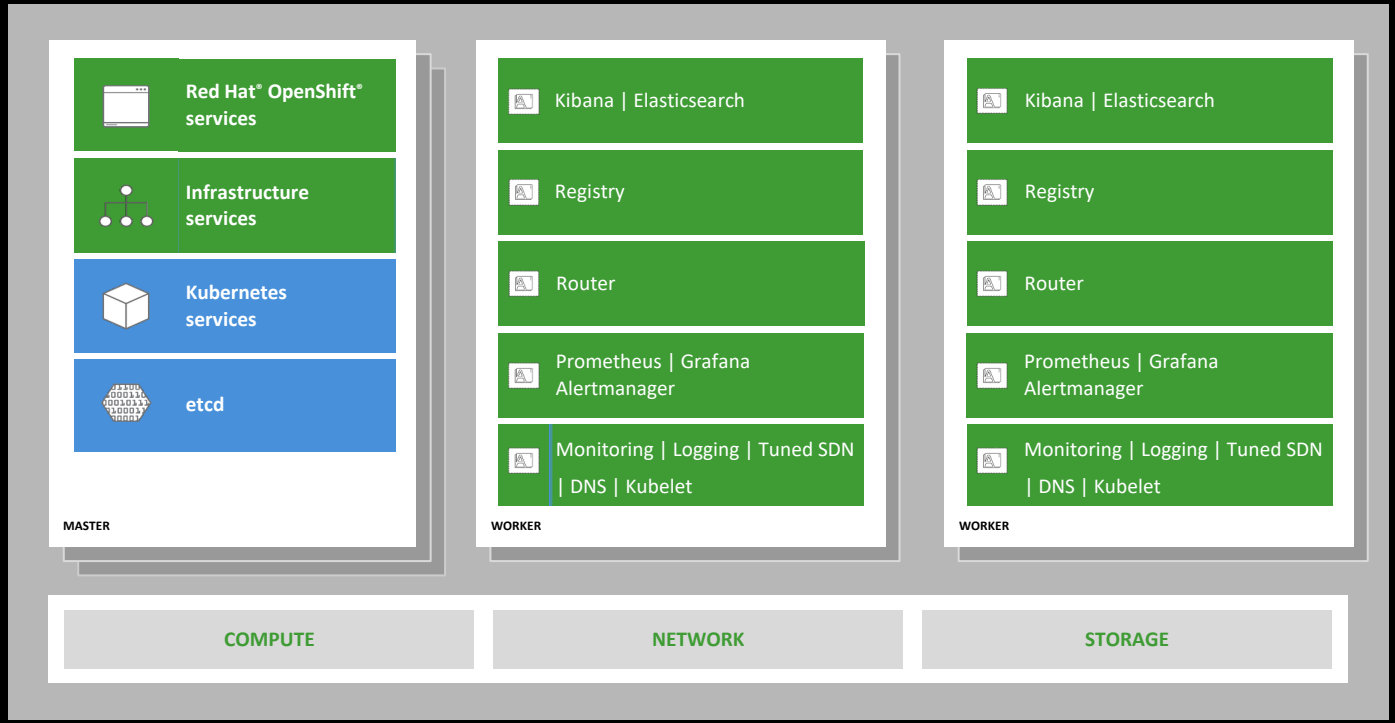
Cluster Monitoring



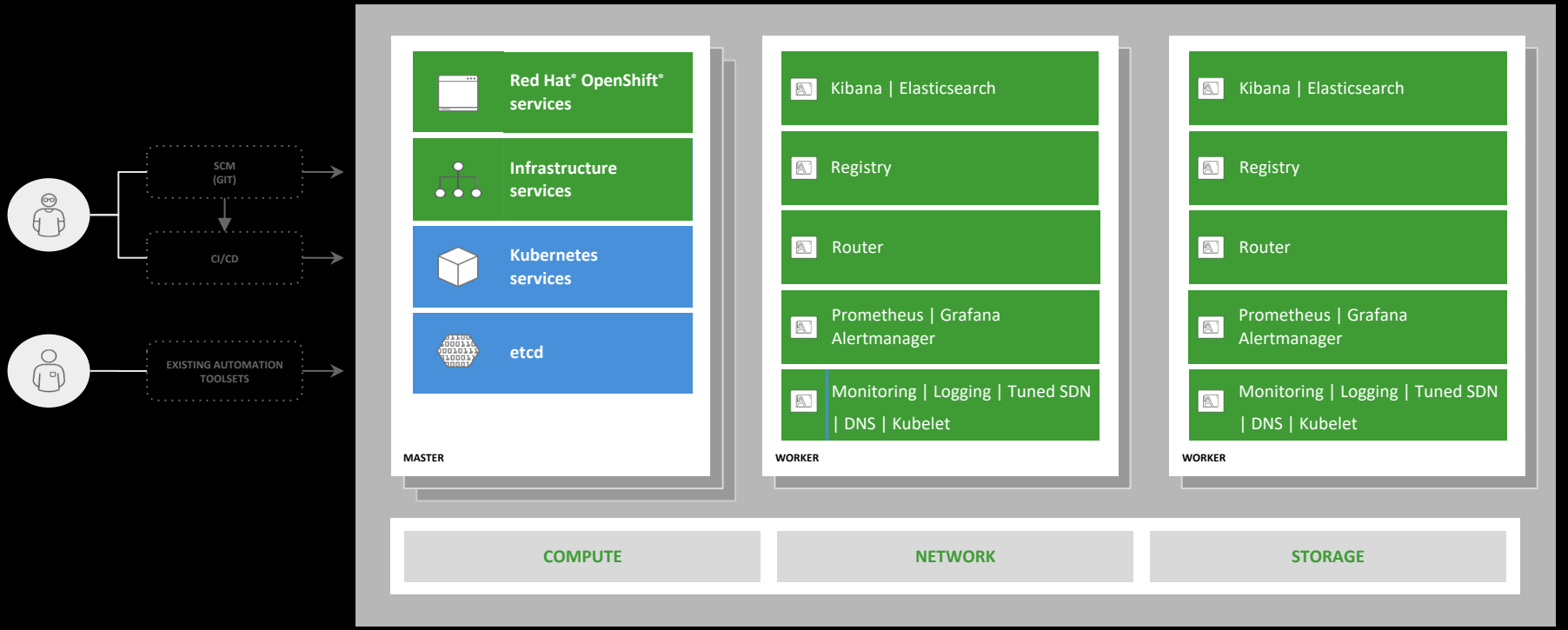
Log aggregation



Integrated routing



Dev and Ops via Web, CLI, API and IDE



Red Hat CoreOS

	RED HAT® ENTERPRISE LINUX®	RED HAT® ENTERPRISE LINUX CoreOS
BENEFITS	• 10+ year enterprise life cycle • Industry standard security • High performance on any infrastructure • Customizable and compatible with wide ecosystem of partner solutions	• Self-managing, over-the-air updates • Immutable and tightly integrated with OpenShift • Host isolation is enforced via Containers • Optimized performance on popular infrastructure
WHEN TO USE	When customization and integration with additional solutions is required	When cloud-native, hands-free operations are a top priority

Immutable Operating System

Red Hat Enterprise Linux CoreOS is versioned with OpenShift

CoreOS is tested and shipped in conjunction with the platform. Red Hat runs thousands of tests against these configurations.

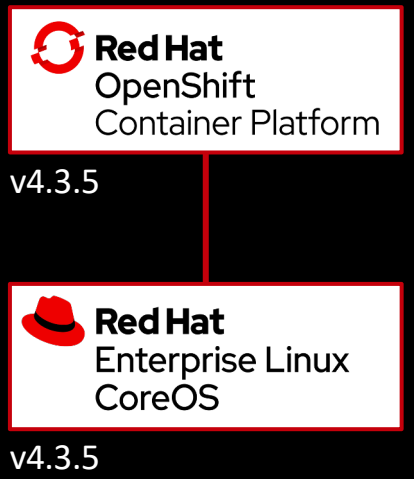
RHEL CoreOS admins are responsible for:

Nothing. 😀🙌

Red Hat Enterprise Linux CoreOS is managed by the cluster

The Operating system is operated as part of the cluster, with the config for components managed by Machine Config Operator:

- CRI-O config
- Kubelet config
- Authorized registries
- SSH config



Common Architectures

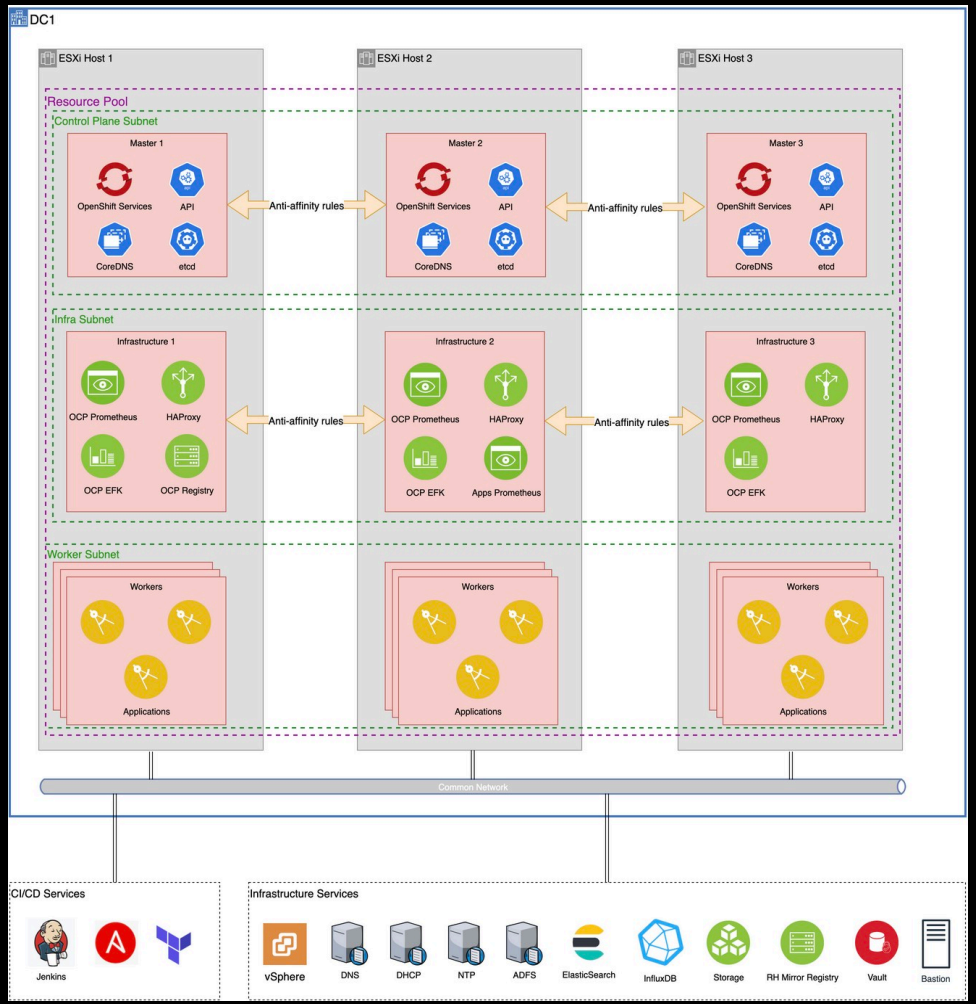
Common Architectures

Single cluster, single datacenter

A single cluster is distributed within one datacenter

Control plane is distributed across ESXi hosts/availability zones

Implements HA/DR measures to protect against host failure



Common Architectures

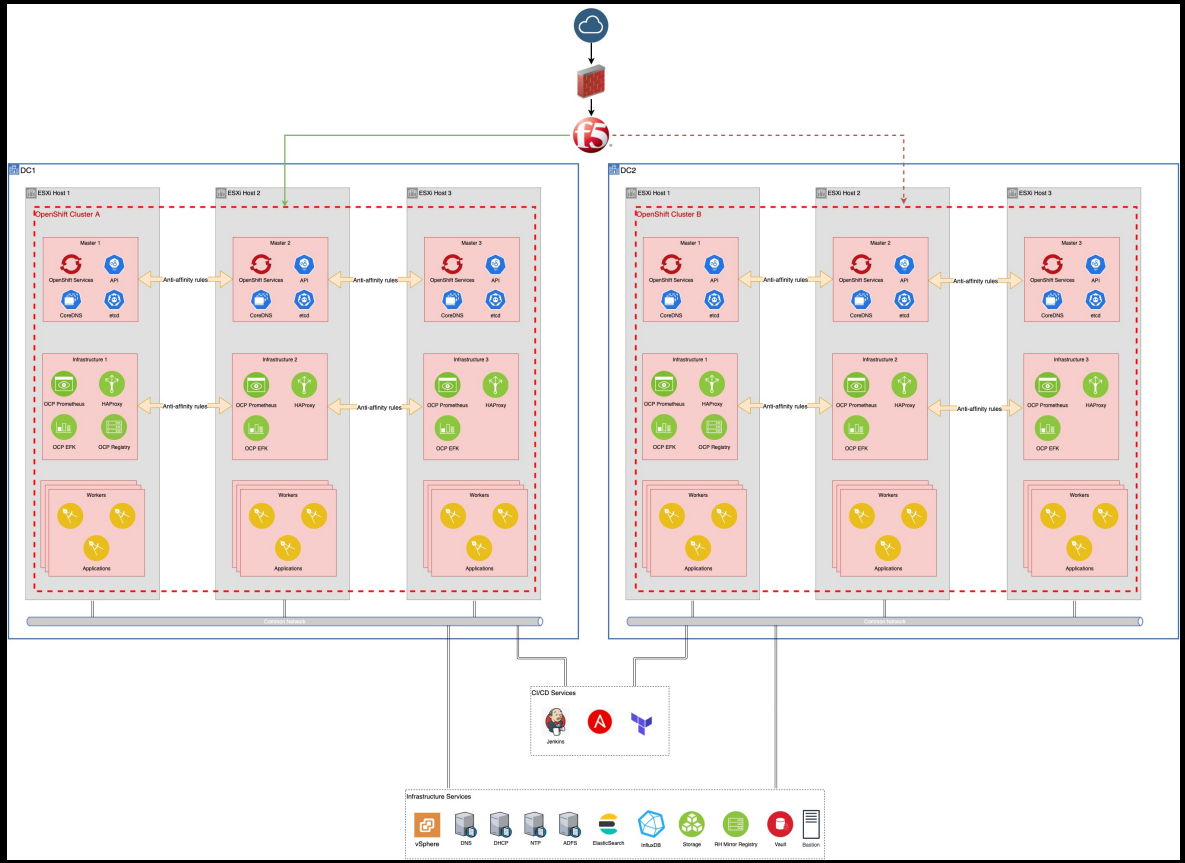
Two clusters, multiple datacentres

Multiple clusters are deployed to different datacenters in an active/active or active/passive approach

Traffic is routed to the active cluster via a global load balancer

Implements the same principles as the single cluster, single datacenter strategy

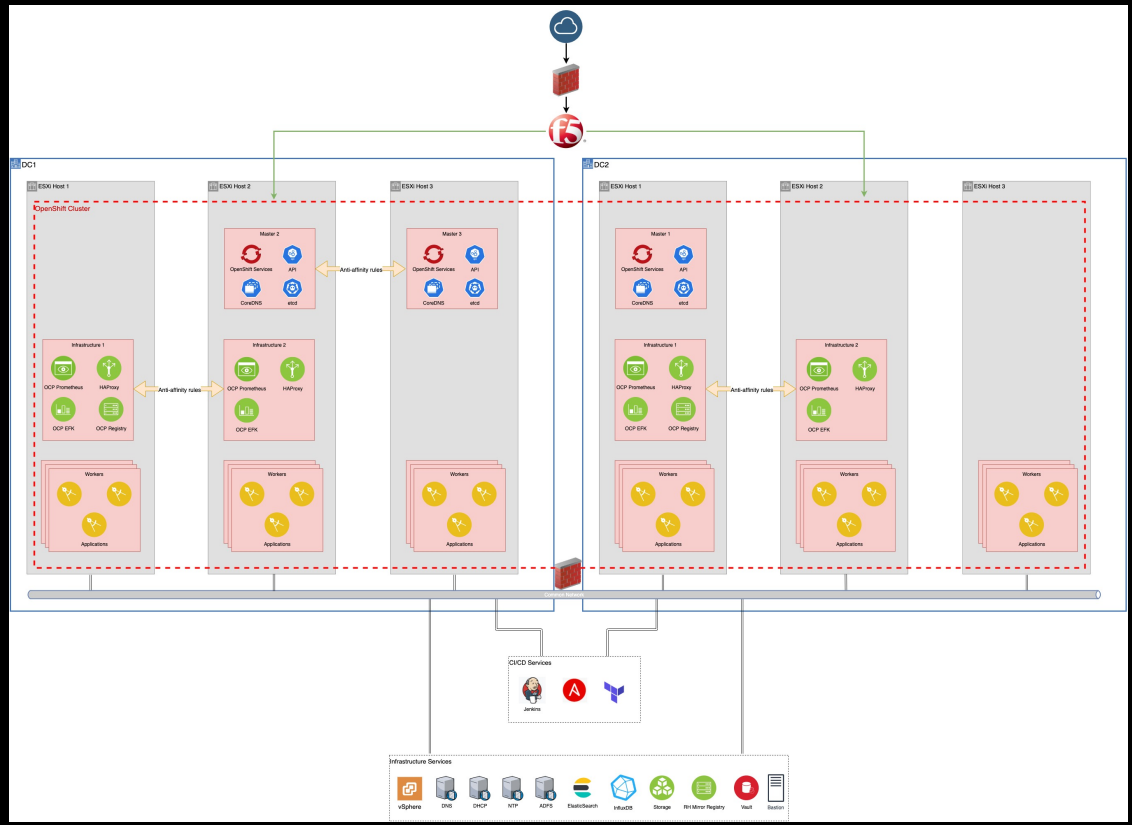
Implements HA/DR measures to protect against site failure



Common Architectures

Single cluster, multiple datacentres (stretched)

- Single cluster deployed across two datacenters with stretched networking approach
- Requires low latency
- Intra-datacenter implements the same principles as the single cluster, single datacenter strategy
- Implements HA/DR measures to protect against site failure
- Datacenter hosting both masters is a weak point



Some Considerations for Designing OpenShift Clusters

Workload and Application considerations

What availability is needed for the application?

RPO and RTO for the application?

What are your workload requirements?

Platform Considerations

Are we understanding the capacity needs? Do we need N+1 or N+2?

What tooling is foreseen to replicate the data between prod and DR?

What are the exter or both? nal integrations required? Logging, monitoring, storage?

Container considerations

How is the traffic sprayed over the HA components?

Do we allow DR for individual applications or only for the cluster?

Infrastructure considerations

How is the HA foreseen for the infrastructure?

Do we have a dark DR site or an active one?

Does it need to scale?

Single cluster, or multiple clusters?

Organization considerations

Who is managing and monitoring the platform for availability?

Do we apply regular switches between prod and DR?

What are the High Availability and Disaster Recovery strategies?

Some Considerations for Designing OpenShift Clusters

Workload Type

- For heritage workloads, some customers may have separate VMs for each application instance (AI), where the # of AIs / VMs will equal the number of pods.
- In these scenarios, be sure to ask about VM specs (cores per VM)
- For microservices workloads be sure to understand the dynamic behaviour

Platform Type

- When evaluating how many servers or VMs will be in use, be sure to confirm # of cores per machine.
- Understand the needs of your workload to determine the type of worker nodes - elasticsearch needs large nodes with high memory
- Also verify whether your customer expects this environment to grow within the next years.

Cluster Requirements

- Look at the isolation and segmentation as this can increase the node numbers
- You should also be sure to verify with your customer whether they need HA and DR
- Check whether the current environment size already accounts for redundancy / HA.
- How many environments are needed and how are they placed over the different DCs.

OpenShift Security

OpenShift Security

CONTROL
Application Security

- Container Content
- CI/CD Pipeline
- Container Registry
- Deployment Policies

DEFEND
Infrastructure

- Container Platform
- Container Host Multi-tenancy
- Network Isolation
- Storage
- Audit & Logging
- API Management

EXTEND

- Security Ecosystem

OpenShift Security

To make the correct security design decisions we need to understand:

The type of workloads the client is going to run

The type of external interactions we need for the applications

The way of interacting with the platform and which interfaces they are going to use.

The different integrations for IAM and other security components

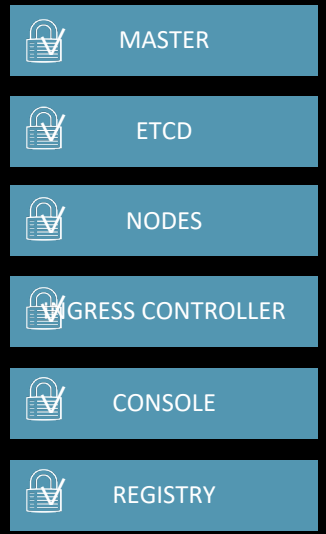
The isolation and segmentation is needed for the different groups/teams

The data protection needs for the different workloads

How containers need to be secured, monitored for mutations
Etc.

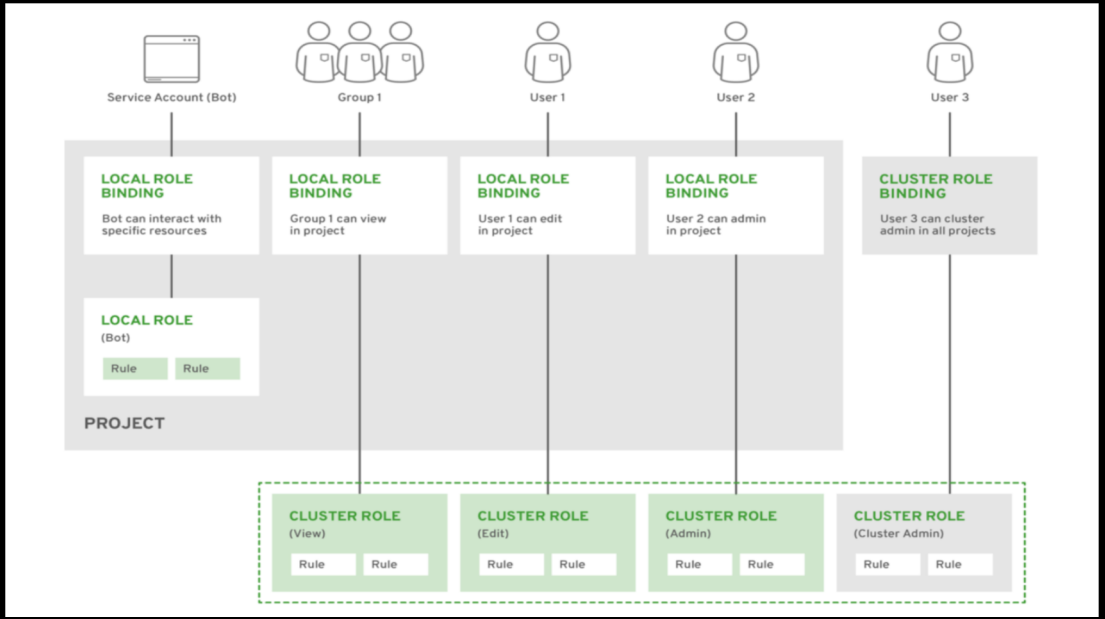
OpenShift Security
- Certificates and Certificate Management

- OpenShift provides its own internal CA
- Certificates are used to provide secure connections to
  - master (APIs) and nodes
  - Ingress controller and registry
  - etcd
- Certificate rotation is automated
- Optionally configure external endpoints to use custom certificates

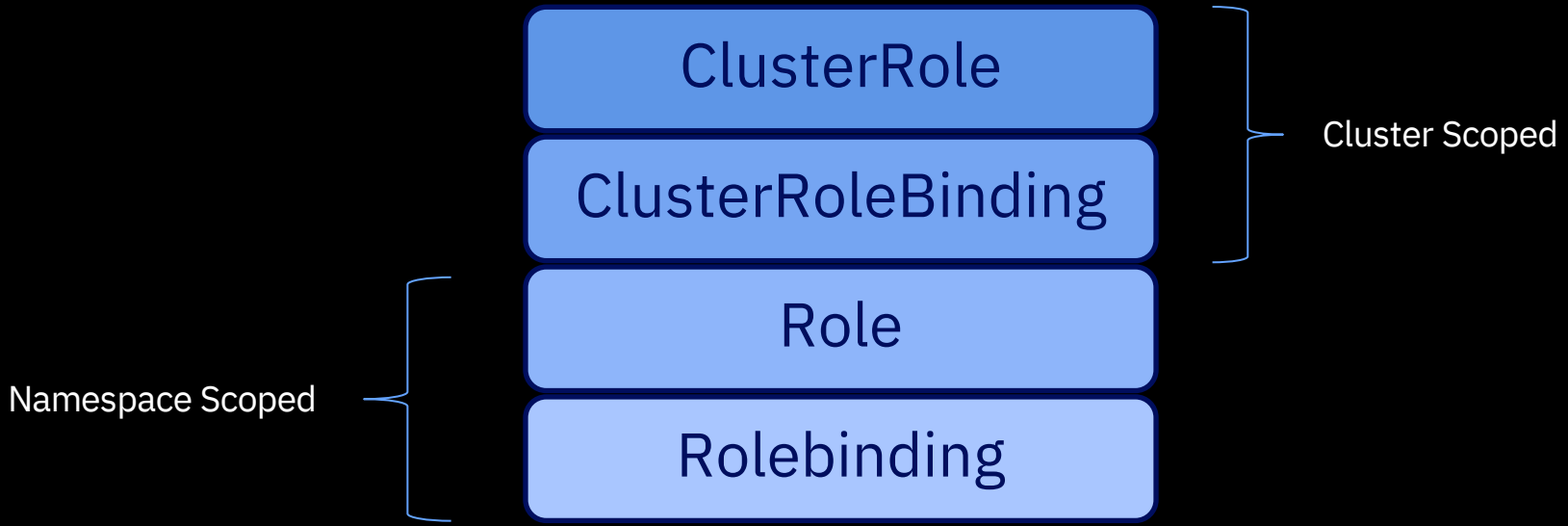


OpenShift Security
- Role Based Access Control (RBAC)

- Project scope & cluster scope available
- Matches request attributes (verb,object,etc)
- If no roles match, request is denied (deny by default)
- Operator- and user-level roles are defined by default
- Custom roles are supported



OpenShift Security
- Role Based Access Control (RBAC)



OpenShift Security
- Role Based Access Control (RBAC)

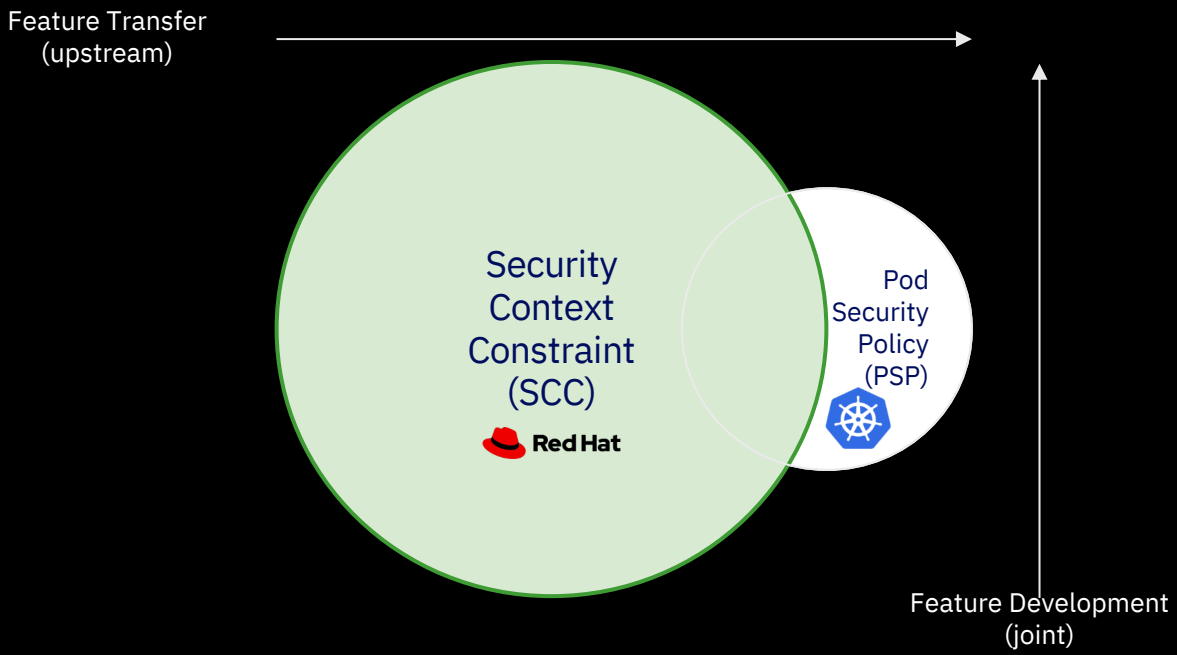
Default Cluster Role	Description
admin	A project manager. If used in a local binding, an admin has rights to view any resource in the project and modify any resource in the project except for quota.
basic-user	A user that can get basic information about projects and users.
cluster-admin	A super-user that can perform any action in any project. When bound to a user with a local binding, they have full control over quota and every action on every resource in the project.
cluster-status	A user that can get basic cluster status information.
edit	A user that can modify most objects in a project but does not have the power to view or modify roles or bindings.
self-provisioner	A user that can create their own projects.
view	A user who cannot make any modifications, but can see most objects in a project. They cannot view or modify roles or bindings.

OpenShift Security
- Security Context Constraints

SCCs allow an administrator to control:

- Whether a pod can run privileged containers.
- The capabilities that a container can request.
- The use of host directories as volumes.
- The SELinux context of the container.
- The container user ID.
- The use of host namespaces and networking.
- The allocation of an FSGroup that owns the pod's volumes.
- The configuration of allowable supplemental groups.
- Whether a container requires the use of a read only root file system.
- The usage of volume types.
- The configuration of allowable seccomp profiles.

OpenShift Security
- Security Context Constraints



OpenShift Security - etcd Encryption

When you enable etcd encryption, encryption keys are created.

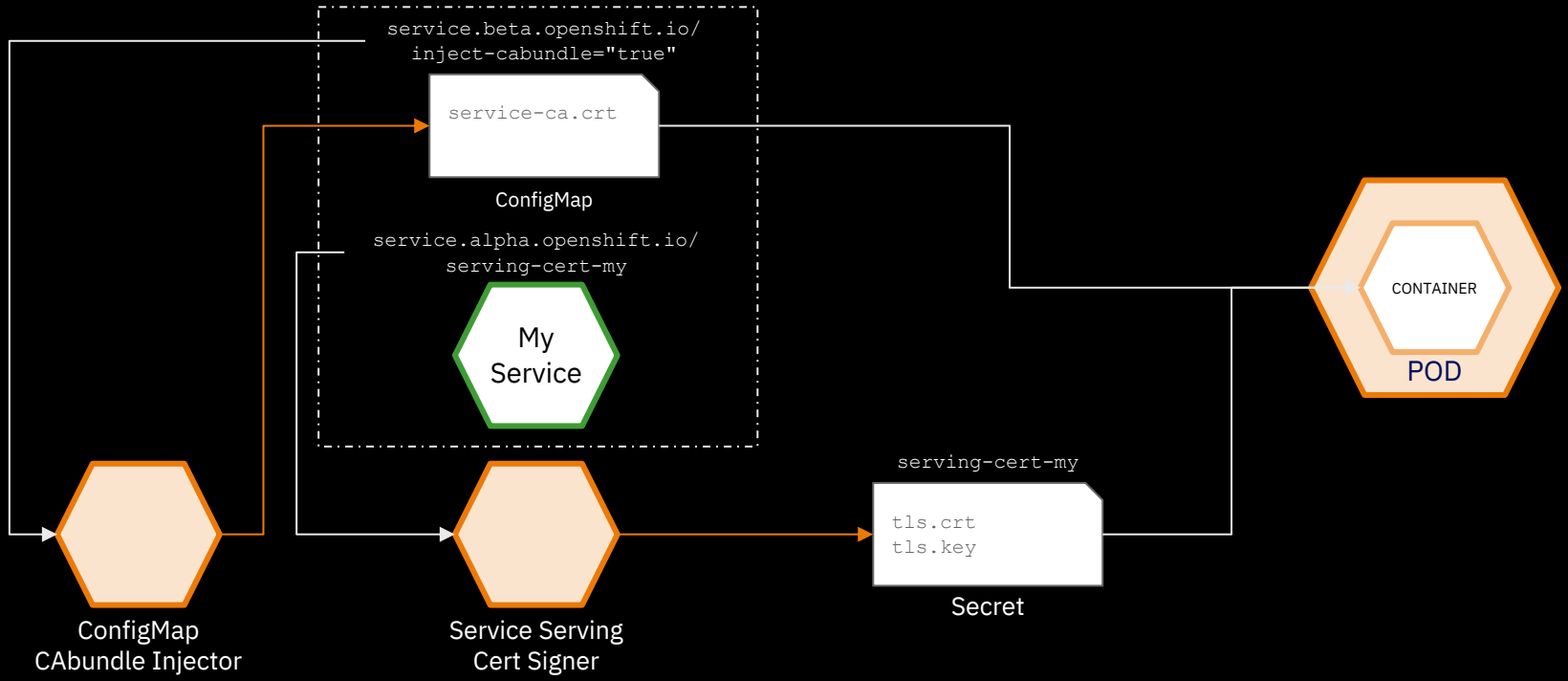
These keys are rotated on a weekly basis. You **must** have these keys in order to restore from an etcd backup.

By default, etcd data is not encrypted in OpenShift Container Platform.

When you enable etcd encryption, the following OpenShift API server and Kubernetes API server resources are encrypted:

- Secrets
- ConfigMaps
- Routes
- OAuth acce
- OAuth auth

OpenShift Security
- Service Certificates



FIPS 140-2 SECURITY CERTIFICATION

https://www.redhat.com/en/about/press-releases/red-hat-continues-drive-more-secure-enterprise-it-re-certifies-red-hat-enterprise-linux-fips-140-2

Validates Secure Design & Implementation of cryptographic modules

- Periodic re-certifications
- Removed SSL3.0
- Disabled protocols with known issues (TLS1.0, TLS1.1)
- Require secure key sizes for existing crypto systems (*RSA, DH: 2048+ bit keys*)
- Provide only secure protocols (TLS1.2, TLS1.3, SSH2, IKEv2)

OpenShift DNS

Built-in internal DNS to reach services by name

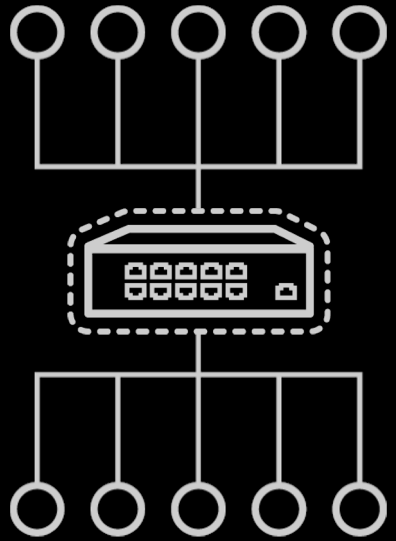
Split DNS is supported via DNSmasq

- Master answers DNS queries for internal services
- Other name servers serve the rest of the queries

You can use DNS forwarding to override the forwarding configuration identified in `etc/resolv.conf` on a per-zone basis by specifying which name server should be used for a given zone.

```
my-svc.my-namespace.svc.cluster.local
```

The DNS Operator deploys and manages CoreDNS to provide a name resolution service to pods, enabling DNS-based Kubernetes Service discovery in OpenShift.



OpenShift Security
- Network Security

A network policy is a specification of how groups of pods are allowed to communicate with each other and other network endpoints.

A default installation of OpenShift allows all pods to communicate with all other pods in the system - there is no pre-defined network segregation unless you select the multitenant mode

```
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: front-allow
  namespace: development
spec:
  podSelector:
    matchLabels:
      role: backend
      app: my-app
  policyTypes:
  - Ingress
  ingress:
  - from:
    - podSelector:
        matchLabels:
          role: webfront
          app: my-app
    ports:
    - protocol: TCP
      port: 3306
```

OpenShift Security - Network Security

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: test-network-policy
  namespace: default
spec:
  podSelector:
    matchLabels:
      role: db
  policyTypes:
  - Ingress
  - Egress
  ingress:
  - from:
    - ipBlock:
        cidr: 172.17.0.0/16
        except:
        - 172.17.1.0/24
    - namespaceSelector:
        matchLabels:
          project: myproject
    - podSelector:
        matchLabels:
          role: frontend
    ports:
    - protocol: TCP
      port: 6379
  egress:
  - to:
    - ipBlock:
        cidr: 10.0.0.0/24
    ports:
    - protocol: TCP
      port: 5978
```

podSelector: Each NetworkPolicy includes a podSelector which selects the grouping of pods to which the policy applies. The example policy selects pods with the label “role=db”. An empty podSelector selects all pods in the namespace.

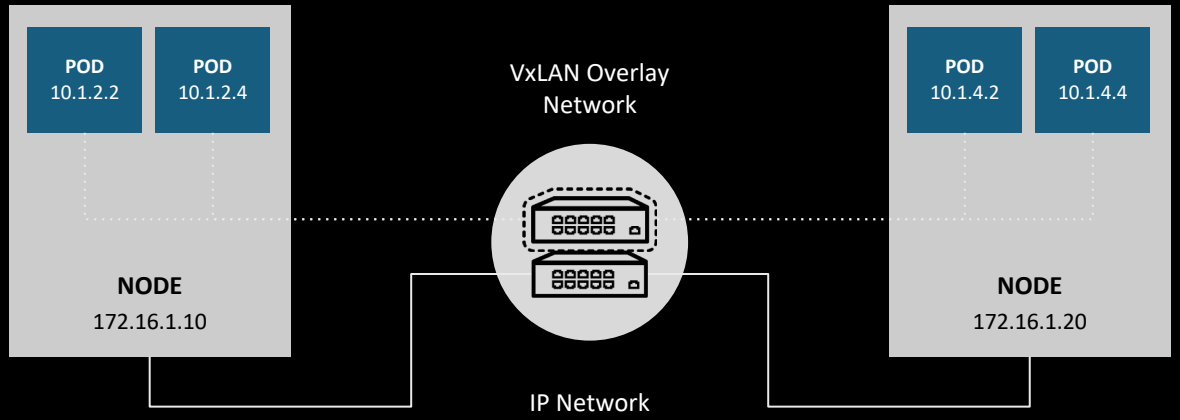
policyTypes: Each NetworkPolicy includes a policyTypes list which may include either Ingress, Egress, or both. The policyTypes field indicates whether or not the given policy applies to ingress traffic to selected pod, egress traffic from selected pods, or both. If no policyTypes are specified on a NetworkPolicy then by default Ingress will always be set and Egress will be set if the NetworkPolicy has any egress rules.

ingress: Each NetworkPolicy may include a list of whitelist ingress rules. Each rule allows traffic which matches both the from and ports sections. The example policy contains a single rule, which matches traffic on a single port, from one of three sources, the first specified via an ipBlock, the second via a namespaceSelector and the third via a podSelector.

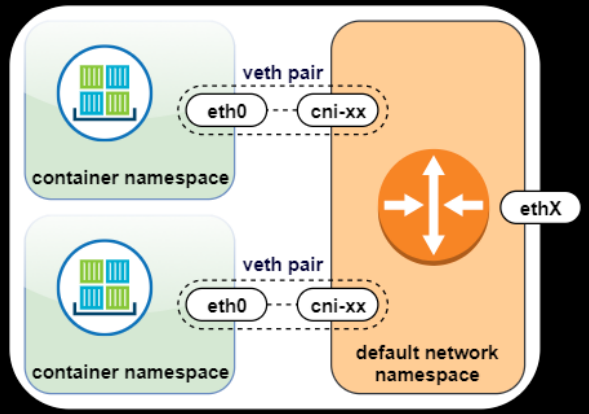
egress: Each NetworkPolicy may include a list of whitelist egress rules. Each rule allows traffic which matches both the to and ports sections. The example policy contains a single rule, which matches traffic on a single port to any destination in 10.0.0.0/24.

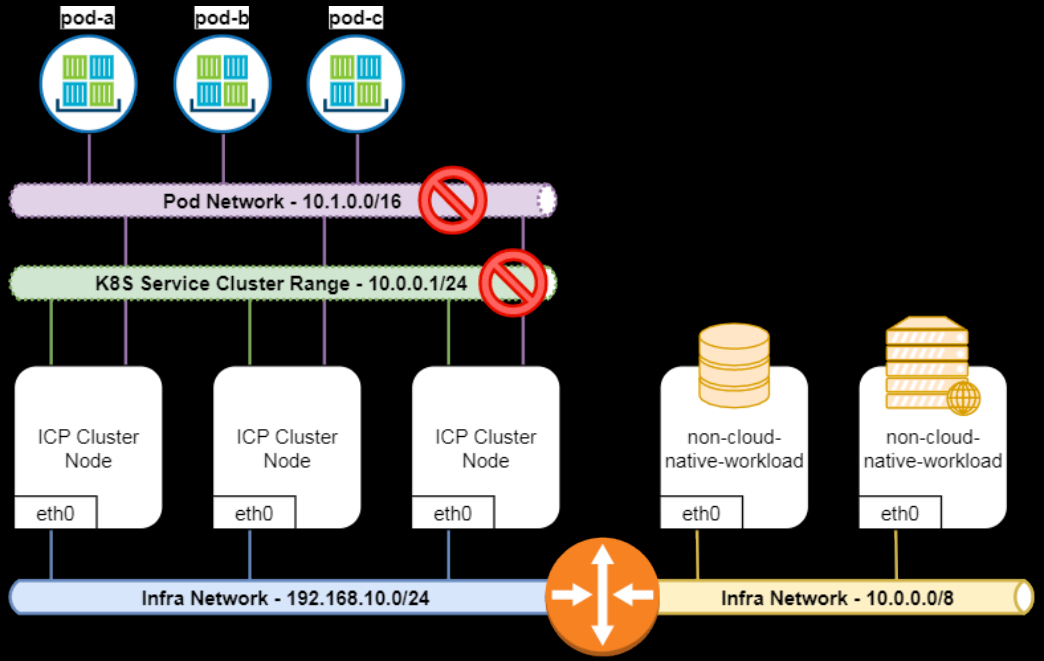
OpenShift Networking

OpenShift Networking



OpenShift Networking





OpenShift Networking
- OpenShift SDN

OpenShift uses software-defined-networking approach for a unified cluster network

Enables pod-to-pod communication

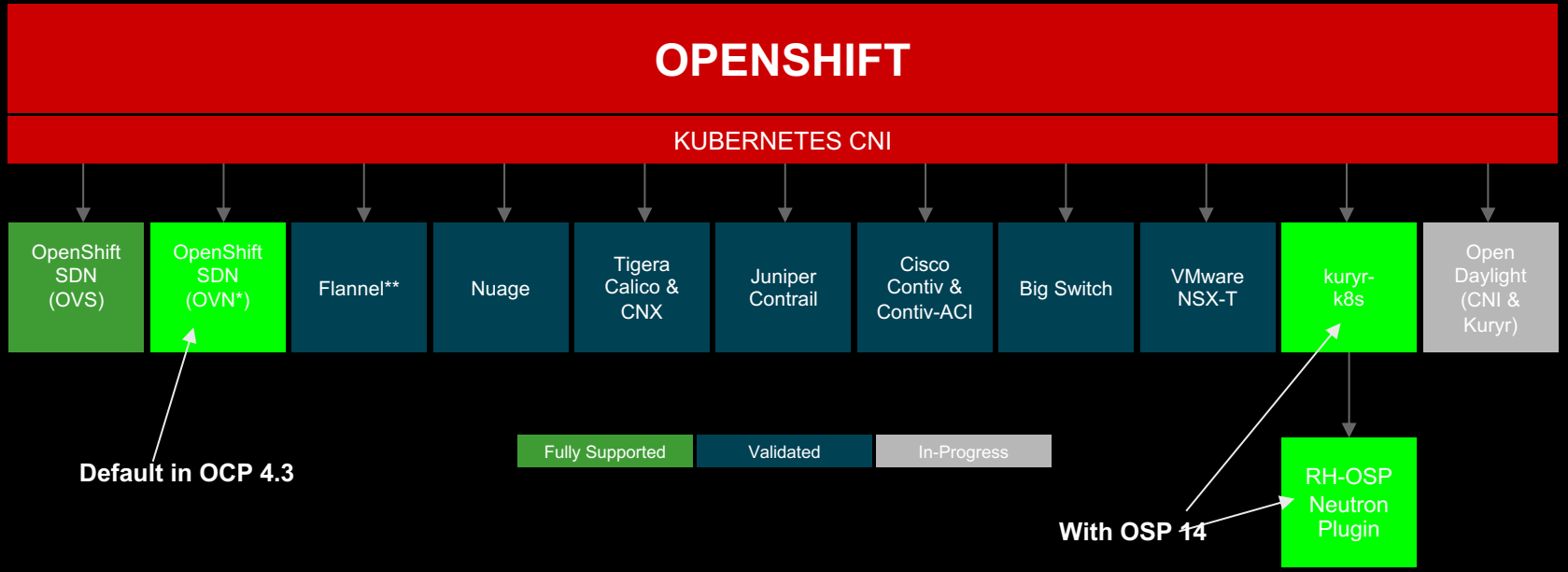
OpenShift SDN is the default

3 modes:

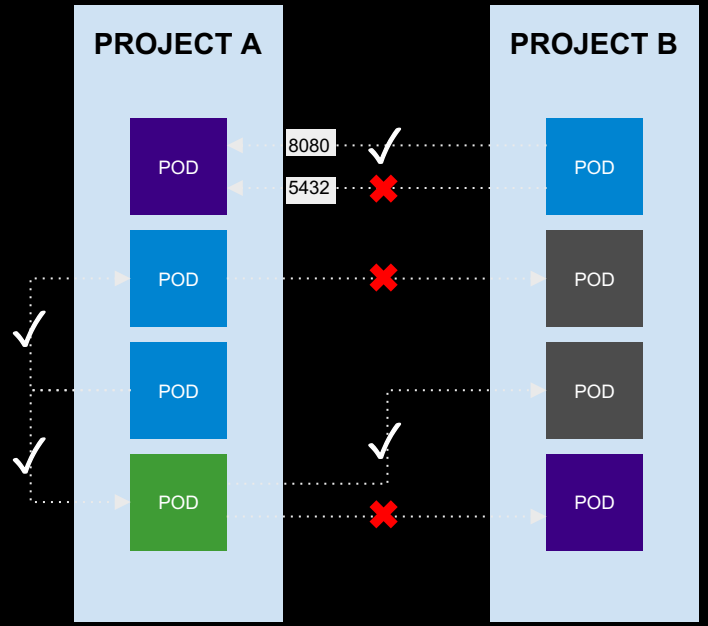
- NetworkPolicy
- Multitenant
- Subnet

Governed by the Cluster Network Operator (CNO)

OpenShift Networking
- Network Plugins



OpenShift Networking
- Network Policy



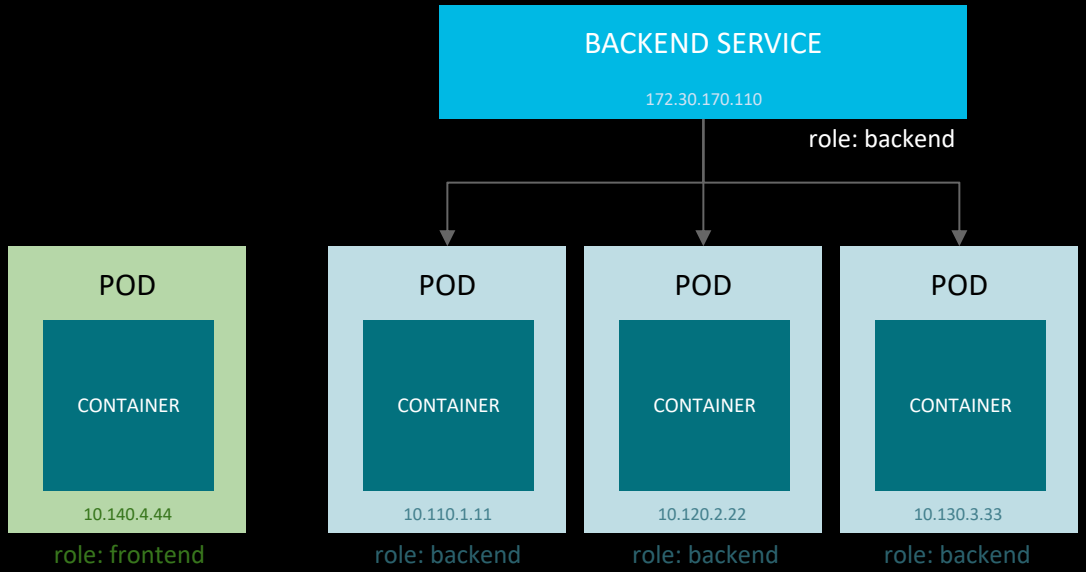
Example Policies

- 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
```

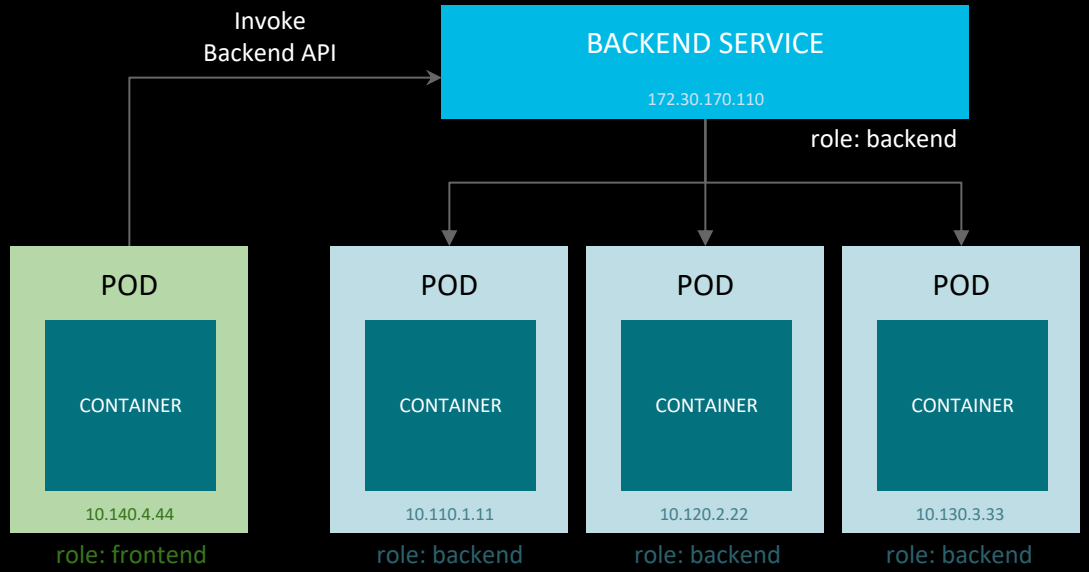
OpenShift Networking
- Services

services provide internal load-balancing and service discovery across pods



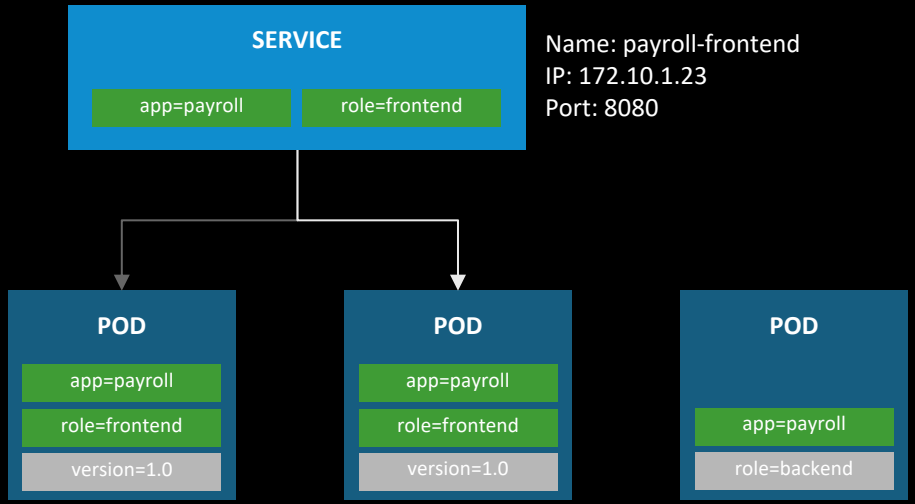
OpenShift Networking - Services

apps can talk to each other via services



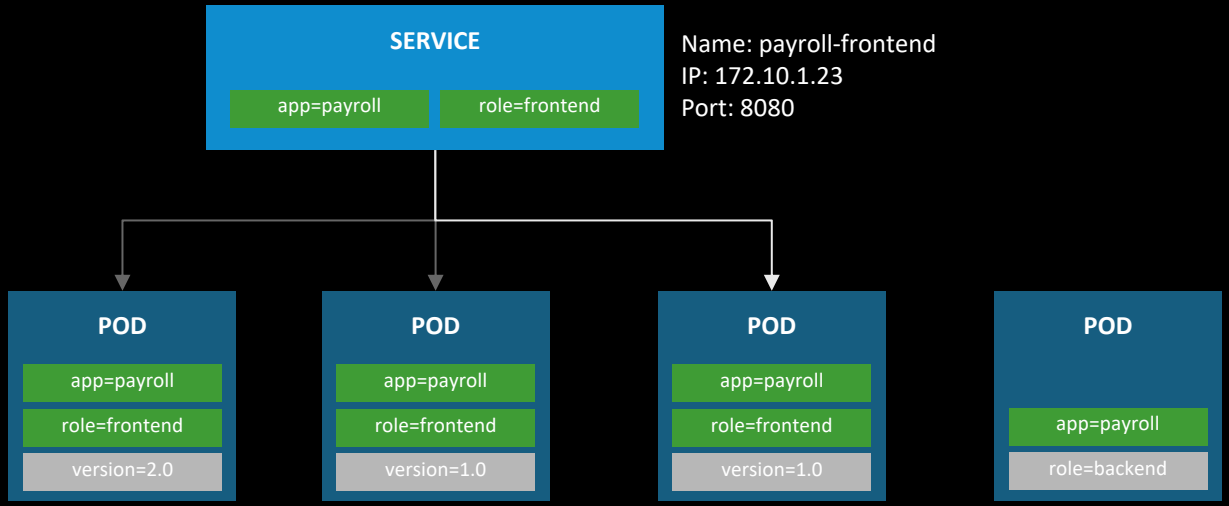
OpenShift Networking
- Service Discovery

BUILT-IN SERVICE DISCOVERY
INTERNAL LOAD-BALANCING



OpenShift Networking
- Service Discovery

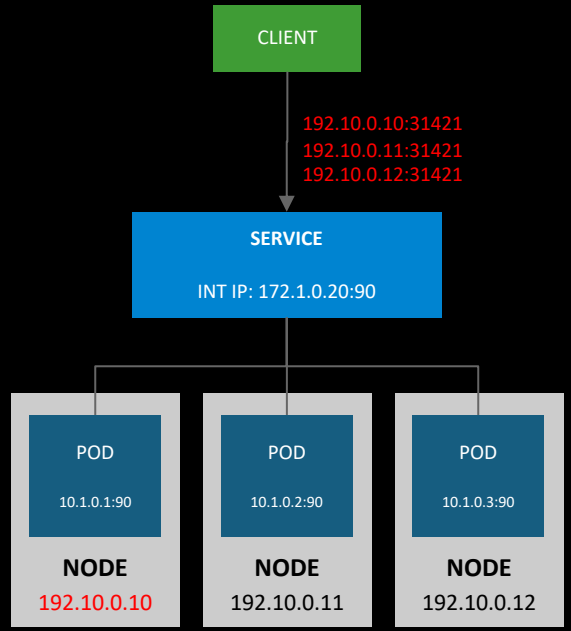
BUILT-IN SERVICE DISCOVERY
INTERNAL LOAD-BALANCING



OpenShift Networking - NodePort

EXTERNAL TRAFFIC TO A SERVICE
ON A RANDOM PORT WITH NODEPORT

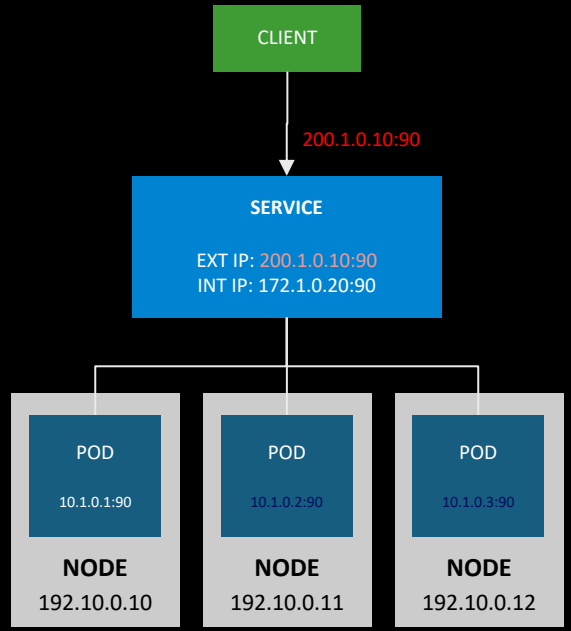
- NodePort binds a service to a unique port on all the nodes
- Traffic received on any node redirects to a node with the running service
- Ports in 30K-60K range which usually differs from the service
- Firewall rules must allow traffic to all nodes on the specific port



OpenShift Networking - External Traffic

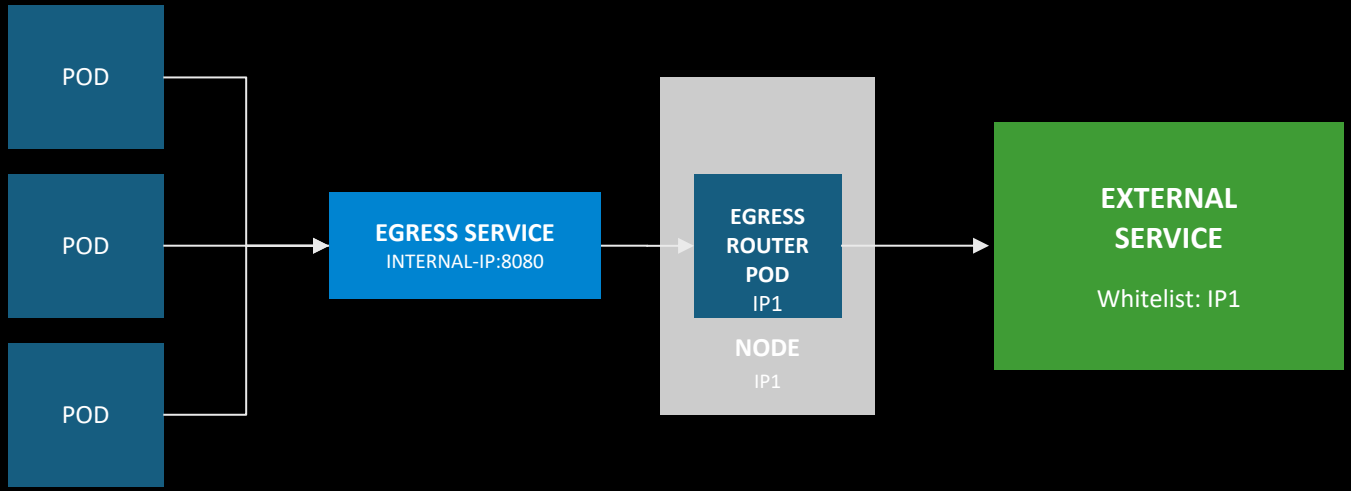
EXTERNAL TRAFFIC TO A SERVICE ON ANY PORT WITH INGRESS

- 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



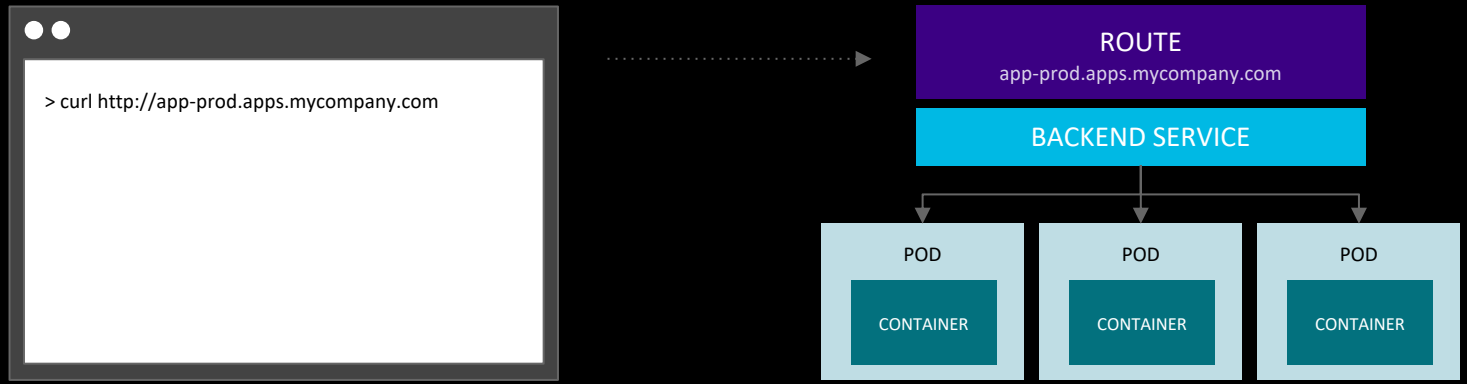
OpenShift Networking
- Egress Traffic

CONTROL OUTGOING TRAFFIC
SOURCE IP WITH EGRESS ROUTER



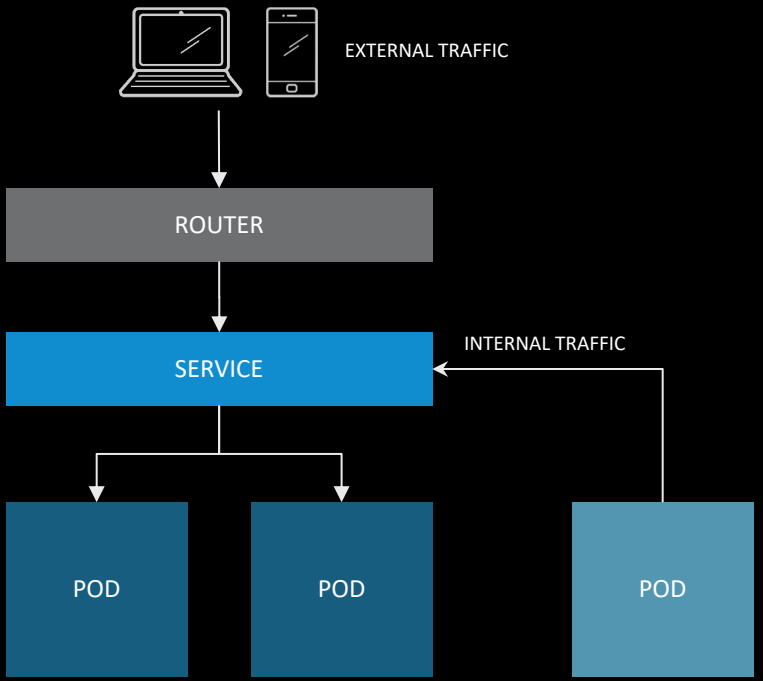
OpenShift Networking
- Routes

Routes add services to the external load-balancer and provide readable urls for the app



OpenShift Networking - Routes

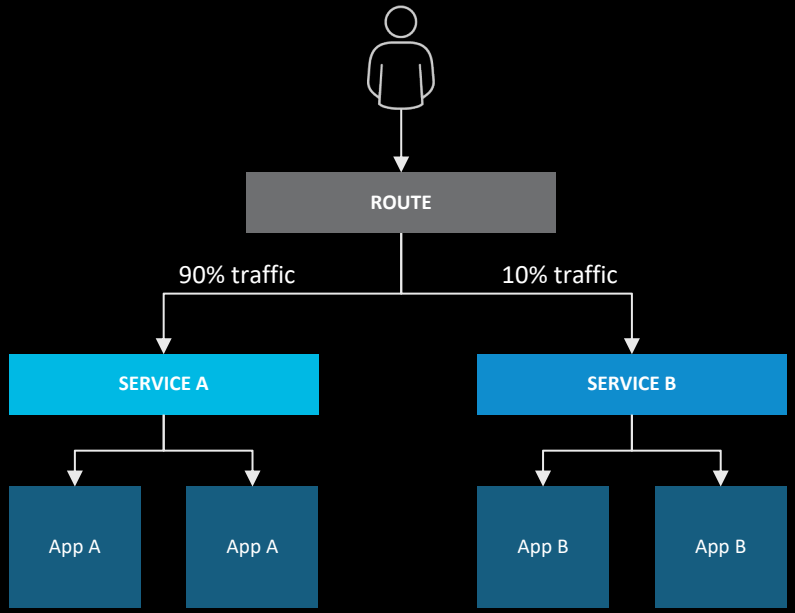
ROUTE EXPOSES SERVICES EXTERNALLY



OpenShift Networking
- Route Traffic Splitting

ROUTE SPLIT TRAFFIC

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



OpenShift Networking - Multiple Pod Networks

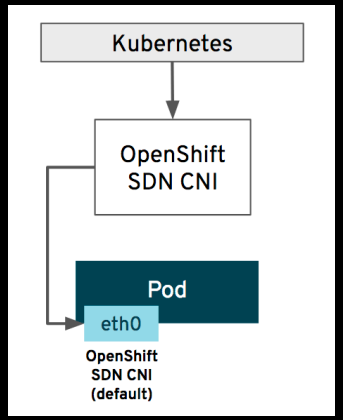
Can add multiple networks to a pod using Multus

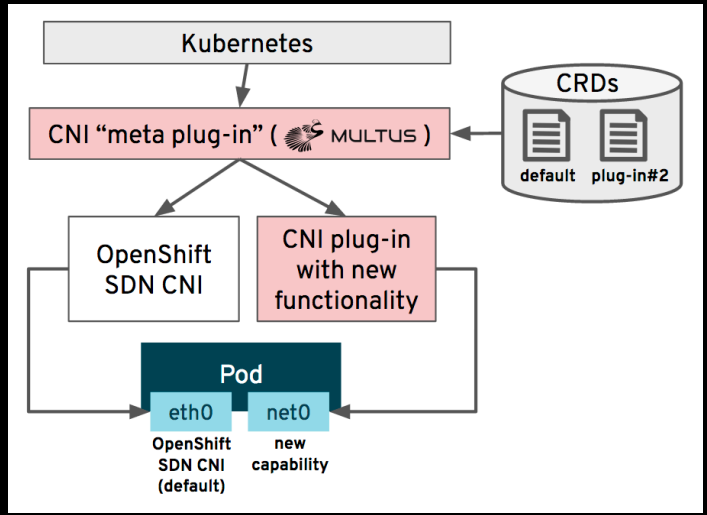
Use Cases

- Performance
- Security

Additional Networks

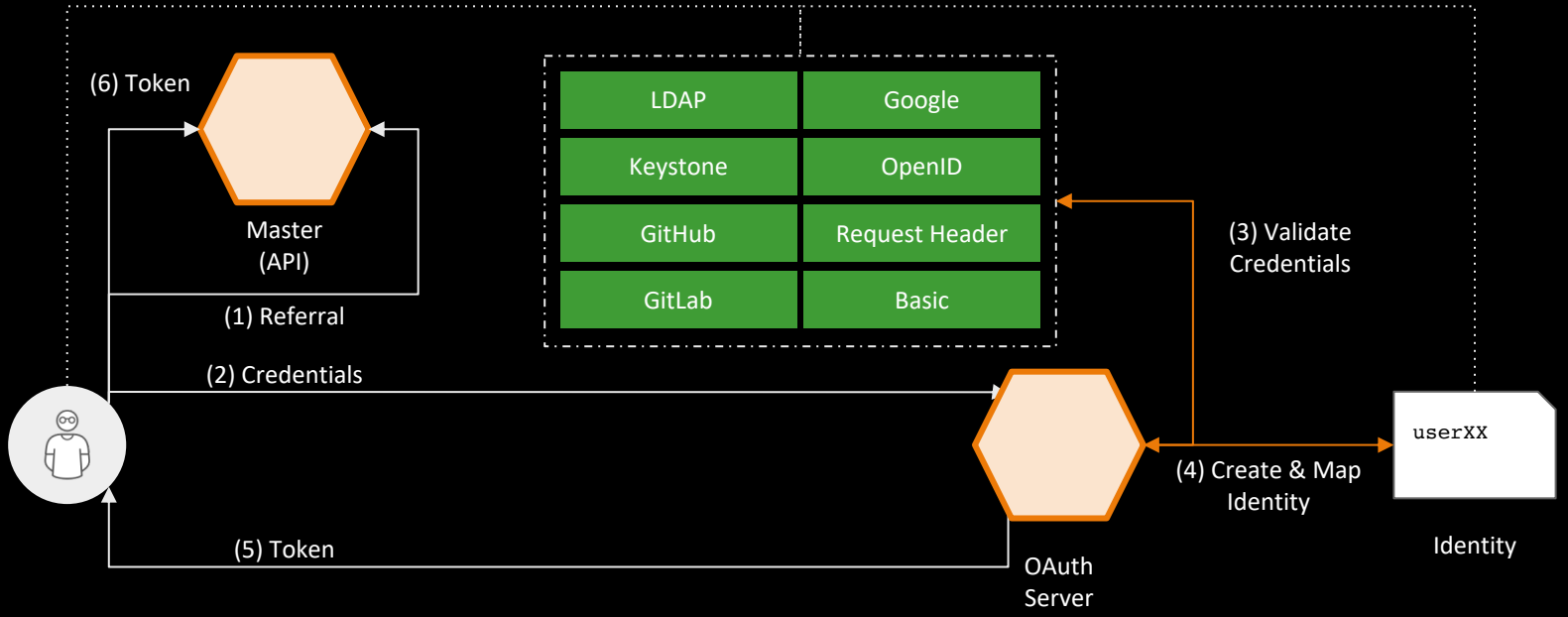
- bridge
- host-device
- macvlan
- ipvlan
- SR-IOV





OpenShift Authentication

OpenShift Authentication



OpenShift Authentication - Identity Providers

Many supported providers

Only kubeadmin exists by default, which should be removed

oAuth configuration is done by creating an oAuth Custom Resource

Identity provider	Description
HTPasswd	Configure the htpasswd identity provider to validate user names and passwords against a flat file generated using htpasswd.
Keystone	Configure the keystone identity provider to integrate your OpenShift Container Platform cluster with Keystone to enable shared authentication with an OpenStack Keystone v3 server configured to store users in an internal database.
LDAP	Configure the ldap identity provider to validate user names and passwords against an LDAPv3 server, using simple bind authentication.
Basic authentication	Configure a basic-authentication identity provider for users to log in to OpenShift Container Platform with credentials validated against a remote identity provider. Basic authentication is a generic backend integration mechanism.
Request header	Configure a request-header identity provider to identify users from request header values, such as X-Remote-User. It is typically used in combination with an authenticating proxy, which sets the request header value.
GitHub or GitHub Enterprise	Configure a github identity provider to validate user names and passwords against GitHub or GitHub Enterprise's OAuth authentication server.
GitLab	Configure a gitlab identity provider to use GitLab.com or any other GitLab instance as an identity provider.
Google	Configure a google identity provider using Google's OpenID Connect integration.
OpenID Connect	Configure an oidc identity provider to integrate with an OpenID Connect identity provider using an Authorization Code Flow.

OpenShift Storage

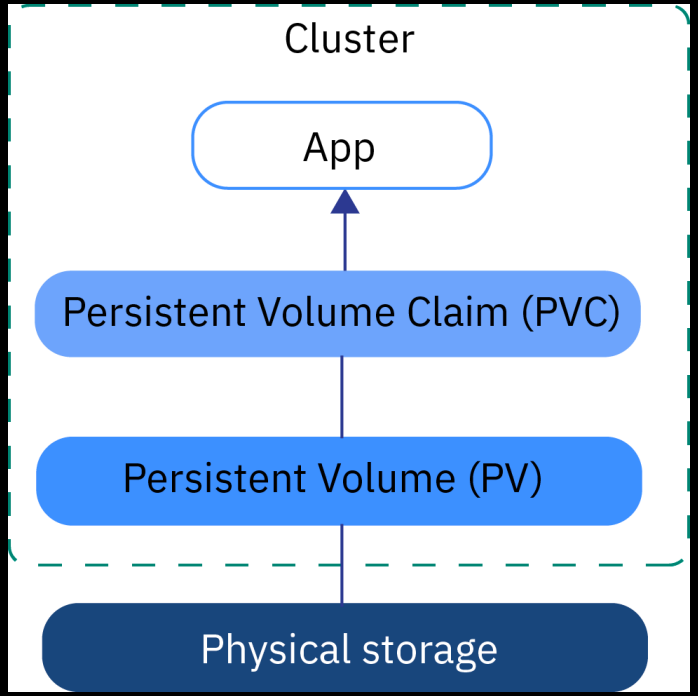
OpenShift Storage

OpenShift leverages Kubernetes Persistent Volumes

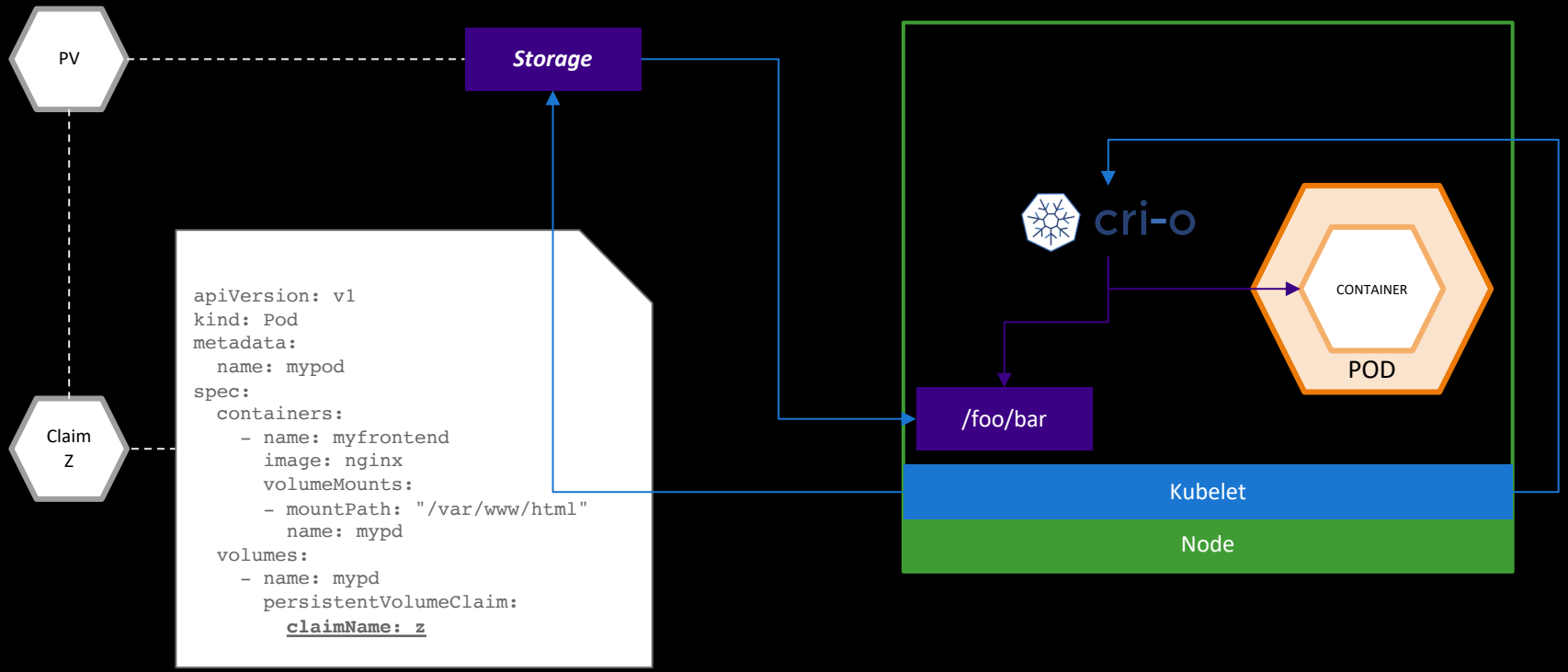
Persistent Volume (PV) is a piece of storage, provisioned by an administrator or dynamically provisioned using Storage Classes

Persistent Volume Claim (PVC) is a claim for that storage by a user

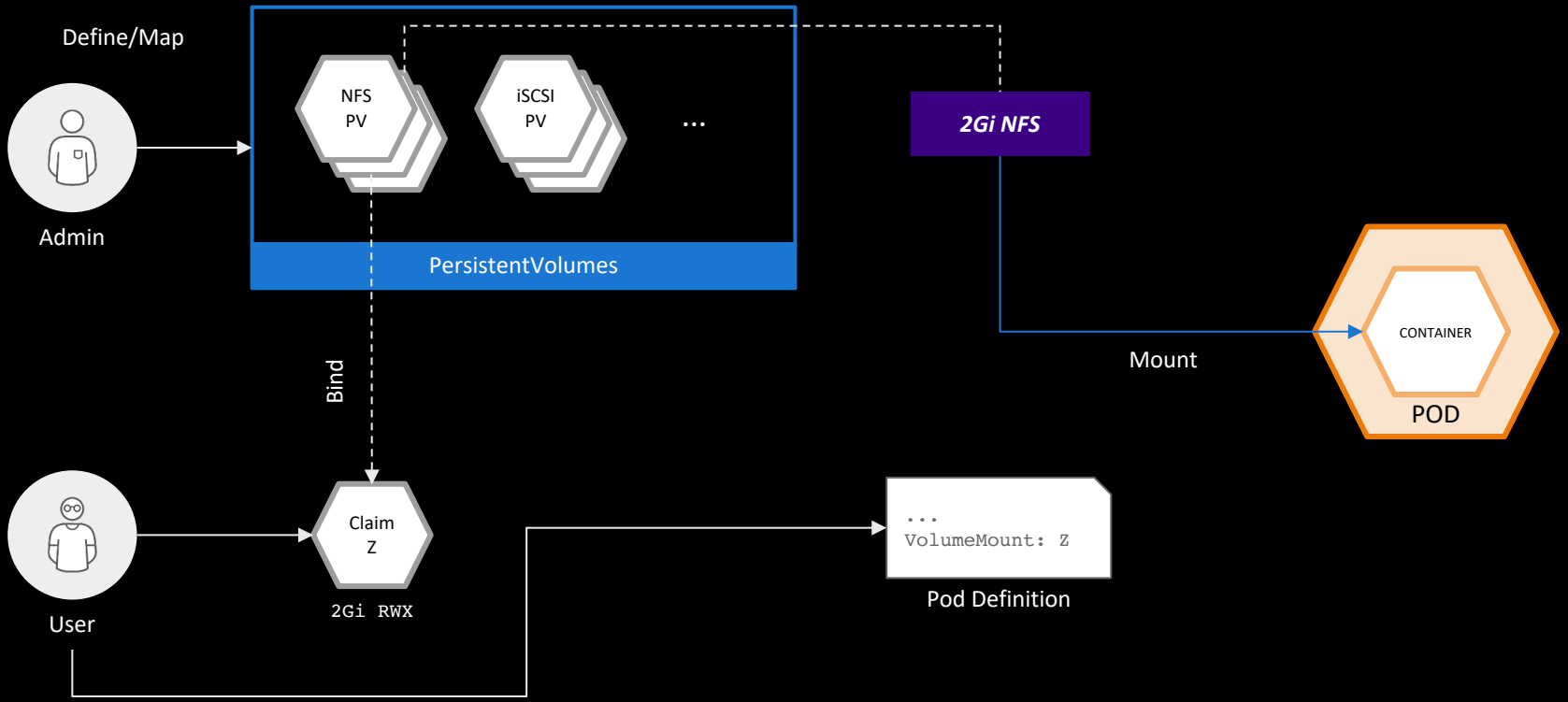
Storage Classes (SC) allow allocating storage technologies and dynamic provisioning



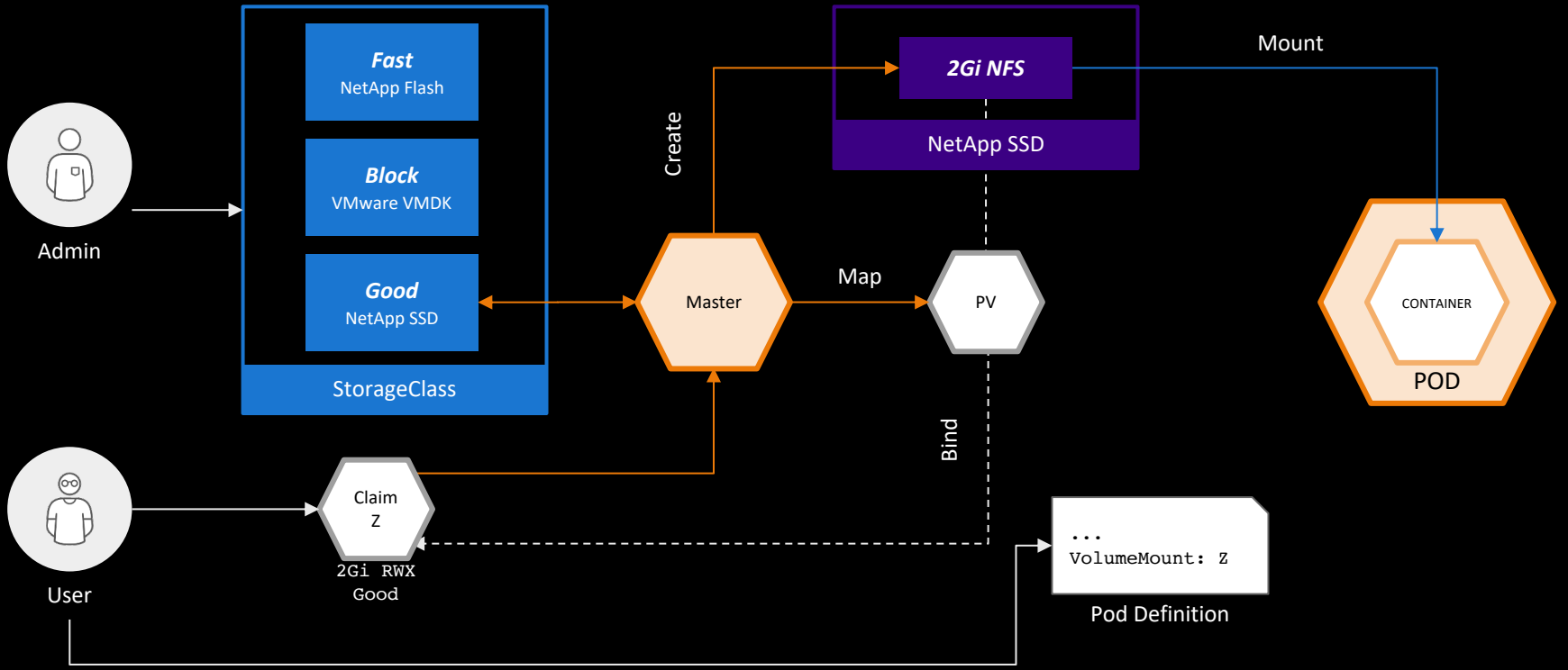
OpenShift Storage - PV Consumption



OpenShift Storage
- Static Volume Provisioning



OpenShift Storage
- Dynamic Provisioning



OpenShift Storage
- Supported Providers

Volume Plug-in	ReadWriteOnce	ReadOnlyMany	ReadWriteMany
AWS EBS	✅	-	-
Azure File	✅	✅	✅
Azure Disk	✅	-	-
Cinder	✅	-	-
Fibre Channel	✅	✅	-
GCE Persistent Disk	✅	-	-
HostPath	✅	-	-
iSCSI	✅	✅	-
Local volume	✅	-	-
NFS	✅	✅	✅
Red Hat OpenShift Container Storage	✅	-	✅
VMware vSphere	✅	-	-

Machine Config Operator

Provides node lifecycle management

Orchestrate updates

Consists of three main components

- **machine-config-controller -** coordinates machine upgrades from the control plane
- **machine-config-daemon** - runs on each node in the cluster and updates a machine to configuration defined by MachineConfig
- **machine-config-server** - provides the Ignition config files to master nodes as they join the cluster.

Machines and MachineSets

The Machine API is a combination of primary resources that are based on the upstream Cluster API project and custom OpenShift Container Platform resources.

Machines

A fundamental unit that describes the host for a Node. A machine has a providerSpec, which describes the types of compute nodes that are offered for different cloud platforms.

MachineSets

Groups of machines. MachineSets are to machines as ReplicaSets are to Pods. If you need more machines or must scale them down, you change the **replicas** field on the MachineSet to meet your compute need.

NOT CURRENTLY USED IN VMWARE

Cluster Autoscaler

Adjusts the size of an OpenShift Container Platform cluster to meet its current deployment needs

It uses declarative, Kubernetes-style arguments to provide infrastructure management

ClusterAutoscaler **increases** the size of the cluster when there are Pods that failed to schedule on any of the current nodes due to insufficient resources or when another node is necessary to meet deployment needs

ClusterAutoscaler **decreases** the size of the cluster when some nodes are consistently not needed for a significant period, such as when it has low resource use and all of its important Pods can fit on other nodes.

OpenShift Installation

OpenShift Installation

OPENSHIFT CONTAINER PLATFORM

Full Stack Automated

Simplified opinionated "Best Practices" for cluster provisioning

Fully automated installation and updates including host container OS.

Red Hat Enterprise Linux CoreOS

Pre-existing Infrastructure

Customer managed resources & infrastructure provisioning

Plug into existing DNS and security boundaries

Red Hat Enterprise Linux CoreOS

Red Hat Enterprise Linux

HOSTED OPENSHIFT

Azure Red Hat OpenShift

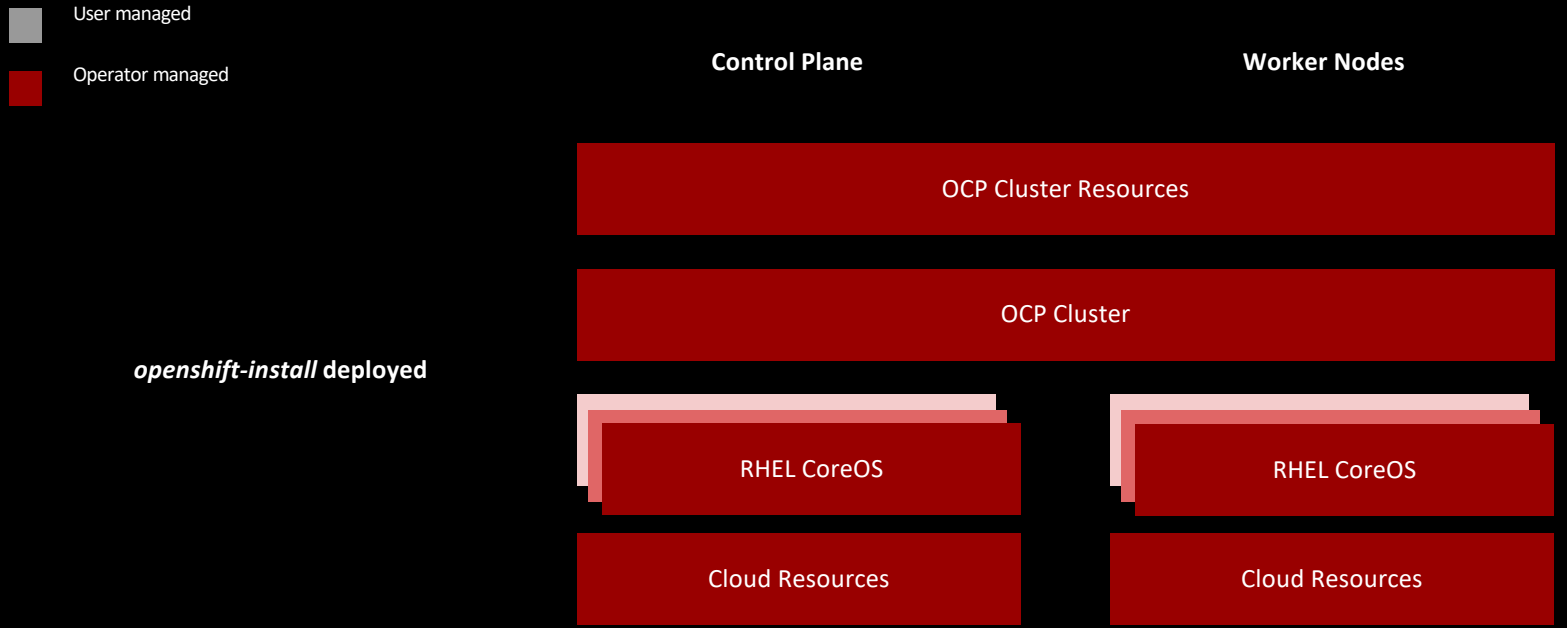
Deploy directly from the Azure console. Jointly managed by Red Hat and Microsoft Azure engineers.

OpenShift Dedicated

Get a powerful cluster, fully
Managed by Red Hat engineers and support.

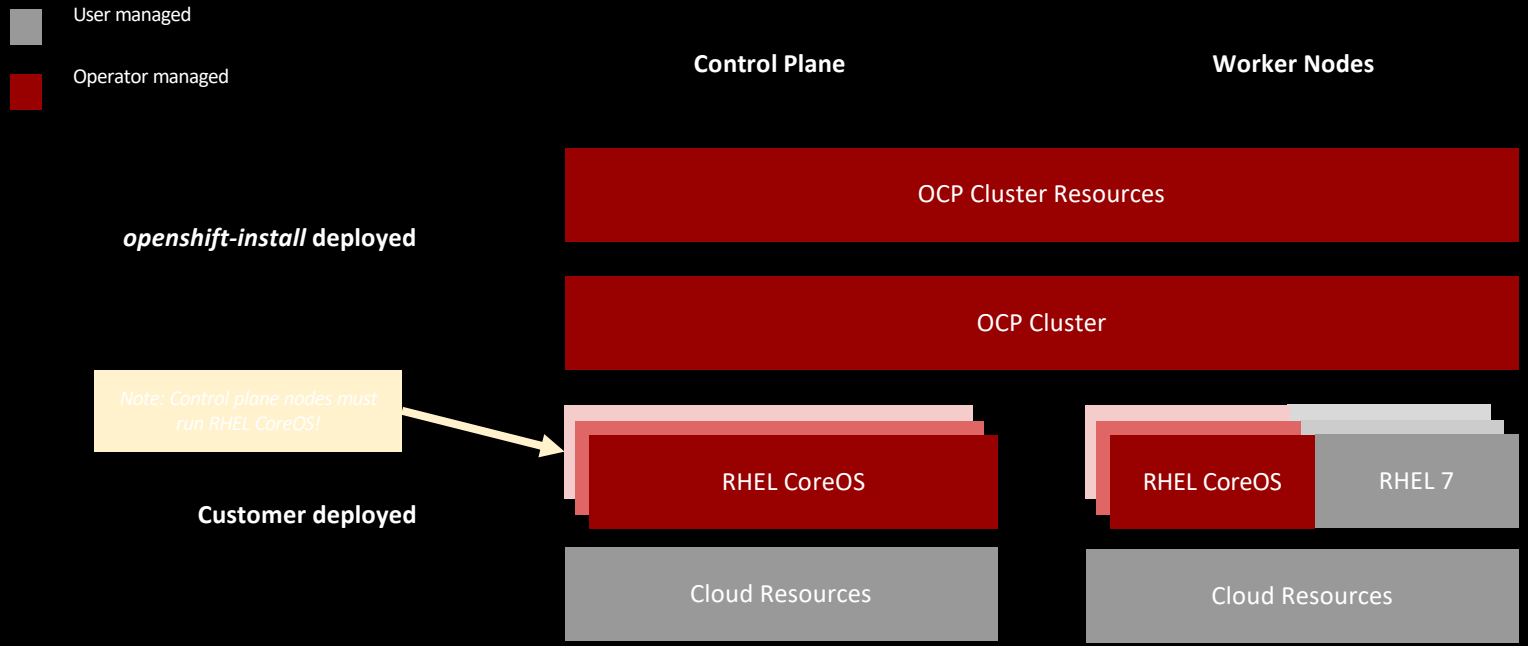
OpenShift Installation - Installation Methods

Full-stack Automated Installation



OpenShift Installation
- Installation Methods

Pre-existing Infrastructure Installation



OpenShift Installation
- Comparison of Paradigms

	Full Stack Automation	Pre-existing Infrastructure
Build Network	Installer	User
Setup Load Balancers	Installer	User
Configure DNS	Installer	User
Hardware/VM Provisioning	Installer	User
OS Installation	Installer	User
Generate Ignition Configs	Installer	Installer
OS Support	Installer: RHEL CoreOS	User: RHEL CoreOS + RHEL 7
Node Provisioning / Autoscaling	Yes	Only for providers with OpenShift Machine API support

OpenShift Installation
- Resource Requirements

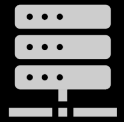
Machine	Operating System	vCPU	RAM	Storage
Bootstrap	RHCOS	4	16 GB	120 GB
Control plane	RHCOS	4	16 GB	120 GB
Compute	RHCOS or RHEL 7.6	2	8 GB	120 GB

Not sized for additional management services!

OpenShift Installation - Pre-requisites

Ignition Webserver

DNS



DHCP

Load Balancer

Internet

Docs

Infrastructure

OpenShift Installation

OpenShift Bootstrap Process: Self-Managed Kubernetes

How to boot a self-managed cluster:

- OpenShift 4 is unique in that management extends all the way down to the operating system
- Every machine boots with a configuration that references resources hosted in the cluster it joins enabling cluster to manage itself
- Downside is that every machine looking to join the cluster is waiting on the cluster to be created
- Dependency loop is broken using a bootstrap machine, which acts as a temporary control plane whose sole purpose is bringing up the permanent control plane nodes
- Permanent control plane nodes get booted and join the cluster leveraging the control plane on the bootstrap machine
- Once the pivot to the permanent control plane takes place, the remaining worker nodes can be booted and join the cluster

Bootstrapping process step by step:

- Bootstrap machine boots and starts hosting the remote resources required for master machines to boot.
- Master machines fetch the remote resources from the bootstrap machine and finish booting.
- Master machines use the bootstrap node to form an etcd cluster.
- Bootstrap node starts a temporary Kubernetes control plane using the newly-created etcd cluster.
- Temporary control plane schedules the production control plane to the master machines.
- Temporary control plane shuts down, yielding to the production control plane.
- Bootstrap node injects OpenShift-specific components into the newly formed control plane.
- Installer then tears down the bootstrap node or if user-provisioned, this needs to be performed by the administrator.

OpenShift Installation

1. Configure DHCP

All the Red Hat Enterprise Linux CoreOS (RHCOS) machines require network in initramfs during boot to fetch Ignition config from the Machine Config Server.

During the initial boot, the machines require a DHCP server in order to establish a network connection, which allows them to download their Ignition config files.

What if I use static/pre-defined IPs?

Still need DHCP.

OpenShift Installation

2. Configure DNS

Component	Record	Description
Kubernetes API	api.<cluster_name>.<base_domain>	This DNS record must point to the load balancer for the control plane machines. This record must be resolvable by both clients external to the cluster and from all the nodes within the cluster.
	api-int.<cluster_name>.<base_domain>	This DNS record must point to the load balancer for the control plane machines. This record must be resolvable from all the nodes within the cluster. The API server must be able to resolve the worker nodes by the host names that are recorded in Kubernetes. If it cannot resolve the node names, proxied API calls can fail, and you cannot retrieve logs from Pods.
Routes	*.apps.<cluster_name>.<base_domain>	A wildcard DNS record that points to the load balancer that targets the machines that run the Ingress router pods, which are the worker nodes by default. This record must be resolvable by both clients external to the cluster and from all the nodes within the cluster.
etcd	etcd-<index>.<cluster_name>.<base_domain>	OpenShift Container Platform requires DNS records for each etcd instance to point to the control plane machines that host the instances. The etcd instances are differentiated by <index> values, which start with 0 and end with n-1, where n is the number of control plane machines in the cluster. The DNS record must resolve to an unicast IPv4 address for the control plane machine, and the records must be resolvable from all the nodes in the cluster.
	_etcd-server-ssl._tcp.<cluster_name>.<base_domain>	For each control plane machine, OpenShift Container Platform also requires a SRV DNS record for etcd server on that machine with priority 0, weight 10 and port 2380. A cluster that uses three control plane machines requires the following records: # _service._proto.name. TTL class SRV priority weight port target. _etcd-server-ssl._tcp.<cluster_name>.<base_domain> 86400 IN SRV 0 10 2380 etcd-0.<cluster_name>.<base_domain>. _etcd-server-ssl._tcp.<cluster_name>.<base_domain> 86400 IN SRV 0 10 2380 etcd-1.<cluster_name>.<base_domain>. _etcd-server-ssl._tcp.<cluster_name>.<base_domain> 86400 IN SRV 0 10 2380 etcd-2.<cluster_name>.<base_domain>.

OpenShift Installation

3. Configure Load Balancer

Port	Machines	Internal	External	Description
`6443`	Bootstrap and control plane. You remove the bootstrap machine from the load balancer after the bootstrap machine initializes the cluster control plane.	x	x	Kubernetes API server
`22623`	Bootstrap and control plane. You remove the bootstrap machine from the load balancer after the bootstrap machine initializes the cluster control plane.	x		Machine Config server
`443`	The machines that run the Ingress router pods, compute, or worker, by default.	x	x	HTTPS traffic
`80`	The machines that run the Ingress router pods, compute, or worker by default.	x	x	HTTP traffic

OpenShift Installation

4. Generate SSH Keys

1. If you do not have an SSH key that is configured for password-less authentication on your computer, create one. For example, on a computer that uses a Linux operating system, run the following command:

```
$ ssh-keygen -t rsa -b 4096 -N '' \
    -f <path>/<file_name> (1)
```

2. Start the **`ssh-agent`** process as a background task:

```
$ eval "$(ssh-agent -s)"

Agent pid 31874
```

3. Add your SSH private key to the **`ssh-agent`**:

```
$ ssh-add <path>/<file_name> (1)

Identity added: /home/<you>/<path>/<file_name> (<computer_name>)
```

OpenShift Installation

5. Get the openshift-install tool

https://cloud.redhat.com/openshift/install

OpenShift Installation

6. Edit the install-config.yaml

```
apiVersion: v1
baseDomain: openshift.cloud.lab.com
compute:
- hyperthreading: Enabled
  name: worker
  replicas: 0
controlPlane:
  hyperthreading: Enabled
  name: master
  replicas: 3
metadata:
  name: ocp4
platform:
  vsphere:
    vcenter: 9.180.210.21
    username: Administrator@isstlab.org
    password: Passw0rd!
    datacenter: clod-fondly
    defaultDatastore: cluster02
pullSecret: '{"auths":{"mirror-registry.openshift.cloud.lab.com:5001":{"auth": "YWRtaW47YWMjAxOQ==","email": "admin@isstlab.com"}}}'
sshKey: 'ssh-rsa …dK8Fpb8i1wdpQ== root@lf-ocp-boot'
```

https://docs.openshift.com/container-platform/4.2/installing/installing_vsphere/installing-vsphere.html#installation-initializing-manual_installing-vsphere

OpenShift Installation

7. Create manifests and ignition files

$ ./openshift-install create manifests --dir=<installation_directory>

Replace the masterSchedulable flag from from true to false in cluster-scheduler-02-config.yml

$ sed -i '' s/'mastersSchedulable: true'/'mastersSchedulable: false'/g manifests/cluster-scheduler-02-config.yml

$ ./openshift-install create ignition-configs --dir=<installation_directory>

```
├── auth
│   ├── kubeadmin-password
│   └── kubeconfig
├── bootstrap.ign
├── id_rsa
├── install-config.yaml
├── master.ign
├── worker.ign
├── metadata.json
```

OpenShift Installation

8. Create append-bootstrap ignition file

Upload the bootstrap Ignition config file, which is named <installation_directory>/bootstrap.ign, that the installation program created to your HTTP server. Note the URL of this file.

```
{
  "ignition": {
    "config": {
      "append": [
        {
          "source": "<bootstrap_ignition_config_url>",
          "verification": {}
        }
      ]
    },
    "timeouts": {},
    "version": "2.1.0"
  },
  "networkd": {},
  "passwd": {},
  "storage": {},
  "systemd": {}
}
```

OpenShift Installation

9. Encrypt ignition files

```
$ base64 -w0 <installation_directory>/master.ign > <installation_directory>/master.64
$ base64 -w0 <installation_directory>/worker.ign > <installation_directory>/worker.64
$ base64 -w0 <installation_directory>/append-bootstrap.ign > <installation_directory>/append-bootstrap.64
```

These will end up as the encoded ignition configuration for the RHCOS VM

OpenShift Installation

10. Upload RHCOS OVA to vSphere client

11. Create infrastructure from RHCOS template

12. Wait for bootstrap to complete

$ ./openshift-install --dir=<installation_directory> wait-for bootstrap-complete --log-level=info

INFO Waiting up to 30m0s for the Kubernetes API at https://api.test.example.com:6443...
INFO API v1.14.6+c4799753c up
INFO Waiting up to 30m0s for the bootstrap-complete event...

After bootstrap process is complete, remove the bootstrap machine from the load balancer.

13. Check Operator status

$ export KUBECONFIG=<installation_directory>/auth/kubeconfig

$ watch -n5 oc get clusteroperators

```
NAME                       VERSION  AVAILABLE  PROGRESSING  DEGRADED  SINCE
authentication             4.2.0    True       False        False     69s
cloud-credential           4.2.0    True       False        False     12m
cluster-autoscaler         4.2.0    True       False        False     11m
console                    4.2.0    True       False        False     46s
dns                        4.2.0    True       False        False     11m
```

OpenShift Installation

14. Configure Image Registry Storage

Production

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: registry
provisioner: no-provisioning
parameters:
```

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: registry
spec:
  capacity:
    storage: 100Gi
  accessModes:
  - ReadWriteMany
  nfs:
    path: /nfs/ocp4/registry
    server: nfs.ocp4.openshift.cloud.lab.com
  persistentVolumeReclaimPolicy: Retain
  storageClassName: registry
```

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  finalizers:
  - kubernetes.io/pvc-protection
  name: image-registry-storage
  namespace: openshift-image-registry
  annotations:
    imageregistry.openshift.io: "true"
spec:
  accessModes:
  - ReadWriteMany
  resources:
    requests:
      storage: 100Gi
  storageClassName: registry
```

```
$ oc patch configs.imageregistry.operator.openshift.io cluster --type merge --patch '{"spec":{"storage":{"claim":"image-registry-storage"}}}'
```

Non-production (default)

```
$ oc patch configs.imageregistry.operator.openshift.io cluster --type merge --patch '{"spec":{"storage":{"emptyDir":{}}}}'
```

OpenShift Installation

15. Wait for cluster to install

```
$ ./openshift-install --dir=<installation_directory> wait-for install-complete

INFO Waiting up to 30m0s for the cluster to initialize...
```

The command succeeds when the Cluster Version Operator finishes deploying the OpenShift Container Platform cluster from Kubernetes API server.

```
$ oc get pods --all-namespaces

NAMESPACE                           NAME                                            READY       STATUS          RESTARTS          AGE
openshift-apiserver-operator        openshift-apiserver-operator-85cb746d55-zqhs8   1/1         Running         1                 9m
openshift-apiserver                 api-server-67b9g                                1/1         Running         0                 3m
openshift-apiserver                 apiserver-ljcmx                                 1/1         Running         0                 1m
openshift-apiserver                 apiserver-z25h4                                 1/1         Running         0                 2m
openshift-authentication-operator   authentication-operator-69d5d8bf84-vh2n8        1/1         Running         0                 5m
...
```

OpenShift Installation

https://github.com/ibm-cloud-architecture/refarch-privatecloud/blob/master/Install_OCP_4.x.md

OpenShift Installation Troubleshooting

Installation

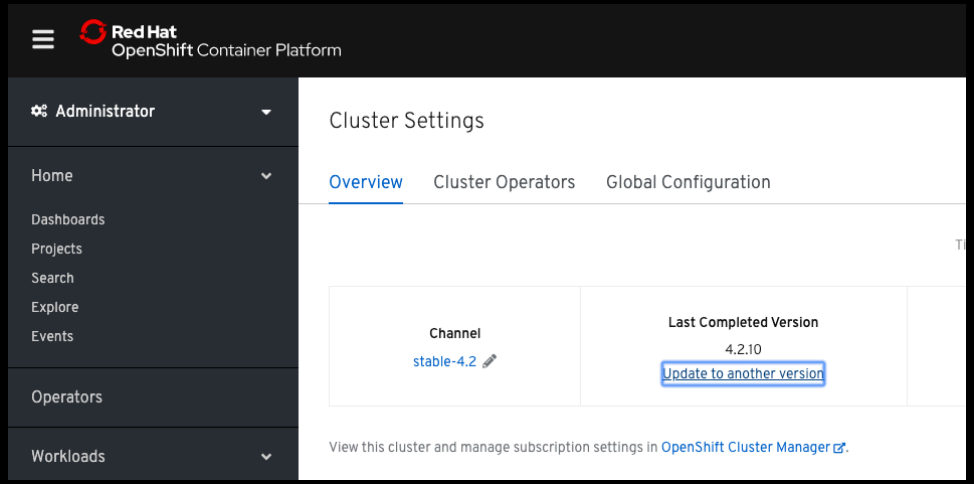
- If the bootstrap is not working properly
  - ignition config could be wrong
  - DHCPDISCOVERY not working
  - DNS not working properly
  - Check firewalls
- If using a mirror-registry (air-gapped) make sure you've extracted the correct openshift-install tool
- If control-plane/compute nodes are not working
  - If nodes cannot pull ignition config?
    - bootstrap is probably not working
    - Check LB is working and routing traffic correctly
  - If nodes cannot resolve DNS names... check DNS entries are correct

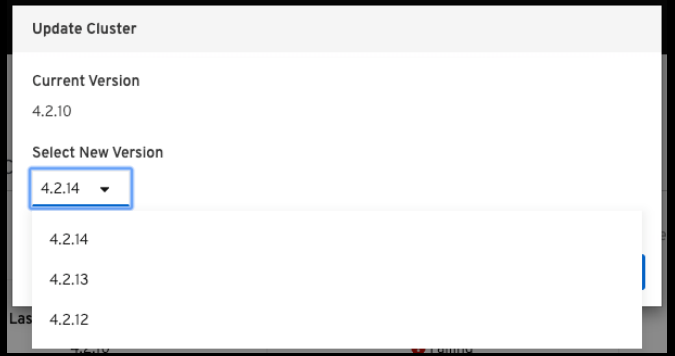
Day 2 Operations

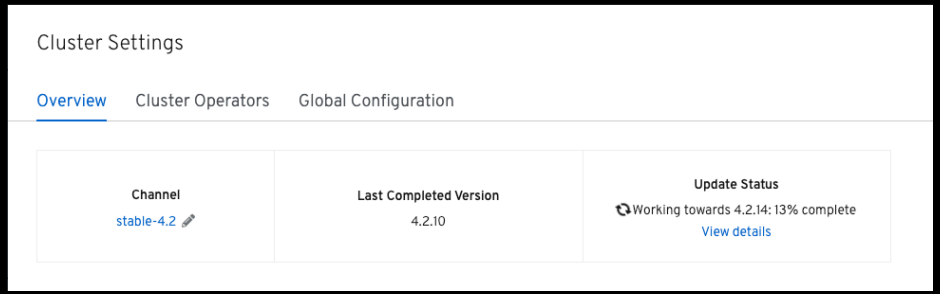
Day 2 Operations

- Cluster Updates
- OpenShift Cluster Logging
- OpenShift Cluster Monitoring
- Adding/Removing nodes
- Node maintenance

Day 2 Operations
- Cluster updates



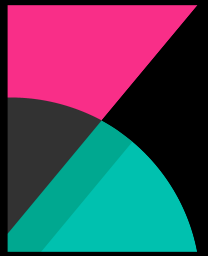




Day 2 Operations - Cluster Logging

Log data storage via **ElasticSearch**

Log collection by **Fluentd**



Log visualisation by **Kibana**

Day 2 Operations
- Cluster Logging

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.

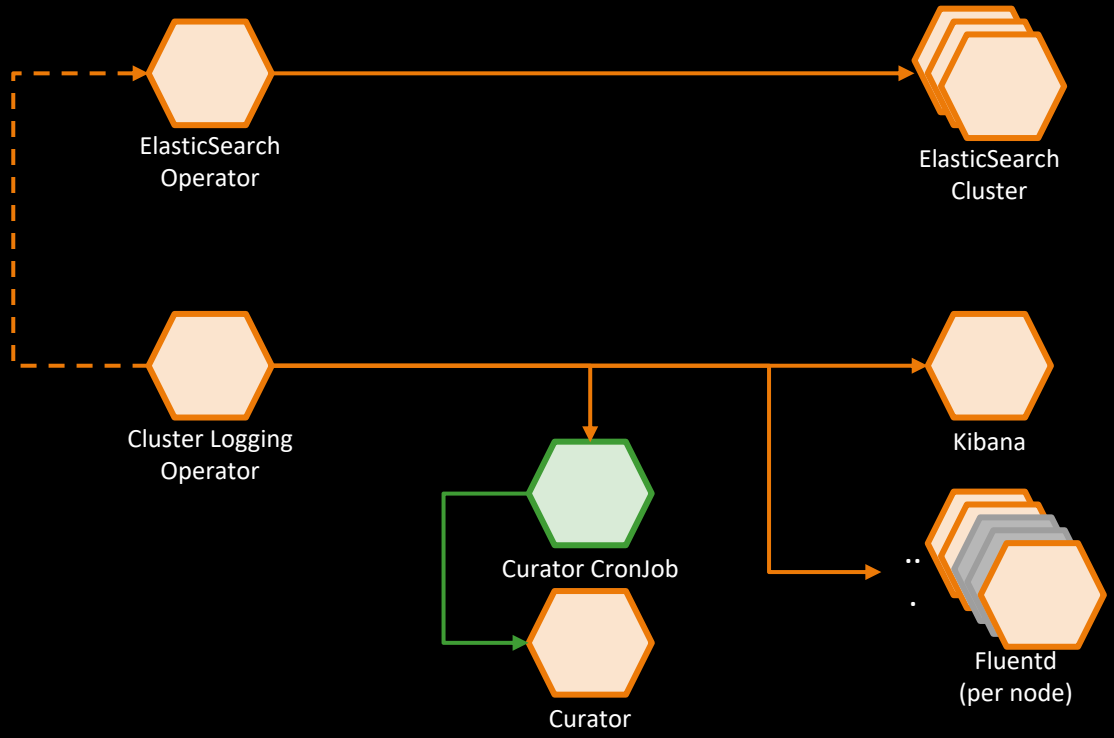
Access control

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

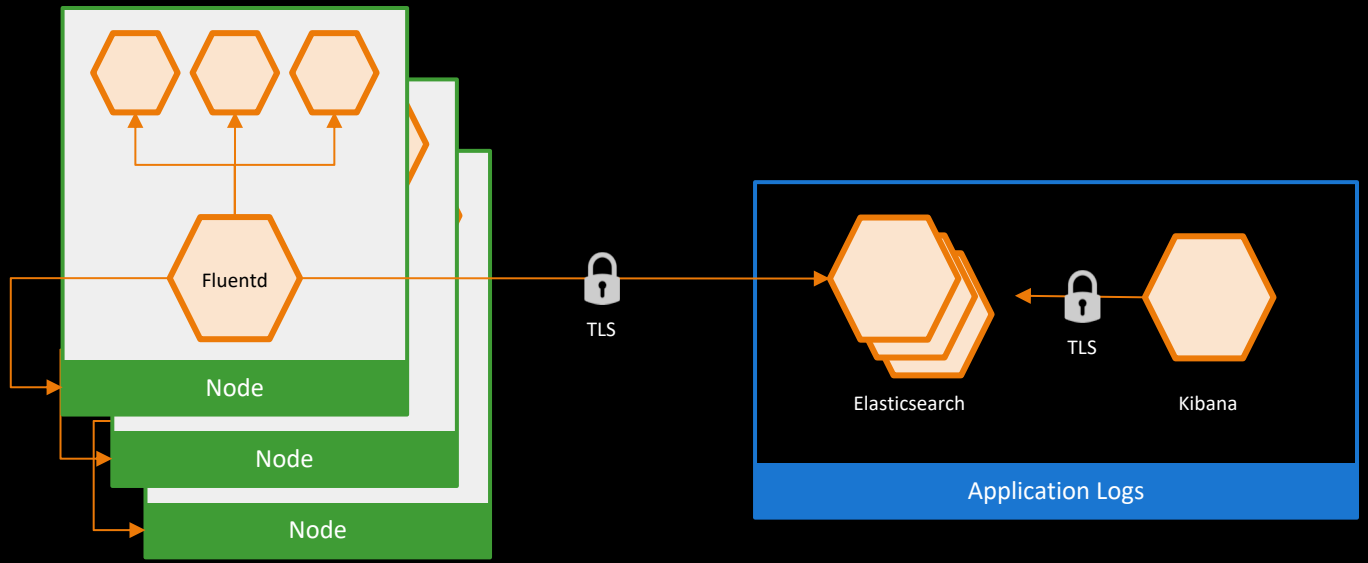
Ability to forward logs elsewhere

- External elasticsearch, Splunk, etc

Day 2 Operations
- Cluster Logging

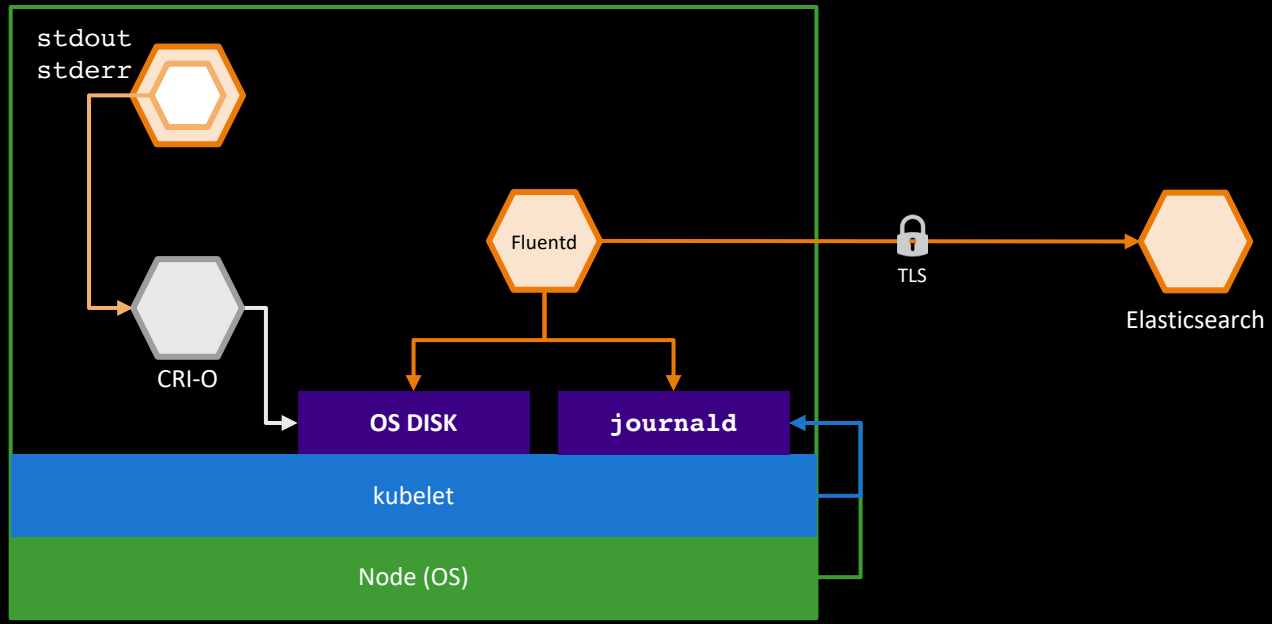


Day 2 Operations
- Cluster Logging



Day 2 Operations - Cluster Logging

Log data flow



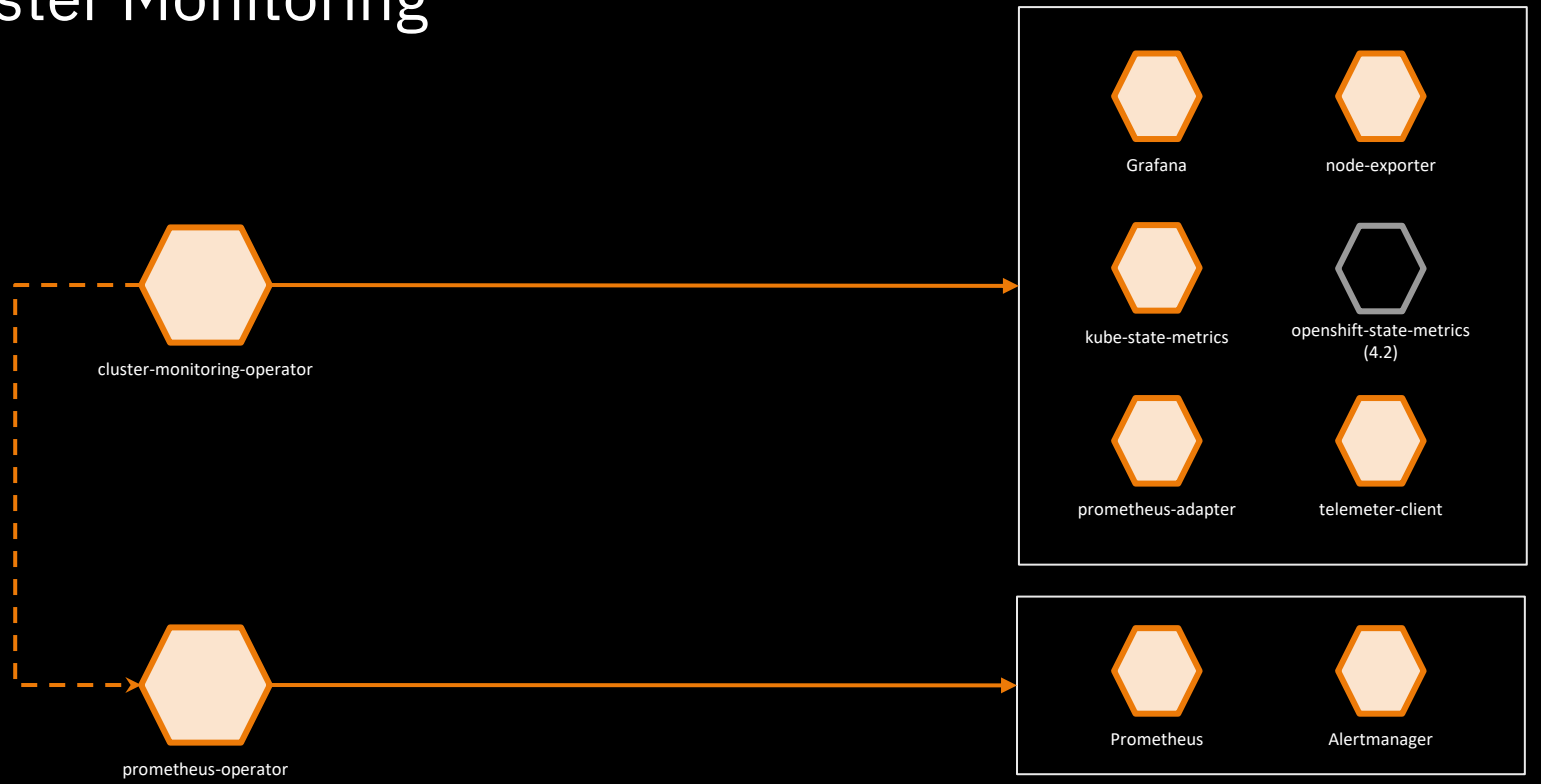
Day 2 Operations
- Cluster Monitoring

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

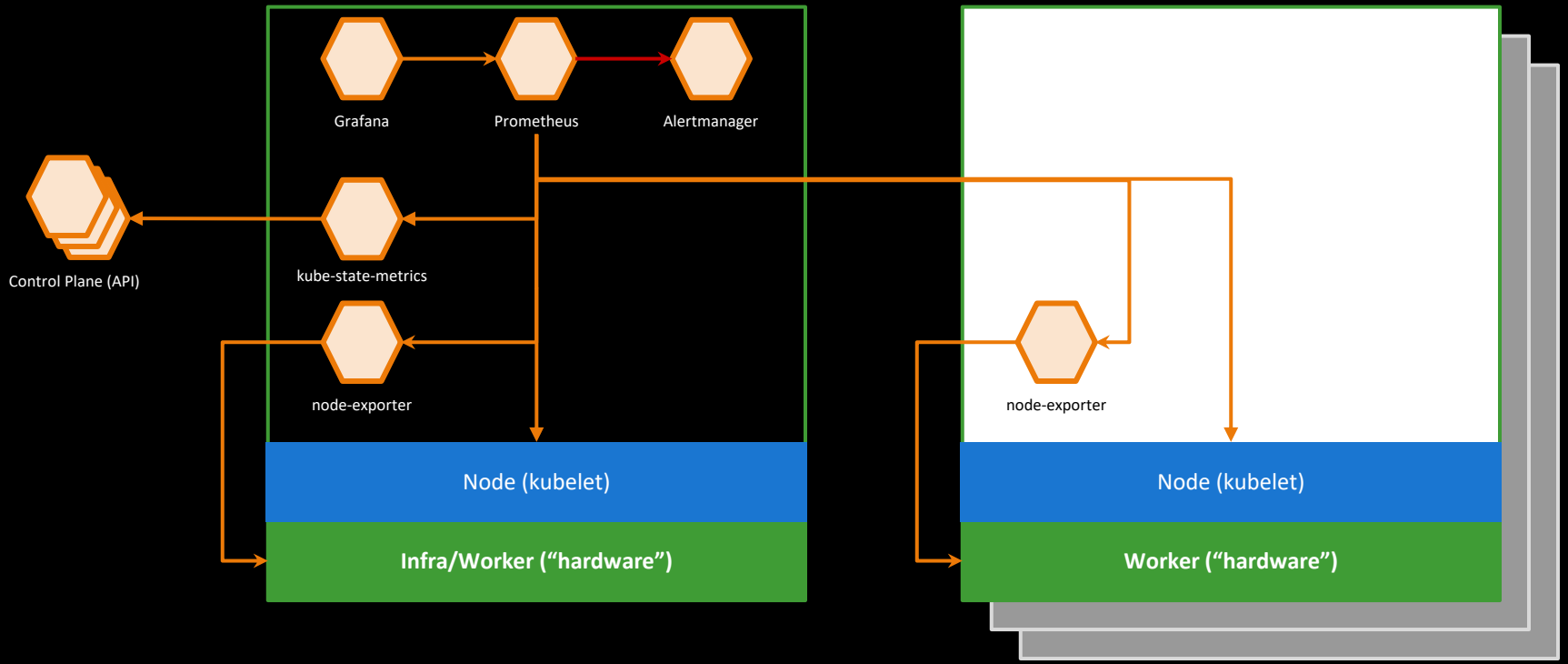
Alerting/notification via Prometheus' Alertmanager, an open-source tool that handles alerts send by Prometheus.

Metrics visualization via Grafana, the leading metrics visualization technology.

Day 2 Operations
- Cluster Monitoring



Day 2 Operations
- Cluster Monitoring



Day 2 Operations
- Adding/Removing nodes

Add Node

1. Deploy new worker node using worker ignition config
2. Accept the CSRs in OpenShift (`oc adm certificate approve <csr-name>`)
3. Node joins the cluster

Remove Node

1. Get the machine

```
$ oc get machine -n openshift-machine-api
```

2. Delete the machine

```
$ oc delete <machine> -n openshift-machine-api
```

3. Delete the VM

Day 2 Operations
- Node maintenance

What node maintenance?

Day 2 Operations
- Debugging nodes

As an Administrator, you have access to commands to debug CoreOS nodes

```
[root@ocp4-inf ~]# oc debug node/worker4.ocp4.os.fyre.ibm.com
Starting pod/worker4ocp4osfyreibmcom-debug ...
To use host binaries, run `chroot /host`
Pod IP: 10.16.18.130
If you don't see a command prompt, try pressing enter.
sh-4.2# chroot /host
sh-4.4# whoami
root
sh-4.4# systemctl status crio
● crio.service - Open Container Initiative Daemon
   Loaded: loaded (/usr/lib/systemd/system/crio.service; disabled; vendor preset: disabled)
  Drop-In: /etc/systemd/system/crio.service.d
           └─10-default-env.conf
   Active: active (running) since Tue 2020-06-23 18:36:21 UTC; 2 days ago
     Docs: https://github.com/cri-o/cri-o
 Main PID: 1327 (crio)
    Tasks: 30
   Memory: 1.6G
      CPU: 7h 1min 9.720s
   CGroup: /system.slice/crio.service
           └─1327 /usr/bin/crio --enable-metrics=true --metrics-port=9537
```