



PRODUCT DOCUMENTATION

# Pivotal Container Service (PKS)

Version 1.2

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## Pivotal Container Service (PKS)

Page last updated:

Pivotal Container Service (PKS) enables operators to provision, operate, and manage enterprise-grade Kubernetes clusters using BOSH and Pivotal Ops Manager.

## Overview

PKS uses the [On-Demand Broker](#) to deploy [Cloud Foundry Container Runtime](#), a BOSH release that offers a uniform way to instantiate, deploy, and manage highly available Kubernetes clusters on a cloud platform using BOSH.

After operators install the PKS tile on the Ops Manager Installation Dashboard, developers can provision Kubernetes clusters using the PKS Command Line Interface (PKS CLI), and run container-based workloads on the clusters with the Kubernetes CLI, [kubectl](#).

PKS is available as part of [Pivotal Cloud Foundry](#) or as a stand-alone product.

## What PKS Adds to Kubernetes

The following table details the features that PKS adds to the Kubernetes platform.

Feature	Included in K8s	Included in PKS
Single tenant ingress	✓	✓
Secure multi-tenant ingress		✓
Stateful sets of pods	✓	✓
Multi-container pods	✓	✓
Rolling upgrades to pods	✓	✓
Rolling upgrades to cluster infrastructure		✓
Pod scaling and high availability	✓	✓
Cluster provisioning and scaling		✓
Monitoring and recovery of cluster VMs and processes		✓
Persistent disks	✓	✓
Secure container registry		✓
Embedded, hardened operating system		✓

## Features

PKS has the following features:

- **Kubernetes compatibility:** Constant compatibility with current stable release of Kubernetes
- **Production-ready:** Highly available from applications to infrastructure, with no single points of failure
- **BOSH advantages:** Built-in health checks, scaling, auto-healing and rolling upgrades
- **Fully automated operations:** Fully automated deploy, scale, patch, and upgrade experience
- **Multi-cloud:** Consistent operational experience across multiple clouds
- **GCP APIs access:** The Google Cloud Platform (GCP) Service Broker gives applications access to the Google Cloud APIs, and Google Container Engine (GKE) consistency enables the transfer of workloads from or to GCP

On vSphere, PKS supports deploying and running Kubernetes clusters in air-gapped environments.

## PKS Components

The PKS control plane contains the following components:

- An [On-Demand Broker](#) that deploys [Cloud Foundry Container Runtime](#) (CFCR), an open-source project that provides a solution for deploying and managing [Kubernetes](#) clusters using [BOSH](#).
- A Service Adapter
- The PKS API

For more information about the PKS control plane, see [PKS Cluster Management](#).

For a detailed list of components and supported versions by a particular PKS release, see the [PKS Release Notes](#).

## PKS Concepts

For conceptual information about PKS, see [PKS Concepts](#).

## PKS Prerequisites

For information about the resource requirements for installing PKS, see the topic that corresponds to your cloud provider:

- [vSphere Prerequisites and Resource Requirements](#)
- [vSphere with NSX-T Prerequisites and Resource Requirements](#)
- [GCP Prerequisites and Resource Requirements](#)
- [AWS Prerequisites and Resource Requirements](#)

## Preparing to Install PKS

To install PKS, you must deploy Ops Manager v2.2.3 and later or v2.3.1 and later. You use Ops Manager to install and configure PKS.

If you are installing PKS to vSphere, you can also configure integration with NSX-T and Harbor.

Consult the following table for compatibility information:

IaaS	Ops Manager v2.2.3+ or v2.3.1+	NSX-T	Harbor
vSphere	Required	Available	Available
GCP	Required	Not Available	Available
AWS	Required	Not Available	Available

For more information about compatibility and component versions, see the [PKS Release Notes](#).

For information about preparing your environment before installing PKS, see the topic that corresponds to your cloud provider:

- [vSphere](#)
- [vSphere with NSX-T Integration](#)
- [GCP](#)
- [AWS](#)

## Installing PKS

For information about installing PKS, see *Installing PKS* for your IaaS:

- [vSphere](#)
- [vSphere with NSX-T Integration](#)
- [Google Cloud Platform \(GCP\)](#)
- [Amazon Web Services \(AWS\)](#)

## Upgrading PKS

For information about upgrading the PKS tile and PKS-deployed Kubernetes clusters, see [Upgrading PKS Overview](#).

## Managing PKS

For information about configuring authentication, creating users, and managing your PKS deployment, see [Managing PKS](#).

## Using PKS

For information about using the PKS CLI to create and manage Kubernetes clusters, see [Using PKS](#).

## Backing up and Restoring PKS

For information about using BOSH Backup and Restore (BBR) to back up and restore PKS, see [Backing up and Restoring PKS](#).

## PKS Security

For information about security in PKS, see [PKS Security](#).

## Diagnosing and Troubleshooting PKS

For information about diagnosing and troubleshooting issues installing or using PKS, see [Diagnosing and Troubleshooting PKS](#).

## PKS Release Notes

Page last updated:

This topic contains release notes for Pivotal Container Service (PKS) v1.2.x.

### v1.2.6

**Release Date:** January 4, 2019

#### Product Snapshot

Element	Details
Version	v1.2.6
Release date	January 4, 2019
Compatible Ops Manager versions	v2.2.3+, v2.3.1+, v2.4.x
Stemcell version	v97.43
Kubernetes version	v1.11.6
On-Demand Broker version	v0.24
NSX-T versions	v2.2, v2.3.0.2, v2.3.1
NCP version	v2.3.1
Docker version	17.12.1-ce <a href="#">CFCR v0.21.12</a>

#### Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the [Resource Config](#) tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of *Installing PKS on AWS*.

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of *Deploying and Accessing Basic Workloads*.

#### Upgrade Path

The supported upgrade paths to PKS v1.2.6 are from PKS v1.2.0 and later.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

#### What's New

PKS v1.2.6 adds support for the following:

- Xenial Stemcell v97.43.

- Fix: PKS v1.2.4 and v1.2.5 introduced a bug that could cause the master nodes of clusters to reach 100% of CPU and memory utilization and become unresponsive when syslog was enabled in the PKS tile. This issue is resolved.

## v1.2.5

Release Date: December 28, 2018

### Product Snapshot

Element	Details
Version	v1.2.5
Release date	December 28, 2018
Compatible Ops Manager versions	v2.2.3+, v2.3.1+, v2.4.x
Stemcell version	v97.42
Kubernetes version	v1.11.6
On-Demand Broker version	v0.24
NSX-T versions	v2.2, v2.3.0.2, v2.3.1
NCP version	v2.3.1
Docker version	17.12.1-ce <a href="#">CFCR v0.21.12</a>

### Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the [Resource Config](#) tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of [Installing PKS on AWS](#).

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of [Deploying and Accessing Basic Workloads](#).

### Upgrade Path

The supported upgrade paths to PKS v1.2.5 are from PKS v1.2.0 and later.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

### What's New

PKS v1.2.5 adds support for the following:

- Fix: CVE-2018-18264 applied. This fixes the security issue related to using Kubernetes Dashboard's service account. For more information, see pull requests [#3400](#) and [#3289](#) in the Kubernetes GitHub repo.
- Kubernetes v1.11.6.
- New certificates are now generated for UAA SAML usage with 4 year expiration.

- New CAs for components to allow for zero-downtime certificate rotation in future PKS releases.

## Known Issues

The following known issues apply to the PKS v1.2.5 release:

- PKS v1.2.4 and v1.2.5 introduced a bug. When syslog is enabled in the PKS tile, a condition can occur that could cause the master nodes of clusters to reach 100% of CPU and memory utilization and become unresponsive. Upgrade to PKS v1.2.6 or later to resolve.

## v1.2.4

**Release Date:** December 10, 2018

## Product Snapshot

Element	Details
Version	v1.2.4
Release date	December 10, 2018
Compatible Ops Manager versions	v2.2.3+, v2.3.1+, v2.4.x
Stemcell version	v9.7.39
Kubernetes version	v1.11.5
On-Demand Broker version	v0.24
NSX-T versions	v2.2, v2.3.0.2
NCP version	v2.3.1
Docker version	17.12.1-ce

 PKS v1.2.4 adds support for Ops Manager v2.4.x. If you want to upgrade Ops Manager to v2.4.x, you must upgrade PKS to v1.2.4 and then upgrade Ops Manager to v2.4.x. For instructions on upgrading PKS, see [Upgrading PKS](#).

## Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the [Resource Config](#) tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of [Installing PKS on AWS](#).

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of [Deploying and Accessing Basic Workloads](#).

## Upgrade Path

The supported upgrade paths to PKS v1.2.4 are from PKS v1.1.5 and later.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

## What's New

PKS v1.2.4 adds support for the following:

- Sink resource support in internetless environments.
- Support for Multiple Tier-0 routers in NSX-T.
- Support for NSX-T ODB v0.24.
- Support for bootstrap security group, custom floating IP, and edge router selection using Network Profiles with NSX-T.
- Fix: Log files should no longer fill the ephemeral disk on Kubernetes API instances.
- Fix: You can now add a new plan to a tile, redeploy the tile, and then create a cluster using the new plan.
- Fix: The command `pks delete-cluster` releases SNAT floating IP allocated for Kubernetes namespaces.
- Fix: For vSphere with NSX-T, the **HTTP Proxy** password field supports the following special characters: <, :, ?, and +.

## Known Issues

The following known issues apply to the PKS v1.2.4 release:

- PKS v1.2.4 and v1.2.5 introduced a bug. When syslog is enabled in the PKS tile, a condition can occur that could cause the master nodes of clusters to reach 100% of CPU and memory utilization and become unresponsive. Upgrade to PKS v1.2.6 or later to resolve.
- If creating a cluster using the `pks create-cluster` command results in a `failed` state and you want to delete the cluster, you must run the `bosh -d DEPLOYMENT-NAME delete-deployment` command before running the `pks delete-cluster` command.
- For vSphere with NSX-T, the **HTTP Proxy** password field does not support the following special characters: & or ;.
- If you are upgrading to PKS v1.2.3 or later and have an existing proxy configuration, also include the following IP addresses in the **No Proxy** field: NSX Manager, vCenter Server, and all ESXi hosts.

## v1.2.3

**Release Date:** November 30, 2018

## Product Snapshot

Element	Details
Version	v1.2.3
Release date	November 30, 2018
Compatible Ops Manager versions	v2.2.3+, v2.3.1+
Stemcell version	v97.34
Kubernetes version	v1.11.5
On-Demand Broker version	v0.24
NSX-T versions	v2.2, v2.3
NCP version	v2.3.1

## Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the **Resource Config** tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of *Installing PKS on AWS*.

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of *Deploying and Accessing Basic Workloads*.

## Upgrade Path

The supported upgrade paths to PKS v1.2.3 are from PKS v1.1.5 and later.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

## What's New

PKS v1.2.3 adds support for the following:

- NSX-T and vCenter IaaS proxy.
- Large-sized NSX-T load balancer with bare metal Edge Node.
- You can specify the size of the Pods IP Block subnet using Network Profiles.
- Kubernetes v1.11.5.
- On-demand-broker v0.24.
- Xenial Stemcell v97.34.
- **Fix:** Issue with mounting NFS Persistent Volumes is resolved.
- Security Fix: addresses [CVE-2018-1002105](#).

## Known Issues

The following known issues apply to the PKS v1.2.3 release:

- If creating a cluster using the `pks create-cluster` command results in a `failed` state and you want to delete the cluster, you must run the `bosh -d DEPLOYMENT-NAME delete-deployment` command before running the `pks delete-cluster` command.
- If you are upgrading to PKS v1.2.3 and have an existing proxy configuration, also include the following IP addresses in the **No Proxy** field: NSX Manager, vCenter Server, and all ESXi hosts.
- Special characters in the **HTTP Proxy** password field are not supported.

## v1.2.2

Release Date: November 14, 2018

## Product Snapshot

Element	Details
Version	v1.2.2
Release date	November 14, 2018
Compatible Ops Manager versions	v2.2.3+, v2.3.1+
Stemcell version	v97.17
Kubernetes version	v1.11.3
On-Demand Broker version	v0.23
NSX-T versions	v2.2, v2.3
NCP version	v2.3

## Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the [Resource Config](#) tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of *Installing PKS on AWS*.

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of *Deploying and Accessing Basic Workloads*.

## Upgrade Path

The supported upgrade paths to PKS v1.2.2 are from PKS v1.1.5 and later.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

## What's New

PKS v1.2.2 includes updates to the containers that underlie sink resources and Wavefront integration. These updates do not add functionality and should not impact existing functionality.

## Known Issues

The following known issues apply to the PKS v1.2.2 release:

- If creating a cluster using the `pks create-cluster` command results in a `failed` state and you want to delete the cluster, you must run the `bosh -d DEPLOYMENT-NAME delete-deployment` command before running the `pks delete-cluster` command.
- If you are upgrading to PKS v1.2.3 and have an existing proxy configuration, also include the following IP addresses in the **No Proxy** field: NSX Manager, vCenter Server, and all ESXi hosts.

## v1.2.1

**Release Date:** November 2, 2018

## Product Snapshot

Element	Details
Version	v1.2.1
Release date	November 2, 2018
Compatible Ops Manager versions	v2.2.2+, v2.3.1+
Stemcell version	v97.17
Kubernetes version	v1.11.3
On-Demand Broker version	v0.23
NSX-T versions	v2.2, v2.3
NCP version	v2.3

## Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the [Resource Config](#) tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of *Installing PKS on AWS*.

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of *Deploying and Accessing Basic Workloads*.

## Upgrade Path

The supported upgrade paths to PKS v1.2.1 are from PKS v1.1.5 and later.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

## What's New

PKS v1.2.1 adds support for the following:

- Routable pod networks for assigning each pod in a Kubernetes cluster a routable (public) IP address. For more information, see [Routable IP Addresses for Pods](#) in *Using Network Profiles (NSX-T Only)*.
- Configurable maximum number of worker nodes per Kubernetes cluster. Previously the maximum was 50 and not configurable. For more information, see the [Plans](#) section of the *Installing PKS* topic for your IaaS. For example, [Plans](#) in *Installing PKS on vSphere*.
- Sink resources for Kubernetes clusters. For more information, see [Creating Sink Resources](#).
- Kubernetes v1.11.3.
- Updated On-Demand Broker.
- Updated UAA.

## Known Issues

The following known issues apply to the PKS v1.2.1 release:

- If creating a cluster using the `pks create-cluster` command results in a `failed` state and you want to delete the cluster, you must run the `bosh -d DEPLOYMENT-NAME delete-deployment` command before running the `pks delete-cluster` command.
- After upgrading to PKS v1.2.1, creating a ClusterSink fails. This issue occurs only after upgrading to PKS v1.2.1 and does not apply to new installations of PKS v1.2.1 or later. For more information, see the corresponding [Knowledge Base](#) article.

## v1.2.0

**Release Date:** September 27, 2018

## Product Snapshot

Element	Details
Version	v1.2.0
Release date	September 27, 2018

Compatible Ops Manager versions	v2.2.2+, v2.3.1+
Stemcell version	v97.17
Kubernetes version	v1.11.2
On-Demand Broker version	v0.22
NSX-T versions	v2.2, v2.3
NCP version	v2.3

## Feature Support by IaaS

	AWS	GCP	vSphere	vSphere with NSX-T
Automatic PKS control plane load balancer	✓*	✓		
Automatic cluster load balancer				✓
HTTP proxy			✓	✓
Multi-AZ storage			✓	✓
Per-namespace subnets				✓
Service <code>type:LoadBalancer</code>	✓**	✓		✓

\* Enter the load balancer name in the [Resource Config](#) tab to connect the load balancer to the PKS control plane. For more information, see the [Resource Config](#) section of *Installing PKS on AWS*.

\*\* For more information about configuring Service `type:LoadBalancer` on AWS, see the [Access Workloads Using an Internal AWS Load Balancer](#) section of *Deploying and Accessing Basic Workloads*.

## Upgrade Path

The supported upgrade paths to PKS v1.2.0 are from PKS v1.1.5 and later.

For customers who have deployed PKS v1.1.5 with NSX-T, NSX-T v2.2 is the version supported for upgrades to PKS v1.2.0.

For more information, see [Upgrading PKS](#) and [Upgrading PKS with NSX-T](#).

## What's New

PKS v1.2.0 adds support for the following:

- Network profiles for per-cluster customization and choice of load balancer size for PKS deployments with NSX-T. For more information, see [Using Network Profiles \(NSX-T Only\)](#).
- Xenial stemcells.
- Multi-master clusters. For more information, see the *Plans* section of [Installing PKS](#) for your IaaS.
- OpenID Connect (OIDC) authentication strategy in Kubernetes. For more information, see the *Configure OpenID Connect* section of [Installing PKS](#) for your IaaS.
  - Cluster administrators can use LDAP users and groups in `RoleBinding` and `ClusterRoleBinding` objects. For more information, see [Managing Users in PKS with UAA](#).
- Namespace sinks. For more information, see [Creating Sink Resources](#).
- PKS can be deployed on Amazon Web Services (AWS). For more information, see the [Amazon Web Services \(AWS\)](#) topic.
- You can specify the number of worker nodes to be installed in parallel. For more information, see the *PKS API* section of [Installing PKS](#) for your IaaS.
- Metrics server is deployed by default. Heapster is still deployed but will be removed in a future release per Kubernetes deprecation notice.
- Support for Horizontal Pod Autoscaling.
- Support for the HostPort feature to allow pods to open external ports on the worker node.
- ETCD release v3.3.9.
- Updated admission controllers based on Kubernetes recommendations, including `DefaultTolerationSeconds` and `ValidatingAdminissionWebhook`. `NamespaceExists` has been removed.

- Changed Docker storage driver from `overlay` to `overlay2`. The old images will remain on each worker in the `/var/vcap/data/docker/docker/overlay` directory.
- Support for the NTLM formatted usernames for vSphere.
- Improved drain script for large cluster upgrades.
- Deprecated support for NSX-T v2.1.
- Fix: vSphere credentials are not stored in the BOSH manifest.

## Known Issues

The following known issues apply to the PKS v1.2.0 release:

- If creating a cluster using the `pks create-cluster` command results in a `failed` state and you want to delete the cluster, you must run the `bosh -d DEPLOYMENT-NAME delete-deployment` command before running the `pks delete-cluster` command.
- If you use a space in any field entry in the PKS tile, the deployment of PKS fails. Ensure your field entries in the PKS tile do not contain leading and trailing spaces or spaces between characters.
- When the PKS tile is being redeployed (during PKS tile upgrade, for instance), the following error message may appear in the Ops Manager status log: `Failed Jobs: pks-api`. The workaround is to disable telemetry data collection in the **Usage Data** pane of the PKS tile.
- For PKS with NSX-T, using the **Generate RSA Certificate** option in the **Networking** section of the PKS tile for generating the **NSX Manager Super User Principal Identity Certificate** results in the following error during deployment of PKS:

```
ERROR: NSX-T Precheck failed due to error code:  
403, error message: The credentials were incorrect  
or the account specified has been locked.
```

This error is the result of a change in the cURL version as part of the stemcell upgrade from Ubuntu v14.04 to v16.04. In Ubuntu 16.04, cURL comes with GnuTLS instead of OpenSSL. For a workaround, use the manual approach for generating the principle identity certificate and key as described in [Generating and Registering the NSX Manager Superuser Principal Identity Certificate and Key](#).

- Namespace sinks do not work in environments without internet access.
- Due to a limitation with the NSX-T v2.2 scheduler component, VMware recommends that you do not use a medium-sized load balancer at this time, even if the NSX-T edge cluster has more than two edge node VMs. This limitation is addressed in NSX-T v2.3, which PKS v1.2.0 supports.
- When using AWS, you must select a VM type under **Master/ETCD VM Type**, **Worker VM Type**, and **Errand VM Type** in the **Plans** section of the PKS tile in order to save a plan on the tile. You cannot leave the VM type on **Automatic**. The recommended minimum VM type is `t2.medium`.
- Existing certificates will expire after a year. The certificates will be updated in a future release.
- The **External Groups Whitelist** field in the **UAA** section of the PKS tile has a 4000 character limit due to the size limitation of JWT tokens.
- In an internetless environment, the images for the kube-system components must be present within the environment to allow the `overlay2` upgrade.
- Kubernetes end users must manually configure their kubeconfig in order to use their LDAP credentials if OIDC is turned on.
- UAA refresh token for OIDC authorization is currently not supported.
- When creating a cluster with the `pks create-cluster` command, you cannot use the `\` character in the value for `--external-hostname`. For more information about creating clusters, see the [Create a Kubernetes Cluster](#) section of [Creating Clusters](#).
- When a cluster is created, the output logs will contain the following warning: `Warning: DNS address not available for the link provider instance: pivotal-container-service/[uuid]`. It has no effect on the cluster creation.
- Enabling Telemetry on environments without Internet access causes tile installation to fail.
- When **Enable UAA as OIDC Provider** is selected in the **UAA** pane of the PKS tile, the Kubernetes Dashboard no longer works with the kubeconfig option. Currently, external identity providers and certificate-based authentication are not supported in Kubernetes.

## PKS Concepts

Page last updated:

This topic describes Pivotal Container Service (PKS) concepts. See the following sections:

- [PKS Cluster Management](#)
- [PKS API Authentication](#)
- [Load Balancers in PKS](#)
- [Monitoring Master/etcd Node VMs](#)
- [VM Sizing for PKS Clusters](#)

## PKS Cluster Management

This topic describes how Pivotal Container Service (PKS) manages the deployment of Kubernetes clusters.

### Overview

Users interact with PKS and PKS-deployed Kubernetes clusters in two ways:

- Deploying Kubernetes clusters with BOSH and managing their lifecycle. These tasks are performed using the PKS command line interface (CLI) and the PKS control plane.
- Deploying and managing container-based workloads on Kubernetes clusters. These tasks are performed using the Kubernetes CLI, `kubectl`.

### Cluster Lifecycle Management

The PKS control plane enables users to deploy and manage Kubernetes clusters.

For communicating with the PKS control plane, PKS provides a command line interface, the PKS CLI. See [Installing the PKS CLI](#) for installation instructions.

### PKS Control Plane Overview

The PKS control plane manages the lifecycle of Kubernetes clusters deployed using PKS. The control plane allows users to do the following through the PKS CLI:

- View cluster plans
- Create clusters
- View information about clusters
- Obtain credentials to deploy workloads to clusters
- Scale clusters
- Delete clusters
- Create and manage network profiles for VMware NSX-T

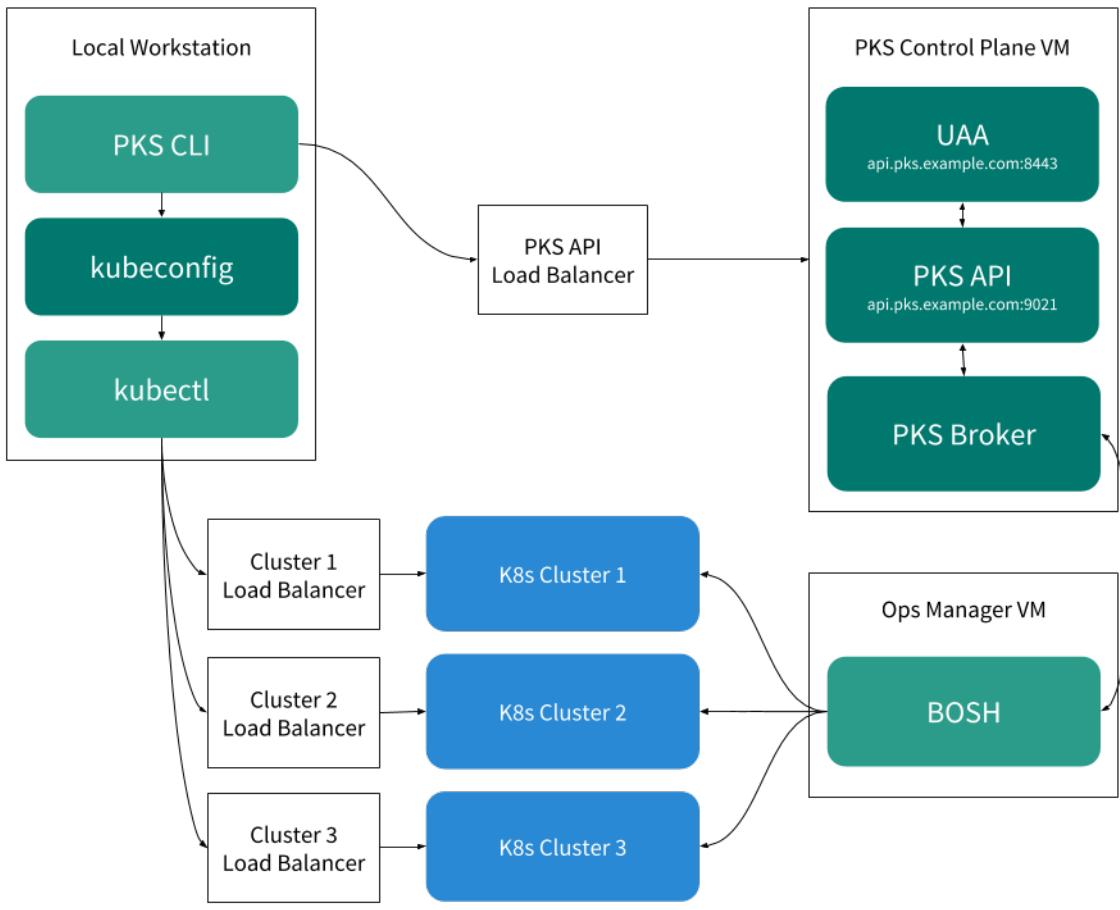
In addition, the PKS control plane can upgrade all existing clusters using the `Upgrade all clusters` BOSH errand. For more information, see [Upgrade Kubernetes Clusters](#) in *Upgrading PKS*.

### PKS Control Plane Architecture

The PKS control plane is deployed on a single VM that includes the following components:

- The PKS API server
- The PKS Broker
- A User Account and Authentication (UAA) server

The following illustration shows how these components interact:



The PKS API Load Balancer is used for AWS, GCP, and vSphere without NSX-T deployments. If PKS is deployed on vSphere with NSX-T, a DNAT rule is configured for the PKS API host so that it is accessible. For more information, see the [Share the PKS API Endpoint](#) section in *Installing PKS on vSphere with NSX-T Integration*.

## UAA

When a user logs in to or logs out of the PKS API through the PKS CLI, the PKS CLI communicates with UAA to authenticate them. The PKS API permits only authenticated users to manage Kubernetes clusters. For more information about authenticating, see [PKS API Authentication](#).

UAA must be configured with the appropriate users and user permissions. For more information, see [Managing Users in PKS with UAA](#).

## PKS API

Through the PKS CLI, users instruct the PKS API server to deploy, scale up, and delete Kubernetes clusters as well as show cluster details and plans. The PKS API can also write Kubernetes cluster credentials to a local kubeconfig file, which enables users to connect to a cluster through `kubectl`.

The PKS API sends all cluster management requests, except read-only requests, to the PKS Broker.

## PKS Broker

When the PKS API receives a request to modify a Kubernetes cluster, it instructs the PKS Broker to make the requested change.

The PKS Broker consists of an [On-Demand Service Broker](#) and a Service Adapter. The PKS Broker generates a BOSH manifest and instructs the BOSH Director to deploy or delete the Kubernetes cluster.

For PKS deployments on vSphere with NSX-T, there is an additional component, the PKS NSX-T Proxy Broker. The PKS API communicates with the PKS NSX-T Proxy Broker, which in turn communicates with the NSX Manager to provision the Node Networking resources. The PKS NSX-T Proxy Broker then forwards the request to the On-Demand Service Broker to deploy the cluster.

## Cluster Workload Management

PKS users manage their container-based workloads on Kubernetes clusters through `kubectl`. For more information about `kubectl`, see [Overview of kubectl](#) in the Kubernetes documentation.

## PKS API Authentication

Page last updated:

This topic describes how the Pivotal Container Service (PKS) API works with User Account and Authentication (UAA) to manage authentication and authorization in your PKS deployment.

### Authenticating PKS API Requests

Before users can log in and use the PKS CLI, you must configure PKS API access with UAA. For more information, see [Configuring PKS API Access](#) with UAA.

You use the UAA Command Line Interface (UAAC) to target the UAA server and request an access token for the UAA admin user. If your request is successful, the UAA server returns the access token. The UAA admin access token authorizes you to make requests to the PKS API using the PKS CLI and grant cluster access to new or existing users. For more information, see [Grant Cluster Access](#) in *Managing Users in PKS with UAA*.

When a user with cluster access logs in to the PKS CLI, the CLI requests an access token for the user from the UAA server. If the request is successful, the UAA server returns an access token to the PKS CLI. When the user runs PKS CLI commands, for example, `pks clusters`, the CLI sends the request to the PKS API server and includes the user's UAA token.

The PKS API sends a request to the UAA server to validate the user's token. If the UAA server confirms that the token is valid, the PKS API uses the cluster information from the PKS broker to respond to the request. For example, if the user runs `pks clusters`, the CLI returns a list of the clusters that the user is authorized to manage.

### Routing to the PKS API Control Plane VM

The PKS API server and the UAA server use different port numbers on the control plane VM. For example, if your PKS API domain is `api.pks.example.com`, you can reach your PKS API and UAA servers at the following URLs:

Server	URL
PKS API	<code>api.pks.example.com:9021</code>
UAA	<code>api.pks.example.com:8443</code>

Refer to [Ops Manager > Pivotal Container Service > PKS API > API Hostname \(FQDN\)](#) for your PKS API domain.

Load balancer implementations differ by deployment environment. For PKS deployments on GCP, AWS, or vSphere without NSX-T, you configure a load balancer to access the PKS API when you install the PKS tile. For more information, see the [Configure External Load Balancer](#) section of *Installing PKS* for your IaaS.

For procedures that describe routing to the PKS control plane VM, see the [Configure External Load Balancer](#) section of *Installing PKS* for your IaaS.

For overview information about load balancers in PKS, see [Load Balancers in PKS Deployments without NSX-T](#).

## Load Balancers in PKS

Page last updated:

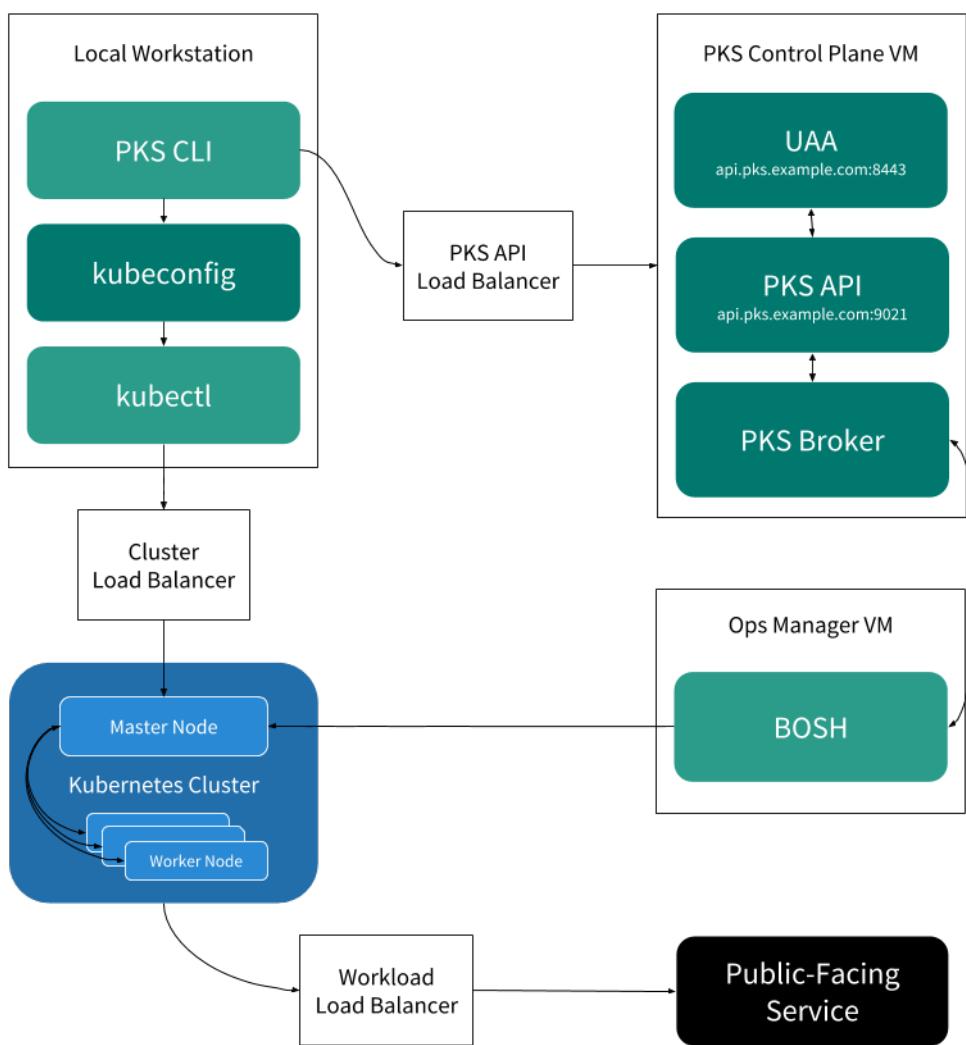
This topic describes the types of load balancers that are used in Pivotal Container Service (PKS) deployments. Load balancers differ by the type of deployment.

## Load Balancers in PKS Deployments without NSX-T

For PKS deployments on GCP, AWS, or vSphere without NSX-T, you can configure load balancers for the following:

- **PKS API:** Configuring this load balancer allows you to run PKS Command Line Interface (CLI) commands from your local workstation.
- **Kubernetes Clusters:** Configuring a load balancer for each new cluster allows you to run Kubernetes CLI (`kubectl`) commands on the cluster.
- **Workloads:** Configuring a load balancer for your application workloads allows external access to the services that run on your cluster.

The following diagram shows where each of the above load balancers can be used within your PKS deployment on GCP, AWS, or on vSphere without NSX-T:



If you use either vSphere without NSX-T or GCP, you are expected to create your own load balancers within your cloud provider console. If your cloud provider does not offer load balancing, you can use any external TCP or HTTPS load balancer of your choice.

## About the PKS API Load Balancer

For PKS deployments on GCP, AWS, and on vSphere without NSX-T, the load balancer for the PKS API allows you to access the PKS API from outside the network. For example, configuring a load balancer for the PKS API allows you to run PKS CLI commands from your local workstation.

For information about configuring the PKS API load balancer, see the [Configure External Load Balancer](#) section of *Installing PKS* for your IaaS.

## About Kubernetes Cluster Load Balancers

For PKS deployments on GCP, AWS, and on vSphere without NSX-T, when you create a cluster, you must configure external access to the cluster by creating an external TCP or HTTPS load balancer. The load balancer allows the Kubernetes CLI to communicate with the cluster.

If you create a cluster in a non-production environment, you can choose not to use a load balancer. To allow kubectl to access the cluster without a load balancer, you can do one of the following:

- Create a DNS entry that points to the cluster's master VM. For example:

```
my-cluster.example.com      A      10.0.0.5
```

- On the workstation where you run kubectl commands, add the master IP address of your cluster and `kubo.internal` to the `/etc/hosts` file. For example:

```
10.0.0.5 kubo.internal
```

For more information about configuring a cluster load balancer, see the following:

- [Configuring a GCP Load Balancer for PKS Clusters](#)
- [Configuring an AWS Load Balancer for PKS Clusters](#)

## About Workload Load Balancers

For PKS deployments on GCP, AWS, and on vSphere without NSX-T, to allow external access to your app, you can either create a load balancer or expose a static port on your workload.

For information about configuring a load balancer for your app workload, see [Deploying and Accessing Basic Workloads](#).

If you use AWS, you must configure routing in the AWS console before you can create a load balancer for your workload. You must create a public subnet in each availability zone (AZ) where you are deploying the workload and tag the public subnet with your cluster's unique identifier.

See the [AWS Prerequisites](#) section of *Deploying and Accessing Basic Workloads* before you create a workload load balancer.

## Load Balancers in PKS Deployments on vSphere with NSX-T

PKS deployments on vSphere with NSX-T do not require a load balancer configured to access the PKS API. They require only a DNAT rule configured so that the PKS API host is accessible. For more information, see [Share the PKS Endpoint](#) in *Installing PKS on vSphere with NSX-T Integration*.

NSX-T handles load balancer creation, configuration, and deletion automatically as part of the Kubernetes cluster create, update, and delete process. When a new Kubernetes cluster is created, NSX-T creates and configures a dedicated load balancer tied to it. The load balancer is a shared resource designed to provide efficient traffic distribution to master nodes as well as services deployed on worker nodes. Each application service is mapped to a virtual server instance, carved out from the same load balancer. For more information, see [Logical Load Balancer](#) in the NSX-T documentation.

Virtual server instances are created on the load balancer to provide access to the following:

- **Kubernetes API and UI services on a Kubernetes cluster.** This allows requests to be load balanced across multiple master nodes.
- **Ingress controller.** This allows the virtual server instance to dispatch HTTP and HTTPS requests to services associated with Ingress rules.
- `type:loadbalancer` **services.** This allows the server to handle TCP connections or UDP flows toward exposed services.

Load balancers are deployed in high-availability mode so that they are resilient to potential failures and able to recover quickly from critical conditions.

 **Note:** The `NodePort` Service type is not supported for PKS deployments on vSphere with NSX-T. Only `type:LoadBalancer` Services and Services associated with Ingress rules are supported on vSphere with NSX-T.

## Resizing Load Balancers

When a new Kubernetes cluster is provisioned using the PKS API, NSX-T creates a dedicated load balancer for that new cluster. By default, the size of the load balancer is set to Small.

With network profiles, you can change the size of the load balancer deployed by NSX-T at the time of cluster creation. For information about network profiles, see [Using Network Profiles \(NSX-T Only\)](#).

 **Note:** PKS supports Small and Medium load balancers. Large load balancers (available with bare metal Edge Nodes only) are not officially supported.

For more information about the types of load balancers NSX-T provisions and their capacities, see [Scaling Load Balancer Resources](#) in the NSX-T documentation.

## Monitoring Master/etcđ Node VMs

Page last updated:

This topic includes information about monitoring the master/etcđ node VMs in your Pivotal Container Service (PKS) deployment. You can monitor Kubernetes cluster health by monitoring and gathering metrics from etcđ.

PKS collocates etcđ, an open source distributed key value store, on Kubernetes master node VMs. The master node VMs use etcđ for service discovery and configuration sharing within the cluster.

For more information about etcđ, see the [etcđ documentation](#) on GitHub.

For more information about configuring master/etcđ nodes in the PKS tile, see the Plans section of *Installing PKS* for your IaaS:

- [vSphere](#)
- [vSphere with NSX-T Integration](#)
- [Google Cloud Platform \(GCP\)](#)
- [Amazon Web Services \(AWS\)](#)

### Monitor etcđ

The etcđ VM provides monitoring data on its client port. You can enable the `/debug` endpoint for more verbose logging, but this can decrease cluster performance.

For more information about monitoring etcđ, see [Monitoring etcđ](#) on GitHub.

### Gather Metrics from etcđ

Each etcđ VM exposes metrics on a `/metrics` endpoint. Connect a metrics system to etcđ to gather information from the endpoint about cluster health.

You can configure any monitoring system of your choice to gather metrics. For example, the etcđ documentation recommends using the open source Prometheus monitoring service. For more information, see the [Prometheus documentation](#).

### Troubleshoot etcđ

We recommend working with Pivotal or VMware Support to troubleshoot master/etcđ node VMs. The monitoring and metrics data you gather from the master/etcđ node VMs can help the Support team diagnose and troubleshoot errors.

## VM Sizing for PKS Clusters

Page last updated:

This topic describes how Pivotal Container Service (PKS) recommends you approach the sizing of VMs for cluster components.

### Overview

When you configure plans in the PKS tile, you provide VM sizes for the master and worker node VMs. For more information about configuring plans, see the Plans section of *Installing PKS* for your IaaS:

- [vSphere](#)
- [vSphere with NSX-T Integration](#)
- [Google Cloud Platform \(GCP\)](#)
- [Amazon Web Services \(AWS\)](#)

You select the number of master nodes when you configure the plan.

For worker node VMs, you select the number and size based on the needs of your workload. The sizing of master and worker node VMs is highly dependent on the characteristics of the workload. Adapt the recommendations in this topic based on your own workload requirements.

### Master Node VM Size

The master node VM size is linked to the number of worker nodes. The VM sizing shown in the following table is per master node:

 **Note:** If there are multiple master nodes, all master node VMs are the same size. To configure the number of master nodes, see the Plans section of *Installing PKS* for your IaaS.

Number of Workers	CPU	RAM (GB)
1-5	1	3.75
6-10	2	7.5
11-100	4	15
101-250	8	30
251-500	16	60
500+	32	120

### Worker Node VM Number and Size

A maximum of 100 pods can run on a single worker node. The actual number of pods that each worker node runs depends on the workload type as well as the CPU and memory requirements of the workload.

To calculate the number and size of worker VMs you require, determine the following for your workload:

- Maximum number of pods you expect to run [ `p` ]
- Memory requirements per pod [ `m` ]
- CPU requirements per pod [ `c` ]

Using the values above, you can calculate the following:

- Minimum number of workers [ `w` ] =  $p / 100$
- Minimum RAM per worker =  $m * 100$
- Minimum number of CPUs per worker =  $c * 100$

This calculation gives you the minimum number of worker nodes your workload requires. We recommend that you increase this value to account for

failures and upgrades.

For example, increase the number of worker nodes by at least one to maintain workload uptime during an upgrade. Additionally, increase the number of worker nodes to fit your own failure tolerance criteria.

Prior to PKS v1.2.1, the maximum number of worker nodes that you could create for a PKS-provisioned Kubernetes cluster was 50. This limit is removed in PKS v1.2.1+.

## Example Worker Node Requirement Calculation

An example app has the following minimum requirements:

- Number of pods [`p`] = 1000
- RAM per pod [`m`] = 1 GB
- CPU per pod [`c`] = 0.10

To determine how many worker node VMs the app requires, do the following:

1. Calculate the number of workers using `p / 100`:

$$1000/100 = 10 \text{ workers}$$

2. Calculate the minimum RAM per worker using `m * 100`:

$$1 * 100 = 100 \text{ GB}$$

3. Calculate the minimum number of CPUs per worker using `c * 100`:

$$0.10 * 100 = 10 \text{ CPUs}$$

4. For upgrades, increase the number of workers by one:

$$10 \text{ workers} + 1 \text{ worker} = 11 \text{ workers}$$

5. For failure tolerance, increase the number of workers by two:

$$11 \text{ workers} + 2 \text{ workers} = 13 \text{ workers}$$

In total, this app workload requires 13 workers with 10 CPUs and 100 GB RAM.

## Telemetry

Page last updated:

This topic describes the metrics that the Pivotal Container Service (PKS) tile sends when you enable the VMware Customer Experience Improvement Program (CEIP) or the Pivotal Telemetry Program (Telemetry). You can opt in or opt out of either program in the **Usage Data** pane of the PKS tile.

For more information, see the *Installing PKS* topic for your IaaS:

- [vSphere](#)
- [vSphere with NSX-T Integration](#)
- [Google Cloud Platform \(GCP\)](#)
- [Amazon Web Services \(AWS\)](#)

## Event Envelope Properties

When PKS sends metrics to CEIP or Telemetry, the tile packages the data with the following deployment information:

Property Name	Property Description	Example Data	Added in PKS Version
event	The type of event	create_cluster	v1.1
product_version	PKS tile version	1.2.0-build.40	v1.1
cloud_provider	Cloud provider for the PKS installation	GCP	v1.1
vcenter_id	vCenter ID	00000a11-22bb-3333-4c4c-555566667777	v1.1

## Cluster Events

PKS sends metrics for the cluster management events shown in the table below:

Event Name	Event Description	Property Name	Property Description	Added in PKS Version
create_cluster	This event is generated when a user creates a cluster.	user_id	A hashed value of the username.	v1.1
		timestamp	The time when the user created the cluster.	v1.1
		plan_name	The name of the PKS plan that was used to create the cluster.	v1.1
		plan_id	The ID of the PKS plan that was used to create the cluster.	v1.1
		cluster_name	The name of the cluster.	v1.1
		cluster_id	The ID of the cluster.	v1.1
		number_of_workers	The number of worker node VMs in the cluster.	v1.1
		number_of_masters	The number of master node VMs in the cluster.	v1.2
resize_cluster	This event is generated when a cluster is resized.	user_id	A hashed value of the username.	v1.1
		timestamp	The time when the user created the cluster.	v1.1
		plan_name	The name of the PKS plan that was used to create the cluster.	v1.1
		plan_id	The ID of the PKS plan that was used to create the cluster.	v1.1
		cluster_name	The name of the cluster.	v1.1
		cluster_id	The ID of the cluster.	v1.1
		old_number_of_workers	The number of worker node VMs in the cluster before the resize event.	v1.1
		.	The number of worker node VMs in the cluster	.

		<b>new_number_of_workers</b>	after the resize event.	v1.1
delete_cluster	This event is generated when a user deletes a cluster.	<b>user_id</b>	A hashed value of the username.	v1.1
		<b>timestamp</b>	The time when the user created the cluster.	v1.1
		<b>plan_name</b>	The name of the PKS plan that was used to create the cluster.	v1.1
		<b>plan_id</b>	The ID of the PKS plan that was used to create the cluster.	v1.1
		<b>cluster_name</b>	The name of the cluster.	v1.1
		<b>cluster_id</b>	The ID of the cluster.	v1.1
api_started	This event is generated when the PKS API is started.	<b>authentication_mode</b>	The authentication mode used to access a Kubernetes cluster.	v1.2
		<b>timestamp</b>	The time when the PKS API started.	v1.2

## Cluster Metrics

PKS sends both agent metrics and cluster pod metrics for each cluster.

The following table describes cluster agent metrics:

Agent Metric Name	Agent Metric Description	Example	Added in PKS Version
agentid	The unique BOSH-generated deployment name for the cluster.	service-instance_00000a11-22bb-3333-4c4c-555566667777	v1.1
isvrlieabled	If vRealize Log Insight (vRLI) is enabled, this value is true. If vRLI is disabled, this value is false.	true	v1.1
isvropsenabled	If vRealize Operations (vROps) is enabled, this value is true. If vROps is disabled, this value is false.	false	v1.1
iswavefrontenabled	If Wavefront is enabled, this value is true. If Wavefront is disabled, this value is false.	true	v1.1
vcenter_id	This is your vCenter ID.	00000a11-22bb-3333-4c4c-555566667777	v1.1

The following table describes cluster pod metrics:

Cluster Pod Metric Name	Cluster Pod Metric Description	Example	Added in PKS Version
collected_at	This timestamp represents the metric collection time on the agent.	2018-05-31 21:45:27.681 UTC	v1.1
cpu_used	This value represents how much CPU was in use at the time when the event happened.	11412427	v1.1
memory_used	This value represents how much memory was in use at the time when the event happened.	4816896	v1.1
pkst_kubernetesclusterinfo_fk	This value is a foreign key that points to an entry in the <i>pkst_kubernetesclusterinfo</i> database.	77777a66-55bb-4444-3c3c-22221110000	v1.1

## PAS and PKS Deployments with Ops Manager

Page last updated:

Ops Manager is a web app that you use to deploy and manage Pivotal Application Service (PAS) and Pivotal Container Service (PKS). This topic explains why Pivotal recommends using separate installations of Ops Manager for PAS and PKS.

For more information about deploying PKS, see [Installing PKS](#).

## Security

Ops Manager deploys the PAS and PKS runtime platforms using BOSH. For security reasons, Pivotal does not recommend installing PAS and PKS on the same Ops Manager instance. For even stronger security, Pivotal recommends deploying each Ops Manager instance using a unique cloud provider account.

## Tile Configuration and Troubleshooting

Separate installations of Ops Manager allow you to customize and troubleshoot runtime tiles independently. You may choose to configure Ops Manager with different settings for your PAS and PKS deployments.

For example, PKS and many PAS features depend on BOSH DNS. If you deploy PAS to a separate Ops Manager instance, you can disable BOSH DNS for troubleshooting purposes. PAS can run without BOSH DNS, but key features such as secure service credentials with CredHub, service discovery for container-to-container networking, and NSX-T integration do not work when BOSH DNS is disabled.

If you deploy PAS and PKS to the same Ops Manager instance, you cannot disable BOSH DNS without breaking your PKS installation along with the PAS features that depend on BOSH DNS.

## Installing PKS

Page last updated:

You can install Pivotal Container Service (PKS) on Amazon Web Services (AWS), Google Cloud Platform (GCP), or vSphere. For installation instructions, see the following:

- [vSphere](#)
- [vSphere with NSX-T Integration](#)
- [GCP](#)
- [AWS](#)

## vSphere

This topic lists the steps to follow when installing Pivotal Container Service (PKS) on vSphere.

## Installing PKS

To install PKS, follow the instructions below:

- [Prerequisites and Resource Requirements](#)
- [Preparing vSphere Before Deploying PKS](#)
- Deploying Ops Manager on vSphere:
  - [Deploying BOSH and Ops Manager v2.2 to vSphere ↗](#)
  - [Deploying BOSH and Ops Manager v2.3 to vSphere ↗](#)
  - [Deploying BOSH and Ops Manager v2.4 to vSphere ↗](#)
- Configuring Ops Manager on vSphere:
  - [Configuring BOSH Director v2.2 on vSphere ↗](#)
  - [Configuring BOSH Director v2.3 on vSphere ↗](#)
  - [Configuring BOSH Director v2.4 on vSphere ↗](#)
- [Installing PKS on vSphere](#)
- [\(Optional\) Integrating VMware Harbor with PKS ↗](#)

## Installing the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## vSphere Prerequisites and Resource Requirements

Page last updated:

This topic describes the prerequisites and resource requirements for installing Pivotal Container Service (PKS) on vSphere.

For prerequisites and resource requirements for installing PKS on vSphere with NSX-T integration, see [vSphere with NSX-T Prerequisites and Resource Requirements](#).

PKS supports air-gapped deployments on vSphere with or without NSX-T integration.

You can also configure integration with the Harbor tile, an enterprise-class registry server for container images. For more information, see [VMware Harbor Registry](#) in the *Pivotal Partner documentation*.

### Prerequisites

Before installing PKS, you must install Ops Manager. You use Ops Manager to install and configure PKS.

To prepare your vSphere environment for installing Ops Manager and PKS, review the sections below and then follow the instructions in [Preparing vSphere Before Deploying PKS](#).

### vSphere Version Requirements

Ops Manager and PKS support the following vSphere component versions:

Versions	Editions
<ul style="list-style-type: none"> <li>• VMware vSphere 6.7*</li> <li>• VMware vSphere 6.5 U2</li> <li>• VMware vSphere 6.5 U1</li> <li>• VMware vSphere 6.5 GA</li> </ul>	<ul style="list-style-type: none"> <li>• vSphere Enterprise Plus</li> <li>• vSphere with Operations Management Enterprise Plus</li> </ul>

\* VMware vSphere 6.7 is supported on Ops Manager v2.3 and later and NSX-T v2.3.

### Resource Requirements

Installing Ops Manager and PKS requires the following virtual machines (VMs):

VM	CPU	RAM	Storage
Pivotal Container Service	2	8 GB	16 GB
Pivotal Ops Manager	1	8 GB	160 GB
BOSH Director	2	8 GB	16 GB

Each PKS deployment requires ephemeral VMs during installation and upgrades of PKS. After you deploy PKS, BOSH automatically deletes these VMs.

To enable PKS to dynamically create the ephemeral VMs when needed, ensure that the following resources are available in your vSphere infrastructure before deploying PKS:

Ephemeral VM	Number	CPU Cores	RAM	Ephemeral Disk
BOSH Compilation VMs	4	4	4 GB	32 GB

Each Kubernetes cluster provisioned through PKS deploys the VMs listed below. If you deploy more than one Kubernetes cluster, you must scale your allocated resources appropriately.

VM	Number	CPU Cores	RAM	Ephemeral Disk	Persistent Disk
master	1 or 3	2	4 GB	8 GB	5 GB
worker	1 or more	2	4 GB	8 GB	50 GB

errand (ephemeral)	1	1	1 GB	8 GB	none
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## Preparing vSphere Before Deploying PKS

Page last updated:

Before you install Pivotal Container Service (PKS) on vSphere **without** NSX-T integration, you must prepare your vSphere environment. In addition to fulfilling the prerequisites specified in [vSphere Prerequisites and Resource Requirements](#), you must create the following two service accounts in vSphere:

- **Master Node Service Account**: You must create a service account for Kubernetes cluster master VMs.
- **BOSH/Ops Manager Service Account**: You must create a service account for BOSH and Ops Manager.

After you create the service accounts listed above, you must grant them privileges in vSphere. Pivotal recommends configuring each service account with the least permissive privileges and unique credentials.

For the master node service account, you can create a custom role in vSphere based on your storage configuration. Kubernetes master node VMs require storage permissions to create load balancers and attach persistent disks to pods. Creating a custom role allows vSphere to apply the same privileges to all Kubernetes master node VMs in your PKS installation.

When you configure the **Kubernetes Cloud Provider** pane of the PKS tile, you enter the master node service account credentials in the **vSphere Master Credentials** fields.

For more information, see the [Kubernetes Cloud Provider](#) section of *Installing PKS on vSphere*.

For the BOSH/Ops Manager service account, you can apply privileges directly to the service account without creating a role. You can also apply the default [VMware Administrator System Role](#) to the service account to achieve the appropriate permission level.

 **Note:** If your Kubernetes clusters span multiple vCenters, you must set the service account privileges correctly in each vCenter.

### Step 1: Create the Master Node Service Account

1. From the vCenter console, create a service account for Kubernetes cluster master VMs.
2. Grant the following **Virtual Machine Object** privileges to the service account:

Privilege (UI)	Privilege (API)
Virtual Machine > Configuration > Advanced	VirtualMachine.Configuration.Advanced
Virtual Machine > Configuration > Settings	VirtualMachine.Configuration.Settings

### Step 2: Grant Storage Permissions

Kubernetes master node VM service accounts require the following:

- Read access to the folder, host, and datacenter of the cluster node VMs
- Permission to create and delete VMs within the resource pool where PKS is deployed

Grant these permissions to the master node service account based on your storage configuration using one of the procedures below:

- [Static Only Persistent Volume Provisioning](#)
- [Dynamic Persistent Volume Provisioning \(with Storage Policy-Based Volume Placement\)](#)
- [Dynamic Persistent Volume Provisioning \(without Storage Policy-Based Volume Placement\)](#)

For more information about vSphere storage configurations, see [vSphere Storage for Kubernetes](#) in the VMware vSphere documentation.

#### Static Only Persistent Volume Provisioning

To configure your Kubernetes master node service account using static only Persistent Volume (PV) provisioning, do the following:

1. Create a custom role that allows the service account to manage Kubernetes node VMs. Give this role a name. For example, `manage-k8s-node-vms`. For more information about custom roles in vCenter, see [Create a Custom Role](#) in the VMware vSphere documentation.

- Grant the following privileges at the **VM Folder** level using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Virtual Machine > Configuration > Add existing disk	VirtualMachine.Config.AddExistingDisk
Virtual Machine > Configuration > Add new disk	VirtualMachine.Config.AddNewDisk
Virtual Machine > Configuration > Add or remove device	VirtualMachine.Config.AddRemoveDevice
Virtual Machine > Configuration > Remove disk	VirtualMachine.Config.RemoveDisk

- Select the **Propagate to Child Objects** checkbox.

- (Optional) Create a custom role that allows the service account to manage Kubernetes volumes. Give this role a name. For example, `manage-k8s-volumes`.

 **Note:** This role is required if you create a Persistent Volume Claim (PVC) to bind with a statically provisioned PV, and the reclaim policy is set to delete. When the PVC is deleted, the statically provisioned PV is also deleted.

- Grant the following privilege at the **Datastore** level using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Datastore > Low level file operations	Datastore.FileManagement

- Clear the **Propagate to Child Objects** checkbox.

- Grant the service account the existing **Read-only** role. This role includes the following privileges at the **vCenter**, **Datacenter**, **Datastore Cluster**, and **Datastore Storage Folder** levels:

Privilege (UI)	Privilege (API)
Read-only	System.Anonymous
	System.Read
	System.View

- Continue to [Step 3: Create the BOSH/Ops Manager Service Account](#).

## Dynamic Persistent Volume Provisioning (with Storage Policy-Based Volume Placement)

To configure your Kubernetes master node service account using dynamic PV provisioning **with** storage policy-based placement, do the following:

- Create a custom role that allows the service account to manage Kubernetes node VMs. Give this role a name. For example, `manage-k8s-node-vms`. For more information about custom roles in vCenter, see [Create a Custom Role](#) in the VMware vSphere documentation.

- Grant the following privileges at the **Cluster**, **Hosts**, and **VM Folder** levels using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Virtual Machine > Resource > Assign virtual machine to resource pool	Resource.AssignVMTToPool
Virtual Machine > Configuration > Add existing disk	VirtualMachine.Config.AddExistingDisk
Virtual Machine > Configuration > Add new disk	VirtualMachine.Config.AddNewDisk
Virtual Machine > Configuration > Add or remove device	VirtualMachine.Config.AddRemoveDevice
Virtual Machine > Configuration > Remove disk	VirtualMachine.Config.RemoveDisk
Virtual Machine > Inventory > Create new	VirtualMachine.Inventory.Create
Virtual Machine > Inventory > Remove	VirtualMachine.Inventory.Delete

- Select the **Propagate to Child Objects** checkbox.

- Create a custom role that allows the service account to manage Kubernetes volumes. Give this role a name. For example, `manage-k8s-volumes`.

- Grant the following privilege at the **Datastore** level using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Datastore > Allocate space	Datastore.AllocateSpace
Datastore > Low level file operations	Datastore.FileManagement

- Clear the **Propagate to Child Objects** checkbox.

3. Create a custom role that allows the service account to read the Kubernetes storage profile. Give this role a name. For example, `k8s-system-read-and-spbm-profile-view`.

- Grant the following privilege at the vCenter level using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Profile-driven storage view	StorageProfile.View

- Clear the **Propagate to Child Objects** checkbox.

4. Grant the service account the existing **Read-only** role. This role includes the following privileges at the vCenter, Datacenter, Datastore Cluster, and Datastore Storage Folder levels:

Privilege (UI)	Privilege (API)
Read-only	System.Anonymous
	System.Read
	System.View

5. Continue to [Step 3: Create the BOSH/Ops Manager Service Account](#).

## Dynamic Volume Provisioning (without Storage Policy-Based Volume Placement)

To configure your Kubernetes master node service account using dynamic PV provisioning **without** storage policy-based placement, do the following:

1. Create a custom role that allows the service account to manage Kubernetes node VMs. Give this role a name. For example, `manage-k8s-node-vms`. For more information about custom roles in vCenter, see [Create a Custom Role](#) in the VMware vSphere documentation.

- Grant the following privileges at the Cluster, Hosts, and VM Folder levels using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Virtual Machine > Configuration > Add existing disk	VirtualMachine.Config.AddExistingDisk
Virtual Machine > Configuration > Add new disk	VirtualMachine.Config.AddNewDisk
Virtual Machine > Configuration > Add or remove device	VirtualMachine.Config.AddRemoveDevice
Virtual Machine > Configuration > Remove disk	VirtualMachine.Config.RemoveDisk

- Select the **Propagate to Child Objects** checkbox.

2. Create a custom role that allows the service account to manage Kubernetes volumes. Give this role a name. For example, `manage-k8s-volumes`.

- Grant the following privilege at the Datastore level using either the vCenter UI or API:

Privilege (UI)	Privilege (API)
Datastore > Allocate space	Datastore.AllocateSpace
Datastore > Low level file operations	Datastore.FileManagement

- Clear the **Propagate to Child Objects** checkbox.

3. Grant the service account the existing **Read-only** role. This role includes the following privileges at the vCenter, Datacenter, Datastore Cluster, and Datastore Storage Folder levels:

Privilege (UI)	Privilege (API)
Read-only	System.Anonymous
	System.Read
	System.View

## Step 3: Create the BOSH/Ops Manager Service Account

- From the vCenter console, create a service account for BOSH and Ops Manager.
- Grant the permissions below to the BOSH and Ops Manager service account.

 **Note:** The privileges listed in this section describe the minimum required permissions to deploy BOSH. You can also apply the default

[VMware Administrator System Role](#) to the service account to achieve the appropriate permission level, but the default role includes more privileges than those listed below.

## vCenter Root Privileges

Grant the following privileges on the root vCenter server entity to the service account:

Privilege (UI)	Privilege (API)
Read-only	System.Anonymous
	System.Read
	System.View
Manage custom attributes	Global.ManageCustomFields

## vCenter Datacenter Privileges

Grant the following privileges on any entities in a datacenter where you deploy PKS:

### Role Object

Privilege (UI)	Privilege (API)
Users inherit the Read-Only role from the vCenter root level	System.Anonymous
	System.Read
	System.View

### Datastore Object

Grant the following privileges must at the datacenter level to upload and delete virtual machine files:

Privilege (UI)	Privilege (API)
Allocate space	Datastore.AllocateSpace
Browse datastore	Datastore.Browse
Low level file operations	Datastore.FileManagement
Remove file	Datastore.DeleteFile
Update virtual machine files	Datastore.UpdateVirtualMachineFiles

### Folder Object

Privilege (UI)	Privilege (API)
Delete folder	Folder.Delete
Create folder	Folder.Create
Move folder	Folder.Move
Rename folder	Folder.Rename

### Global Object

Privilege (UI)	Privilege (API)
Set custom attribute	Global.SetCustomField

## Host Object

Privilege (UI)	Privilege (API)
Modify cluster	Host.Inventory.EditCluster

## Inventory Service Object

Privilege (UI)	Privilege (API)
vSphere Tagging > Create vSphere Tag	InventoryService.Tagging.CreateTag
vSphere Tagging > Delete vSphere Tag	InventoryService.Tagging.EditTag
vSphere Tagging > Edit vSphere Tag	InventoryService.Tagging.DeleteTag

## Network Object

Privilege (UI)	Privilege (API)
Assign network	Network.Assign

## Resource Object

Privilege (UI)	Privilege (API)
Assign virtual machine to resource pool	Resource.AssignVMToPool
Migrate powered off virtual machine	Resource.ColdMigrate
Migrate powered on virtual machine	Resource.HotMigrate

## vApp Object

Grant these privileges at the resource pool level.

Privilege (UI)	Privilege (API)
Import	VApp.Import
vApp application configuration	VApp.ApplicationConfig

## Virtual Machine Object

### Configuration

Privilege (UI)	Privilege (API)
Add existing disk	VirtualMachine.Config.AddExistingDisk
Add new disk	VirtualMachine.Config.AddNewDisk
Add or remove device	VirtualMachine.Config.AddRemoveDevice
Advanced	VirtualMachine.Config.AdvancedConfig
Change CPU count	VirtualMachine.Config.CPUCount
Change resource	VirtualMachine.Config.Resource
Configure managedBy	VirtualMachine.Config.ManagedBy
Disk change tracking	VirtualMachine.Config.ChangeTracking
Disk lease	VirtualMachine.Config.DiskLease
Display connection settings	VirtualMachine.Config.MksControl
Extend virtual disk	VirtualMachine.Config.DiskExtend
Memory	VirtualMachine.Config.Memory
Modify device settings	VirtualMachine.Config.EditDevice

Raw device	VirtualMachine.Config.RawDevice
Reload from path	VirtualMachine.Config.ReloadFromPath
Remove disk	VirtualMachine.Config.RemoveDisk
Rename	VirtualMachine.Config.Rename
Reset guest information	VirtualMachine.Config.ResetGuestInfo
Set annotation	VirtualMachine.Config.Annotation
Settings	VirtualMachine.Config.Settings
Swapfile placement	VirtualMachine.Config.SwapPlacement
Unlock virtual machine	VirtualMachine.Config.Unlock

## Guest Operations

Privilege (UI)	Privilege (API)
Guest Operation Program Execution	VirtualMachine.GuestOperations.Execute
Guest Operation Modifications	VirtualMachine.GuestOperations.Modify
Guest Operation Queries	VirtualMachine.GuestOperations.Query

## Interaction

Privilege (UI)	Privilege (API)
Answer question	VirtualMachine.Interact.AnswerQuestion
Configure CD media	VirtualMachine.Interact.SetCDMedia
Console interaction	VirtualMachine.Interact.ConsoleInteract
Defragment all disks	VirtualMachine.Interact.DefragmentAllDisks
Device connection	VirtualMachine.Interact.DeviceConnection
Guest operating system management by VIX API	VirtualMachine.Interact.GuestControl
Power off	VirtualMachine.Interact.PowerOff
Power on	VirtualMachine.Interact.PowerOn
Reset	VirtualMachine.Interact.Reset
Suspend	VirtualMachine.Interact.Suspend
VMware Tools install	VirtualMachine.Interact.ToolsInstall

## Inventory

Privilege (UI)	Privilege (API)
Create from existing	VirtualMachine.Inventory.CreateFromExisting
Create new	VirtualMachine.Inventory.Create
Move	VirtualMachine.Inventory.Move
Register	VirtualMachine.Inventory.Register
Remove	VirtualMachine.Inventory.Delete
Unregister	VirtualMachine.Inventory.Unregister

## Provisioning

Privilege (UI)	Privilege (API)
Allow disk access	VirtualMachine.Provisioning.DiskRandomAccess
Allow read-only disk access	VirtualMachine.Provisioning.DiskRandomRead
Allow virtual machine download	VirtualMachine.Provisioning.GetVmFiles
Allow virtual machine files upload	VirtualMachine.Provisioning.PutVmFiles
Clone template	VirtualMachine.Provisioning.CloneTemplate
Clone virtual machine	VirtualMachine.Provisioning.Clone
Customize	VirtualMachine.Provisioning.Customize

Deploy template Mark as template	VirtualMachine.Provisioning.DeployTemplate VirtualMachine.Provisioning.MarkAsTemplate
Mark as virtual machine	VirtualMachine.Provisioning.MarkAsVM
Modify customization specification	VirtualMachine.Provisioning.ModifyCustSpecs
Promote disks	VirtualMachine.Provisioning.PromoteDisks
Read customization specifications	VirtualMachine.Provisioning.ReadCustSpecs

## Snapshot Management

Privilege (UI)	Privilege (API)
Create snapshot	VirtualMachine.State.CreateSnapshot
Remove snapshot	VirtualMachine.State.RemoveSnapshot
Rename snapshot	VirtualMachine.State.RenameSnapshot
Revert snapshot	VirtualMachine.State.RevertToSnapshot

## Next Steps

After you complete the instructions provided in this topic, install one of the following:

- Pivotal Ops Manager v2.2.3 or later
- Pivotal Ops Manager v2.3.1 or later
- Pivotal Ops Manager v2.4.x

 **Note:** You use Ops Manager to install and configure PKS. Each version of Ops Manager supports multiple versions of PKS. To confirm that your Ops Manager version supports the version of PKS that you install, see [PKS Release Notes](#).

To install an Ops Manager version that is compatible with the PKS version you intend to use, follow the instructions in the corresponding version of the Ops Manager documentation.

Version	
Ops Manager v2.2	<ul style="list-style-type: none"> <li>• <a href="#">Deploying BOSH and Ops Manager to vSphere ↗</a></li> <li>• <a href="#">Configuring BOSH Director on vSphere ↗</a></li> </ul>
Ops Manager v2.3	<ul style="list-style-type: none"> <li>• <a href="#">Deploying BOSH and Ops Manager to vSphere ↗</a></li> <li>• <a href="#">Configuring BOSH Director on vSphere ↗</a></li> </ul>
Ops Manager v2.4	<ul style="list-style-type: none"> <li>• <a href="#">Deploying BOSH and Ops Manager to vSphere ↗</a></li> <li>• <a href="#">Configuring BOSH Director on vSphere ↗</a></li> </ul>

## Installing PKS on vSphere

Page last updated:

This topic describes how to install and configure Pivotal Container Service (PKS) on vSphere.

### Prerequisites

Before performing the procedures in this topic, you must have deployed and configured Ops Manager. For more information, see [vSphere Prerequisites and Resource Requirements](#).

If you use an instance of Ops Manager that you configured previously to install other runtimes, confirm the following settings before you install PKS:

1. Navigate to Ops Manager.
2. Open the **Director Config** pane.
3. Select the **Enable Post Deploy Scripts** checkbox.
4. Clear the **Disable BOSH DNS server for troubleshooting purposes** checkbox.
5. Click the **Installation Dashboard** link to return to the Installation Dashboard.
6. Click **Review Pending Changes**. Select all products you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).

 **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

7. Click **Apply Changes**.

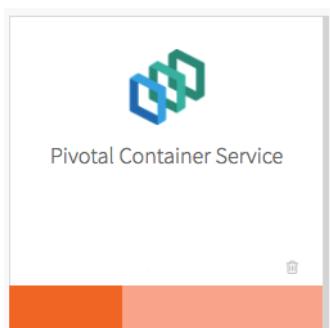
### Step 1: Install PKS

To install PKS, do the following:

1. Download the product file from [Pivotal Network](#).
2. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
3. Click **Import a Product** to upload the product file.
4. Under **Pivotal Container Service** in the left column, click the plus sign to add this product to your staging area.

### Step 2: Configure PKS

Click the orange **Pivotal Container Service** tile to start the configuration process.



**⚠️ WARNING:** When you configure the PKS tile, do not use spaces in any field entries. This includes spaces between characters as well as leading and trailing spaces. If you use a space in any field entry, the deployment of PKS fails.

## Assign AZs and Networks

Perform the following steps:

1. Click **Assign AZs and Networks**.
2. Select the availability zone (AZ) where you want to deploy the PKS API VM as a singleton job.

**Note:** You must select an additional AZ for balancing other jobs before clicking **Save**, but this selection has no effect in the current version of PKS.

Place singleton jobs in  
 us-west-2a  
 us-west-2b  
 us-west-2c

Balance other jobs in  
 us-west-2a  
 us-west-2b  
 us-west-2c

Network

Service Network

Save

3. Under **Network**, select the infrastructure subnet you created for the PKS API VM.
4. Under **Service Network**, select the services subnet you created for Kubernetes cluster VMs.
5. Click **Save**.

## PKS API

Perform the following steps:

1. Click **PKS API**.
2. Navigate to your DNS provider and create an entry that points a fully qualified domain name (FQDN) within your system domain to the public IP address of the load balancer for the PKS API. For example, `api.pks.example.com`.

To retrieve the public IP address of the PKS API load balancer, log in to your IaaS console. If you used Terraform, you can also find the IP address in the `terraform.tfstate` file.

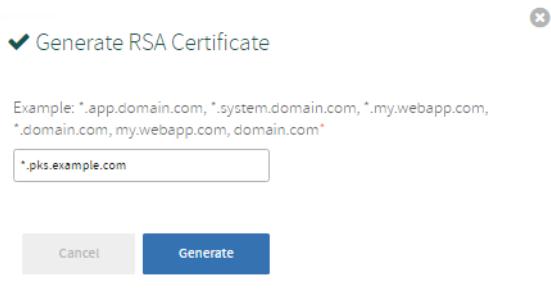
3. Under **Certificate to secure the PKS API**, provide your own certificate and private key pair.

The certificate that you supply should cover the domain that routes to the PKS API VM with TLS termination on the ingress.

If you do not have a certificate and private key pair, PKS can generate one for you by performing the following steps.

**Note:** If you configured Ops Manager Front End without a certificate, you can use this new certificate to complete Ops Manager configuration. To configure your Ops Manager Front End certificate, see [Configure Front End](#).

- Select the **Generate RSA Certificate** link.
- Enter the domain for your API hostname. This can be a standard FQDN or a wildcard domain.
- Click **Generate**.



- Under **API Hostname (FQDN)**, enter the FQDN that you have registered to point to the PKS API load balancer, such as `api.pks.example.com`.
- Under **Worker VM Max in Flight**, enter the maximum number of non-canary worker instances to create or resize in parallel within an availability zone.

This field sets the `max_in_flight` variable, which limits how many instances of a component can start simultaneously when a cluster is created or resized. The variable defaults to `1`, which means that only one component starts at a time.

- Click **Save**.

## Plans

To activate a plan, perform the following steps:

- Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.

**Note:** A plan defines a set of resource types used for deploying clusters. You can configure up to three plans. You must configure **Plan 1**.

- Select **Active** to activate the plan and make it available to developers deploying clusters.

**Plan\***

Active

**Name \***

**Description \***

Example: This plan will configure a lightweight kubernetes cluster. Not recommended for production workloads.

The plan description for the service instance

**Master/ETCD Node Instances ( min: 1, max: 3 ) \***

**Master/ETCD VM Type\***

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

**Master Persistent Disk Type\***

10 GB

**Master/ETCD Availability Zones \***

us-central1-f  
 us-central1-a  
 us-central1-c

3. Under **Name**, provide a unique name for the plan.
4. Under **Description**, edit the description as needed. The plan description appears in the Services Marketplace, which developers can access by using PKS CLI.
5. Under **Master/ETCD Node Instances**, select the default number of Kubernetes master/etcd nodes to provision for each cluster. You can enter either **1** or **3**.

**Note:** If you deploy a cluster with multiple master/etcd node VMs, confirm that you have sufficient hardware to handle the increased load on disk write and network traffic. For more information, see [Hardware recommendations](#) in the etcd documentation.

In addition to meeting the hardware requirements for a multi-master cluster, we recommend configuring monitoring for etcd to monitor disk latency, network latency, and other indicators for the health of the cluster. For more information, see [Monitoring Master/etcd Node VMs](#).

- ⚠ WARNING:** To change the number of master/etcd nodes for a plan, you must ensure that no existing clusters use the plan. PKS does not support changing the number of master/etcd nodes for plans with existing clusters.
6. Under **Master/ETCD VM Type**, select the type of VM to use for Kubernetes master/etcd nodes. For more information, see the [Master Node VM Size](#) section of *VM Sizing for PKS Clusters*.
  7. Under **Master Persistent Disk Type**, select the size of the persistent disk for the Kubernetes master node VM.
  8. Under **Master/ETCD Availability Zones**, select one or more AZs for the Kubernetes clusters deployed by PKS. If you select more than one AZ, PKS deploys the master VM in the first AZ and the worker VMs across the remaining AZs.
  9. Under **Maximum number of workers on a cluster**, set the maximum number of Kubernetes worker node VMs that PKS can deploy for each cluster.

**Note:** Clusters with more than 200 workers have not been validated.

Maximum number of workers on a cluster (min: 1) \*

Worker Node Instances (min: 1, max: 50) \*

Worker VM Type\*

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

Worker Persistent Disk Type\*

50 GB

Worker Availability Zones \*

us-central1-f  
 us-central1-a  
 us-central1-c

Errand VM Type\*

micro (cpu: 1, ram: 1 GB, disk: 8 GB)

- Under **Worker Node Instances**, select the default number of Kubernetes worker nodes to provision for each cluster.

If the user creating a cluster with the PKS Command Line Interface (CLI) does not specify a number of worker nodes, the cluster is deployed with the default number set in this field. This value cannot be greater than the maximum worker node value you set in the previous field. For more information about creating clusters, see [Creating Clusters](#).

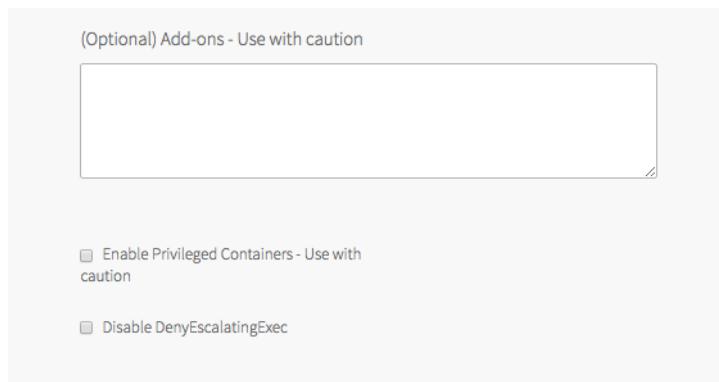
For high availability, create clusters with a minimum of three worker nodes, or two per AZ if you intend to use PersistentVolumes (PVs). For example, if you deploy across three AZs, you should have six worker nodes. For more information about PVs, see [PersistentVolumes](#) in *Maintaining Workload Uptime*. Provisioning a minimum of three worker nodes, or two nodes per AZ is also recommended for stateless workloads.

If you later reconfigure the plan to adjust the default number of worker nodes, the existing clusters that have been created from that plan are not automatically upgraded with the new default number of worker nodes.

- Under **Worker VM Type**, select the type of VM to use for Kubernetes worker node VMs. For more information, see the [Worker Node VM Number and Size](#) section of *VM Sizing for PKS Clusters*.

**Note:** If you install PKS in an NSX-T environment, we recommend that you select a **Worker VM Type** with a minimum disk size of 16 GB. The disk space provided by the default **medium** Worker VM Type is insufficient for PKS with NSX-T.

- Under **Worker Persistent Disk Type**, select the size of the persistent disk for the Kubernetes worker node VMs.
- Under **Worker Availability Zones**, select one or more AZs for the Kubernetes worker nodes. PKS deploys worker nodes equally across the AZs you select.
- Under **Errand VM Type**, select the size of the VM that contains the errand. The smallest instance possible is sufficient, as the only errand running on this VM is the one that applies the **Default Cluster App** YAML configuration.
- (Optional) Under **(Optional) Add-ons - Use with caution**, enter additional YAML configuration to add custom workloads to each cluster in this plan. You can specify multiple files using **---** as a separator. For more information, see [Adding Custom Workloads](#).



16. (Optional) To allow users to create pods with privileged containers, select the **Enable Privileged Containers - Use with caution** option. For more information, see [Pods](#) in the Kubernetes documentation.
17. (Optional) To disable the admission controller, select the **Disable DenyEscalatingExec** checkbox. If you select this option, clusters in this plan can create security vulnerabilities that may impact other tiles. Use this feature with caution.
18. Click **Save**.

To deactivate a plan, perform the following steps:

1. Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.
2. Select **Plan Inactive**.
3. Click **Save**.

## Kubernetes Cloud Provider

In the procedure below, you use credentials for vCenter master VMs. You must have provisioned the service account with the correct permissions. For more information, see [Create the Master Node Service Account](#) in *Preparing vSphere Before Deploying PKS*.

To configure your Kubernetes cloud provider settings, follow the procedure below:

1. Click **Kubernetes Cloud Provider**.
2. Under **Choose your IaaS**, select **vSphere**.
3. Ensure the values in the following procedure match those in the **vCenter Config** section of the **Ops Manager** tile.

Choose your IaaS\*

- GCP
- vSphere

vCenter Master Credentials \*

Username
Password

vCenter Host \*

--

Datacenter Name \*

--

Datastore Name \*

--

Stored VM Folder \*

--

- a. Enter your **vCenter Master Credentials**. Enter the username using the format `user@CF-EXAMPLE.com`. For more information about the master node service account, see [Preparing to Deploy PKS on vSphere](#).
- b. Enter your **vCenter Host**. For example, `vcenter.CF-EXAMPLE.com`.
- c. Enter your **Datacenter Name**. For example, `CF-EXAMPLE-dc`.
- d. Enter your **Datastore Name**. For example, `CF-EXAMPLE-ds`.
- e. Enter the **Stored VM Folders** so that the persistent stores know where to find the VMs. To retrieve the name of the folder, navigate to your BOSH Director tile, click **vCenter Config**, and locate the value for **VM Folder**. The default folder name is `pcf_vms`.



**Note:** We recommend using a shared datastore for multi-AZ and multi-cluster environments.

4. Click **Save**.

## (Optional) Logging

You can designate an external syslog endpoint for PKS component and cluster log messages.

To specify the destination for PKS log messages, do the following:

1. Click **Logging**.
2. To enable syslog forwarding, select **Yes**.

Enable Syslog for PKS?\*

No  
 Yes

Address \*

Port \*

Transport Protocol\*

Enable TLS

Permitted Peer

TLS Certificate

3. Under **Address**, enter the destination syslog endpoint.
4. Under **Port**, enter the destination syslog port.
5. Select a transport protocol for log forwarding.
6. (Optional) Pivotal strongly recommends that you enable TLS encryption when forwarding logs as they may contain sensitive information. For example, these logs may contain cloud provider credentials. To enable TLS, perform the following steps:
  - a. Under **Permitter Peer**, provide the accepted fingerprint (SHA1) or name of remote peer. For example, `*.YOUR-LOGGING-SYSTEM.com`.
  - b. Under **TLS Certificate**, provide a TLS certificate for the destination syslog endpoint.

**Note:** You do not need to provide a new certificate if the TLS certificate for the destination syslog endpoint is signed by a Certificate Authority (CA) in your BOSH certificate store.

7. You can manage logs using [VMware vRealize Log Insight \(vRLI\)](#). The integration pulls logs from all BOSH jobs and containers running in the cluster, including node logs from core Kubernetes and BOSH processes, Kubernetes event logs, and POD stdout and stderr.

**Note:** Before you configure the vRLI integration, you must have a vRLI license and vRLI must be installed, running, and available in your environment. You need to provide the live instance address during configuration. For instructions and additional information, see the [vRealize Log Insight documentation](#).

By default, vRLI logging is disabled. To enable and configure vRLI logging, under **Enable VMware vRealize Log Insight Integration?**, select **Yes** and

Enable VMware vRealize Log Insight Integration?\*

No  
 Yes

Host \*

Enable SSL?

Disable SSL certificate validation

CA certificate

Rate limiting \*

then perform the following steps:

- Under **Host**, enter the IP address or FQDN of the vRLI host.
- (Optional) Select the **Enable SSL?** checkbox to encrypt the logs being sent to vRLI using SSL.
- Choose one of the following SSL certificate validation options:
  - To skip certificate validation for the vRLI host, select the **Disable SSL certificate validation** checkbox. Select this option if you are using a self-signed certificate in order to simplify setup for a development or test environment.



**Note:** Disabling certificate validation is not recommended for production environments.

- To enable certificate validation for the vRLI host, clear the **Disable SSL certificate validation** checkbox.
- (Optional) If your vRLI certificate is not signed by a trusted CA root or other well known certificate, enter the certificate in the **CA certificate** field. Locate the PEM of the CA used to sign the vRLI certificate, copy the contents of the certificate file, and paste them into the field. Certificates must be in PEM-encoded format.
- Under **Rate limiting**, enter a time in milliseconds to change the rate at which logs are sent to the vRLI host. The rate limit specifies the minimum time between messages before the fluentd agent begins to drop messages. The default value (0) means the rate is not limited, which suffices for many deployments.



**Note:** If your deployment is generating a high volume of logs, you can increase this value to limit network traffic. Consider starting with a lower number, such as 10, and tuning to optimize for your deployment. A large number might result in dropping too many log entries.

- To enable clusters to drain app logs to sinks using `syslog://`, select the **Enable Sink Resources** checkbox. For more information about using sink resources, see [Creating Sink Resources](#).

Enable Sink Resources

**Save**

- Click **Save**. These settings apply to any clusters created after you have saved these configuration settings and clicked **Apply Changes**. If the **Upgrade all clusters errand** has been enabled, these settings are also applied to existing clusters.

**Note:** The PKS tile does not validate your vRLI configuration settings. To verify your setup, look for log entries in vRLI.

## Networking

To configure networking, do the following:

1. Click **Networking**.

Container Networking Interface\*

Flannel  
 NSX-T

HTTP/HTTPS Proxy (for vSphere only)\*

Disabled  
 Enabled

Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)  
 Enable outbound internet access

2. Under **Container Networking Interface**, select **Flannel**.

3. (Optional) Configure a global proxy for all outgoing HTTP and HTTPS traffic from your Kubernetes clusters. This setting will not set the proxy for running Kubernetes workloads or pods.

Production environments can deny direct access to public Internet services and between internal services by placing an HTTP or HTTPS proxy in the network path between Kubernetes nodes and those services.

If your environment includes HTTP or HTTPS proxies, configuring PKS to use these proxies allows PKS-deployed Kubernetes nodes to access public Internet services and other internal services. Follow the steps below to configure a global proxy for all outgoing HTTP/HTTPS traffic from your Kubernetes clusters:

HTTP/HTTPS Proxy (for vSphere only)\*

Disabled  
 Enabled

HTTP Proxy URL

HTTP Proxy Credentials

Username  
Password

HTTPS Proxy URL

HTTPS Proxy Credentials

Username  
Password

No Proxy

- Under **HTTP/HTTPS proxy**, select **Enabled**.
- Under **HTTP Proxy URL**, enter the URL of your HTTP/HTTPS proxy endpoint. For example, `http://myproxy.com:1234`.
- (Optional) If your proxy uses basic authentication, enter the username and password under **HTTP Proxy Credentials**.
- Under **No Proxy**, enter the service network CIDR where your PKS cluster is deployed. List any additional IP addresses that should bypass the proxy.



**Note:** By default, the `.internal`, `10.100.0.0/8`, and `10.200.0.0/8` IP address ranges are not proxied. This allows internal PKS communication.

- Under **Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)**, ignore the **Enable outbound internet access** checkbox.

- Click **Save**.

## UAA

To configure the UAA server, do the following:

1. Click **UAA**.
2. Under **PKS CLI Access Token Lifetime**, enter a time in seconds for the PKS CLI access token lifetime.

The screenshot shows a configuration form for UAA. It includes fields for 'PKS API Access Token Lifetime (in seconds)' (set to 600) and 'PKS API Refresh Token Lifetime (in seconds)' (set to 21600). A checkbox 'Enable UAA as OIDC provider' is checked. Below these, there's a note about configuring the user account store with either internal or external mechanisms, followed by two radio button options: 'Internal UAA' (selected) and 'LDAP Server'.

3. Under **PKS CLI Refresh Token Lifetime**, enter a time in seconds for the PKS CLI refresh token lifetime.
4. Select one of the following options:

- o To use an internal user account store for UAA, select **Internal UAA**. Click **Save** and continue to [\(Optional\) Monitoring](#).
- o To use an external user account store for UAA, select **LDAP Server** and continue to [Configure LDAP as an Identity Provider](#).

**Note:** Selecting **LDAP Server** allows admin users to give cluster access to groups of users. For more information about performing this procedure, see [Grant Cluster Access to a Group](#) in *Managing Users in PKS with UAA*.

## Configure LDAP as an Identity Provider

To integrate UAA with one or more LDAP servers, configure PKS with your LDAP endpoint information as follows:

1. Under **UAA**, select **LDAP Server**.

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA

LDAP Server

Server URL \*

`ldaps://example.com`

LDAP Credentials \*

Username

Password

User Search Base \*

`ou=Groups,dc=example,dc=com`

User Search Filter \*

`cn={0}`

Group Search Base

`ou=Groups,dc=example,dc=com`

Group Search Filter \*

`member={0}`

2. For **Server URL**, enter the URLs that point to your LDAP server. If you have multiple LDAP servers, separate their URLs with spaces. Each URL must include one of the following protocols:

- `ldap://` : Use this protocol if your LDAP server uses an unencrypted connection.
- `ldaps://` : Use this protocol if your LDAP server uses SSL for an encrypted connection. To support an encrypted connection, the LDAP server must hold a trusted certificate or you must import a trusted certificate to the JVM truststore.

3. For **LDAP Credentials**, enter the LDAP Distinguished Name (DN) and password for binding to the LDAP server. For example, `cn=administrator,ou=Users,dc=example,dc=com`. If the bind user belongs to a different search base, you must use the full DN.

**Note:** We recommend that you provide LDAP credentials that grant read-only permissions on the LDAP search base and the LDAP group search base.

4. For **User Search Base**, enter the location in the LDAP directory tree where LDAP user search begins. The LDAP search base typically matches your domain name.

For example, a domain named `cloud.example.com` may use `ou=Users,dc=example,dc=com` as its LDAP user search base.

5. For **User Search Filter**, enter a string to use for LDAP user search criteria. The search criteria allows LDAP to perform more effective and efficient searches. For example, the standard LDAP search filter `cn=Smith` returns all objects with a common name equal to `Smith`.

In the LDAP search filter string that you use to configure PKS, use `{0}` instead of the username. For example, use `cn={0}` to return all LDAP objects with the same common name as the username.

In addition to `cn`, other common attributes are `mail`, `uid` and, in the case of Active Directory, `sAMAccountName`.

**Note:** For information about testing and troubleshooting your LDAP search filters, see [Configuring LDAP Integration with Pivotal Cloud Foundry](#).

6. For **Group Search Base**, enter the location in the LDAP directory tree where the LDAP group search begins.

For example, a domain named `cloud.example.com` may use `ou=Groups,dc=example,dc=com` as its LDAP group search base.

Follow the instructions in the [Grant PKS Access to an External LDAP Group](#) section of *Managing Users in PKS with UAA* to map the groups under this search base to roles in PKS.

7. For **Group Search Filter**, enter a string that defines LDAP group search criteria. The standard value is `member={0}`.

8. For **Server SSL Cert**, paste in the root certificate from your CA certificate or your self-signed certificate.

Server SSL Cert

Server SSL Cert AltName

First Name Attribute

Last Name Attribute

Email Attribute \*

mail

Email Domain(s)

LDAP Referrals\*

Automatically follow any referrals

9. For **Server SSL Cert AltName**, do one of the following:

- o If you are using `ldaps://` with a self-signed certificate, enter a Subject Alternative Name (SAN) for your certificate.
- o If you are not using `ldaps://` with a self-signed certificate, leave this field blank.

10. For **First Name Attribute**, enter the attribute name in your LDAP directory that contains user first names. For example, `cn`.

11. For **Last Name Attribute**, enter the attribute name in your LDAP directory that contains user last names. For example, `sn`.

12. For **Email Attribute**, enter the attribute name in your LDAP directory that contains user email addresses. For example, `mail`.

13. For **Email Domain(s)**, enter a comma-separated list of the email domains for external users who can receive invitations to Apps Manager.

14. For **LDAP Referrals**, choose how UAA handles LDAP server referrals to other user stores. UAA can follow the external referrals, ignore them without returning errors, or generate an error for each external referral and abort the authentication.

15. For **External Groups Whitelist**, enter a comma-separated list of group patterns which need to be populated in the user's `id_token`. For further information on accepted patterns see the description of the `config.externalGroupsWhitelist` in the OAuth/OIDC [Identity Provider Documentation](#).

**Note:** When sent as a Bearer token in the Authentication header, wide pattern queries for users who are members of multiple groups, can cause the size of the `id_token` to extend beyond what is supported by web servers.

#### External Groups Whitelist

\*

Comma-separated list of external groups from LDAP that get added as roles in the ID Token, required to allow access to cluster to groups

16. Click **Save**.

(Optional) Configure OpenID Connect

You can use OpenID Connect (OIDC) to instruct Kubernetes to verify end-user identities based on authentication performed by an authorization server, such as UAA.

To configure PKS to use OIDC, select **Enable UAA as OIDC provider**. With OIDC enabled, Admin Users can grant cluster-wide access to Kubernetes end users.

PKS API Access Token Lifetime (in seconds) \*

PKS API Refresh Token Lifetime (in seconds) \*

Enable UAA as OIDC provider      This will configure created clusters to use UAA as the OIDC provider.

For more information about configuring OIDC, see the table below:

Option	Description
OIDC disabled	If you do not enable OIDC, Kubernetes authenticates users against its internal user management system.
OIDC enabled	If you enable OIDC, Kubernetes uses the authentication mechanism that you selected in <a href="#">UAA</a> : <ul style="list-style-type: none"> <li>• If you selected <b>Internal UAA</b>, Kubernetes authenticates users against the internal UAA authentication mechanism.</li> <li>• If you selected <b>LDAP Server</b>, Kubernetes authenticates users against the LDAP server.</li> </ul>

For additional information on getting credentials with OIDC configured, see [Retrieve Cluster Credentials](#) in *Retrieving Cluster Credentials and Configuration*.

**Note:** When you enable OIDC, existing PKS-provisioned Kubernetes clusters are upgraded to use OIDC. This invalidates your kubeconfig files. You must regenerate the files for all clusters.

## (Optional) Monitoring

You can monitor Kubernetes clusters and pods metrics externally using the integration with [Wavefront by VMware](#).

**Note:** Before you configure Wavefront integration, you must have an active Wavefront account and access to a Wavefront instance. You provide your Wavefront access token during configuration and enabling errands. For additional information, see [Pivotal Container Service Integration Details](#) in the Wavefront documentation.

By default, monitoring is disabled. To enable and configure Wavefront monitoring, do the following:

1. Under **Wavefront Integration**, select **Yes**.

Pivotal Container Service

- Settings
- Status
- Credentials
- Logs

Assign AZs and Networks

PKS API

Plan 1

Plan 2

Plan 3

Kubernetes Cloud Provider

Logging

Networking

UAA

Monitoring

Usage Data

Configure PKS Monitoring Integration(s)

Wavefront Integration\*

No

Yes

Wavefront URL \*

1

The URL of your Wavefront Subscription, ex: https://try.wavefront.com/api

Wavefront Access Token \*

2

Change

Wavefront Alert Recipient

3

Save

2. Under **Wavefront URL**, enter the URL of your Wavefront subscription. For example, `https://try.wavefront.com/api`.
3. Under **Wavefront Access Token**, enter the API token for your Wavefront subscription.
4. To configure Wavefront to send alerts by email, enter email addresses or Wavefront Target IDs separated by commas under **Wavefront Alert Recipient**. For example: `user@example.com,Wavefront_TargetID`. To create alerts, you must enable errands.
5. In the **Errands** tab, enable **Create pre-defined Wavefront alerts errand** and **Delete pre-defined Wavefront alerts errand**.

PKS API

Errands are scripts that run at designated points during an installation.

Plan 1

Post-Deploy Errands

Plan 2

NSX-T Validation errand

On

Plan 3

Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied

Off

Kubernetes Cloud Provider

Create pre-defined Wavefront alerts errand

1 Default (Off)

Logging

Networking

UAA

Monitoring

Usage Data

Errands

Pre-Delete Errands

Delete all clusters errand

Default (On)

Resource Config

Delete pre-defined Wavefront alerts errand

2 Default (Off)

6. Click **Save**. Your settings apply to any clusters created after you have saved these configuration settings and clicked **Apply Changes**.

**Note:** The PKS tile does not validate your Wavefront configuration settings. To verify your setup, look for cluster and pod metrics in

Wavefront.

## Usage Data

VMware's Customer Experience Improvement Program (CEIP) and the Pivotal Telemetry Program (Telemetry) provides VMware and Pivotal with information that enables the companies to improve their products and services, fix problems, and advise you on how best to deploy and use our products. As part of the CEIP and Telemetry, VMware and Pivotal collect technical information about your organization's use of the Pivotal Container Service ("PKS") on a regular basis. Since PKS is jointly developed and sold by VMware and Pivotal, we will share this information with one another. Information collected under CEIP or Telemetry does not personally identify any individual.

Regardless of your selection in the **Usage Data** pane, a small amount of data is sent from Cloud Foundry Container Runtime (CFCR) to the PKS tile. However, that data is not shared externally.

To configure the **Usage Data** pane:

1. Select the **Usage Data** side-tab.
2. Read the Usage Data description.
3. Make your selection.
  - a. To join the program, select **Yes, I want to join the CEIP and Telemetry Program for PKS**.
  - b. To decline joining the program, select **No, I do not want to join the CEIP and Telemetry Program for PKS**.
4. Click **Save**.

 **Note:** If you join the CEIP and Telemetry Program for PKS, open your firewall to allow outgoing access to <https://vcsa.vmware.com/ph-prd> on port 443

## Errands

Errands are scripts that run at designated points during an installation.

To configure when post-deploy and pre-delete errands for PKS are run, make a selection in the dropdown next to the errand. For a typical PKS deployment, we recommend that you leave the default settings.

## NSX-T Validation errand

Validates NSX-T configuration and tags resources

Default (Off)



## Upgrade all clusters errand

Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied

Default (On)



## Create pre-defined Wavefront alerts errand

Create pre-defined Wavefront alerts

Default (Off)



## Pre-Delete Errands

### Delete all clusters errand

Deletes all clusters provisioned by PKS when the PKS tile is deleted

Default (On)



### Delete pre-defined Wavefront alerts errand

Delete pre-defined Wavefront alerts errand

Default (Off)



For more information about errands and their configuration state, see [Managing Errands in Ops Manager](#).

**WARNING:** Because PKS uses floating stemcells, updating the PKS tile with a new stemcell triggers the rolling of every VM in each cluster. Also, updating other product tiles in your deployment with a new stemcell causes the PKS tile to roll VMs. This rolling is enabled by the **Upgrade all clusters errand**. We recommend that you keep this errand turned on because automatic rolling of VMs ensures that all deployed cluster VMs are patched. However, automatic rolling can cause downtime in your deployment.

If you are upgrading PKS, you must enable the **Upgrade All Clusters** errand.

## Resource Config

To modify the resource usage of PKS, click **Resource Config** and edit the **Pivotal Container Service** job.

Resource Config					
JOB	INSTANCES	PERSISTENT DISK TYPE	VM TYPE	LOAD BALANCERS	INTERNET CONNECTED
Pivotal Container Service	Automatic: 1	Automatic: 10 GB	Automatic: large	tcp:pks-api	<input checked="" type="checkbox"/>

**Note:** If you experience timeouts or slowness when interacting with the PKS API, select a VM Type with greater CPU and memory resources for the Pivotal Container Service job.

## Step 3: Apply Changes

1. Return to the Ops Manager Installation Dashboard.

2. Click **Review Pending Changes**. Select the product that you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).

 **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

3. Click **Apply Changes**.

## Step 4: Retrieve the PKS API Endpoint

You must share the PKS API endpoint to allow your organization to use the API to create, update, and delete clusters. For more information, see [Creating Clusters](#).

To retrieve the PKS API endpoint, do the following:

1. Navigate to the Ops Manager Installation Dashboard.
2. Click the Pivotal Container Service tile.
3. Click the **Status** tab and locate the **Pivotal Container Service** job. The IP address of the Pivotal Container Service job is the PKS API endpoint.

## Step 5: Configure External Load Balancer

After you install the PKS tile, configure an external load balancer to access the PKS API from outside the network. You can use any external load balancer.

Your external load balancer forwards traffic to the PKS API endpoint on ports 8443 and 9021. Configure the external load balancer to resolve to the domain name you set in the [PKS API](#) section of the tile configuration.

Configure your load balancer with the following information:

- IP address from [Retrieve PKS API Endpoint](#)
- Ports 8443 and 9021
- HTTPS or TCP protocol

## Step 6: Install the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## Step 7: Configure PKS API Access

Follow the procedures in [Configuring PKS API Access](#).

## Step 8: Configure Authentication for PKS

Configure authentication for PKS using User Account and Authentication (UAA). For information, see [Managing Users in PKS with UAA](#).

## Next Steps

After installing PKS on vSphere, you may want to do the following:

- Integrate VMware Harbor with PKS to store and manage container images. For more information, see [Integrating VMware Harbor Registry with PKS](#).
- Create your first PKS cluster. For more information, see [Creating Clusters](#).

## Installing PKS on vSphere with NSX-T Data Center

This topic lists the sections to follow when installing PKS on vSphere with NSX-T Data Center.

### Preparing to Install PKS on vSphere with NSX-T

In preparation for installing PKS on vSphere with NSX-T, review the following documentation:

- [Prerequisites and Resource Requirements](#)
- [Firewall Ports and Protocols Requirements](#)
- [NSX-T Deployment Topologies for PKS](#)
- [Preparing to Deploy PKS with NSX-T on vSphere](#)

### Installing PKS on vSphere with NSX-T

To install PKS on vSphere with NSX-T, complete the instructions in each of the following sections in the order listed:

- [Deploying NSX-T for PKS](#)
- [Creating the PKS Management Plane](#)
- [Creating the PKS Compute Plane](#)
- [Deploying Ops Manager with NSX-T for PKS](#)
- [Generating and Registering the NSX Manager Certificate for PKS](#)
- [Configuring BOSH Director with NSX-T for PKS](#)
- [Generating and Registering the NSX Manager Superuser Principal Identity Certificate and Key for PKS](#)
- [Creating NSX-T Objects for PKS](#)
- [Installing PKS on vSphere with NSX-T](#)
- [Implementing a Multi-Foundation PKS Deployment](#)

### Post-Installation NSX-T Configurations

After you have installed PKS on vSphere with NSX-T, refer to the following sections for additional NSX-T configuration options:

- [Using Proxies with PKS on NSX-T](#)
- [Defining Network Profiles](#)
- [Configuring Multiple Tier-0 Routers for Tenant Isolation](#)

### Installing the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

### Installing Harbor Registry

To install Harbor Registry for PKS, see [Integrating VMware Harbor with PKS](#).



## vSphere with NSX-T Prerequisites and Resource Requirements

Page last updated:

This topic describes the prerequisites and resource requirements for installing Pivotal Container Service (PKS) on vSphere with NSX-T integration.

For prerequisites and resource requirements for installing PKS on vSphere without NSX-T integration, see [vSphere Prerequisites and Resource Requirements](#).

PKS supports air-gapped deployments on vSphere with or without NSX-T integration.

You can also configure integration with the Harbor tile, an enterprise-class registry server for container images. For more information, see [VMware Harbor Registry](#) in the *Pivotal Partner documentation*.

### Prerequisites

#### vSphere Version Requirements

PKS on vSphere supports the following vSphere component versions:

Versions	Editions
• VMware vSphere 6.7*	
• VMware vSphere 6.5 U2	
• VMware vSphere 6.5 U1	
• VMware vSphere 6.5 GA	
	• vSphere Enterprise Plus
	• vSphere with Operations Management Enterprise Plus

\* VMware vSphere 6.7 is supported on Ops Manager v2.3 and later and NSX-T v2.3.

#### NSX-T Integration Component Version Requirements

Deploying NSX-T requires the additional following component versions:

Component	Version
VMware NSX-T	2.2, 2.3

#### Pivotal Ops Manager

Before you install PKS, you must install one of the following:

- Pivotal Ops Manager v2.2.3 or later
- Pivotal Ops Manager v2.3.1 or later
- Pivotal Ops Manager v2.4.x

 **Note:** You use Ops Manager to install and configure PKS. Each version of Ops Manager supports multiple versions of PKS. To confirm that your Ops Manager version supports the version of PKS that you install, see [PKS Release Notes](#).

To install an Ops Manager version that is compatible with the PKS version you intend to use, follow the instructions in the corresponding version of the Ops Manager documentation.

Version	
Ops Manager v2.2	<ul style="list-style-type: none"><li>• <a href="#">Deploying BOSH and Ops Manager to vSphere</a></li><li>• <a href="#">Configuring BOSH Director on vSphere</a></li></ul>
Ops Manager v2.3	<ul style="list-style-type: none"><li>• <a href="#">Deploying BOSH and Ops Manager to vSphere</a></li></ul>

Ops Manager v2.3	<ul style="list-style-type: none"> <li><a href="#">Configuring BOSH Director on vSphere ↗</a></li> </ul>
Ops Manager v2.4	<ul style="list-style-type: none"> <li><a href="#">Deploying BOSH and Ops Manager to vSphere ↗</a></li> <li><a href="#">Configuring BOSH Director on vSphere ↗</a></li> </ul>

## Resource Requirements

### PKS

Installing Ops Manager and PKS requires the following virtual machines (VMs):

VM	CPU	RAM	Storage
Pivotal Container Service	2	8 GB	16 GB
Pivotal Ops Manager	1	8 GB	160 GB
BOSH Director	2	8 GB	16 GB

Each PKS deployment requires ephemeral VMs during installation and upgrades of PKS. After you deploy PKS, BOSH automatically deletes these VMs.

To enable PKS to dynamically create the ephemeral VMs when needed, ensure that the following resources are available in your vSphere infrastructure before deploying PKS:

Ephemeral VM	Number	CPU Cores	RAM	Ephemeral Disk
BOSH Compilation VMs	4	4	4 GB	16 GB

### Kubernetes

Each Kubernetes cluster provisioned through PKS deploys the VMs listed below. If you deploy more than one Kubernetes cluster, you must scale your allocated resources appropriately.

VM	Number	CPU Cores	RAM	Ephemeral Disk	Persistent Disk
master	1 or 3	2	4 GB	8 GB	5 GB
worker	1 or more	2	4 GB	8 GB	10 GB
errand (ephemeral)	1	1	1 GB	8 GB	none

### NSX-T

Deploying NSX-T requires the additional following resources from your vSphere environment:

NSX-T Component	Instance Count	Memory per Instance	vCPU per Instance	Disk Space per Instance
NSX Manager Appliance	1	16 GB	4	140 GB
NSX Controllers	3	16 GB	4	120 GB
NSX-T Edge	1 up to 8	16 GB	8	120 GB

## Firewall Requirements

For the firewall ports and protocols requirements for using PKS on vSphere with NSX-T integration, see [Firewall Ports and Protocols Requirements](#).

## Other Requirements

- Complete any confirmation tasks described in the [VMware NSX-T Data Center Documentation ↗](#) to verify your configuration before proceeding to the

next step.

- Comply with any requirements described in the [VMware NSX-T Data Center Documentation](#).

 **Note:** When you use NSX-T 2.1, creating namespaces with names longer than 40 characters may result in a truncated or hashed name in the NSX-T Manager UI.

## Firewall Ports and Protocols Requirements

Page last updated:

This topic describes the firewall ports and protocols requirements for using Pivotal Container Service (PKS) on vSphere with NSX-T integration.

In environments with strict inter-network access control policies, firewalls often require conduits to pass communication between system components on a different network or allow interfacing with external systems such as with enterprise applications or the public Internet.

For PKS, we recommend that you disable security policies that filter traffic between the networks supporting the system. When that is not an option, refer to the following table, which identifies the flows between system components in a typical PKS deployment.

**Note:** You must set the communication path in your firewall settings to accommodate how you elect to control what groups have access to deploy and scale PKS-deployed Kubernetes clusters in your organization. In this case, mirror the settings on the lines below for the Operator -> PKS API server.

Source Component	Destination Component	Destination Protocol	Destination Port	Service
Application User	NSX-T Load Balancers	TCP/UDP	varies	varies
Application User	NSX-T Ingress Controllers	TCP/UDP	varies	varies
Cloud Foundry BOSH Director	Domain Name Server	UDP	53	dns
Cloud Foundry BOSH Director	vCenter Server	TCP	443	https
Cloud Foundry BOSH Director	vSphere ESXI Mgmt. vmknic	TCP	443	https
Compilation Job VMs	Domain Name Server	UDP	53	dns
Developer	Harbor Private Image Registry	TCP	4443	notary
Developer	Harbor Private Image Registry	TCP	443	https
Developer	Harbor Private Image Registry	TCP	80	http
Developer	K8s Cluster Master/Etcd Nodes	TCP	8443	uaa auth
Developer	NSX-T Load Balancers	TCP/UDP	varies	varies
Developer	NSX-T Ingress Controllers	TCP/UDP	varies	varies
Domain Name Server	vCenter Server	UDP	1433	ms-sql-server
Harbor Private Image Registry	Domain Name Server	UDP	53	dns
Harbor Private Image Registry	Public CVE Source Database	TCP	443	https
Harbor Private Image Registry	Public CVE Source Database	TCP	80	http
K8s Cluster Master/Etcd Nodes	Cloud Foundry BOSH Director	TCP	4222	bosh nats server
K8s Cluster Master/Etcd Nodes	Cloud Foundry BOSH Director	TCP	25250	bosh blobstore
K8s Cluster Master/Etcd Nodes	Domain Name Server	UDP	53	dns
K8s Cluster Master/Etcd Nodes	NSX Manager Server	TCP	443	https
K8s Cluster Master/Etcd Nodes	vCenter Server	TCP	443	https
K8s Cluster Worker Nodes	Cloud Foundry BOSH Director	TCP	4222	bosh nats server
K8s Cluster Worker Nodes	Cloud Foundry BOSH Director	TCP	25250	bosh blobstore
K8s Cluster Worker Nodes	Domain Name Server	UDP	53	dns
K8s Cluster Worker Nodes	Harbor Private Image Registry	TCP	8853	bosh dns health
K8s Cluster Worker Nodes	Harbor Private Image Registry	TCP	443	https
K8s Cluster Worker Nodes	NSX Manager Server	TCP	443	https
K8s Cluster Worker Nodes	vCenter Server	TCP	443	https
NSX Controllers	Network Time Server	UDP	123	ntp
NSX Edge Management	NSX Edge TEP vNIC	UDP	3784	bfd
NSX Manager Server	Domain Name Server	UDP	53	dns
NSX Manager Server	SFTP Backup Server	TCP	22	ssh
Operator	Harbor Private Image Registry	TCP	443	https
Operator	Harbor Private Image Registry	TCP	80	http

Source Component	Destination Component	Destination Protocol	Destination Port	Service
Operator	NSX Manager Server	TCP	443	https
Operator	PCF Operations Manager	TCP	22	ssh
Operator	PCF Operations Manager	TCP	443	https
Operator	PCF Operations Manager	TCP	80	http
Operator	PKS API Server	TCP	8443	uaa auth
Operator	PKS API Server	TCP	9021	pk api server
Operator	vCenter Server	TCP	443	https
Operator	vCenter Server	TCP	80	http
Operator	vSphere ESXI Mgmt. vmknic	TCP	22	ssh
PCF Operations Manager	Domain Name Server	UDP	53	dns
PCF Operations Manager	K8s Cluster Worker Nodes	TCP	22	ssh
PCF Operations Manager	Network Time Server	UDP	123	ntp
PCF Operations Manager	vCenter Server	TCP	443	https
PCF Operations Manager	vSphere ESXI Mgmt. vmknic	TCP	443	https
PKS API Server	Domain Name Server	UDP	53	dns
PKS API Server	K8s Cluster Master/Etcd Nodes	TCP	8443	uaa auth
PKS API Server	NSX Manager Server	TCP	443	https
PKS API Server	vCenter Server	TCP	443	https
vCenter Server	Domain Name Server	UDP	53	dns
vCenter Server	Network Time Server	UDP	123	ntp
vCenter Server	vSphere ESXI Mgmt. vmknic	TCP	8080	vsanvp
vCenter Server	vSphere ESXI Mgmt. vmknic	TCP	9080	io filter storage
vCenter Server	vSphere ESXI Mgmt. vmknic	TCP	443	https
vCenter Server	vSphere ESXI Mgmt. vmknic	TCP	902	ideafarm-door

You have the option to expose containerized applications, running in a Kubernetes cluster, for external consumption through various ports and methods.

You can enable external access to applications by way of NSX and non-NSX load balancers and ingress. Enabling access to applications through standard Kubernetes load-balancers and ingress controller types allow for specific port and protocol designations, while the NAT function offered through NSX-T will allow external addresses and ports to be automatically mapped and resolved to internal/local addresses and ports.

The NodePort Service type is not supported for PKS deployments on vSphere with NSX-T. Only `type:LoadBalancer` and Services associated with Ingress rules are supported on vSphere with NSX-T.

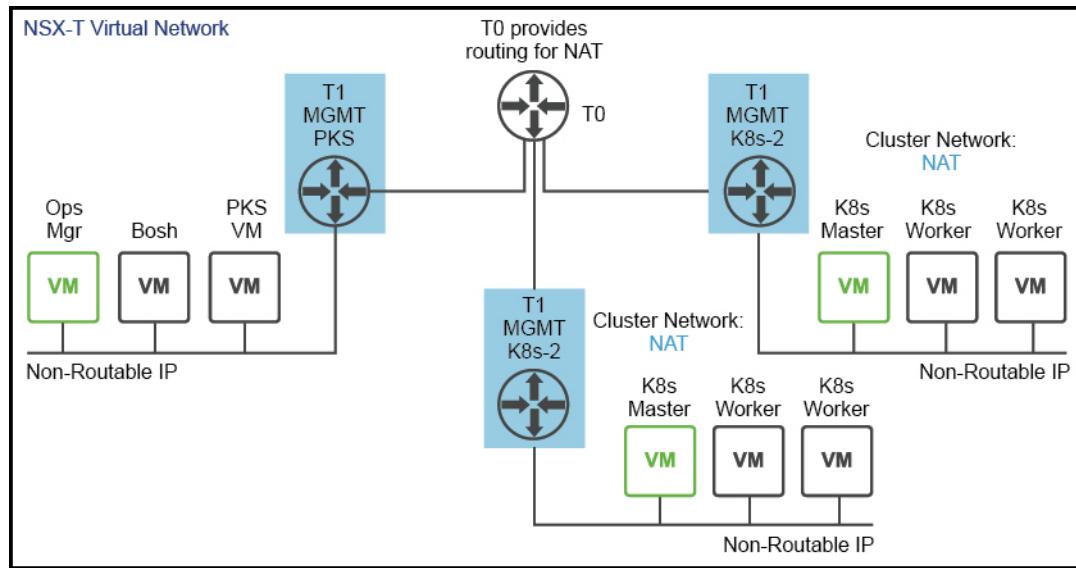
## NSX-T Deployment Topologies for PKS

Page last updated:

There are three supported topologies in which to deploy NSX-T with PKS.

### NAT Topology

The following figure shows a Network Address Translation (NAT) deployment:



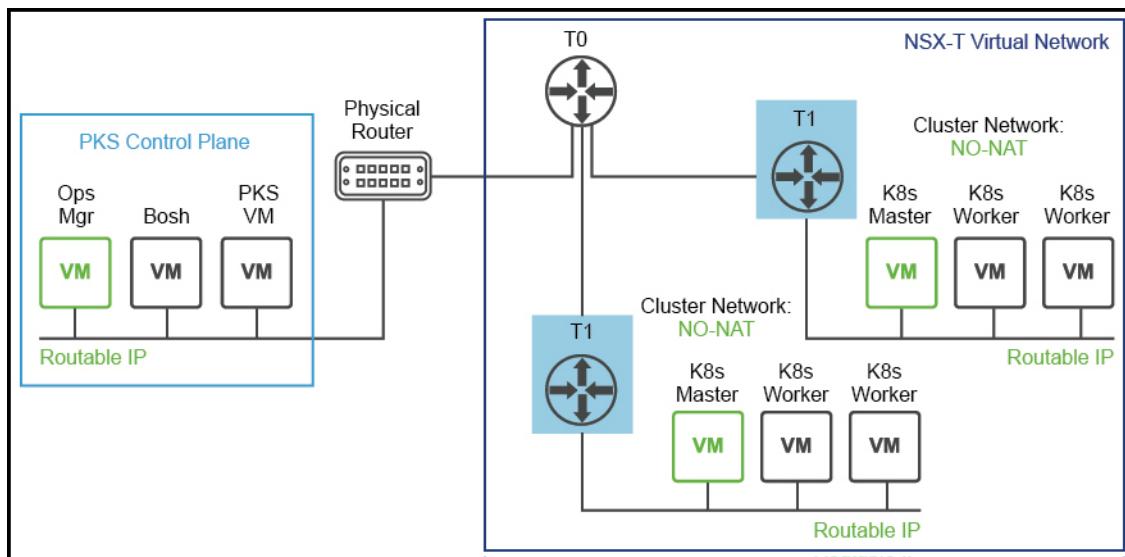
[View a larger version of this image.](#)

This topology has the following characteristics:

- PKS control plane (Ops Manager, BOSH Director, and PKS VM) components are all located on a logical switch that has undergone Network Address Translation on a T0.
- Kubernetes cluster master and worker nodes are located on a logical switch that has undergone Network Address Translation on a T0. This requires DNAT rules to allow access to Kubernetes APIs.

### No-NAT with Virtual Switch (VSS/VDS) Topology

The following figure shows a No-NAT with Virtual Switch (VSS/VDS) deployment:



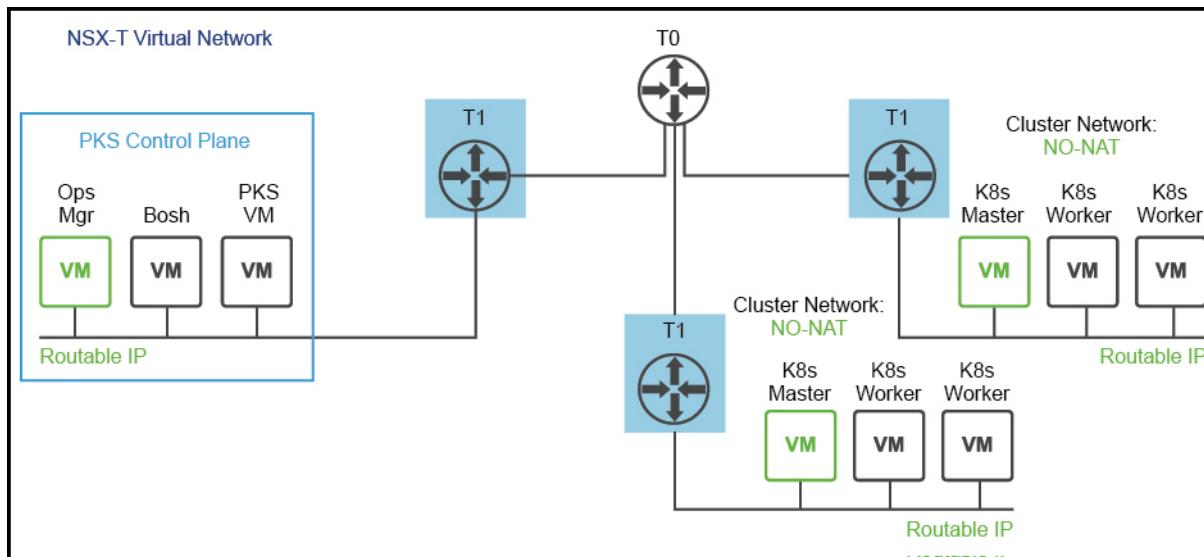
[View a larger version of this image.](#)

This topology has the following characteristics:

- PKS control plane (Ops Manager, BOSH Director, and PKS VM) components are using corporate routable IP addresses.
- Kubernetes cluster master and worker nodes are using corporate routable IP addresses.
- The PKS control plane is deployed outside of the NSX-T network and the Kubernetes clusters are deployed and managed within the NSX-T network. Since BOSH needs routable access to the Kubernetes Nodes to monitor and manage them, the Kubernetes Nodes need routable access.

## No-NAT with Logical Switch (NSX-T) Topology

The following figure shows a No-NAT with Logical Switch (NSX-T) deployment:



[View a larger version of this image.](#)

This topology has the following characteristics:

- PKS control plane (Ops Manager, BOSH Director, and PKS VM) components are using corporate routable IP addresses.
- Kubernetes cluster master and worker nodes are using corporate routable IP addresses.
- The PKS control plane is deployed inside of the NSX-T network. Both the PKS control plane components (VMs) and the Kubernetes Nodes use corporate routable IP addresses.



## Preparing to Deploy PKS on vSphere with NSX-T

Page last updated:

Before you install PKS on vSphere with NSX-T integration, you must prepare your NSX-T environment. Complete all of the steps listed in the order presented to manually create the NSX-T environment for PKS.

### Step 1: Plan Network Topology, Subnets, and IP Blocks

#### Plan NSX-T Deployment Topology

Review [vSphere with NSX-T Prerequisites and Resource Requirements](#).

Review the [Deployment Topologies](#) for PKS on vSphere with NSX-T, and the [NSX-T Data Center documentation](#) to ensure that your chosen network topology will enable the following communications:

- vCenter, NSX-T components, and ESXi hosts must be able to communicate with each other.
- The BOSH Director VM must be able to communicate with vCenter and the NSX Manager.
- The BOSH Director VM must be able to communicate with all nodes in all Kubernetes clusters.
- Each PKS-provisioned Kubernetes cluster deploys the NSX-T Node Agent and the Kube Proxy that run as BOSH-managed processes on each worker node.

In addition, the NSX-T Container Plugin (NCP) runs as a BOSH-managed process on the Kubernetes master node. In a multi-master PKS deployment, the NCP process runs on all master nodes. However, the process is active only on one master node. If the NCP process on an active master is unresponsive, BOSH activates another NCP process. Refer to the [NCP documentation](#) for more information.

#### Plan Network CIDRs

Before you install PKS on vSphere with NSX-T, you should plan for the CIDRs and IP blocks that you are using in your deployment.

Plan for the following network CIDRs in the IPv4 address space according to the instructions in the VMware [NSX-T documentation](#).

- **VTEP CIDRs:** One or more of these networks host your GENEVE Tunnel Endpoints on your NSX Transport Nodes. Size the networks to support all of your expected Host and Edge Transport Nodes. For example, a CIDR of `192.168.1.0/24` provides 254 usable IPs.
- **PKS MANAGEMENT CIDR:** This small network is used to access PKS management components such as Ops Manager, BOSH Director, the PKS Service VM, and the Harbor Registry VM (if deployed). For example, a CIDR of `10.172.1.0/28` provides 14 usable IPs. For the [No-NAT deployment topologies](#), this is a corporate routable subnet /28. For the [NAT deployment topology](#), this is a non-routable subnet /28, and DNAT needs to be configured in NSX-T to access the PKS management components.
- **PKS LB CIDR:** This network provides your load balancing address space for each Kubernetes cluster created by PKS. The network also provides IP addresses for Kubernetes API access and Kubernetes exposed services. For example, `10.172.2.0/24` provides 256 usable IPs. This network is used when creating the `ip-pool-vips` described in [Creating NSX-T Objects for PKS](#), or when the services are deployed. You enter this network in the **Floating IP Pool ID** field in the **Networking** pane of the PKS tile.

#### Plan IP Blocks

When you install PKS on NSX-T, you are required to specify the **Pods IP Block ID** and **Nodes IP Block ID** in the **Networking** pane of the PKS tile. These IDs map to the two IP blocks you must configure in NSX-T: the Pods IP Block for Kubernetes pods, and the Node IP Block for Kubernetes nodes (VMs). For more information, see the [Networking](#) section of [Installing PKS on vSphere with NSX-T Integration](#).

NAT mode

Pods IP Block ID \*

78384e39-6bc6-4cc0-a8e2-8d70b727003f

Nodes IP Block ID \*

ad51f33b-e7ae-45f5-81dd-fd481177f1dc

Enter the UUID of the IP Block to be used for kubernetes Nodes

## Pods IP Block

Each time a Kubernetes namespace is created, a subnet from the **Pods IP Block** is allocated. The subnet size carved out from this block is /24, which means a maximum of 256 pods can be created per namespace. When a Kubernetes cluster is deployed by PKS, by default 3 namespaces are created. Often additional namespaces will be created by operators to facilitate cluster use. As a result, when creating the **Pods IP Block**, you must use a CIDR range larger than /24 to ensure that NSX has enough IP addresses to allocate for all pods. The recommended size is /16. For more information, see [Create NSX Network Objects](#) below.

### ip-block-pks-pods-snats

Overview Subnets	
<a href="#">Summary</a>   <a href="#">EDIT</a>	
Name	ip-block-pks-pods-snats
ID	78384e39-6bc6-4cc0-a8e2-8d70b727003f
Description	
CIDR	172.16.0.0/16
Created	5/11/2018, 2:12:50 PM by admin
Last Updated	7/16/2018, 8:43:42 AM by pks-nsx-t-superuser
<a href="#">Tags</a>   <a href="#">MANAGE</a>	

**Note:** By default, **Pods IP Block** is a block of non-routable, private IP addresses. After you deploy PKS, you can define a network profile that specifies a routable IP block for your pods. The routable IP block overrides the default non-routable **Pods IP Block** when a Kubernetes cluster is deployed using that network profile. For more information, see [Routable Pods](#) in *Using Network Profiles (NSX-T Only)*.

## Nodes IP Block

Each Kubernetes cluster deployed by PKS owns a /24 subnet. To deploy multiple Kubernetes clusters, set the **Nodes IP Block ID** in the **Networking** pane of the PKS tile to larger than /24. The recommended size is /16. For more information, see [Create NSX Network Objects](#) below.

**Note:** You can use a smaller nodes block size for no-NAT environments with a limited number of routable subnets. For example, /20 allows up to 16 Kubernetes clusters to be created.

## ip-block-pks-nodes-snat

**Overview** Subnets

Summary | EDIT

Name	ip-block-pks-nodes-snat
ID	ad51f33b-e7ae-45f5-81dd-fd481177f1dc
Description	
CIDR	172.15.0.0/16
Created	5/21/2018, 11:53:50 AM by admin
Last Updated	7/16/2018, 8:43:32 AM by pks-nsx-t-superuser

> Tags | MANAGE

## Reserved IP Blocks

Do not use any of the IP blocks listed in this section for pods or nodes. If you create Kubernetes clusters with any of the blocks listed below, the Kubernetes worker nodes cannot reach Harbor or internal Kubernetes services.

The Docker daemon on the Kubernetes worker node uses the subnet in the following CIDR range. Do not use IP addresses in the following CIDR range:

- 172.17.0.1/16
- 172.18.0.1/16
- 172.19.0.1/16
- 172.20.0.1/16
- 172.21.0.1/16
- 172.22.0.1/16

If PKS is deployed with Harbor, Harbor uses the following CIDR ranges for its internal Docker bridges. Do not use IP addresses in the following CIDR range:

- 172.18.0.0/16
- 172.19.0.0/16
- 172.20.0.0/16
- 172.21.0.0/16
- 172.22.0.0/16

Each Kubernetes cluster uses the following subnet for Kubernetes services. Do not use the following IP block for the Nodes IP Block:

- 10.100.200.0/24

## Step 2: Deploy NSX Manager

Deploy the [NSX Manager Unified Appliance](#). For instructions, see [Deploy the NSX Manager](#).

## Step 3: Deploy NSX Controllers

Deploy one or more [NSX Controllers](#). You must deploy at least 1 NSX Controller for PKS; 3 NSX Controllers are recommended. For instructions, see [Deploy NSX Controllers](#).

## Step 4: Create NSX Clusters

Create NSX Clusters for the [Management Plane](#) and [Control Plane](#). For instructions, see [Create NSX Clusters](#).

## Step 5: Deploy NSX Edge Nodes

Deploy two or more [NSX Edge Nodes](#). Edge Nodes for PKS run load balancers for PKS API traffic, Kubernetes pod LB services, and pod ingress controllers. For instructions, see [Deploy NSX Edge Nodes](#).

PKS supports active/standby Edge Node failover and requires at least two Edge Nodes. In addition, PKS requires the Edge Node Large VM (8 vCPU, 16 GB of RAM, and 120 GB of storage). The default size of the LB provisioned for PKS is small. You can customize this after deploying PKS using [Network Profiles](#).

## Step 6: Register NSX Edge Nodes

[Register with the NSX Manager each NSX Edge Node](#) planned for use with PKS. For instructions, see [Register NSX Edge Nodes](#).

## Step 7: Enable VIB Repository Service

The VIB repository service provides access to native libraries for NSX Transport Nodes. For instructions on enabling VIB, see [Enable VIB Repository Service on NSX Manager](#).

## Step 8: Create TEP IP Pool

Create Tunnel Endpoint IP Pool (TEP IP Pool) within the usable range of the [VTEP CIDR](#) created [Plan Network CIDRS](plan-cidrs). This IP pool is used for NSX Transport Nodes. For more information, see [NSX Edge Networking Setup](#). For instructions, see [Create TEP IP Pool](#).

## Step 9: Create Overlay Transport Zone

Create an [NSX Overlay Transport Zone](#) (TZ-Overlay) for PKS Control Plane services and Kubernetes Cluster deployment overlay networks. For instructions, see [Create Overlay TZ](#).

## Step 10: Create VLAN Transport Zone

Create an [NSX VLAN Transport Zone](#) (TZ-VLAN) for NSX Edge uplinks (ingress/egress) for PKS-managed Kubernetes clusters. For instructions, see [Create VLAN TZ](#).

## Step 11: Create Uplink Profile for Edge Nodes

Create an [NSX Uplink Profile](#) for Edge Nodes to be used with PKS. For instructions, see [Create Uplink Profile for Edge Nodes](#).

## Step 12: Create Transport Edge Nodes

Create [NSX Edge Transport Nodes](#), which allow Edge Nodes to exchange traffic for virtual networks among other NSX nodes. For instructions, see [Create Transport Edge Nodes](#).

## Step 13: Create Edge Cluster

Create an [NSX Edge Cluster](#) and add each NSX Edge Transport Node to the Edge Cluster. For instructions, see [Create Transport Edge Nodes](#).

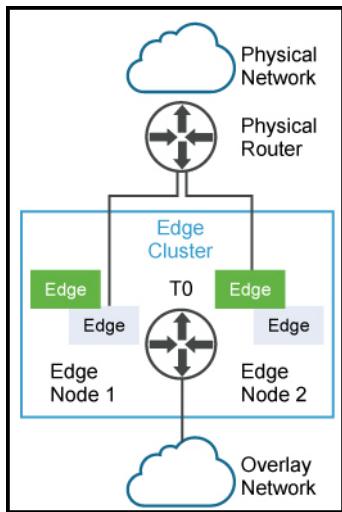
## Step 14: Create T0 Logical Router for PKS

[NSX Tier-0 Logical Routers](#) route data between the NSX-T virtual network and the physical network. For instructions, see [Create T0 Router](#).

## Step 15: Configure NSX Edge for High Availability (HA)

Configure NSX Edge for high availability (HA) using Active/Standby mode to support failover, as shown in the following figure. For instructions, see [Configure Edge HA](#).

**Note:** If the T0 Router is not properly configured for HA, failover to the standby Edge Node will not occur. See [Configure Edge HA](nsxt-deploy.html#configure-edge-ha) for instructions.



## Step 16: Prepare ESXi Hosts for PKS Compute Plane

An [NSX Transport Node](#) allows NSX Nodes to exchange traffic for virtual networks. ESXi hosts dedicated to the PKS Compute Cluster must be prepared as transport nodes. For instructions, see [Prepare Compute Cluster ESXi Hosts](#).

**Note:** The Transport Nodes must be placed on free host NICs not already used by other vSwitches on the ESXi host. Use the [VTEPS](#) IP pool that allows ESXi hosts to route and communicate with each other, as well as other Edge Transport Nodes.

## Step 17: Create NSX-T Objects for PKS Management Plane

Prepare the vSphere and NSX-T infrastructure for the PKS Management Plane where the PKS, Ops Manager, BOSH Director, and Harbor Registry VMs are deployed. This includes a vSphere resource pool for PKS management components, NSX [Tier-1 \(T1\) Logical Switch](#), and a [Tier-1 Logical Router and Port](#). For instructions, see [Prepare Management Plane](#).

If you are using the [NAT Topology](#), create the following NAT rules on the T0 Router. For instructions, see [Prepare Management Plane](#).

Type	For
DNAT	External -> Ops Manager
DNAT	External -> Harbor (optional)
SNAT	PKS Management Plane -> vCenter and NSX-T Manager
SNAT	PKS Management Plane -> DNS
SNAT	PKS Management Plane -> NTP
SNAT	PKS Management Plane -> LDAP/AD
SNAT	PKS Management Plane -> ESXi

## Step 18: Create NSX-T Objects for PKS Compute Plane

Create Resource Pools for AZ-1 and AZ-2, which map to the Availability Zones you will create when you configure BOSH Director and reference when you install the PKS tile. In addition, create SNAT rules on the T0 router:

- One for K8s Master Nodes (hosting NCP) to reach the NSX-T Manager
- One for Kubernetes Master Node Access to LDAP/AD (optional)

For instructions, see [Prepare Compute Plane](#).

## Step 19: Deploy Ops Manager in the NSX-T Environment

Deploy Ops Manager 2.3.2+ on the NSX-T Management Plane network. For instructions, see [Deploy Ops Manager on vSphere with NSX-T](#).

## Step 20: Generate NSX Manager Certificate

Generate the CA Cert for the NSX Manager and import the certificate to NSX Manager. For instructions, see [Generate the NSX Manager CA Cert](#).

## Step 21: Configure BOSH Director for vSphere with NSX-T

Create availability zones (AZs) that map to the Management and Compute resource pools in vSphere, and the Management and Control networks in NSX-T. For instructions, see [Configure BOSH Director for vSphere with NSX-T](#).

## Step 22: Generate NSX Manager Principal Identity Certificate

Generate the NSX Manager Super User Principal Identity Certificate and register it with the NSX Manager using the NSX API. For instructions, see [Generate the NSX Manager PI Cert](#).

## Step 23: Create NSX-T Objects for PKS

Create IP blocks for the [node networks](#) and the [pod networks](#). The subnets for both nodes and pods should have a size of 256 (/16). For more information, see [Plan IP Blocks](#) as well as [Reserved IP Blocks](#).

In addition, create a Floating IP Pool from which to assign routable IP addresses to components. This network provides your load balancing address space for each Kubernetes cluster created by PKS. The network also provides IP addresses for Kubernetes API access and Kubernetes exposed services.

These objects are required to configure the PKS tile for NSX-T networking. For instructions, see [Create NSXT Object for PKS](#).

## Step 24: Install PKS on vSphere with NSX-T

At this point your NSX-T environment is prepared for PKS installation using the PKS tile in Ops Manager. For instructions, see [Installing PKS on vSphere with NSX-T](#).

## Step 25: Install Harbor Registry for PKS

The VMware Harbor Registry is recommended for PKS. Install Harbor in the NSX Management Plane with other PKS components (PKS API, Ops Manager, and BOSH). For instructions, see [Installing Harbor Registry on vSphere with NSX-T](#) in the PKS Harbor documentation.

If you are using the [NAT deployment topology](#) for PKS, create a DNAT rule that maps the private Harbor IP address to a routable IP address from the floating IP pool on the PKS management network. See [Create DNAT Rule](#).



## Deploying NSX-T for PKS

Page last updated:

To deploy NSX-T for PKS, complete the following set of procedures, in the order presented.

Before you begin this procedure, ensure that you have successfully completed all preceding steps for installing PKS on vSphere with NSX-T, including:

- [Prerequisites and Resource Requirements](#)
- [NSX-T Deployment Topologies for PKS](#)
- [Preparing to Deploy PKS with NSX-T on vSphere](#)

### Step 1: Deploy NSX Manager

The NSX Manager is provided as an OVA file named **NSX Unified Appliance** that you import into your vSphere environment and configure.

Complete either of the following procedures to deploy the NSX Manager appliance:

- [Deploy NSX Manager using the vSphere client](#)
- [Deploy NSX Manager using the ovftool CLI](#)

To verify deployment of the NSX Manager:

1. Power on the NSX Manager VM.
2. Ping the NSX Manager VM. Get the IP address for the NSX Manager from the **Summary** tab in vCenter. Verify that you can ping the host. For example, run `ping 10.196.188.21`.
3. SSH to the VM. Use the IP address for the NSX Manager to remotely connect using SSH. From Unix hosts use the command `ssh admin@IP_ADDRESS_OF_NSX_MANAGER`. For example, run `ssh admin@10.196.188.21`. On Windows use Putty and provide the IP address. Enter the CLI user name and password that you defined during OVA import.
4. Review NSX CLI usage. Once you are logged into the NSX Manager VM, enter `?` to view the command usage and options for the NSX CLI.
5. Connect to the NSX Manager web interface using a supported browser at the URL `https://IP_ADDRESS_OF_NSX_MANAGER`. For example, `https://10.16.176.10`.

### Step 2: Deploy NSX Controllers

The NSX Controller provides communications for NSX-T components.

You must deploy at least one NSX Controller for PKS. Three NSX Controllers are recommended.

Complete either of the following procedures to deploy an NSX Controller:

- [Deploy NSX Controllers using the vSphere client](#)
- [Deploy NSX Controllers using the ovftool CLI](#)

To verify deployment of the NSX Controller:

1. Power on the NSX Controller VM.
2. Ping the NSX Controller VM. Get the IP address for the NSX Controller from the **Summary** tab in vCenter. Make sure you use a routable IP. If necessary click **View all X IP addresses** to reveal the proper IP address. Verify that you can ping the Controller host. For example, run `ping 10.196.188.22`.
3. SSH to the VM. Use the IP address for the NSX Controller to remotely connect using SSH. From Unix hosts use the command `ssh admin@IP_ADDRESS_OF_NSX_CONTROLLER`. For example, run `ssh admin@10.196.188.22`. On Windows use Putty and provide the IP address. Enter the CLI admin user name and password that you defined during installation.
4. Review NSX CLI usage. After you are logged into the NSX Controller VM, enter `?` to view the command usage and options for the NSX CLI.

**Note:** Repeat the deployment and verification procedure for each NSX Controller you intend to use for PKS.

## Step 3: Create NSX Clusters (Management and Control)

In this section you create NSX Clusters for the PKS Management Plane and Control Plane.

1. Complete this procedure to create the NSX Management Cluster: [Join NSX Controllers with the NSX Manager](#).
2. Complete this procedure to create the NSX Control Cluster: [Initialize Control Cluster](#).
3. If you are deploying more than one NSX Controller, complete this procedure: [Join Additional NSX Controllers with the Cluster Master](#).

To verify the creation of NSX Clusters:

1. Verify that the NSX Controller is **Connected** to the NSX Manager:

```
NSX-CONTROLLER-1> get managers
```

2. Verify that the status of the Control Cluster is **active**:

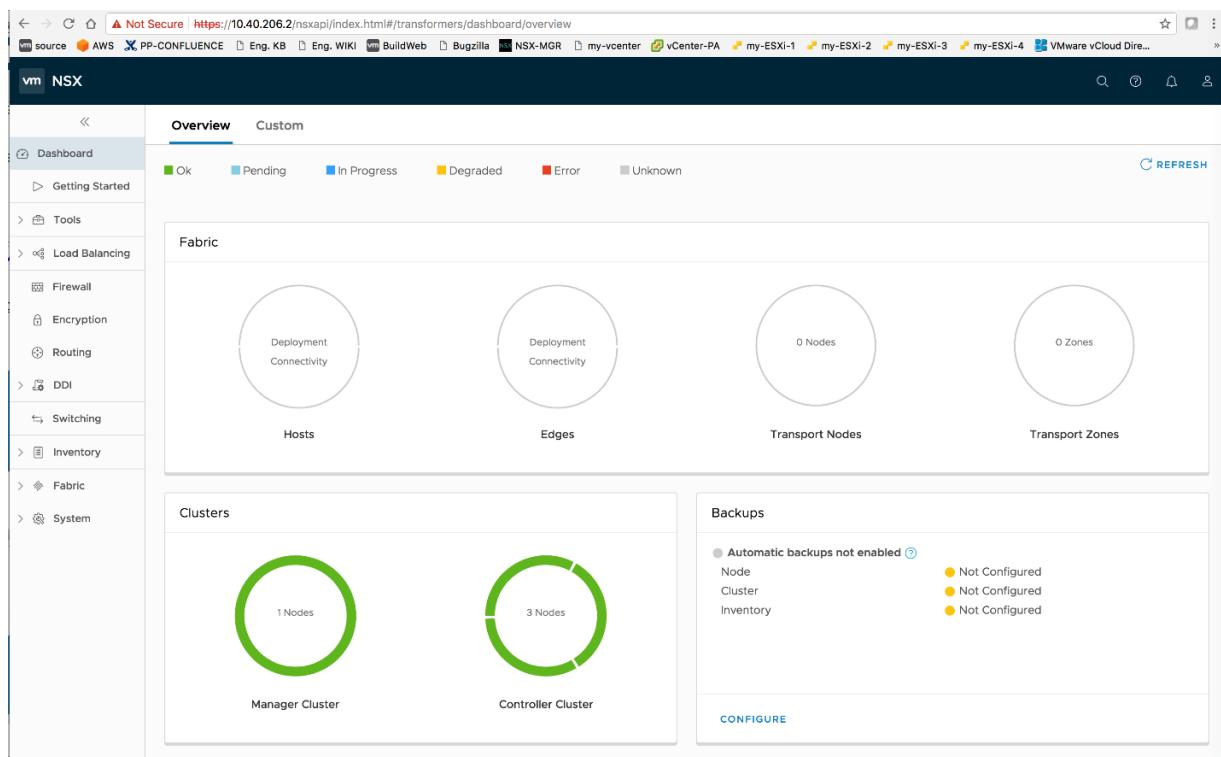
```
NSX-CONTROLLER-1> get control-cluster status
```

3. Verify that the Management Cluster is **STABLE**:

```
NSX-MGR-1-1-0> get management-cluster status
```

4. Verify the configuration of the NSX Clusters.

- o Connect to the NSX Manager web interface using a supported browser at the URL [https://IP\\_ADDRESS\\_OF\\_NSX\\_MANAGER](https://IP_ADDRESS_OF_NSX_MANAGER). For example, <https://10.16.176.10>.
- o Log in using your admin credentials.
- o Select **Dashboard > System > Overview**.
- o Confirm that the status of the NSX Manager and each NSX Controller is green.



## Step 4: Deploy NSX Edge Nodes

Edge Nodes provide the bridge between the virtual network environment implemented using NSX-T and the physical network. Edge Nodes for PKS run load balancers for PKS API traffic, Kubernetes pod LB services, and pod ingress controllers.

PKS supports active/standby Edge Node failover and requires at least two Edge Nodes. In addition, PKS requires the Edge Node Large VM (8 vCPU, 16 GB of RAM, and 120 GB of storage). The Small and Medium VMs are not suitable for use with PKS. Bare metal edge support is planned. See [Edge Node Requirements](#) for details.

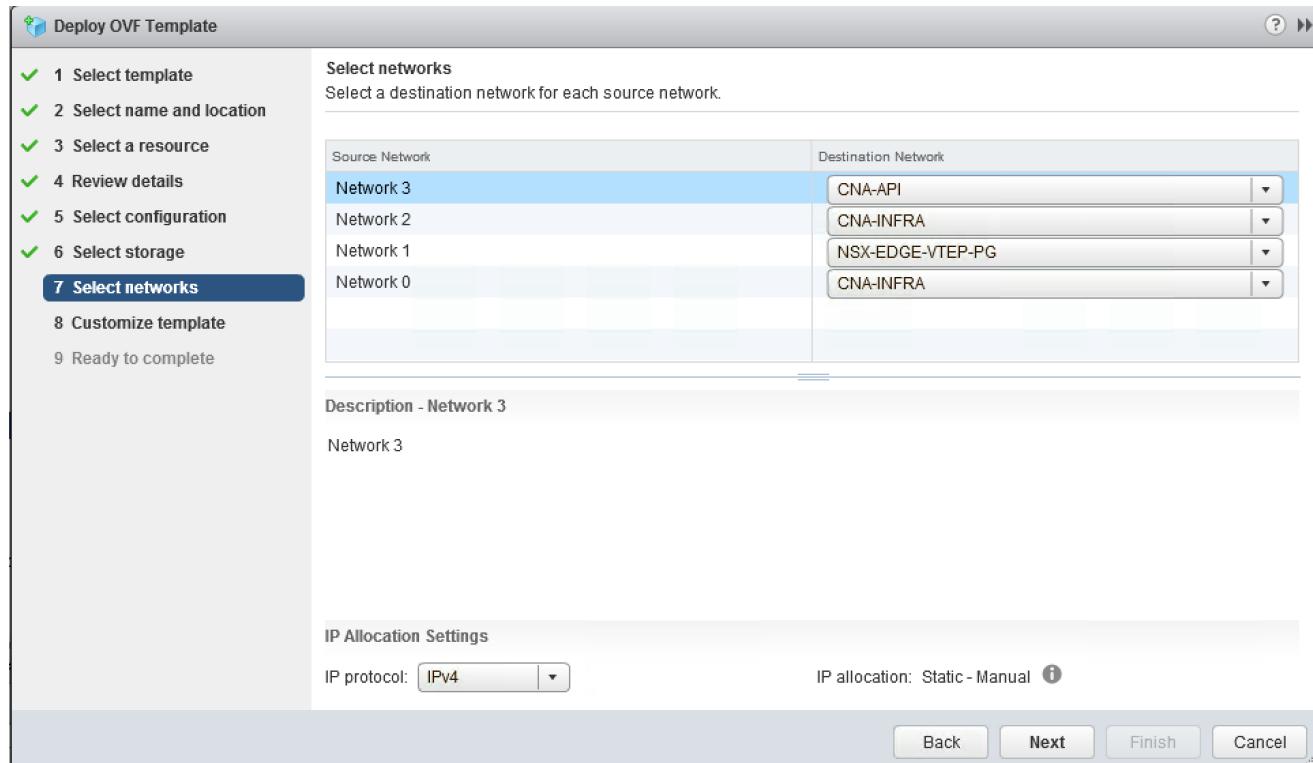
Complete either of the following procedures to deploy an NSX Edge Node:

- [Edge Node Installation using vSphere Client](#)
- [Edge Node Installation using ovftool CLI](#)

When deploying the Edge Node, be sure to connect the vNICs of the NSX Edge VMs to an appropriate PortGroup for your environment:

- **Network 0:** For management purposes. Connect the first Edge interface to your environment's PortGroup/VLAN where your Edge Management IP can route and communicate with the NSX Manager.
- **Network 1:** For TEP (Tunnel End Point). Connect the second Edge interface to your environment's PortGroup/VLAN where your GENEVE VTEPs can route and communicate with each other. Your **VTEP CIDR** should be routable to this PortGroup.
- **Network 2:** For uplink connectivity to external physical router. Connect the third Edge interface to your environment's PortGroup/VLAN where your T0 uplink interface is located.
- **Network 3:** Unused (select any port group)

For example:



To verify Edge Node deployment:

1. Power on the Edge Node VM.
2. Ping the Edge VM. Get the IP address for the NSX Manager from the **Summary** tab in vCenter. Verify that you can ping the host by running `ping IP_ADDRESS_OF_NSX_EDGE_NODE`. For example, run `ping 10.196.188.21`.
3. SSH to the Edge VM. Use the IP address for the NSX Manager to remotely connect using SSH. From Unix hosts use the command `ssh admin@IP_ADDRESS_OF_NSX_EDGE_NODE`. For example, run `ssh admin@10.196.188.21`. On Windows use Putty and provide the IP address. Enter the CLI admin user name and password that you defined in the **Customize template > Application** section.
4. Review NSX CLI usage. After you are logged into the NSX Manager VM, enter `?` to view the command usage and options for the NSX CLI.

**Note:** Repeat the deployment and verification process for each NSX Edge Node you intend to use for PKS.

## Step 5: Register NSX Edge Nodes with NSX Manager

To register an Edge Node with NSX Manager, complete this procedure: [Join NSX Edge with the Management Plane](#).

To verify Edge Node registration with NSX Manager:

1. SSH to the Edge Node and run the following command. Verify that the Status is `Connected`:

```
nsx-edge-1> get managers
```

2. In the NSX Manager Web UI, go to **Fabric > Nodes > Edges**. You should see each registered Edge Node.

Edge	ID	Deployment Type	Management IP	Host	Deployment Status	Controller Connectivity	Manager Con	Transport Node	Edge Cluster	Logical Routers
NSX-edge-2	21ce...a24c	Virtual Machine	10.40.206.7		Node Ready	Not Available	Up	Not Configured		0
nsx-edge-1	04c4...b48d	Virtual Machine	10.40.206.6		Node Ready	Not Available	Up	Not Configured		0

**Note:** Repeat this procedure for each NSX Edge Node you are deploying for PKS.

## Step 6: Enable Repository Service on NSX Manager

To enable VIB installation from the NSX Manager repository, the repository service needs to be enabled in NSX Manager.

1. SSH into NSX Manager by using the command `ssh admin@IP_ADDRESS_OF_NSX_MANAGER` (Unix) or Putty (Windows).
2. Run the following command:

```
nsx-manager> set service install-upgrade enable
```

## Step 7: Create TEP IP Pool

To create the TEP IP Pool, complete this procedure: [Create an IP Pool for Tunnel Endpoint IP Addresses](#).

When creating the TEP IP Pool, refer to the following example:

## Add New IP Pool

[?](#) [X](#)

Name *	TEP-ESXI-POOL										
Description	<input type="text"/>										
<b>Subnets</b>											
<a href="#">+ ADD</a> <a href="#">DELETE</a> <table border="1"> <thead> <tr> <th>IP Ranges*</th> <th>Gateway</th> <th>CIDR*</th> <th>DNS Servers</th> <th>DNS Suffix</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 23.23.23.1 - 23.23.23.10</td> <td>23.23.23.254</td> <td>23.23.23.0/24</td> <td>23.23.23.254</td> <td>corp.local</td> </tr> </tbody> </table>		IP Ranges*	Gateway	CIDR*	DNS Servers	DNS Suffix	<input checked="" type="checkbox"/> 23.23.23.1 - 23.23.23.10	23.23.23.254	23.23.23.0/24	23.23.23.254	corp.local
IP Ranges*	Gateway	CIDR*	DNS Servers	DNS Suffix							
<input checked="" type="checkbox"/> 23.23.23.1 - 23.23.23.10	23.23.23.254	23.23.23.0/24	23.23.23.254	corp.local							
<a href="#">SAVE</a> <a href="#">CANCEL</a>											

To verify TEP IP Pool configuration:

1. In NSX Manager, select **Inventory > Groups > IP Pools**.
2. Verify that the TEP IP Pool you created is present.

ID	Subnets	Allocations
104f..615c	1	0 of 10

## Step 8: Create Overlay Transport Zone

Create an Overlay Transport Zone (`TZ-Overlay`) for PKS control plane services and Kubernetes clusters associated with VDS `hostswitch1`.

To create TZ-Overlay, complete this procedure: [Create Transport Zones](#).

When creating the TZ-Overlay for PKS, refer to the following example:

## New Transport Zone

Name \* TZ-Overlay

Description

Host Switch Name \* hostswitch1

Traffic Type  Overlay  VLAN

**SAVE** **CANCEL**

To verify TZ-Overlay creation:

1. In NSX Manager select **Fabric > Transport Zones**.
2. Verify that you see the TZ-Overlay transport zone you created:

Transport Zones						
Actions		ID	Traffic Type	Host Switch Name	Status	Logical Switches Logical Ports
<input checked="" type="checkbox"/>	+ ADD	<input type="button" value="EDIT"/>	<input type="button" value="DELETE"/>	<input type="button" value="ACTIONS"/>		
<input checked="" type="checkbox"/>	TZ-Overlay	cc0c...4622	Overlay	hostswitch1	Unknown	0 0

## Step 9: Create VLAN Transport Zone

Create the VLAN Transport Zone ( [TZ-VLAN](#) ) for NSX Edge Node uplinks (ingress/egress) for PKS Kubernetes clusters associated with VDS [hostswitch2](#) .

To create TZ-VLAN, complete this procedure: [Create Transport Zones](#).

When creating the TZ-VLAN for PKS, refer to the following example:

## New Transport Zone

Name \* TZ-VLAN

Description

Host Switch Name \* hostswitch2

Traffic Type  Overlay  VLAN

**SAVE** **CANCEL**

To verify TZ-VLAN creation:

1. In NSX Manager select **Fabric > Transport Zones**.
2. Verify that you see the TZ-VLAN transport zone:

The screenshot shows the NSX Manager interface with the 'Transport Zones' section selected. The table lists two entries:

Transport Zone	ID	Traffic Type	Host Switch Name	Status	Logical Switches	Logical Ports
TZ-Overlay	cc0c...4622	Overlay	hostswitch1	Unknown	0	0
<b>TZ-VLAN</b>	cc29...832b	VLAN	hostswitch2	Unknown	0	0

## Step 10: Create Uplink Profile for Edge Nodes

To create an Uplink Profile, complete this procedure: [Create an Uplink Profile](#).

When creating the Uplink Profile for PKS, refer to the following example:

## New Uplink Profile

(?) X

Name \* edge-uplink-profile

Description

Teaming Policy \* Failover Order ▾

### LAGs

+ ADD  DELETE

<input type="checkbox"/>	Name *	LACP Mode	LACP Load Balancing *	Uplinks	LACP Time
No LAGs found					

Active Uplinks \* uplink-1

Standby Uplinks

Transport VLAN 0 ▾

MTU \* 1600 ▾

SAVE

CANCEL

To verify Uplink Profile creation:

1. In NSX Manager select Fabric > Profiles > Uplink Profiles.
2. Verify that you see the Edge Node uplink profile you created:

Uplink Profile	ID	Teaming Policy	Active Uplinks	Standby Uplinks	Transport VLAN	MTU
edge-uplink-profile	5fd6...97ca	Failover Order	uplink-1		0	1600
nsx-default-uplink-hostswitch-profile	0a26...dc9f	Failover Order	uplink-1	uplink-2	0	1600

## Step 11: Create Edge Transport Nodes

Create NSX Edge Transport Nodes which allow Edge Nodes to exchange virtual network traffic with other NSX nodes.

Be sure to add both the VLAN and OVERLAY NSX Transport Zones to the NSX Edge Transport Nodes and confirm NSX Controller and Manager connectivity. Use the MAC addresses of the Edge VM interfaces to deploy the virtual NSX Edges:

- Connect the OVERLAY N-VDS to the vNIC (`fp-eth#`) that matches the MAC address of the second NIC from your deployed Edge VM.
- Connect the VLAN N-VDS to the vNIC (`fp-eth#`) that matches the MAC address of the third NIC from your deployed Edge VM.

To create an Edge Transport Node for PKS:

1. Log in to NSX Manager ([https://IP\\_ADDRESS\\_OF\\_NSX\\_MANAGERS](https://IP_ADDRESS_OF_NSX_MANAGERS)).
2. Go to **Fabric > Nodes > Edges**.
3. Select an Edge Node.
4. Click Actions > **Configure as Transport Node**.

Edge	ID	Dep	Deployment Status	Controller Connectivity	Manager Con	Transport Node	Edge Cluster	Logical Routers
NSX-edge-2	21ce...a24c	Virt	Node Ready	Not Available	Up	Not Configured	0	0
nsx-edge-1	04c4...b48d	Virt	Node Ready	Not Available	Up	Not Configured	0	0

5. In the General tab, enter a name and select both Transport Zones: TZ-Overlay (Overlay) and TZ-VLAN (VLAN).

## Configure as Transport Node - nsx-edge-1 X

**General \***    **Host Switches \***

---

Name \* edge-TN1

**Transport Zones**

Available (2)

Q

- TZ-Overlay (Overlay)
- TZ-VLAN (VLAN)

Create New Transport Zone < >

Selected (2)

Q

- TZ-Overlay (Overlay)
- TZ-VLAN (VLAN)

Max Limit: 10

SAVE
CANCEL

6. Select the **Host Switches** tab.

7. Configure the first transport node switch. For example:

- o Edge Switch Name: hostswitch1
- o Uplink Profile: edge-uplink-profile
- o IP Assignment: Use IP Pool
- o IP Pool: TEP-ESXi-POOL
- o Virtual NICs: fp-eth0 (corresponds to Edge VM vnic1 (second vnic))

## Configure as Transport Node - nsx-edge-1

X

General \*      Host Switches \*

Host Switch Type  Standard  Preconfigured

[+ ADD HOST SWITCH](#)

▼ **New Node Switch**

Edge Switch Name \* hostswitch1

Uplink Profile \* edge-uplink-profile

[Create New Uplink Profile](#)

IP Assignment \* Use IP Pool

IP Pool \* TEP-ESXi-POOL

[OR Create and Use a new IP Pool](#)

Virtual NICs \* fp-eth0      uplink-1

[SAVE](#)

[CANCEL](#)

8. Click Add Host Switch.

9. Configure the second transport node switch. For example:

- o Edge Switch Name: hostswitch2
- o Uplink Profile: edge-uplink-profile
- o Virtual NICs: fp-eth1 (corresponds to Edge VM vnic2 (third vnic))

## Configure as Transport Node - nsx-edge-1

x

General \* Host Switches \*

Host Switch Type  Standard  Preconfigured

[+ ADD HOST SWITCH](#)

> [hostswitch1](#)

[New Node Switch](#)

[DELETE](#)

Edge Switch Name \* hostswitch2

Uplink Profile \* edge-uplink-profile

[Create New Uplink Profile](#)

IP Assignment \*

Virtual NICs \* fp-eth1

uplink-1

[SAVE](#)

[CANCEL](#)



**Note:** Repeat this procedure for the second Edge Transport Node (Edge-TN2), as well as additional Edge Node pairs you deploy for PKS.

To verify the creation of Edge Transport Nodes:

1. In NSX Manager, select **Fabric > Nodes > Edges**.
2. Verify that Controller Connectivity and Manager Connectivity are for both Edge Nodes.

Edge	ID	Deployment Type	Management IP	Host	Deployment Status	Controller Connectivity	Manager Conn	Transport Node	Edge Cluster	Logical Routers
NSX-edge-2	21ce...a24c	Virtual Machine	10.40.206.7		Node Ready	Up	Up	edge-TN2		0
nsx-edge-1	04c4...b48d	Virtual Machine	10.40.206.6		Node Ready	Up	Up	edge-TN1		0

3. In NSX Manager, select **Fabric > Nodes > Transport Node**

4. Verify that the configuration state is **Success**.

Transport Node	ID	Host Switches	Configuration State	Status	IP Addresses	Fabric Node Type	Transport Zones	NSX Version
edge-TN1	04c4...b48d	2	<span style="color: green;">Success</span>	<span style="color: grey;">Unknown</span>	10.40.206.6	Edge - Virtual Machine	TZ-Overlay TZ-VLAN	2.1.0.0.0.71547...
edge-TN2	21ce...a24c	2	<span style="color: green;">Success</span>	<span style="color: grey;">Unknown</span>	10.40.206.7	Edge - Virtual Machine	TZ-Overlay TZ-VLAN	2.1.0.0.0.71547...

5. SSH to each NSX Edge VM and verify that the Edge Transport Node is “connected” to the Controller.

```
nsx-edge-1> get controllers
```

## Step 12: Create Edge Cluster

Create an NSX Edge Cluster and add each Edge Transport Node to the Edge Cluster by completing this procedure:[Create an NSX Edge Cluster](#).

When creating the Edge Cluster for PKS, refer to the following example:

## Add Edge Cluster

(?) X

Name \*

edgecluster1

Description

Edge Cluster Profile nsx-default-edge-high-availability-profile

X ▾

Transport Nodes edge-TN1, edge-TN2

[EDIT...](#)

[SAVE](#)

[CANCEL](#)



To verify Edge Cluster creation:

1. In NSX Manager, select **Fabric > Nodes > Edge Clusters**.

2. Verify that you see the new Edge Cluster.

Edge Cluster	ID	Member Type	Cluster Profile	Transport Nodes
edgecluster1	3427...3742	Edge Node	nsx-default-edge-high-availability-pr...	2

3. Select **Edge Cluster > Related > Transport Nodes**.

4. Verify that all Edge Transport Nodes are members of the Edge Cluster.

Transport Node	ID
edge-TN1	04c4...b48d
edge-TN2	21ce...a24c

5. SSH to NSX Edge Node 1 and run the following commands to verify proper connectivity.

```
nsx-edge-1> get vteps  
nsx-edge-1> get host-switches  
nsx-edge-1> get edge-cluster status  
nsx-edge-1> get controller sessions
```

6. SSH to NSX Edge Node 2 and repeat the above commands to verify proper connectivity.

7. Verify Edge-TN1 to Edge-TN2 connectivity (TEP to TEP).

```
nsx-edge-1> get logical-router  
nsx-edge-1> vrf 0  
nsx-edge-1(vrf)> ping IP-ADDRESS-EDGE-2
```

## Step 13: Create T0 Logical Router

Create a Tier-0 Logical Router for PKS. The [Tier-0 Logical Router](#) is used to route data between the physical network and the NSX-T-defined virtual network.

To create a Tier-0 (T0) logical router:

1. Define a T0 logical switch with an ingress/egress uplink port. Attach the T0 LS to the VLAN Transport Zone.
2. Create a logical router port and assign to it a routable CIDR block, for example `10.172.1.0/28`, that your environment uses to route to all PKS assigned IP pools and IP blocks.
3. Connect the T0 router to the uplink VLAN logical switch.
4. Attach the T0 router to the Edge Cluster and set HA mode to **Active-Standby**. NAT rules are applied on the T0 by NCP. If the T0 router is not set in **Active-Standby** mode, the router does not support NAT rule configuration.
5. Lastly, configure T0 routing to the rest of your environment using the appropriate routing protocol for your environment or by using static routes.

### Create VLAN Logical Switch (LS)

1. In NSX Manager, go to **Switching > Switches**.
2. Click **Add** and create a VLAN logical switch (LS). For example:

## Add New Logical Switch

[?](#) [X](#)

[General](#) [Switching Profiles](#)

---

Name \* uplink-LS1

Description

Transport Zone \* TZ-VLAN

Admin Status [Up](#)

Replication Mode  Hierarchical Two-Tier replication  Head replication

VLAN \* 0

[SAVE](#) [CANCEL](#)

3. Click **Save** and verify that you see the new LS:

NSX		Switches							
		Switches		Ports		Switching Profiles			
		<a href="#">+ ADD</a>		<a href="#">EDIT</a>		<a href="#">DELETE</a>		<a href="#">ACTIONS</a> ▾	
		Logical Switch	↑	ID	Admin Status	Logical Ports	Traffic Type	Config State	Transport Zone
		uplink-LS1		b4d7...1171	<span style="color: green;">Up</span>	<span style="color: blue;">0</span>	VLAN : 0	Success	TZ-VLAN

## Create T0 Router Instance

1. In NSX Manager, go to **Routing > Routers**.
2. Click **Add** and select the **Tier-0 Router** option.

The screenshot shows the NSX interface with the following details:

- Header:** vm NSX
- Left Sidebar:** A navigation menu with the following items:
  - Dashboard
  - Getting Started
  - Tools
  - Load Balancing
  - Firewall
  - Encryption
  - Routing** (selected)
- Main Content Area:** The "Routers" tab is selected. The interface includes:
  - A toolbar with + ADD, EDIT, and DELETE buttons.
  - A dropdown menu showing two options: Tier-0 Router and Tier-1 Router.

3. Create new T0 router as follows:

- **Name:** Enter a name for the T0 router, such as `T0-LR` or `t0-pks`, for example.
- **Edge Cluster:** Select the Edge Cluster, `edgecluster1` or `edge-cluster-pks`, for example.
- **High Availability Mode:** Select `Active-Standby` (required).

## New Tier-0 Router

[?](#) [X](#)

Tier-0 Router   Advanced

---

Name \* TO-LR

Description

Edge Cluster \* edgecluster1

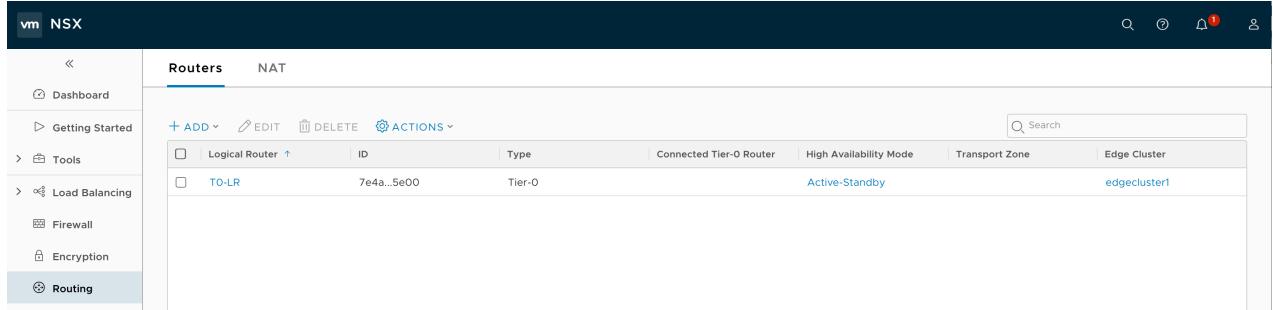
High Availability Mode  Active-Active  Active-Standby

Preferred Member edge-TN1

OR Create a New Edge Cluster

[SAVE](#) [CANCEL](#)

- Click **Save** and verify you see the new T0 Router instance:



The screenshot shows the NSX Manager interface with the 'Routers' tab selected. The left sidebar has 'Routing' selected. The main table displays the following data:

Logical Router	ID	Type	Connected Tier-0 Router	High Availability Mode	Transport Zone	Edge Cluster
TO-LR	7e4a...5e00	Tier-0		Active-Standby		edgecluster1

**Note:** Be sure to select Active/Standby. NAT rules are applied on T0 by NCP. If not set Active-Standby, NCP will not be able to create NAT rules on the T0 Router.

## Create T0 Router Port

- In NSX Manager, go to **Routing > Routers**.
- Select the T0 Router you just created.
- Select **Configuration > Router Ports**.

4. Select the T0 Router and click Add.

Logical Router ID	Type	IP Address/mask	Connected To	Transport Node	Relay Service	Statistics

5. Create new T0 router port. Attach the T0 router port to the uplink logical switch you created (`uplink-LS1`, for example). Assign an IP address and CIDR that your environment uses to route to all PKS assigned IP pools and IP blocks. For example:

- o **Name:** `Uplink1`
- o **Type:** Uplink
- o **Transport Node:** `edge-TN1`
- o **Logical Switch:** `uplink-LS1`
- o **Logical Switch Port:** `uplink1-port`
- o **IP Address/mask:** `10.40.206.24/25` (for example)

## New Router Port

Name \* Uplink1

Description

Type  Uplink  Downlink  Loopback

Transport Node \* edge-TN1

Logical Switch uplink-LS1 [X](#) [▼](#)

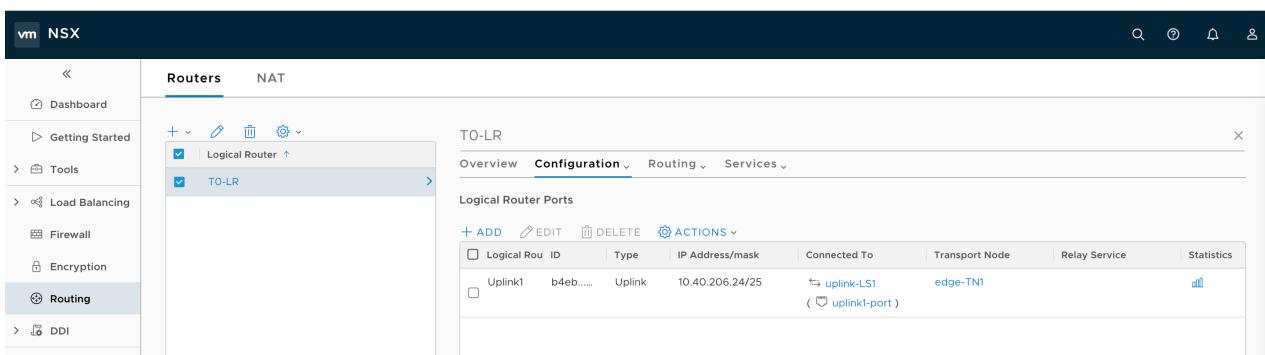
[OR Create a New Switch](#)

Logical Switch Port  Attach to new switch port  
 Switch Port Name uplink1-port  Attach to existing switch port

IP Address/mask \* 10.40.206.24/25

[SAVE](#) [CANCEL](#)

6. Click **Save** and verify that you see the new port interface:



The screenshot shows the NSX interface for managing Logical Router Ports. On the left, there's a sidebar with options like Dashboard, Getting Started, Tools, Load Balancing, Firewall, Encryption, Routing (which is selected), and DDI. The main area is titled 'Routers' and shows a list of logical routers. One is selected, named 'TO-LR'. Under 'TO-LR', the 'Configuration' tab is active, showing the 'Logical Router Ports' section. A table lists the port 'Uplink1' with details: Type 'Uplink', IP Address/mask '10.40.206.24/25', Connected To 'uplink-LS1', Transport Node 'edge-TN1', and a note '( uplink1-port )'.

### Define Default Static Route

Configure T0 routing to the rest of your environment using the appropriate routing protocol (if you are using no-NAT-mode), or using static routes (if you are using NAT-mode). The following example uses static routes for the T0 router. The CIDR used must route to the IP you just assigned to your T0 uplink interface.

1. Go to **Routing > Routers** and select the T0 Router.
2. Select **Routing > Static Routes** and click **Add**.
3. Create a new static route for the T0 router. For example:

- o Network:
- o Next Hop:  (for example)
- o Admin Distance:
- o Logical Router Port:

### Add Static Route

(?) X

---

Network \*

Description

Next Hops

[+ ADD](#)
 [DELETE](#)

<input checked="" type="checkbox"/> Next Hop *	Admin Distance	Logical Router Port
<input checked="" type="checkbox"/> 10.40.206.125	1	Uplink1

Select NULL as Next Hop to configure Null Routes

SAVE

CANCEL

4. Click **Save** and verify that see the newly created static route:

## Verify T0 Router Creation

The T0 router uplink IP should be reachable from the corporate network. From your local laptop or workstation, ping the uplink IP address. For example:

```
PING 10.40.206.24 (10.40.206.24): 56 data bytes
64 bytes from 10.40.206.24: icmp_seq=0 ttl=53 time=33.738 ms
64 bytes from 10.40.206.24: icmp_seq=1 ttl=53 time=36.965 ms
```

## Step 14: Configure Edge Nodes for HA

Configure [high-availability \(HA\) for NSX Edge Nodes](#). If the T0 Router is not correctly configured for HA, failover to the standby Edge Node will not occur.

Proper configuration requires two new uplinks on the T0 router: one attached to Edge TN1, and the other attached to Edge TN2. In addition, you need to create a VIP that is the IP address used for the T0 uplink defined when the T0 Router was created.

Logical Router Port	ID	Type	IP Address/mask	Connected To	Transport Node	Relay Service	Statistics
TIERO-R...	043a...	Linked ...	100.64.112.6/31	lb-pks-fa14eb2b...			
TIERO-R...	4629...	Linked ...	100.64.112.14/31	pks-dld47217-48...			
TIERO-R...	50f3...	Linked ...	100.64.112.10/31	pks-fa14eb2b-97...			
TIERO-R...	9d3d...	Linked ...	100.64.112.20/31	pks-dld47217-48...			
TIERO-R...	a26b...	Linked ...	100.64.112.22/31	pks-dld47217-48...			
TIERO-R...	b1fa...	Linked ...	100.64.112.4/31	pks-fa14eb2b-97...			
TIERO-R...	bdd7...	Linked ...	100.64.112.12/31	pks-fa14eb2b-97...			
TIERO-R...	c7e8...	Linked ...	100.64.112.24/31	pks-dld47217-48...			
TIERO-R...	dde5...	Linked ...	100.64.112.16/31	lb-pks-dld47217...			
TIERO-R...	f128...	Linked ...	100.64.112.8/31	pks-fa14eb2b-97...			
TIERO-R...	f832...	Linked ...	100.64.112.18/31	pks-dld47217-48...			
<b>Uplink1</b>	585e...	Uplink	10.40.206.10/25	↳ uplink-LS1 ( 8f0831de-0ff...	edge-TN1		
<b>Uplink2</b>	e1f5...	Uplink	10.40.206.9/25	↳ uplink-LS1 ( uplink1-port )	edge-TN2		

## Create Uplink1 for Edge-TN1

On the T0 router, create the Uplink1 router port and attach it to Egde TN1. For example:

- IP Address/Mask: `10.40.206.10/25

- **URPF Mode:** None (optional)
- **Transport Node:** `edge-TN1`
- **Logical Switch:** `uplink-LS1`

## Edit Router Port - Uplink1

[?](#) [X](#)

Name \*

Uplink1

Description

Type

Uplink

Downlink

Loopback

Transport Node \*

edge-TN1

▼

URPF Mode

Strict

None

Logical Switch

uplink-LS1

[X](#) [▼](#)

[OR Create a New Switch](#)

Logical Switch Port

Attach to new switch port

Attach to existing switch port

Switch Port Name `uplink1-port`

[X](#) [▼](#)

IP Address/mask \*

10.40.206.10/25

[SAVE](#)

[CANCEL](#)



## Create Uplink2 for Edge-TN2

On the T0 router, create the Uplink2 router port and attach it to Egde TN2. For example:

- IP Address/Mask:
- URPF Mode: None (optional)
- Transport Node:
- Logical Switch:

## Edit Router Port - Uplink-2

[?](#) [X](#)

Name *	<input type="text" value="Uplink-2"/>
Description	<input type="text"/>
Type	<input checked="" type="radio"/> Uplink <input type="radio"/> Downlink <input type="radio"/> Loopback
Transport Node *	<input type="text" value="edge-TN2"/> <a href="#">▼</a>
URPF Mode	<input type="radio"/> Strict <input checked="" type="radio"/> None
Logical Switch	<input type="text" value="uplink-LS1"/> <a href="#">X</a> <a href="#">▼</a>
	<a href="#">OR Create a New Switch</a>
Logical Switch Port	<input type="radio"/> Attach to new switch port <input checked="" type="radio"/> Attach to existing switch port Switch Port Name <input type="text" value="8f0831de-01f1-41b7-84ee-ceed3e13"/> <a href="#">X</a> <a href="#">▼</a>
IP Address/mask *	<input type="text" value="10.40.206.9/25"/>

[SAVE](#)

[CANCEL](#)

Create HA VIP

Create an HA virtual IP (VIP) address. Once created the HA VIP becomes the official IP for the T0 router uplink. External router devices peering with the T0 router **must** use this IP address.

**Note:** The IP addresses for uplink-1, uplink-2 and HA VIP must belong to same subnet.

- On the T0 router, create the HA VIP. For example:

- VIP Address:**
- Uplinks Ports:**  and

### Edit HA VIP Configuration - 10.40.206.24/25

VIP Address \*

Status \*  Enabled

Uplink Ports \*

Available (2)

Q

<input checked="" type="checkbox"/> Uplink-2
<input checked="" type="checkbox"/> Uplink1

< >

Selected (2)

Q

<input type="checkbox"/> Uplink-2
<input type="checkbox"/> Uplink1

Select Exactly: 2

- Verify creation of the HA VIP.

Routers NAT								
<p>+ <input type="button"/> <input type="button"/> <input type="button"/> <input type="button"/></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Logical Router <input type="button"/></li> <li><input checked="" type="checkbox"/> TO-LR <input type="button"/></li> <li><input type="checkbox"/> T1-MGMT-K8s-Cluster <input type="button"/></li> <li><input type="checkbox"/> T1-MGMT-K8s-Cluster-Routed-Topo <input type="button"/></li> <li><input type="checkbox"/> T1-MGMT-PKS <input type="button"/></li> <li><input type="checkbox"/> lb-pks-d1d47217-4887-4ac5-bbf3-3302fd17... <input type="button"/></li> <li><input type="checkbox"/> lb-pks-fa14eb2b-977e-4b40-a008-30e58d... <input type="button"/></li> <li><input type="checkbox"/> pks-d1d47217-4887-4ac5-bbf3-3302fd177d... <input type="button"/></li> </ul>	<p>TO-LR</p> <p>Overview Configuration Routing Services</p> <p>HA VIP Configuration</p> <p>+ ADD <input type="button"/> EDIT <input type="button"/> DELETE <input type="button"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>VIP Address</th> <th>Uplink Ports</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>10.40.206.24/25</td> <td>Uplink-2,Uplink1</td> <td>Enabled</td> </tr> </tbody> </table>	VIP Address	Uplink Ports	Status	10.40.206.24/25	Uplink-2,Uplink1	Enabled	
VIP Address	Uplink Ports	Status						
10.40.206.24/25	Uplink-2,Uplink1	Enabled						

## Create Static Route for HA

- On the T0 router, create a static default route so that the next hop points to the HA VIP address. For example:

- Network:**
- Next Hop:**

- Logical Router Port: empty

## Edit Static Route - 0.0.0.0/0

(?) X

Network \* 0.0.0.0/0

Description

Next Hops

+ ADD    DELETE

<input type="checkbox"/> Next Hop *	Admin Distance	Logical Router Port
<input type="checkbox"/> 10.40.206.125	1	

Select NULL as Next Hop to configure Null Routes

**SAVE**

**CANCEL**

2. Using vCenter, disconnect the last interface of each Edge Node VM (this interface can cause duplicate packets.)

The screenshot shows the vSphere inventory tree. The selected item is 'nsx-edge-1'. Other visible items include 'DNS Server', 'Harbor', 'Jenkins', 'Jumpbox', 'KuBo-Bosh-0-7-0', 'KuBo-Bosh-0-9-0', 'NSX-T EDGE', 'NSX-T MGMT', and several NSX controllers ('nsx-controller-1', 'nsx-controller-2', 'nsx-controller-3').

The screenshot shows the 'VM Hardware' settings for the 'nsx-edge-1' VM. The table includes the following information:

CPU	8 CPU(s), 7624 MHz used
Memory	16384 MB, 2785 MB memory active
Hard disk 1	120 GB
Network adapter 1	CNA-INFRA (connected)
Network adapter 2	NSX-EDGE-VTEP-PG (connected)
Network adapter 3	CNA-INFRA (connected)
Network adapter 4	CNA-API (disconnected)
Video card	4 MB
Other	Additional Hardware
Compatibility	ESXi 6.0 and later (VM version 11)

At the bottom right of the window, there is a 'Edit settings...' button.

## Verify Edge Node HA

- The T0 router should display both Edge TNs in active/standby pairing.

The screenshot shows the NSX-T Manager interface under the 'Routers' tab. A sidebar on the left lists various logical routers, with 'TO-LR' selected. The main panel shows the 'TO-LR' logical router details. Under 'High Availability Mode: TO-LR', it lists two transport nodes: 'edge-TN2' with status 'Standby' and 'edge-TN1' with status 'Active'. To the right, there is a detailed view of the logical router configuration, including its UUID (7e4ab666-2646-4c56-8a4c-cd47a5c55e00), tier (Tier-0), mode (Active-Standby), preemptive behavior, edge cluster (edgecluster1), and IP ranges (169.254.0.0/28, 10.64.0.0/16). The configuration was last updated on 12/12/2017 at 3:41:34 PM by admin.

- Run the following commands to verify HA channels:

```
nsx-edge-n-1> get high-availability channels
nsx-edge-n-1> get high-availability channels stats
nsx-edge-n-1> get logical-router
nsx-edge-n-1> get logical-router ROUTER-UUID high-availability status
```

## Step 15: Prepare ESXi Servers for the PKS Compute Cluster

For each ESXi host in the NSX-T Fabric to be used for PKS Compute purposes, create an associated transport node. For example, if you have three ESXi hosts in the NSX-T Fabric, create three nodes named `tnode-host-1`, `tnode-host-2`, and `tnode-host-3`. Add the Overlay Transport Zone to each ESXi Host Transport Node.

Prepare each ESXi server dedicated for the PKS Compute Cluster as a Transport Node. These instructions assume that for each participating ESXi host the ESXi hypervisor is installed and the `vmk0` is configured. In addition, each ESXi host must have at least one **free nic/vmnic** for use with NSX Host Transport Nodes that is not already in use by other vSwitches on the ESXi host. Make sure the `vmnic1` (second physical interface) of the ESXi host is not used. NSX will take ownership of it (opaque NSX vswitch will use it as uplink). For more information, see [Add a Hypervisor Host to the NSX-T Fabric](#) in the VMware NSX-T documentation.

### Add ESXi Host to NSX-T Fabric

Complete the following operation for each ESXi host to be used by the PKS Compute Cluster.

- Go to **Fabric > Nodes > Hosts**.
- Click **Add** and create a new host. For example:
  - IP Address:** 10.115.40.72
  - OS:** ESXi
  - Username:** root
  - Password:** PASSWORD

## Add Host

(?) X

Name \* ESXi-COMP-1

IP Addresses \*

10.115.40.72 X

Operating System \* ESXi

Username \* root

Password \* .....|

SHA-256  
Thumbprint

**SAVE**

**CANCEL**

3. After clicking **Save**, click **Yes** if the following invalid thumbprint message appears.

### Invalid Thumbprint

X

The thumbprint entered was invalid.



Would you like to use this server provided thumbprint?

f85a80b8e409a5a890d2b905140da09ac7da6c203d5c8e7a98811f8b3cf5a553

**YES**

**NO**

4. NSX installs VIBs on the ESXi host. In a few moments, you should see the new defined host. Deployment status should show **NSX Installed** and Manager Connectivity should show **Up**.

The screenshot shows the NSX Manager interface with the 'Hosts' tab selected. The left sidebar includes links for Dashboard, Getting Started, Tools, Load Balancing, Firewall, and Encryption. The main area displays a table of hosts, with one entry visible:

	Host	ID	IP Addresses	OS Type	OS Version	Deployment Status	NSX Version	Controller Conn	Manager Conn	Transport Node (TN)
<input type="checkbox"/>	ESXi-COMP-1	cee7...4b76	10.115.40.72	ESXi	6.5.0	NSX Installed	2.1.0.0.0.7...	Not Availa...	Up	Not Configured

## Create Transport Node

1. In NSX Manager, go to **Fabric > Nodes > Transport Nodes**
2. Click **Add** and create a new Transport Node. For example:
  - o **Name:** ESXi-COMP-1-TN
  - o **Node:** ESXi-COMP-1
  - o **TZ:** TZ-Overlay

## Add Transport Node

(?) X

General \* Host Switches \*

Name \* ESXi-COMP-1-TN

Node \* ESXi-COMP-1 (10.115.40.72) ▾

### Transport Zones

<input type="checkbox"/> Available (2)
<input type="checkbox"/> TZ-Overlay (Overlay)
<input type="checkbox"/> TZ-VLAN (VLAN)

[Create New Transport Zone](#) < >

<input type="checkbox"/> Selected (1)
<input type="checkbox"/> TZ-Overlay (Overlay)

Max Limit: 10

**SAVE**

**CANCEL**

3. Select the **Host Switches** tab.

4. Configure a Host Switch. For example:

- **Host Switch Name:** `hostswitch1`
- **Uplink Profile:** `nsx-default-uplink-hostswitch-profile`
- **IP Assignment:** `Use IP Pool`
- **IP POOL:** `TEP-ESXi-POOL`
- **Physical NICs:** `vmnic1`

## Add Transport Node

[?](#) [X](#)[General \\*](#) [Host Switches \\*](#)Host Switch Type  Standard  Preconfigured[+ ADD HOST SWITCH](#)[▼ New Node Switch](#)

Host Switch Name \* hostswitch1

Uplink Profile \* nsx-default-uplink-hostswitch-profile

[Create New Uplink Profile](#)

IP Assignment \* Use IP Pool

IP Pool \* TEP-ESXi-POOL

[OR Create and Use a new IP Pool](#)

Physical NICs vmnic1 uplink-1

[Add PNIC](#)[SAVE](#)[CANCEL](#)

## Verify ESXi Host Preparation for PKS Compute Cluster

1. Verify that you see the ESXi Compute Transport Node:

	Transport Node ID	Host Switches	Configuration State	Status	IP Addresses	Fabric Node Type	Transport Zones	NSX Version
<input checked="" type="checkbox"/>	ESXi-COMP-...	cee7...4b76	1 ● Success	● Down	10.115.40.72	Host - ESXi 6.5.0	TZ-Overlay	2.1.0.0.0.715...
<input type="checkbox"/>	edge-TN1	04c4...b48d	2 ● Success	● Up	10.40.206.6	Edge - Virtual Machi...	TZ-Overlay TZ-VLAN	2.1.0.0.0.715...
<input type="checkbox"/>	edge-TN2	21ce...a24c	2 ● Success	● Up	10.40.206.7	Edge - Virtual Machi...	TZ-Overlay TZ-VLAN	2.1.0.0.0.715...

2. Verify the status is **Up**.

**Note:** If you are using NSX-T 2.3, the status should be up. If you are using NSX-T 2.2, the status may incorrectly show as down (because the Tunnel Status is Down.) Either way, verify TEP communications as described in the next step.

3. Make sure the NSX TEP vmk is created on ESXi host and TEP to TEP communication (with Edge TN for instance) works.

```
[root@ESXi-1:] esxcfg-vmknic -l
[root@ESXi-1:] vmkping ++netstack=vxlan <IP of the vmk10 interface> -d -s 1500
```

## Next Step

After you complete this procedure, follow the instructions in [Creating the PKS Management Plane](#).

## Creating the PKS Management Plane

Page last updated:

Prepare the vSphere and NSX-T infrastructure for the PKS Management Plane where the PKS, Ops Manager, BOSH Director, and Harbor Registry VMs are deployed.

### Prerequisites

Before you begin this procedure, ensure that you have reviewed the following documentation for installing PKS on vSphere with NSX-T:

- [Prerequisites and Resource Requirements](#)
- [NSX-T Deployment Topologies for PKS](#)
- [Preparing to Deploy PKS with NSX-T on vSphere](#)

In addition, ensure that you have successfully deployed NSX-T for PKS. For more information, see [Deploying NSX-T for PKS](#).

### About the PKS Management Plane

The PKS Management Plane is the network for PKS Management components, including PKS, Ops Manager, and BOSH Director. The PKS Management Plane includes a vSphere resource pool for Management Plane components, as well as a NSX Tier-1 Logical Switch, Tier-1 Logical Router, and Router Port, as well as NSX NAT rules.

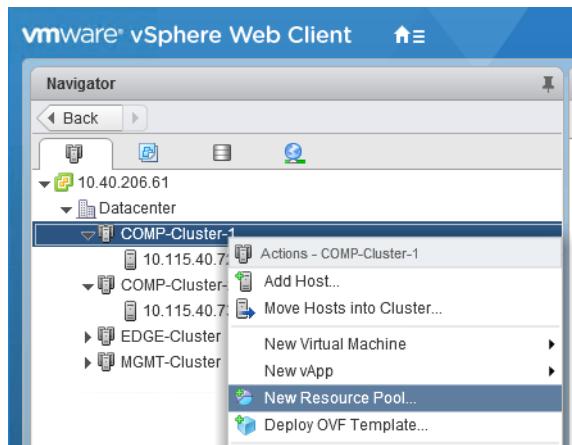
If you are using either the the [NAT deployment topology](#) or the [No-NAT with Logical Switch deployment topology](#), create a [Tier-1 \(T1\) Logical Switch](#), and a [Tier-1 Logical Router and Port](#). Link the T1 logical router to the T0 logical router, and select the Edge Cluster defined for PKS. Enable route advertisement for the T1 Logical Router and advertise All NSX connected routes for the PKS Management Plane VMs (PKS, Ops Manager, and BOSH Director).

If you are using the [NAT Topology](#), create the following NAT rules on the T0 Router.

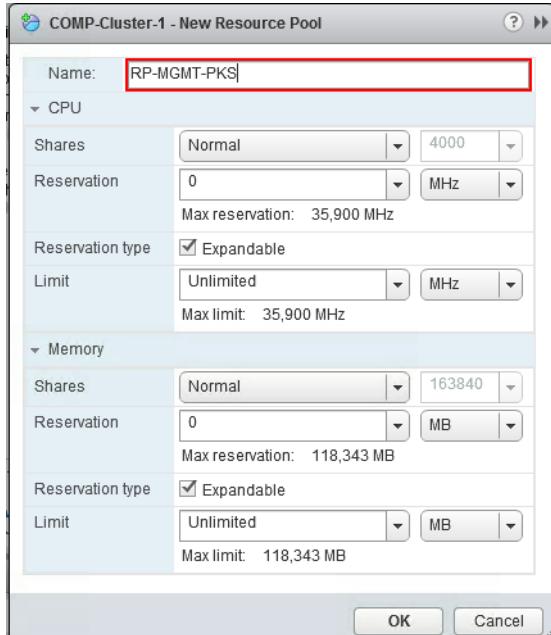
- Destination NAT (DNAT) rule that maps an external IP address from the **PKS MANAGEMENT CIDR** to the IP where you deploy Ops Manager on the PKS Management logical switch. For example, a DNAT rule that maps `10.172.1.2` to `172.31.0.2`, where `172.31.0.2` is the IP address you assign to Ops Manager when connected to `ls-pks-mgmt`.
- (Optional) Destination NAT (DNAT) rule that maps an external IP address from the **PKS MANAGEMENT CIDR** to the IP where you deploy Harbor on the PKS Management logical switch. For example, a DNAT rule that maps `10.172.1.3` to `172.31.0.3`, where `172.31.0.3` is the IP address you assign to Harbor when connected to `ls-pks-mgmt`.
- Source NAT (SNAT) rule to allow the PKS Management VMs to communicate with your vCenter and NSX Manager environments. For example, an SNAT rule that maps `172.31.0.0/24` to `10.172.1.1`, where `10.172.1.1` is a routable IP address from your **PKS MANAGEMENT CIDR**.
- SNAT rule for PKS management components to access ESXi Hosts.
- (Optional) SNAT rules for access to other management servers, such as DNS, NTP, and LDAP/AD.

### Step 1. Create vSphere Resource Pool for the PKS Management Plane

1. Log in to vCenter for your vSphere environment.

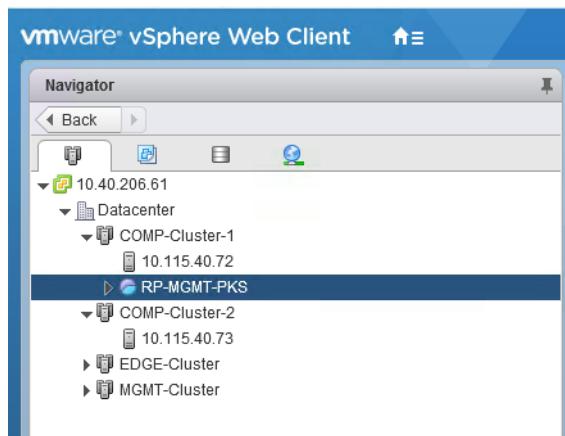


2. Select Compute Cluster > New Resource Pool.



3. Name the resource pool, such as RP-MGMT-PKS.

4. Click OK



5. Verify resource pool creation.

## Step 2. Create NSX-T Logical Switch for the PKS Management Plane

1. In NSX Manager, select Switching > Add.

Add New Logical Switch

[?](#) [X](#)

[General](#) [Switching Profiles](#)

Name \*

Description

Transport Zone \*

Uplink Teaming Policy Name \*

Admin Status  Up

Replication Mode  Hierarchical Two-Tier replication  
 Head replication

VLAN

Only VLAN Trunk Spec is allowed (eg: 1, 5, 10-12, 31-35).

[CANCEL](#) [ADD](#)

2. Create a new logical switch. For example:

3. Click **Add**.

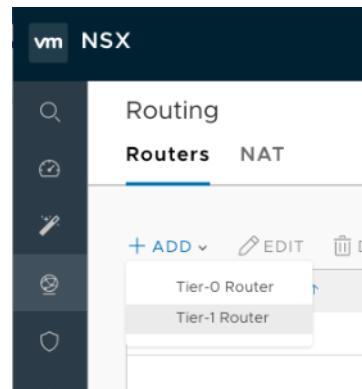
4. Verify logical switch creation.

Switching						
<a href="#">Switches</a>		<a href="#">Ports</a>	<a href="#">Switching Profiles</a>			
<a href="#">+ ADD</a> <a href="#">EDIT</a> <a href="#">DELETE</a> <a href="#">ACTIONS</a> <input type="text" value="Search"/>						
Logical Switch	ID	Admin Status	Logical Ports	Traffic Type	Config State	Transport Zone
<a href="#">LS-MGMT-PKS</a>	63a7...b6bd	<input checked="" type="radio"/> Up	0	Overlay : 54173	In Progress	TZ-Overlay
<a href="#">uplink-LS1</a>	b4d7...1171	<input checked="" type="radio"/> Up	3	VLAN : 0	Success	TZ-VLAN

## Step 3. Create NSX-T Tier-1 Router for the PKS Management Plane

Defining a T1 router involves creating the router and attaching it to the logical switch, creating a router port, and advertising the routes.

### Create T1 Router



1. In NSX Manager, select **Routing > Add > Tier-1 Router**.

New Tier-1 Router (?) X

**Tier-1 Router** [Advanced](#)

Name *	T1-MGMT-PKS
Description	<input type="text"/>
Tier-0 Router	<input type="text"/> <span>x v</span>
Edge Cluster	<input type="text"/> <span>x v</span>

CANCEL ADD

2. Configure the T1 router. For example:

3. Click **Add**.

4. Verify T1 router creation.

T1 Router List						
Actions		ID	Type	Connected Tier-0 Router	High Availability Mode	Transport Zone
<input type="checkbox"/>	EDIT	<input type="checkbox"/> DELETE	<input type="checkbox"/> ACTIONS	Logical Router	7e4a...5e00	Tier-0
<input type="checkbox"/>	TO-LR	7e4a...5e00	Tier-0	Active-Standby	TZ-VLAN	edgecluster1
<input type="checkbox"/>	T1-MGMT-PKS	1f32...ea95	Tier-1			

## Create T1 Router Port

1. Select the T1 router you created.

2. Select **Configuration > Router Ports**.

The screenshot shows the Pivotal Network Management interface. On the left, there's a sidebar with 'Routing' and tabs for 'Routers' and 'NAT'. Under 'Routers', there's a tree view with 'Logical Router' expanded, showing 'TO-LR' and 'T1-MGMT-PKS'. 'T1-MGMT-PKS' is selected and highlighted in blue. On the right, a main panel titled 'T1-MGMT-PKS' has tabs for 'Overview', 'Configuration' (which is selected), 'Routing', and 'Services'. The 'Configuration' tab has sub-tabs 'Logical Route' and 'Router Ports'. The 'Router Ports' sub-tab is active, showing a table with columns: Logical Route ID, Type, IP Address/mask, Connected To, Transport Node, Relay Service, and Statistics. The table currently displays 'No Logical Router Ports found'.

3. Click Add and configure the T1 router port. For example:

- o Name:
- o Logical Switch:

**New Router Port**

Name*	T1-MGMT-PKS-PORT
Description	<input type="text"/>
Type	Downlink
URPF Mode	<input checked="" type="radio"/> Strict <input type="radio"/> None
Logical Switch	LS-MGMT-PKS <a href="#">OR Create a New Switch</a>
Logical Switch Port	<input checked="" type="radio"/> Attach to new switch port Switch Port Name: <input type="text" value="10.0.0.1/24"/> <input type="radio"/> Attach to existing switch port
IP Address/mask*	<input type="text" value="10.0.0.1/24"/>
Relay Service	<input type="text"/>

**CANCEL** **ADD**

- o IP Address/mask:

4. Click Add.

5. Verify T1 router port creation.

## Advertise the T1 Routes

1. Select the T1 router > Routing > Route Advertisement.

2. Advertise the T1 route as follows:

- o Status: enabled

**Edit Route Advertisement Configuration**

Status	<input checked="" type="checkbox"/> Enabled
Advertise All NSX Connected Routes	<input checked="" type="checkbox"/> Yes
Advertise All NAT Routes	<input type="checkbox"/> No
Advertise All Static Routes	<input type="checkbox"/> No
Advertise All LB VIP Routes	<input type="checkbox"/> No
Advertise All LB SNAT IP Routes	<input type="checkbox"/> No

**CANCEL** **SAVE**

- o Advertise all NSX connected routes: yes

3. Click **Save**.

4. Verify route advertisement.

T1-MGMT-PKS

Overview Configuration Routing Services

Route Advertisement | EDIT

Status Enabled

Advertise All NSX Connected Routes Yes

Advertise All NAT Routes No

Advertise All Static Routes No

Advertise All LB VIP Routes No

Advertise All LB SNAT IP Routes No

Advertised Networks 1 Networks

Advertise Routes + ADD EDIT DELETE

Network	Resource Name	Resource Type	Advertised Route	Advertised
10.0.0.0/24	T1-MGMT-PK...	LogicalRoute...	NSX_STATIC	Yes

1 Advertised Networks

## Verify T1 Router

- Select the T1 Router > Overview.

T1-MGMT-PKS

Overview Configuration Routing Services

Summary | EDIT

Name	T1-MGMT-PKS
ID	f63210e3-c96e-4ed4-9f5e-054478d4ea95
Location	
Description	
Type	Tier-1
High Availability Mode	Active-Standby
Failover Mode	Non-Preemptive
Edge Cluster	edgecluster1
Intra Tier1 transit subnet	169.254.0.0/28
Created	10/12/2018, 4:05:59 PM by admin

Tier-0 Connection | CONNECT

- Tier-0 Router
- > Service Routers
- > Distributed Routers
- > Tags | MANAGE

- Select Tier-0 Connection > Connect, then select the T0 router and click Connect.

Connect to Tier-0 Router

Tier-0 Router\* TO-LR

CANCEL CONNECT

3. Verify connectivity between T1 and T0 routers.

The screenshot shows the NSX Manager interface under the 'Routing' section. On the left, a sidebar lists 'Logical Router' (TO-LR) and 'T1-MGMT-PKS'. The 'T1-MGMT-PKS' entry is selected and highlighted in blue. The main panel displays the 'T1-MGMT-PKS' router details under the 'Overview' tab. The summary table includes the following information:

Name	T1-MGMT-PKS
ID	f63210e3-c96e-4ed4-9f5e-054478d4ea95
Location	
Description	
Type	Tier-1
High Availability Mode	Active-Standby
Failover Mode	Non-Preemptive
Edge Cluster	edgecluster1
Intra Tier1 transit subnet	169.254.0.0/28
Created	10/12/2018, 4:05:59 PM by admin

Below the summary, there are sections for 'Tier-O Connection' (connected to TO-LR), 'Service Routers', 'Distributed Routers', 'Router Links Information', and 'Tags'.

4. Select the **T1 router > Router ports**. The T1 router created for the PKS Management Plane should have 2 ports: one connected to the T0 router, and a second port connected to logical switch defined for the PKS Management Plane. This second port will be the default gateway for all VMs connected to this LS.

The screenshot shows the NSX Manager interface under the 'Routing' section. The 'T1-MGMT-PKS' router is selected. The 'Configuration' tab is active, specifically the 'Logical Router Ports' section. A table lists the ports:

Logical Route ID	Type	IP Address/mask	Connected To	Transport Node	Relay Service	Statistics
LinkedPo...	24fe..432c	Linked Po...	100.64.112.17/31	TO-LR ( LinkedPort_T1-MGMT-... )	edge-TN1 edge-TN3	
T1-MGMT...	e08f..39e8	Downlink	10.0.0.1/24	LS-MGMT-PKS ( cf5e0f08-522e-412... )		

## Step 4. Create DNAT Rule on T0 Router for Ops Manager

Create a DNAT rule on the T0 Router to access the Ops Manager Web UI, which is required to deploy PKS.

The Destination NAT (DNAT) rule on the T0 maps an external IP address from the **PKS MANAGEMENT CIDR** to the IP where you deploy Ops Manager on the PKS Management logical switch that you created on the T0 router. For example, a DNAT rule that maps `10.172.1.2` to `172.31.0.2`, where `172.31.0.2` is the IP address you assign to Ops Manager when connected to `ls-pks-mgmt`.

To create a DNAT rule for Ops Manager:

1. In NSX Manager, select **Routing > Routers**.
2. Select the **T0 Router > Services > NAT**.

The screenshot shows the Pivotal Routing interface with the NAT tab selected for the TO-LR logical router. The table below shows no NAT rules have been defined.

ID	Action	Match	Translated	Applied To	Stats
Protocol	Source IP	Source Ports	Destination IP	Destination Ports	
No NAT Rules found					

3. Add and configure a DNAT rule with the routable IP address as the destination and the internal IP address for Ops Manager as the translated IP. For example:

- Priority: 1000
- Action: DNAT
- Destination IP: 10.40.14.1

**New NAT Rule**

Priority: 1000

Action\*: DNAT

Protocol: Any Protocol

Source IP: (empty)

Destination IP\*: 10.40.14.1

Translated IP\*: 10.0.0.2

Translated Ports: (empty)

Applied To: (empty)

Status: Enabled

Logging: Disabled

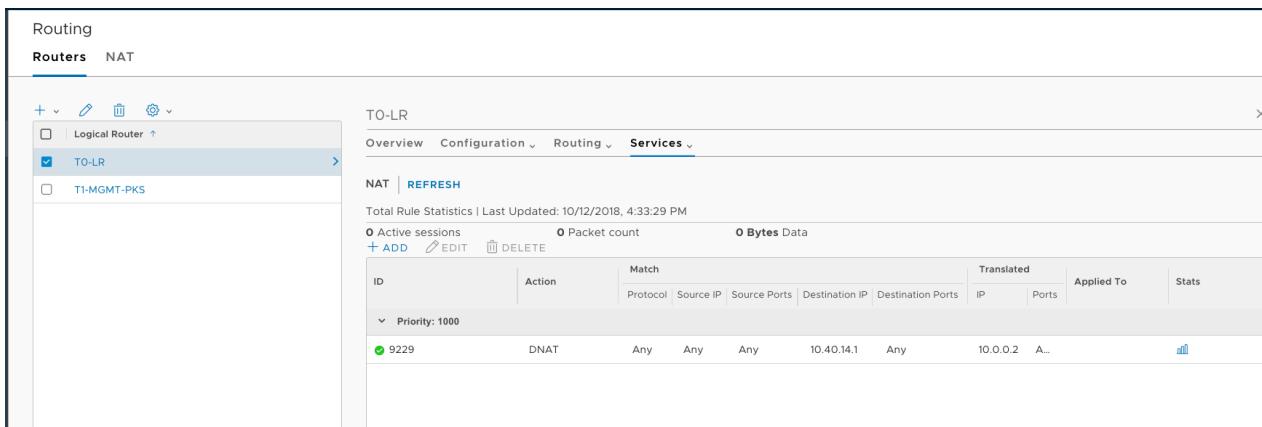
Firewall Bypass: Enabled

**CANCEL** **ADD**

- Translated IP: 10.0.0.2

4. Click **Add**.

5. Verify the DNAT rule.



## Step 5. Create DNAT Rule on T0 Router for Harbor Registry

If you are using VMware Harbor Registry with PKS, create a similar DNAT rule on T0 router to access the Harbor Web UI. This DNAT rule maps the private Harbor IP address to a routable IP address from the floating IP pool on the PKS Management network. See [Create DNAT Rule](#) in the VMware Harbor Registry documentation for instructions.

## Step 6. Create SNAT rule on T0 router for vCenter and NSX Manager

Create a SNAT rule on T0 router for PKS management components to access vCenter and NSX manager. The Source NAT (SNAT) rule on the T0 allows the PKS Management VMs to communicate with your vCenter and NSX Manager environments. For example, a SNAT rule that maps `172.31.0.0/24` to `10.172.1.1`, where `10.172.1.1` is a routable IP address from your **PKS MANAGEMENT CIDR**.

**Note:** Limit the Destination CIDR for the SNAT rules to the subnets that contain your vCenter and NSX Manager IP addresses.

1. Select **T0 router > Services > NAT**.
2. Click ADD and configure the SNAT rule. For example:
  - o **Priority:** 1010
  - o **Action:** SNAT
  - o **Source:** 10.0.0.0/24
  - o **Destination IP:** 10.40.206.0/24

New NAT Rule

Priority	1010
Action*	SNAT
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol
Source IP	10.0.0.0/24
Destination IP	10.40.206.0/24
Translated IP*	10.40.14.2
Applied To	
Status	<input checked="" type="checkbox"/> Enabled
Logging	<input type="checkbox"/> Disabled
Firewall Bypass	<input checked="" type="checkbox"/> Enabled

**CANCEL** **ADD**

- Translated IP: 10.40.14.2

3. Click Add.

4. Verify SNAT rule creation.

The screenshot shows the NSX Manager interface under the 'Routers' tab. On the left, a tree view shows 'Logical Router' expanded, with 'T0-LR' selected. The main pane is titled 'TO-LR' and shows the 'Services > NAT' configuration. The 'NAT' tab is active. At the top, it says 'Total Rule Statistics | Last Updated: 10/13/2018, 9:43:29 AM'. Below that are buttons for '+ ADD', 'EDIT', and 'DELETE'. A table lists the NAT rules:

ID	Action	Match	Translated	Applied To	Stats
Protocol   Source IP   Source Ports   Destination IP   Destination Ports   IP   Ports					
Priority: 1000					
9229	DNAT	Any Any Any	10.40.14.1	Any	10.0.0.2 A_
Priority: 1010					
9230	SNAT	Any 10.0.0... Any	10.40.206...	Any	10.40... A_

## Step 7. Create SNAT Rules on T0 Router for DNS, NTP, and LDAP/AD

1. In NSX Manager, select T0 router > Services > NAT.

2. Add a SNAT rule for DNS. For example:

- Priority: 1010
- Action: SNAT
- Source: 10.0.0.0/24
- Destination IP: 10.20.20.1

New NAT Rule

Priority	1010
Action*	SNAT
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol
Source IP	10.0.0.0/24
Destination IP	10.20.20.1
Translated IP*	10.40.14.2
Applied To	
Status	<input checked="" type="checkbox"/> Enabled
Logging	<input type="checkbox"/> Disabled
Firewall Bypass	<input checked="" type="checkbox"/> Enabled

**CANCEL** **ADD**

- Translated IP: 10.40.14.2

3. Click Add.

4. Add a SNAT rule for NTP. For example:

- Priority: 1010
- Action: SNAT
- Source: 10.0.0.0/24
- Destination IP: 10.113.60.176

New NAT Rule

Priority	1010
Action*	SNAT
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol
Source IP	10.0.0.0/24
Destination IP	10.113.60.176
Translated IP*	10.40.14.2
Applied To	
Status	<input checked="" type="checkbox"/> Enabled
Logging	<input type="checkbox"/> Disabled
Firewall Bypass	<input checked="" type="checkbox"/> Enabled

**CANCEL** **ADD**

- Translated IP: 10.40.14.2

5. Click **Add**.

6. Add a SNAT rule for LDAP/AD. For example:

- **Priority:** 1010
- **Action:** SNAT
- **Source:** 10.0.0.0/24
- **Destination IP:** 10.40.207.0/24

**Edit NAT Rule - 9233**

Priority	1010
Action *	SNAT
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol
Source IP	10.0.0.0/24
Destination IP	10.40.207.0/24
Translated IP *	10.40.14.2
Applied To	
Status	<input checked="" type="checkbox"/> Enabled
Logging	<input type="checkbox"/> Disabled
Firewall Bypass	<input checked="" type="checkbox"/> Enabled
<a href="#">CANCEL</a> <a href="#">SAVE</a>	

- **Translated IP:** 10.40.14.2

7. Click **Add**.

8. Verify SNAT rule creation.

TO-LR										
<a href="#">Overview</a> <a href="#">Configuration</a> <a href="#">Routing</a> <a href="#">Services</a>										
<a href="#">NAT</a>   <a href="#">REFRESH</a>										
Total Rule Statistics   Last Updated: 10/16/2018, 1:13:29 PM										
<span style="float: left;">0 Active sessions</span> <span style="float: left;">0 Packet count</span> <span style="float: left;">0 Bytes Data</span>										
<a href="#">+ ADD</a> <a href="#">EDIT</a> <a href="#">DELETE</a>										
ID	Action	Match					Translated	Applied To	Stats	
		Protocol	Source IP	Source Ports	Destination IP	Destination Ports	IP	Ports		
<b>▼ Priority: 1000</b>										
9229	DNAT	Any	Any	Any	10.40.14.1	Any	10.0.0.2	A...		
<b>▼ Priority: 1010</b>										
9230	SNAT	Any	10.0.0...	Any	10.40.206.0/24	Any	10.40....	A...		
9231	SNAT	Any	10.0.0...	Any	10.20.20.1	Any	10.40....	A...		
9232	SNAT	Any	10.0.0...	Any	10.113.60.176	Any	10.40....	A...		
9233	SNAT	Any	10.0.0...	Any	10.40.207.0/24	Any	10.40....	A...		

## Step 8. Create SNAT Rule on T0 Router for ESXi Hosts

Create a SNAT rule on T0 router for PKS management components to access ESXi Hosts (Management IP). The Destination IP is the Management IP subnet where ESXi Hosts are networked.

**Note:** Ops Manager and BOSH must use the NFCP protocol to the actual ESX hosts to which it is uploading stemcells. Specifically, **Ops Manager & BOSH Director -> ESXi**.

1. Select **T0 router > Services > NAT**.
2. Click **Add** and configure the SNAT rule. For example:
  - o **Priority:** 1010
  - o **Action:** SNAT
  - o **Destination IP:** 10.115.40.0/24

### Edit NAT Rule - 9235

Priority	1010
Action*	SNAT
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol
Source IP	10.0.0.0/24
Destination IP	10.115.40.0/24
Translated IP*	10.40.14.2
Applied To	
Status	<input checked="" type="checkbox"/> Enabled
Logging	<input type="checkbox"/> Disabled
Firewall Bypass	<input checked="" type="checkbox"/> Enabled

**CANCEL** **SAVE**

- o **Translated IP:** 10.40.14.2

3. Click **Add**.

Edit NAT Rule - 9235 X

Priority	1010	▼
Action*	SNAT	▼
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol	
Source IP	10.0.0.0/24	
Destination IP	10.115.40.0/24	
Translated IP*	10.40.14.2	
Applied To	X ▼	
Status	<input checked="" type="checkbox"/> Enabled	
Logging	<input type="checkbox"/> Disabled	
Firewall Bypass	<input checked="" type="checkbox"/> Enabled	

CANCEL SAVE

4. Verify SNAT rule creation:

## Next Step

After you complete this procedure, follow the instructions in [Creating the PKS Compute Plane](#).

## Creating the PKS Compute Plane

Page last updated:

This section provides instructions for preparing the vSphere and NSX-T infrastructure for the PKS Compute Plane where Kubernetes clusters run.

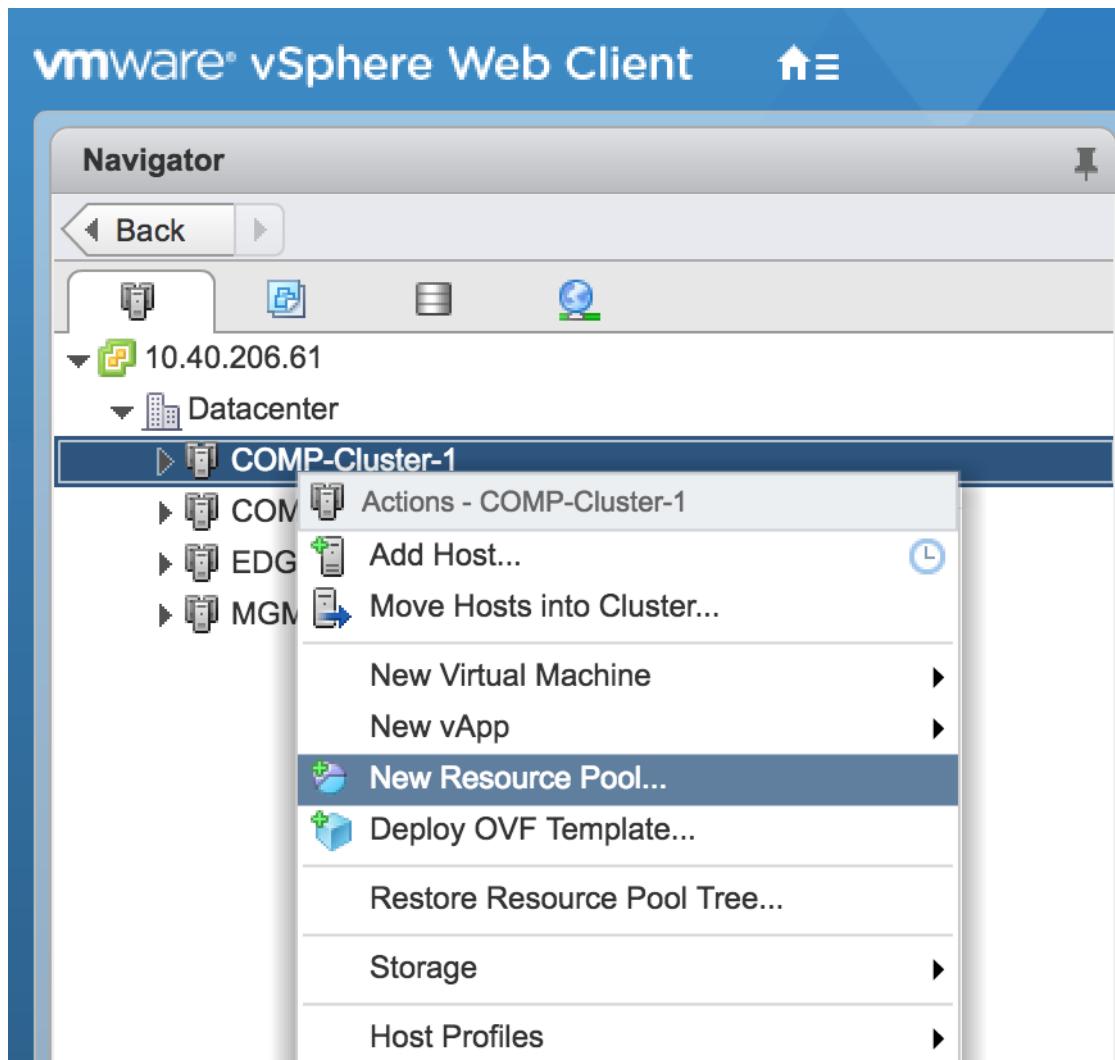
### Prerequisites

Before you begin this procedure, ensure that you have successfully completed all preceding steps for installing PKS on vSphere with NSX-T, including:

- [Deploying NSX-T for PKS](#)
- [Creating the PKS Management Plane](#)

### Step 1: Create vSphere Resource Pools for AZ-1 and AZ-2

1. Log in to vCenter for your vSphere environment.
2. Select **Compute Cluster > New Resource Pool**.



3. Name the resource pool, such as `RP-PKS-AZ-1`.

 COMP-Cluster-1 - New Resource Pool

Name: RP-PKS-AZ-1

?

CPU

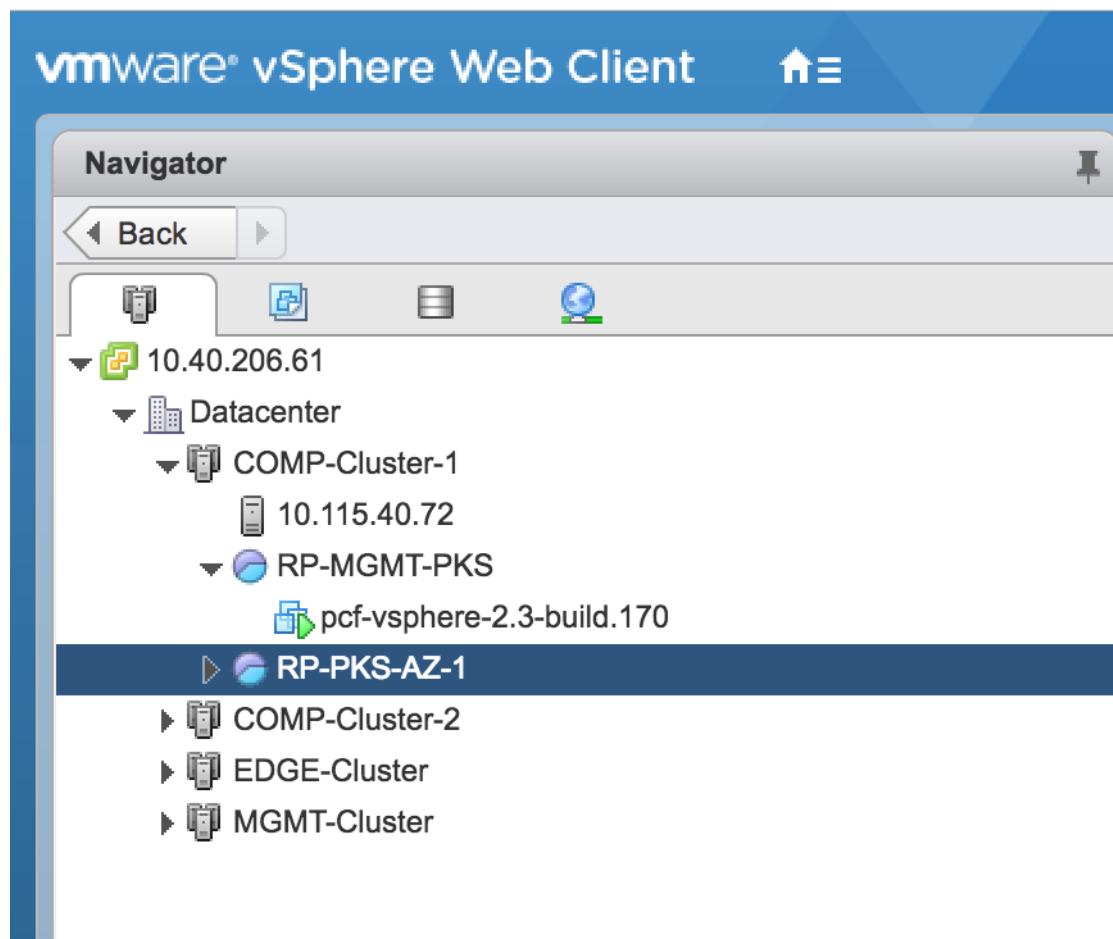
Shares	Normal	4000
Reservation	0	MHz
Max reservation: 35,900 MHz		
Reservation type	<input checked="" type="checkbox"/> Expandable	
Limit	Unlimited	MHz
Max limit: 35,900 MHz		

Memory

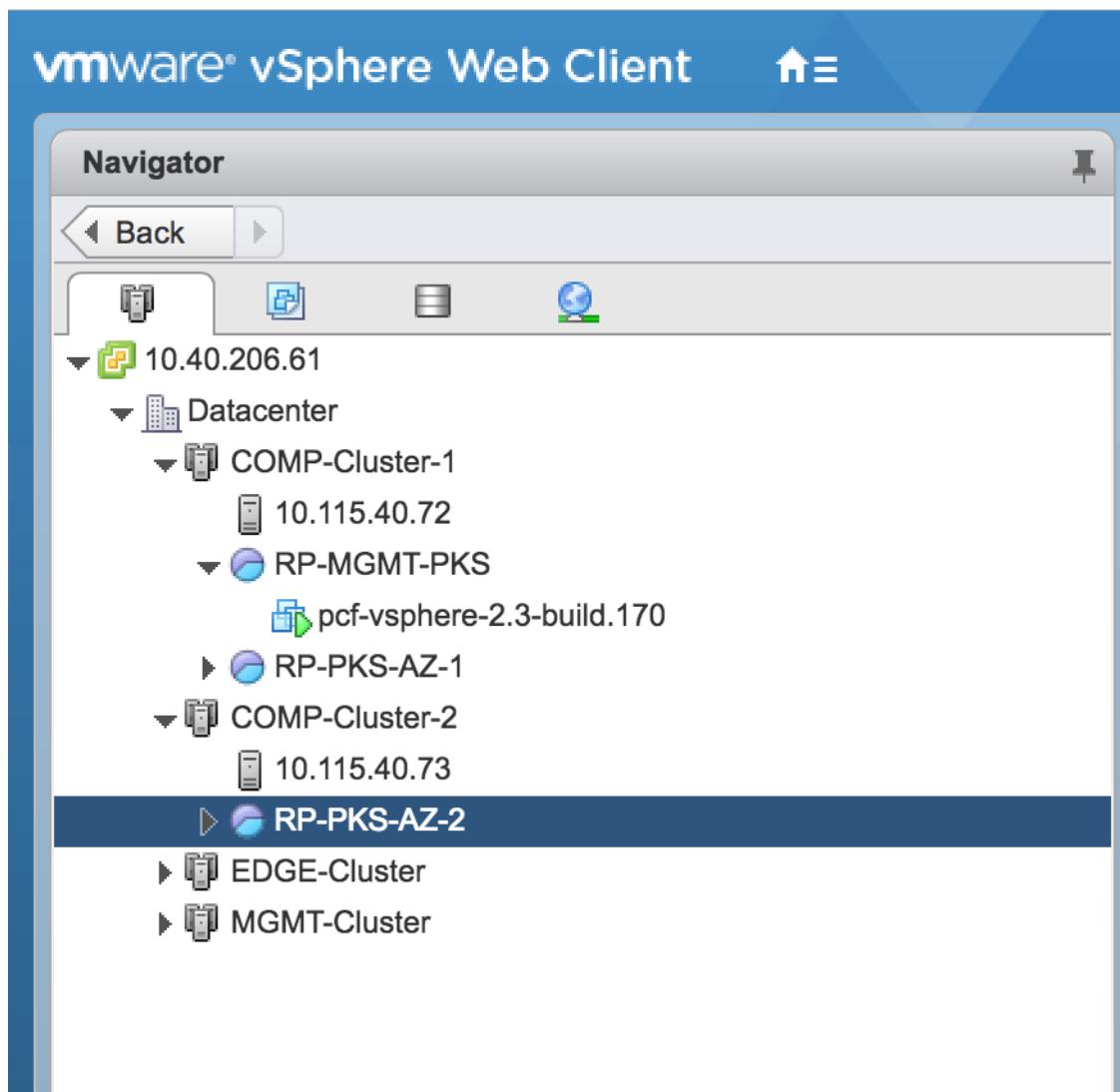
Shares	Normal	163840
Reservation	0	MB
Max reservation: 118,255 MB		
Reservation type	<input checked="" type="checkbox"/> Expandable	
Limit	Unlimited	MB
Max limit: 118,335 MB		

OK Cancel

4. Click OK and verify resource pool creation:



5. Repeat the same operation for Compute Cluster 2 (`RP-PKS-AZ-2`):



## Step 2: Create SNAT rule on T0 Router for Kubernetes Access to NSX Manager

Create a SNAT rule on T0 router for K8s Master Nodes (hosting NCP) to reach NSX Manager.

1. Select the **T0 router > Services > NAT**.
2. Click **ADD** and configure the SNAT rule. For example:
  - o Priority: 1011
  - o Action: SNAT
  - o Source: 192.168.0.0/16
  - o Destination IP: 10.40.206.0/24

## Edit NAT Rule - 9239

Priority	1011
Action *	SNAT
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol
Source IP	192.168.0.0/16
Destination IP	10.40.206.0/24
Translated IP *	10.40.14.3
Applied To	
Status	<input checked="" type="checkbox"/> Enabled
Logging	<input type="checkbox"/> Disabled
Firewall Bypass	<input checked="" type="checkbox"/> Enabled
<input type="button" value="CANCEL"/> <input type="button" value="SAVE"/>	

- Translated IP: 10.40.14.3

3. Click Save.

4. Verify SNAT rule creation:

ID	Action	Match	Translated	Applied To	Stats					
ID	Action	Protocol	Source IP	Source Ports	Destination IP	Destination Ports	IP	Ports	Applied To	Stats
9229	DNAT	Any	Any	Any	10.40.14.1	Any	10.0.0.2	A...		
9230	SNAT	Any	10.0.0.0/24	Any	10.40.206.0/24	Any	10.40.14.2	A...		
9231	SNAT	Any	10.0.0.0/24	Any	10.20.20.1	Any	10.40.14.2	A...		
9232	SNAT	Any	10.0.0.0/24	Any	10.113.60.176	Any	10.40.14.2	A...		
9233	SNAT	Any	10.0.0.0/24	Any	10.40.207.39	Any	10.40.14.2	A...		
9235	SNAT	Any	10.0.0.0/24	Any	10.115.40.0/24	Any	10.40.14.2	A...		
9239	SNAT	Any	192.168.0.0/16	Any	10.40.206.0/24	Any	10.40.14.3	A...		

## Step 3: Create SNAT Rule on T0 Router for Kubernetes Access to LDAP/AD

Create a SNAT rule on T0 router for K8s Master Nodes (hosting NCP) to reach AD (LDAP) Server (if necessary).

- In NSX Manager, select the T0 router > Services > NAT.
- Add an SNAT rule for K8S Master Node access to LDAP/AD. For example:
  - Priority: 1011
  - Action: SNAT
  - Source: 192.168.0.0/16
  - Destination IP: 10.40.207.0/24

## Edit NAT Rule - 9240

x

Priority	1011	▼
Action*	SNAT	▼
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol	
Source IP	192.168.0.0/16	
Destination IP	10.40.207.0/24	
Translated IP *	10.40.14.3	
Applied To	<span style="float: right;">x ▼</span>	
Status	<input checked="" type="checkbox"/> Enabled	
Logging	<input type="checkbox"/> Disabled	
Firewall Bypass	<input checked="" type="checkbox"/> Enabled	
<span style="border: 1px solid #ccc; padding: 2px;">CANCEL</span> <span style="background-color: #0070C0; color: white; border: 1px solid #0070C0; padding: 2px 10px;">SAVE</span>		

- Translated IP: 10.40.14.3

3. Click Save.

4. Add and verify SNAT rule creation:

ID	Action	Match				Translated		Applied To	Stats
		Protocol	Source IP	Source Ports	Destination IP	Destination Ports	IP	Ports	
9229	DNAI	Any	Any	Any	10.40.14.1	Any	10.0.0.2	A...	<span style="color: green;">[graph icon]</span>
9230	SNAT	Any	10.0.0.0/24	Any	10.40.206.0/24	Any	10.40.14.2	A...	<span style="color: green;">[graph icon]</span>
9231	SNAT	Any	10.0.0.0/24	Any	10.20.20.1	Any	10.40.14.2	A...	<span style="color: green;">[graph icon]</span>
9232	SNAT	Any	10.0.0.0/24	Any	10.113.60.176	Any	10.40.14.2	A...	<span style="color: green;">[graph icon]</span>
9233	SNAT	Any	10.0.0.0/24	Any	10.40.207.39	Any	10.40.14.2	A...	<span style="color: green;">[graph icon]</span>
9235	SNAT	Any	10.0.0.0/24	Any	10.115.40.0/24	Any	10.40.14.2	A...	<span style="color: green;">[graph icon]</span>
9239	SNAT	Any	192.168.0.0/16	Any	10.40.206.0/24	Any	10.40.14.3	A...	<span style="color: green;">[graph icon]</span>
9240	SNAT	Any	192.168.0.0/16	Any	10.40.207.0/24	Any	10.40.14.3	A...	<span style="color: green;">[graph icon]</span>

## Next Step

After you complete this procedure, follow the instructions in [Deploying Ops Manager with NSX-T for PKS](#).

## Deploying Ops Manager with NSX-T for PKS

Page last updated:

This topic provides instructions for deploying Ops Manager on VMware vSphere with NSX-T integration for use with PKS.

**Note:** For security purposes, VMware requires a dedicated instance of Ops Manager for use with PKS. Do not deploy Pivotal Application Service (PAS) on the same instance of Ops Manager as PKS. For more information, see [PAS and PKS Deployments with Ops Manager](#).

### Prerequisites

- [Deploy NSX-T for PKS](#)
- [Create PKS Management Plane](#)
- [Create PKS Compute Plane](#)

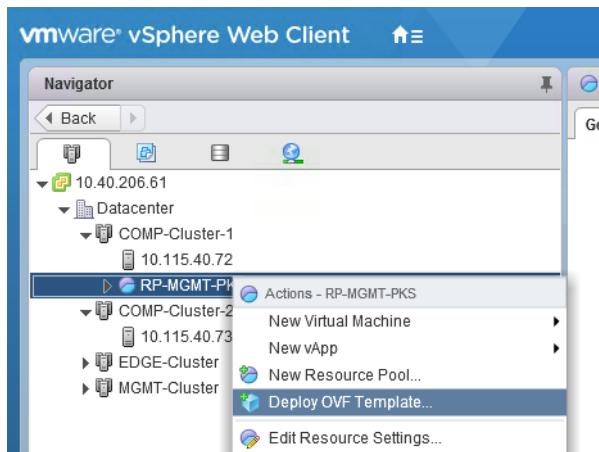
### Deploy Ops Manager for PKS

1. Before starting, refer to the [PKS Release Notes](#) for supported Ops Manager versions for PKS. Or, download the [Compatibility Matrix](#) from the Ops Manager download page.
2. Before starting, refer to the known issues in the [PCF Ops Manager Release v2.2 Release Notes](#) or the [PCF Ops Manager Release v2.3 Release Notes](#).
3. Download the [Pivotal Cloud Foundry Ops Manager for vSphere .ova](#) file at [Pivotal Network](#). Use the dropdown menu to select the supported Ops Manager release.  
Ops Manager for vSphere is provided as an OVA file ( `pcf-vsphere-2.3-build.170.ova` , for example) that you import into your vSphere environment. An OVA file is a template for a VM.

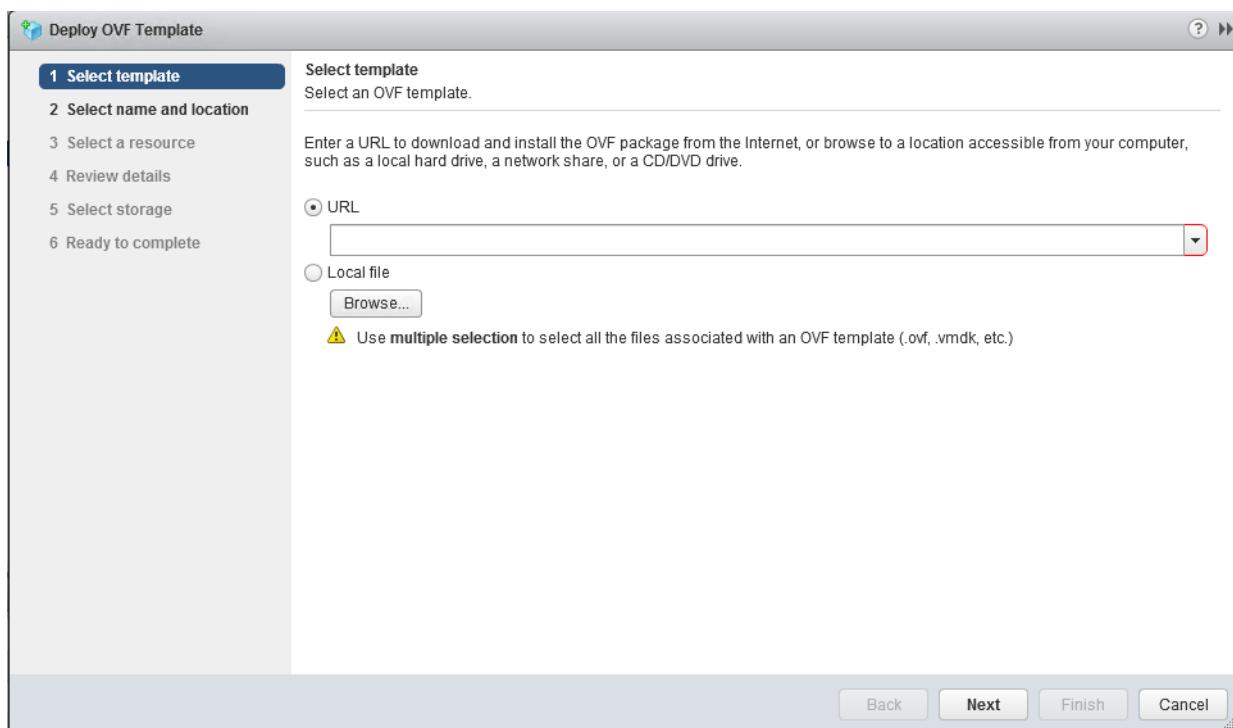
The screenshot shows the Pivotal Network homepage. At the top, there's a navigation bar with links for Documentation, Downloads, Support, Contact Us, Sign In, and Register. Below the navigation, there's a search bar and a "Compatibility Matrix Documentation" link, which is highlighted with a red arrow. The main content area features a section for "Pivotal Cloud Foundry Operations Manager". It includes a "Get Email Updates" button, a "PRODUCT OVERVIEW" link, and a dropdown menu set to "Releases: 2.3.5". Below this, there are two sections: "Release Download Files" and "Release Details". The "Release Download Files" section lists two files: "Pivotal Cloud Foundry Ops Manager for vSphere - 2.3-build.194" (4.01 GB) and "Pivotal Cloud Foundry Ops Manager for OpenStack - 2.3-build.194" (6.84 GB). The "Release Details" section provides the following information:

RELEASE DATE	2018-11-05
RELEASE TYPE	Security Release
END OF GENERAL SUPPORT	2019-06-30

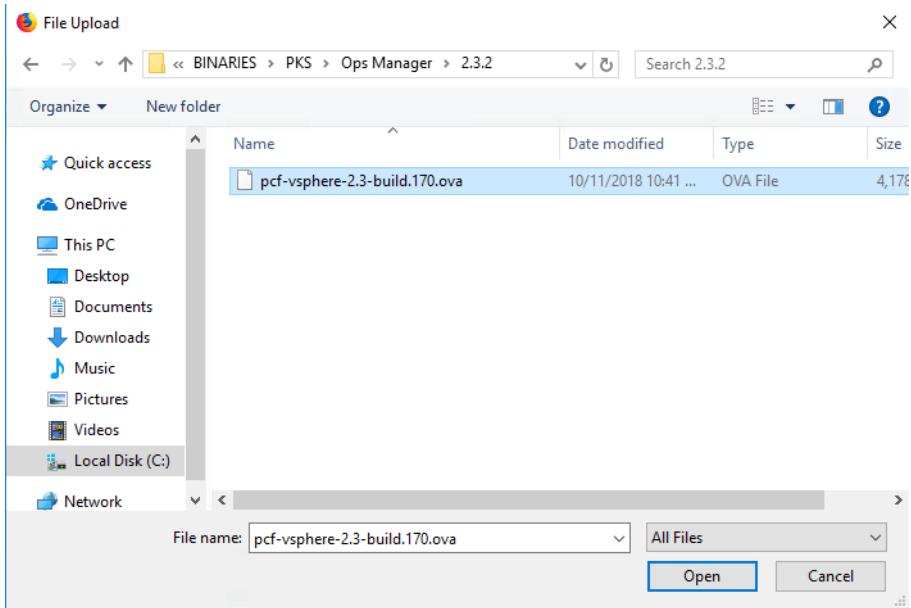
4. Log into vCenter using the vSphere Web Client (FLEX) to deploy the Ops Manager OVA. This can also be done using the using the vSphere Client (HTML5), the OVFTool, or the PowerCLI.
5. Select the Resource Pool defined for the PKS Management Plane. See [Create PKS Management Plane](#) if you have not defined the PKS Management Resource Pool.
6. Right click the PKS Management Plane Resource Pool and select [Deploy OVF Template](#).



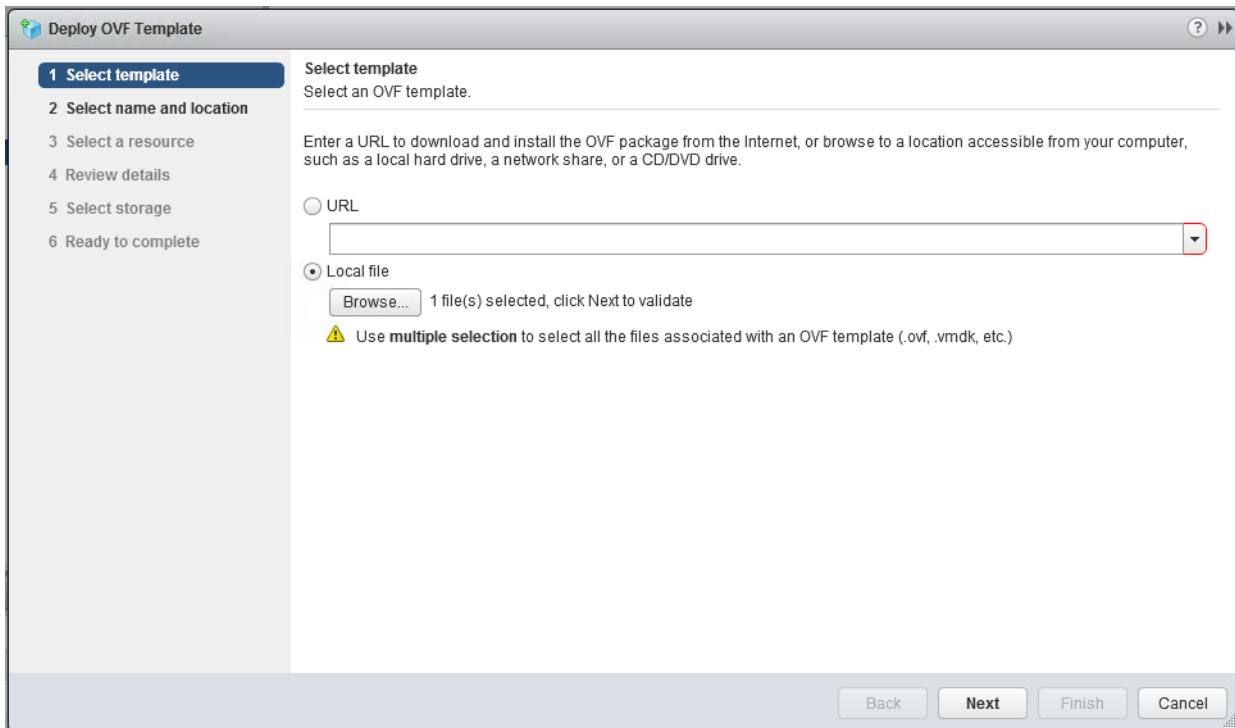
- At the **Select template** screen, click **Browse**.



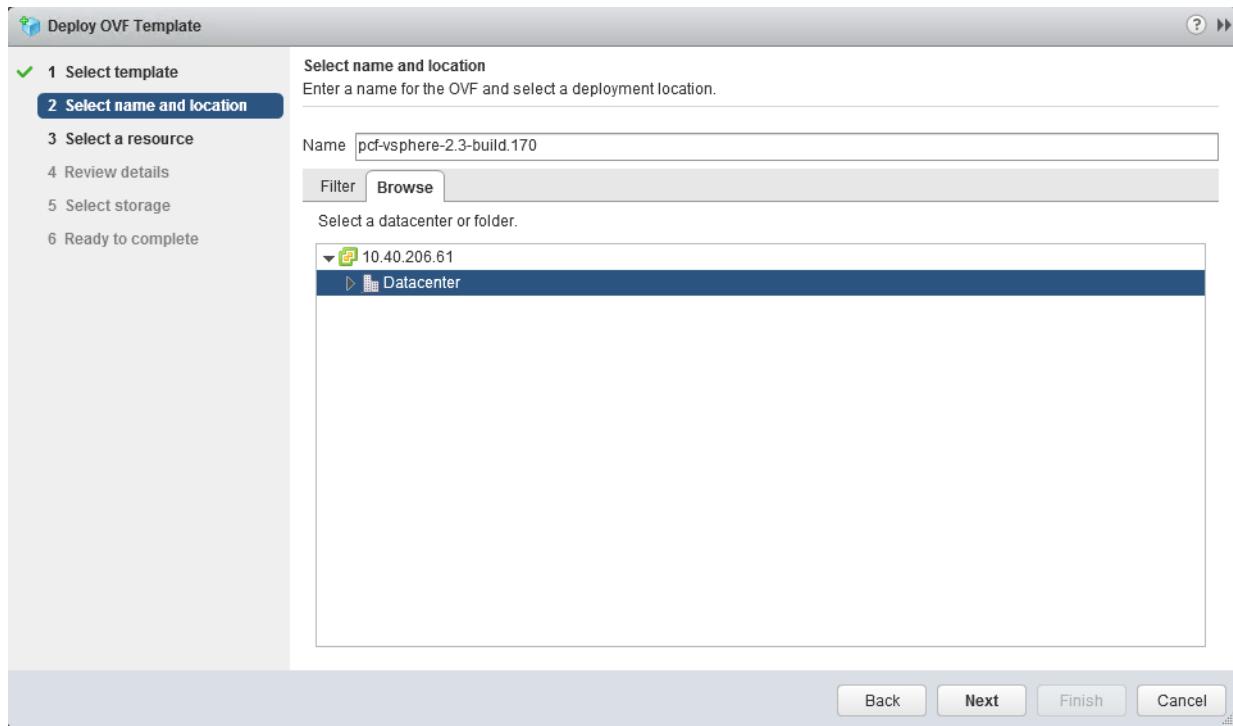
- Select the Ops Manager OVA file you downloaded and click **Open**.



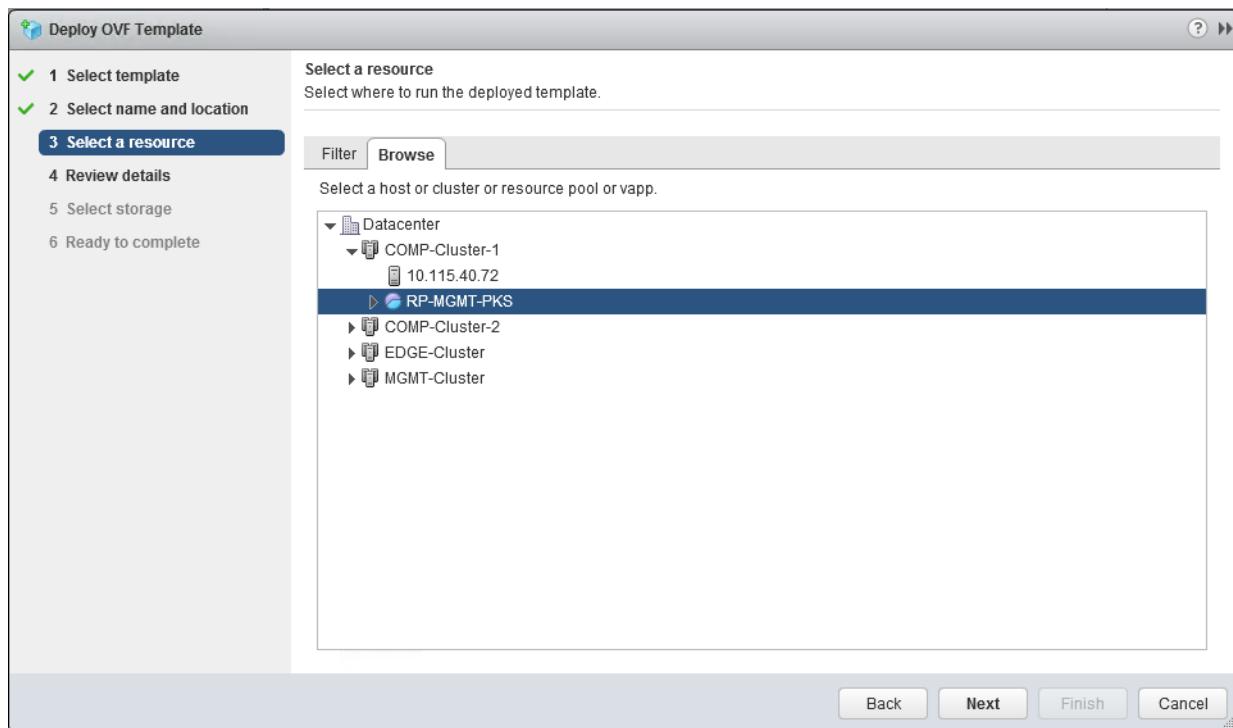
9. Review template selection and click Next.



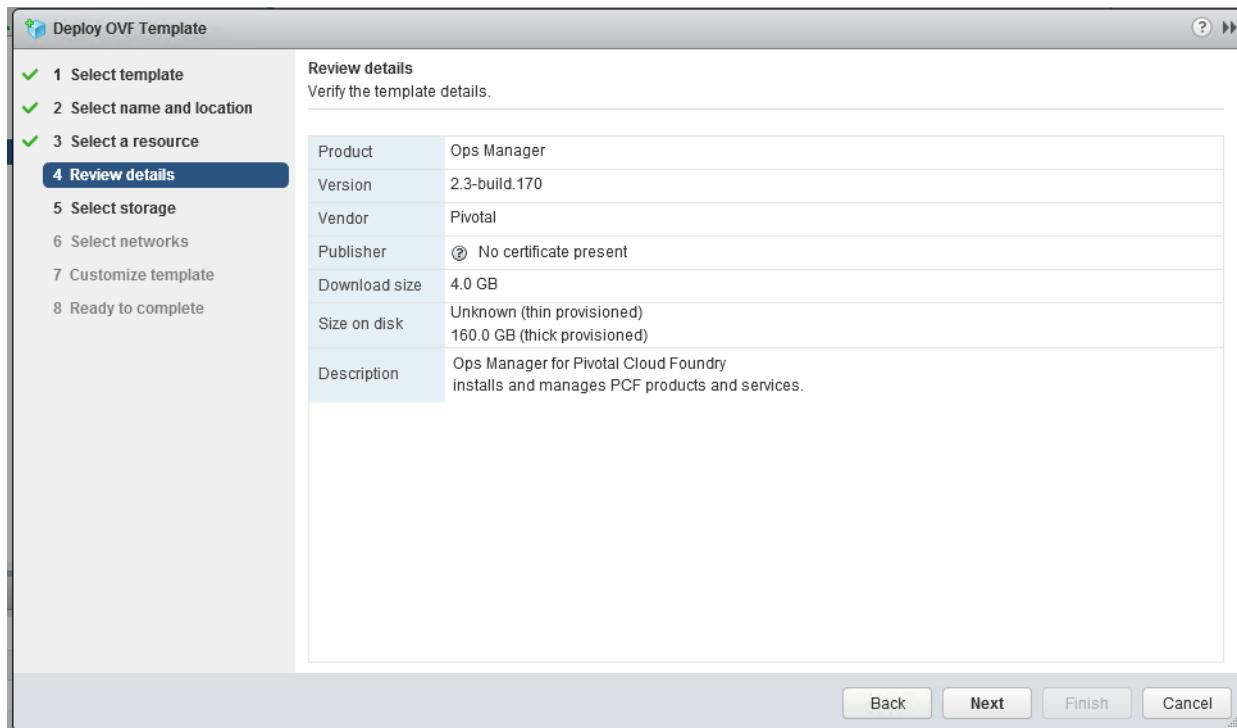
10. At the **Select Name and location** screen, enter a name for the Ops Manager VM (or use the default name), select the **Datacenter object**, and click **Next**



- At the **Select a resource** screen, select the PKS Management Plane Resource Pool and click **Next**.

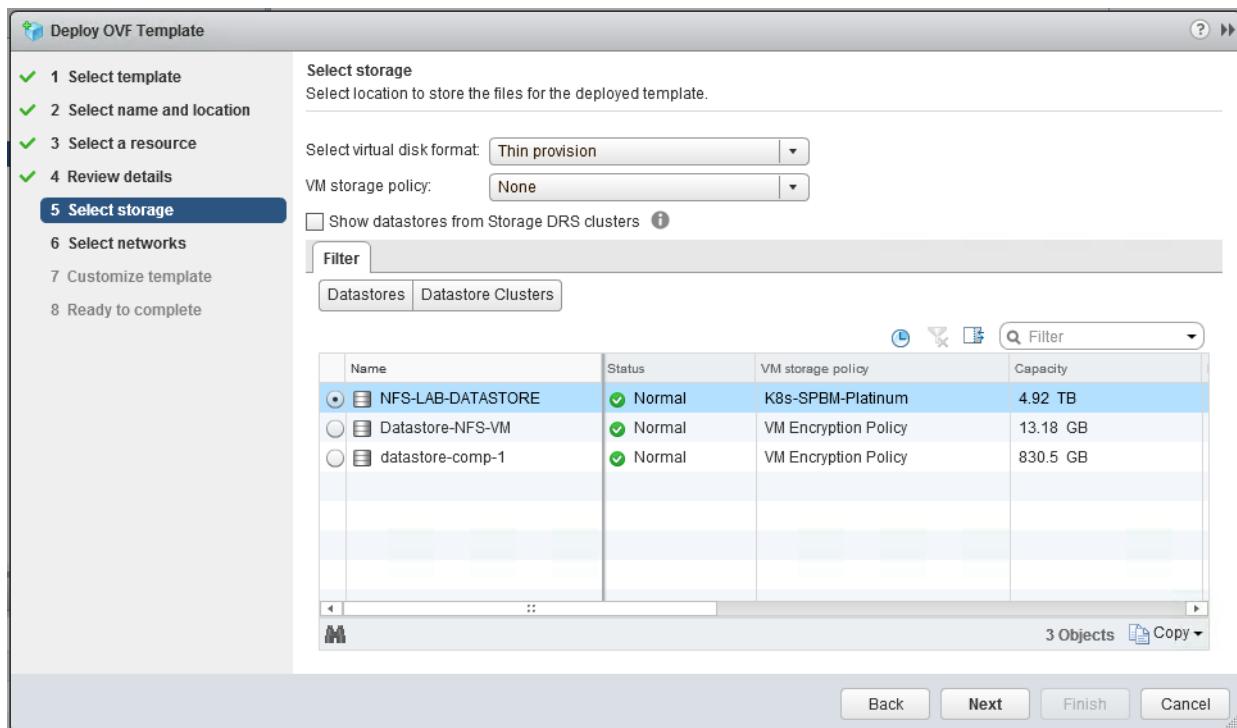


- At the **Review Details** screen, confirm the configuration up to this point and click **Next**.

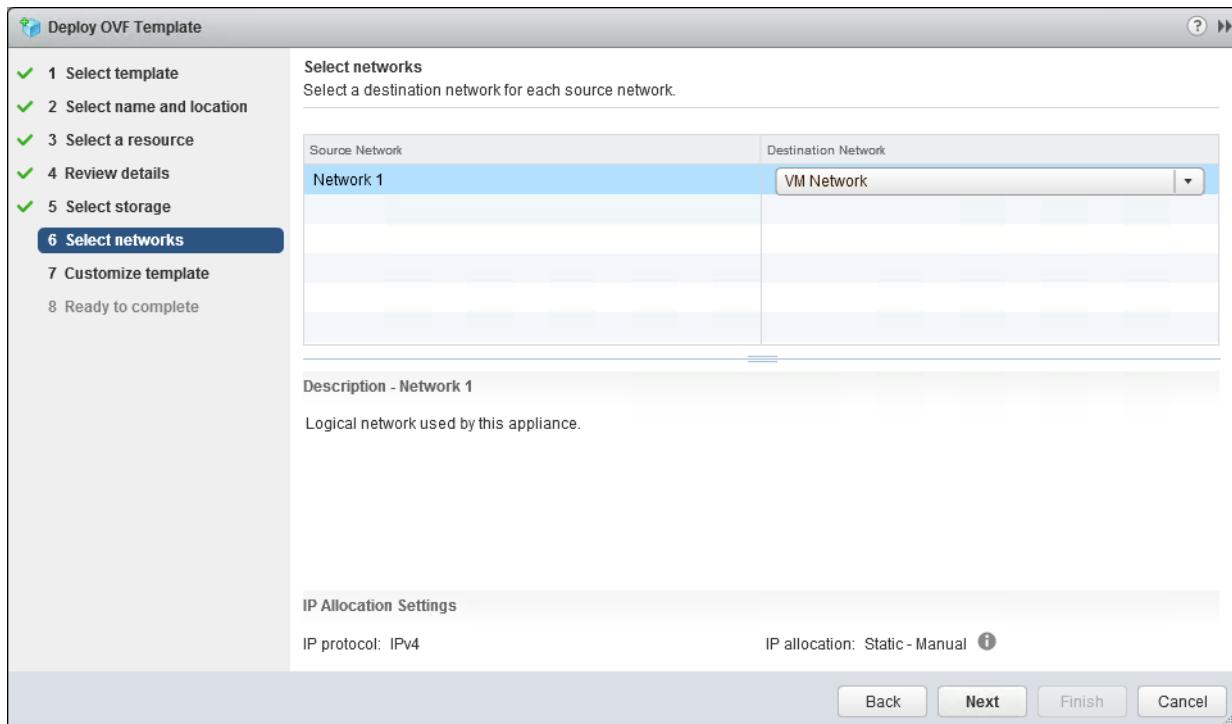


13. At the **Select Storage** screen, select **Thin Provision**, choose the desired Datastore, and click **Next**. For more information about disk formats, see [Provisioning a Virtual Disk in vSphere](#).

**⚠ Warning:** Ops Manager requires a Director VM with at least 8GB memory.



14. At the **Select Networks** screen, if you are using vSphere 6.7, select either the PKS Management T1 Logical Switch that you defined when [Creating the PKS Management Plane](#), or if you are using vSphere 6.5, select a vSS or vDS port-group such as the standard **VM Network**, and click **Next**.



**WARNING:** With VMware vCenter Server 6.5, when initially deploying the Ops Manager OVA, you cannot connect to an NSX-T logical switch. You must first connect to a vSphere Standard (vSS) or vSphere Distributed Switch (vDS). After the OVA deployment is complete, before powering on the Ops Manager VM, connect the network interface to the NSX-T logical switch. The instructions below describe how to do this. This issue is resolved in VMware vCenter Server 6.7. For more information about this issue, see the [VMware Knowledge Base](#).

15. At the **Customize template** screen, enter the following information.

- **Admin Password:** A default password for the “ubuntu” user. If you do not enter a password, Ops Manager will not boot up.
- **Custom hostname:** The hostname for the Ops Manager VM, for example `ops-manager`.
- **DNS:** One or more DNS servers for the Ops Manager VM to use, for example `10.20.20.1`.
- **Default Gateway:** The default gateway for Ops Manager to use, for example `10.0.0.1`.
- **IP Address:** The IP address of the Ops Manager network interface, for example `10.0.0.2` (assuming PKS NAT-mode).
- **NTP Server:** The IP address of one or more NTP servers for Ops Manager, for example `10.113.60.176`.
- **Netmask:** The network mask for Ops Manager, for example, `255.255.255.0`.

**Deploy OVF Template**

Customize template  
Customize the deployment properties of this software solution.

All properties have valid values

Uncategorized	8 settings
Admin Password	This password is used to SSH into the Ops Manager. The username is 'ubuntu'. One or both of Admin Password and SSH Key is required. Enter password <input type="password"/> Confirm password <input type="password"/>
Custom Hostname	This will be set as the hostname on the VM. Default: 'pivotal-ops-manager'. <input type="text" value="ops-manager"/>
DNS	The domain name servers for the Ops Manager (comma separated). Leave blank if DHCP is desired. <input type="text" value="10.20.20.1"/>
Default Gateway	The default gateway address for the Ops Manager's network. Leave blank if DHCP is desired. <input type="text" value="10.0.0.1"/>
IP Address	The IP address for the Ops Manager. Leave blank if DHCP is desired. <input type="text" value="10.0.0.2"/>
NTP Servers	Comma-delimited list of NTP servers <input type="text" value="10.113.60.176"/>
Netmask	The netmask for the Ops Manager's network. Leave blank if DHCP is desired. <input type="text" value="255.255.255.0"/>
Public SSH Key	The Public SSH Key is used to allow SSHing into the Ops Manager with your private ssh key. The username is 'ubuntu'. One or both of Admin Password and SSH Key is required.

Back Next Finish Cancel

16. Click **Next**.

17. At the **Ready to complete** screen, review the configuration settings and click **Finish**. This action begins the OVA import and deployment process.

**Deploy OVF Template**

Ready to complete  
Review configuration data.

Name	pcf-vsphere-2.3-build.170
Source VM name	pcf-vsphere-2.3-build.170
Download size	4.0 GB
Size on disk	Unknown
Datacenter	Datacenter
Resource	RP-MGMT-PKS
Storage mapping	1
Network mapping	1
IP allocation settings	IPv4, Static - Manual
Properties	Custom Hostname = ops-manager DNS = 10.20.20.1 Default Gateway = 10.0.0.1 IP Address = 10.0.0.2 NTP Servers = 10.113.60.176 Netmask = 255.255.255.0 Public SSH Key =

Back Next Finish Cancel

18. Use the **Recent Tasks** panel at the bottom of the vCenter dashboard to check the progress of the OVA import and deployment. If the import or deployment is unsuccessful, check the configuration for errors.

vmware vSphere Web Client    Updated at 3:52 PM | Launch vSphere Client (HTML5) | Administrator@VSHERE.LOCAL

**Navigator**

- Back
- 10.40.206.61
  - Datacenter
    - COMP-Cluster-1
      - 10.115.40.72
      - RP-MGMT-PKS
    - COMP-Cluster-2
      - 10.115.40.73
    - EDGE-Cluster
    - MGMT-Cluster

**Getting Started** Summary Monitor Configure Permissions Resource Pools VMs

**What is a Resource Pool?**

Resource pools can be used to hierarchically partition available CPU and memory resources of a standalone host or a cluster.

**Basic Tasks**

[Create a new virtual machine](#)

**Explore Further**

[Learn more about resource pools](#)

**Recent Tasks**

Task Name	Target	Status	Initiator	Queued For	Start Time	Completion Time
Deploy OVF template	pcf-vsphere-2.3-bui...	0 %	VSPHERE.LOCAL\W...		6 ms	10/12/2018 4:23:19 ...
Import OVF package	RP-MGMT-PKS	0 %	vsphere.local\Admini...		103 ms	10/12/2018 4:15:15 ...

19. Once the deployment completes successfully, right-click the Ops Manager VM and select **Edit Settings**.

vmware vSphere Web Client

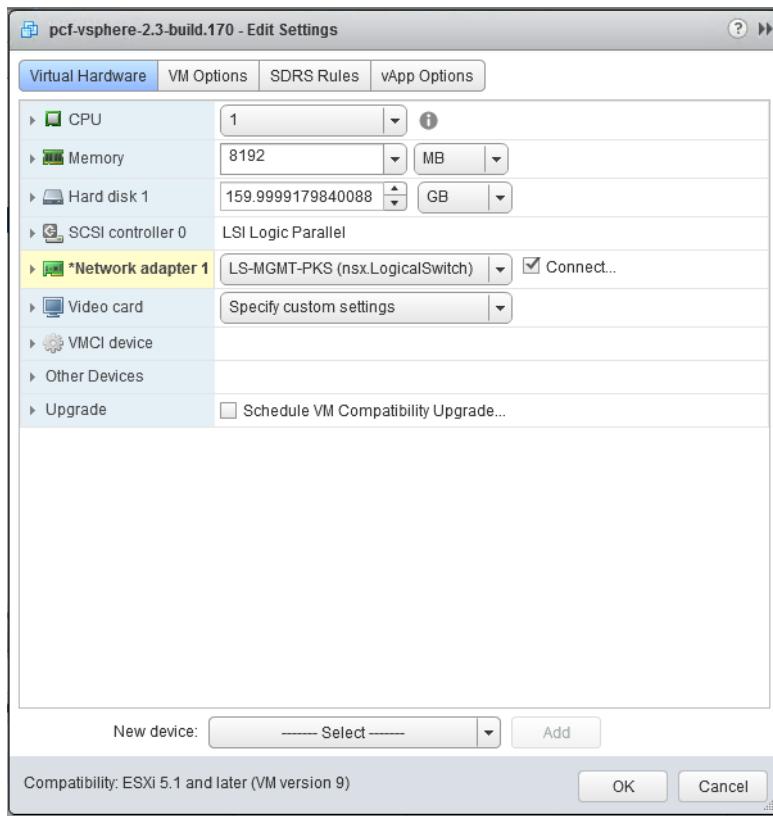
**Navigator**

- Back
- 10.40.206.61
  - Datacenter
    - COMP-Cluster-1
      - 10.115.40.72
      - RP-MGMT-PKS
    - pcf-vsphere-2.3-build.170
    - COMP-Cluster-2
      - 10.115.40.73
    - EDGE-Cluster
    - MGMT-Cluster

**Actions - pcf-vsphere-2.3-build.170**

- Power
- Guest OS
- Snapshots
- Open Console
- Migrate...
- Clone
- Template
- Fault Tolerance
- VM Policies
- Compatibility
- Export System Logs...
- Edit Resource Settings...
- Edit Settings...**

20. If you initially selected a vDS or vSS network for the **Virtual Hardware > Network adapter 1** setting, change the vNIC connection to use the `nsx.LogicalSwitch` that is defined for the PKS Management Plane, for example `LS-MGMT-PKS`. See [Create PKS Management Plane](#) if you have not defined the PKS Management T1 Logical Switch and Router.



21. Right-click the Ops Manager VM and click **Power On**.

## Configure Ops Manager for PKS

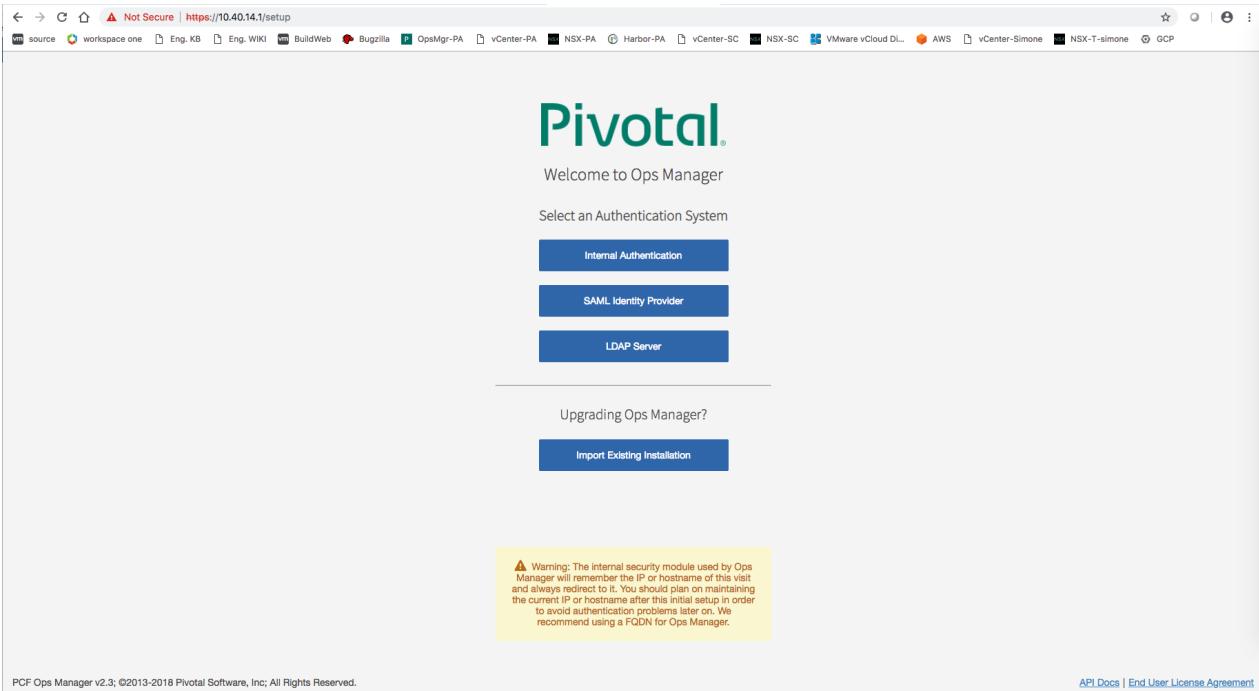
- Create a DNS entry for the IP address that you used for Ops Manager. You must use this fully qualified domain name when you log into Ops Manager in the [Installing Pivotal Cloud Foundry on VSphere](#) topic. Use the routable IP address assigned to Ops Manager.

**Note:** Ops Manager security features require you to create a fully qualified domain name to access Ops Manager during the [initial configuration](#).

- Navigate to the fully qualified domain of your Ops Manager in a web browser.

**Note:** It is normal to experience a brief delay before the interface is accessible while the web server and VM start up.

**Note:** If you are using the [NAT deployment topology](#), you will need a DNAT rule that maps the Ops Manager private IP to a routable IP. See [Create PKS Management Plane](#) for instructions.



3. The first time you start Ops Manager, you are required select an authentication system. These instructions use **Internal Authentication**. See [Set Up Ops Manager](#) in the PCF documentation for configuration details for the **SAML** and **LDAP** options.

The screenshot shows the 'Internal Authentication' setup page. It includes fields for an Admin user (username: admin, password: two masked fields), a second user (two masked fields), proxy settings (Http proxy,Https proxy, No proxy), and a checkbox for agreeing to the End User License Agreement. A blue 'Setup Authentication' button is at the bottom.

**Internal Authentication**

admin

.....

.....

.....

.....

.....

Http proxy

Https proxy

No proxy

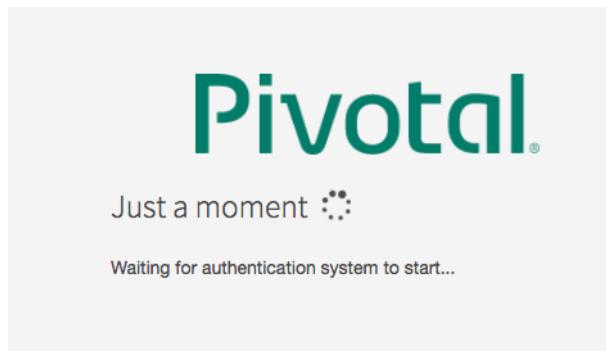
I agree to the terms and conditions of the [End User License Agreement](#).

**Setup Authentication**

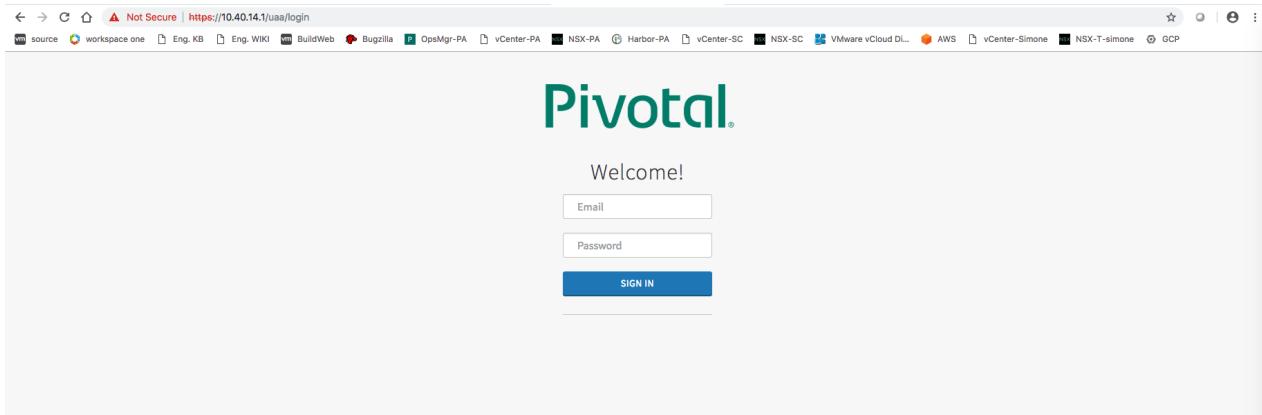
4. Select **Internal Authentication** and provide the following information:

- o **Username**, **Password**, and **Password confirmation** to create an Admin user.
- o **Decryption passphrase** and the **Decryption passphrase confirmation**. This passphrase encrypts the Ops Manager datastore, and is not recoverable.
- o **HTTP proxy** or **HTTPS proxy**, follow the instructions in [Configuring Proxy Settings for the BOSH CPI](#).

5. Click **Setup Authentication**. It will take a few minutes to initialize the database.



6. Log in to Ops Manager with the user name and password you created.



7. Verify success. You should be able to log in, and you should see the BOSH Director tile is present and ready for configuration, indicated by the orange color.

## Next Step

After you complete this procedure, follow the instructions in [Generating and Registering the NSX Manager Certificate for PKS](#).

## Generating and Registering the NSX Manager Certificate for PKS

Page last updated:

This topic describes how to generate and register the NSX Manager certificate authority (CA) certificate in preparation for installing Pivotal Container Service (PKS) on vSphere with NSX-T.

### Prerequisites

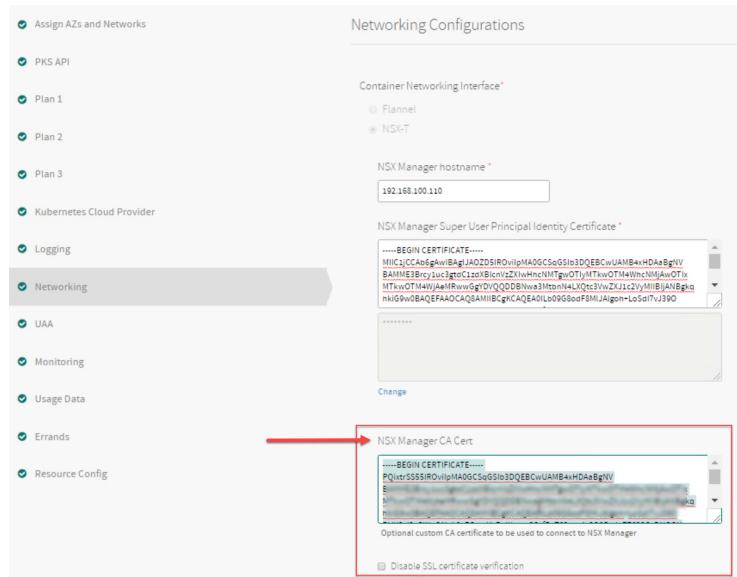
Before you begin this procedure, ensure that you have successfully completed all preceding steps for installing PKS on vSphere with NSX-T, including:

- [Deploy NSX-T for PKS](#)
- [Create PKS Management Plane](#)
- [Create PKS Compute Plane](#)
- [Deploy Ops Manager with NSX-T for PKS](#)

### About the NSX Manager CA Certificate

The NSX Manager CA certificate is used to authenticate with the NSX Manager. You create an IP-based, self-signed certificate and register it with the NSX Manager. During PKS installation on vSphere with NSX-T, you provide this certificate in the **NSX Manager CA Cert** field in the **Networking** pane in the PKS tile.

See the **NSX Manager CA Cert** field in the following screenshot:



For configuration information, see the [Networking](#) section of *Installing PKS on vSphere with NSX-T*.

By default, the NSX Manager includes a self-signed API certificate with its hostname as the subject and issuer. Ops Manager requires strict certificate validation and expects the subject and issuer of the self-signed certificate to be either the IP address or fully qualified domain name (FQDN) of the NSX Manager. As a result, you need to regenerate the self-signed certificate using the FQDN of the NSX Manager in the subject and issuer field and then register the certificate with the NSX Manager using the NSX API.

The **Disable SSL certificate verification** option lets you disable validation of the NSX Manager CA certificate. Select this option for testing purposes only.

**Note:** If you disable SSL certificate verification, leave the CA certificate field blank. If you enter text in this field when SSL certificate verification is disabled, the PKS installation fails. If you populate the CA certificate field and later decide to disable SSL certificate verification, you must remove the certificate.

## Step 1: Generate a Self-Signed CA Certificate for the NSX Manager

Complete the following steps to generate a self-signed CA certificate for the NSX Manager:

1. Create a file for the certificate request parameters named `nsx-cert.cnf`.
2. Copy the following parameters and paste them into the file, replacing `NSX-MANAGER-IP-ADDRESS` with the IP address of your NSX Manager, and `NSX-MANAGER-COMMONNAME` with the FQDN of the NSX Manager host:

```
[ req ]
default_bits = 2048
distinguished_name = req_distinguished_name
req_extensions = req_ext
prompt = no
[ req_distinguished_name ]
countryName = US
stateOrProvinceName = California
localityName = CA
organizationName = NSX
commonName = NSX-MANAGER-COMMONNAME
[ req_ext ]
subjectAltName = @alt_names
[alt_names]
DNS.1 = NSX-MANAGER-COMMONNAME,NSX-MANAGER-IP-ADDRESS
```

For example:

```
[ req ]
default_bits = 2048
distinguished_name = req_distinguished_name
req_extensions = req_ext
prompt = no
[ req_distinguished_name ]
countryName = US
stateOrProvinceName = California
localityName = Palo-Alto
organizationName = NSX
commonName = nsxmgr-01a.example.com
[ req_ext ]
subjectAltName=DNS:nsxmgr-01a.example.com,IP:192.0.2.40
```

3. Export the `NSX_MANAGER_IP_ADDRESS` and `NSX_MANAGER_COMMONNAME` environment variables using the IP address of your NSX Manager and the FQDN of the NSX Manager host.

For example:

```
$ export NSX_MANAGER_IP_ADDRESS=192.0.2.40
$ export NSX_MANAGER_COMMONNAME=nsxmgr-01a.example.com
```

4. Generate the certificate using openssl. Run the following command:

```
$ openssl req -newkey rsa:2048 -x509 -nodes \
-keyout nsx.key -new -out nsx.crt -subj /CN=$NSX_MANAGER_COMMONNAME \
-reqexts SAN -extensions SAN -config <(cat ./nsx-cert.cnf \
<(printf "[SAN]\nsubjectAltName=DNS:$NSX_MANAGER_COMMONNAME,IP:$NSX_MANAGER_IP_ADDRESS")) -sha256 -days 365
```

5. Verify that the certificate looks correct and that the NSX manager IP is in the Subject Alternative Name (SAN) by running the following command:

```
$ openssl x509 -in nsx.crt -text -noout
```

## Step 2: Import the Certificate to NSX Manager

In this section you import the self-signed CA certificate you generated in the previous step to the NSX Manager.

Complete the following steps to import the certificate to the NSX Manager:

1. Log in to the NSX Manager UI.
2. Navigate to **System > Trust > Certificates**.

3. Click Import > Import Certificate.

The screenshot shows the NSX Manager interface with the title bar "vm NSX". Under the "Certificates" tab, there is a sub-menu with "IMPORT" and "DELETE" options. Below these are two buttons: "Import Certificate" and "Import CA Certificate". A yellow callout box with a lightbulb icon contains the note: "Note: Make sure you select Import Certificate and not Import CA Certificate."

4. Give the certificate a unique name, such as `NSX-API-CERT-NEW`.

**Note:** Use a unique name for the new certificate you import. The default NSX Manager CA certificate is typically named `NSX-API-CERT`.

5. Browse to and select the CA certificate and private key you generated in the previous section of steps.

6. Click Save.

The dialog box has the title "Import Certificate". It contains the following fields:  
 - Name: `NSX-API-CERT-NEW`  
 - Certificate Contents: A text area containing a certificate snippet starting with "-----BEGIN CERTIFICATE-----".  
 - Private Key: A text area containing a private key snippet starting with "-----BEGIN PRIVATE KEY-----".  
 - Password: An empty text field.  
 - Confirm Password: An empty text field.  
 - Description: An empty text area.  
 - Buttons: "CANCEL" and "IMPORT".

## Step 3: Register the Certificate with NSX Manager

The last step is to exchange the default CA certificate with the new CA certificate you generated. You must use the NSX API.

Complete the following steps to register the certificate with the NSX Manager:

1. Get the ID of the certificate. Run the following command, replacing `ADMIN-PASSWORD` with the administrator password, and `CERTIFICATE-NAME` with the certificate name:

```
curl --insecure -u admin:'ADMIN-PASSWORD' -X \
GET "https://$NSX_MANAGER_IP_ADDRESS/api/v1/trust-management/certificates" \
| jq -r '.results[] | select(.display_name == "CERTIFICATE-NAME") | .id'
```

2. Register the certificate with NSX Manager, replacing `CERTIFICATE-ID` with the certificate ID, and `ADMIN-PASSWORD` with the administrator password:

```
export CERTIFICATE_ID="$CERTIFICATE-ID" curl --insecure -u admin:'ADMIN-PASSWORD' -X \
POST "https://$NSX_MANAGER_IP_ADDRESS/api/v1/node/services/http?action=apply_certificate&certificate_id=$CERTIFICATE_ID"
```

## Next Step

[Configure BOSH Director with NSX-T for PKS.](#)

## Configuring BOSH Director with NSX-T for PKS

Page last updated:

This topic describes how to configure BOSH Director for vSphere with NSX-T integration for PKS.

### Prerequisites

Before you begin this procedure, ensure that you have successfully completed all preceding steps for installing PKS on vSphere with NSX-T, including:

- [Deploying NSX-T for PKS](#)
- [Creating the PKS Management Plane](#)
- [Creating the PKS Compute Plane](#)
- [Deploying Ops Manager with NSX-T for PKS](#)
- [Generating and Registering the NSX Manager Certificate for PKS](#)

### Step 1: Log in to Ops Manager

1. Log in to Ops Manager with the Admin username and password credentials.
2. Click the **BOSH Director for vSphere** tile.

The screenshot shows the PCF Ops Manager interface. At the top, there's a navigation bar with tabs for 'INSTALLATION DASHBOARD', 'STEMCELL LIBRARY', and 'CHANGELOG'. On the far right, it shows 'admin' with a dropdown arrow. Below the dashboard, there's a large central area titled 'Installation Dashboard' featuring a 'vmware' logo and the text 'BOSH Director for vSphere v2.3-build.170'. To the left of this main area, there's a sidebar with a 'Import a Product' button and a link to 'Download PCF compatible products at Pivotal Network'. At the bottom of the sidebar, there's a 'Delete All Unused Products' button. The footer contains copyright information: 'PCF Ops Manager v2.3-build.170; ©2013-2018 Pivotal Software, Inc; All Rights Reserved.' and links to 'API Docs' and 'End User License Agreement'.

### Step 2: Configure vCenter for PKS

1. Select **vCenter Config**.

vCenter Config

Director Config

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

## vCenter Config

Name\*

vCenter Host\*

vCenter Username\*

vCenter Password\*   
[Change](#)

Datacenter Name\*  The name of the datacenter as it appears in vCenter

Virtual Disk Type\*

Ephemeral Datastore Names (comma delimited)\*

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2. Enter the following information:

- **vCenter Host:** The hostname of the vCenter that manages ESXi/vSphere.
- **vCenter Username:** A vCenter username with create and delete privileges for virtual machines (VMs) and folders.
- **vCenter Password:** The password for the vCenter user specified above.
- **Datacenter Name:** The name of the datacenter as it appears in vCenter.
- **Virtual Disk Type:** The Virtual Disk Type to provision for all VMs. For guidance on selecting a virtual disk type, see [Provisioning a Virtual Disk in vSphere](#).
- **Ephemeral Datastore Names (comma delimited):** The names of the datastores that store ephemeral VM disks deployed by Ops Manager.
- **Persistent Datastore Names (comma delimited):** The names of the datastores that store persistent VM disks deployed by Ops Manager.

3. Select **NSX Networking**, then select **NSX-T**.

Standard vCenter Networking

NSX Networking

NSX Mode\*  NSX-V  NSX-T

NSX Address\*

NSX Username\*  User to connect to the NSX manager

NSX Password\*

NSX CA Cert   

  
-----END CERTIFICATE-----

VM Folder\*

Template Folder\*

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4. Configure NSX-T networking as follows:

- **NSX Address:** Enter the IP address of the NSX Manager host.
- **NSX Username and NSX Password:** Enter the NSX Manager username and password.

- **NSX CA Cert:** Provide the CA certificate in PEM format that authenticates to the NSX server. Open the [NSX CA Cert that you generated](#) and copy/paste its content to this field.

5. Configure the following folder names:

- **VM Folder:** The vSphere datacenter folder where Ops Manager places VMs. Enter `pks_vms`.
- **Template Folder:** The vSphere datacenter folder where Ops Manager places VMs. Enter `pks_templates`.
- **Disk path Folder:** The vSphere datastore folder where Ops Manager creates attached disk images. You must not nest this folder. Enter `pks_disk`.

**Note:** After your initial deployment, you cannot edit the VM Folder, Template Folder, and Disk path Folder names.

The screenshot shows the 'NSX CA Cert' section with a placeholder 'admin'. Below it is a 'NSX Password\*' field with a placeholder '\*\*\*\*\*'. Under 'NSX CA Cert', there is a large text area containing a PEM certificate. The 'Folder Names' section follows, with fields for 'VM Folder\*', 'Template Folder\*', and 'Disk path Folder\*'. Each field has a placeholder ('pks\_vms', 'pks\_templates', 'pks\_disk') and a descriptive tooltip below it. A 'Save' button is at the bottom.

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6. Click **Save**.

The screenshot shows the 'BOSH Director for vSphere' settings page. The 'vCenter Config' tab is selected. It includes fields for 'Name\*' (vCenter-PA), 'vCenter Host\*' (10.40.206.61), 'vCenter Username\*' (administrator@vsphere.local), and 'vCenter Password\*' (placeholder). On the left, a sidebar lists configuration sections: 'vCenter Config' (selected), 'Director Config', 'Create Availability Zones', 'Create Networks', 'Assign AZs and Networks', 'Security', 'Syslog', and 'Resource Config'. A 'Settings' tab is also visible. At the bottom, there is a footer with copyright information and links to 'API Docs' and 'End User License Agreement'.

## Step 3: Configure BOSH Director

### 1. Select Director Config.

Director Config

NTP Servers (comma delimited)\*  
10.113.60.176

Bosh HM Forwarder IP Address

Enable VM Resurrector Plugin

Enable Post Deploy Scripts

Recreate All VMs  
This will force BOSH to recreate all VMs on the next deploy. Persistent disk will be preserved

Recreate All Persistent Disks  
Checking this box will recreate all Persistent Disks for the Director and all other Tiles

Enable bosh deploy retries  
This will attempt to re-deploy a failed deployment up to 5 times.

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### 2. In the NTP Servers (comma delimited) field, enter your NTP server addresses.

**Note:** The NTP server configuration only updates after VM recreation. Ensure that you select the Recreate all VMs checkbox if you modify the value of this field.

### 3. Leave the JMX Provider IP Address field blank.

**Note:** Starting from PCF v2.0, BOSH-reported system metrics are available in the Loggregator Firehose by default. If you continue to use PCF JMX Bridge for consuming them outside of the Firehose, you may receive duplicate data. To prevent this duplicate data, leave the JMX Provider IP Address field blank.

### 4. Leave the Bosh HM Forwarder IP Address field blank.

**Note:** Starting in PCF v2.0, BOSH-reported component metrics are available in the Loggregator Firehose by default. If you continue to use the BOSH HM Forwarder to consume these component metrics, you may receive duplicate data. To prevent this, leave the Bosh HM Forwarder IP Address field blank. For additional guidance, see [BOSH System Metrics Available in Loggregator Firehose](#) in the PCF v2.0 Release Notes.

### 5. Select the Enable VM Resurrector Plugin to enable BOSH Resurrector functionality.

### 6. Select Enable Post Deploy Scripts to run a post-deploy script after deployment. This script allows the job to execute additional commands against a deployment.

**Note:** You must enable post-deploy scripts to install PKS.

### 7. Select Recreate all VMs to force BOSH to recreate all VMs on the next deploy. This process does not destroy any persistent disk data.

### 8. For typical PKS deployments, the default settings for all other BOSH Director configuration parameters are suitable. Optionally you can apply additional configurations to BOSH Director. See [Director Config Page](#) in *Configuring BOSH Director on vSphere* in the PCF documentation for details.

**Note:** If you need to be able to remotely access the BOSH Director VM using the BOSH CLI, and you are deploying PKS with NSX-T in a NAT topology, you must provide the Director Hostname for BOSH at the time of installation. See [Director Config Page](#) in *Configuring BOSH Director on vSphere* in the PCF documentation for details.

9. Click **Save**.

PCF Ops Manager

INSTALLATION DASHBOARD STEMCELL LIBRARY CHANGELOG admin ▾

Settings updated

BOSH Director for vSphere

Director Config

NTP Servers (comma delimited)\*  
10.113.60.176

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

Enable VM Resurrector Plugin

Enable Post Deploy Scripts

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## Step 4: Create Availability Zones

Ops Manager Availability Zones correspond to your vCenter clusters and resource pools. Multiple Availability Zones allow you to provide high-availability and load balancing to your applications. When you run more than one instance of an application, Ops Manager balances those instances across all of the Availability Zones assigned to the application. At least three availability zones are recommended for a highly available installation of your chosen runtime.

**Note:** For more information about using availability zones in vSphere, see [Understanding Availability Zones in VMware Installations](#) in the PCF documentation.

1. Select **Create Availability Zones**.

BOSH Director for vSphere

Settings Status Credentials

Create Availability Zones

Availability Zone	Description
AZ-MGMT	Selected
AZ-TEST	
AZ-PROD	

Add

Create Availability Zones

Clusters and resource pools to which you will deploy Pivotal products

Save

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2. Use the following steps to create one or more Availability Zones for PKS to use:

- Click **Add** and create the PKS Management AZ.
- Enter a unique **Name** for the Availability Zone, such as **AZ-MGMT**.

- Select the IaaS configuration (vSphere/vCenter).
- Enter the name of an existing vCenter Cluster to use as an Availability Zone, such as COMP-CLUSTER-1.
- Enter the name of the PKS Management Resource Pool in the vCenter cluster that you specified above, such as RP-MGMT-PKS. The jobs running in this Availability Zone share the CPU and memory resources defined by the pool.
- Click Add Cluster and create at least one PKS Compute AZ.
- Specify the Cluster and the Resource Pool, such as RP-PKS-AZ.
- Add additional clusters as necessary. Click the trash icon to delete a cluster. The first cluster cannot be deleted.

vCenter Config

Director Config

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

### Create Availability Zones

Availability Zones  
Clusters and resource pools to which you will deploy Pivotal products

**AZ-MGMT**

Name\*

IaaS Configuration\*

Clusters

Cluster

Resource Pool

**Save**

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vCenter Config

Director Config

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

### Create Availability Zones

Availability Zones  
Clusters and resource pools to which you will deploy Pivotal products

**AZ-COMP-1**

Name\*

IaaS Configuration\*

Clusters

Cluster

Resource Pool

**Save**

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vCenter Config

Director Config

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

### Create Availability Zones

Availability Zones  
Clusters and resource pools to which you will deploy Pivotal products

AZ-MGMT

AZ-COMP-1

AZ-COMP-2

Name\* AZ-COMP-2 A unique name for this availability zone

IaaS Configuration\* vCenter-PA

Clusters

Cluster COMP-Cluster-2

Resource Pool RP-PKS-AZ-2

**Save**

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3. Click **Save**.

**PCF Ops Manager** INSTALLATION DASHBOARD STEMCELL LIBRARY CHANGELOG admin ▾

Successfully verified availability zone settings

### BOSH Director for vSphere

Settings Status Credentials

vCenter Config

Director Config

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

### Create Availability Zones

Availability Zones  
Clusters and resource pools to which you will deploy Pivotal products

AZ-MGMT

AZ-COMP-1

AZ-COMP-2

Name\* AZ-COMP-2 A unique name for this availability zone

IaaS Configuration\* vCenter-PA

Clusters

Cluster COMP-Cluster-2

Resource Pool RP-PKS-AZ-2

**Save**

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## Step 5: Create Networks

1. Select **Create Networks**.

The screenshot shows the 'PCF Ops Manager' interface. In the top navigation bar, there are links for 'INSTALLATION DASHBOARD', 'STEMCELL LIBRARY', and 'CHANGELOG'. On the far right, there is a user dropdown labeled 'admin'. Below the navigation, the title 'BOSH Director for vSphere' is displayed. Underneath it, there are tabs for 'Settings', 'Status', and 'Credentials', with 'Settings' being the active tab. On the left side of the main content area, there is a sidebar with several configuration items, each with a checked checkbox: 'vCenter Config', 'Director Config', 'Create Availability Zones', 'Create Networks' (which is highlighted with a yellow arrow pointing to it), 'Assign AZs and Networks', 'Security', 'Syslog', and 'Resource Config'. To the right of the sidebar, there is a 'Create Networks' button. A warning message below it states: 'Warning: Pivotal recommends keeping the IP settings throughout the life of your installation. Ops Manager may prevent you from changing them in the future. Contact Pivotal support for help completing such a change.' Below this, there is a 'Verification Settings' section with a checked checkbox for 'Enable ICMP checks'. Further down, there is a 'Networks' section with a sub-section for 'One or many IP ranges upon which your products will be deployed'. A 'Save' button is located at the bottom of this section. At the very bottom of the page, there is a footer bar with the text 'PCF Ops Manager v2.3-build.170; ©2013-2018 Pivotal Software, Inc; All Rights Reserved.' and links for 'API Docs' and 'End User License Agreement'.

2. Select **Enable ICMP checks** to enable ICMP on your networks. Ops Manager uses ICMP checks to confirm that components within your network are reachable.

3. Click **Add Network**.

The screenshot shows the 'Add Network' form. The network is named 'NET-MGMT-PKS'. The 'Subnets' section contains a 'vSphere Network Name\*' field with 'LS-MGMT-PKS' and a 'CIDR\*' field with '10.0.0.0/24'. The 'Reserved IP Ranges' field contains '10.0.0.1-10.0.0.2'. The 'DNS\*' field contains '10.20.20.1'. The 'Gateway\*' field contains '10.0.0.1'. Under 'Availability Zones\*', the checkbox for 'AZ-MGMT' is checked, while 'AZ-COMP-1' and 'AZ-COMP-2' are unchecked. At the bottom of the form, there is a footer bar with the text 'PCF Ops Manager v2.3-build.170; ©2013-2018 Pivotal Software, Inc; All Rights Reserved.' and links for 'API Docs' and 'End User License Agreement'.

4. Create the following network:

- o **NET-MGMT-PKS** : Network for Ops Manager, BOSH Director, and the PKS API. This network maps to the NSX logical switch created for the PKS Management Network. See [Creating PKS Management Plane](#).

**Note:** NSX-T automatically creates the service network to be used by the master and worker nodes (VMs) for Kubernetes clusters managed by PKS. You should not manually create this network.

Use the following values as a guide when you define the network in BOSH. Replace the IP addresses with ranges you defined for the [PKS Management Network](#). Reserve any IP addresses from the subnet that are already in use, such as the IP for Ops Manager and subnet gateway.

	Field	Configuration
Infrastructure Network	Name	NET-MGMT-PKS
	vSphere Network Name	LS-MGMT-PKS
	CIDR	10.0.0.0/24
	Reserved IP Ranges	10.0.0.1-10.0.0.2
	DNS	10.20.20.1
	Gateway	10.0.0.1

- Select the AZ-MGMT Availability Zone to use with the NET-MGMT-PKS network.

**Note:** Do not select the COMPUTE network at this point in the configuration. It will be performed at the end of the procedure.

- Click **Save**.

PCF Ops Manager

INSTALLATION DASHBOARD STEMCELL LIBRARY CHANGELOG admin ▾

Settings updated

BOSH Director for vSphere

Settings Status Credentials

vCenter Config  
 Director Config  
 Create Availability Zones  
 Create Networks  
 Assign AZs and Networks  
 Security  
 Syslog  
 Resource Config

Create Networks

Warning: Pivotal recommends keeping the IP settings throughout the life of your installation. Ops Manager may prevent you from changing them in the future. Contact Pivotal support for help completing such a change.

Verification Settings

Enable ICMP checks

Networks

Add Network

One or more IP ranges upon which your products will be deployed

NET-MGMT-PKS

Save

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## Step 6: Assign AZs and Networks

- Select **Assign AZs and Networks**.

The screenshot shows the PCF Ops Manager interface for configuring BOSH Director. The top navigation bar includes links for Installation Dashboard, Stemcell Library, and Changelog, along with a user dropdown for 'admin'. The main content area is titled 'BOSH Director for vSphere' and contains a sidebar with several configuration tabs: vCenter Config, Director Config, Create Availability Zones, Create Networks, Assign AZs and Networks, Security, Syslog, and Resource Config. The 'Assign AZs and Networks' tab is currently selected, indicated by a grey arrow pointing to it. The main panel displays instructions for assigning a Singleton Availability Zone (AZ-MGMT) and a Network (NET-MGMT-PKS). A 'Save' button is at the bottom right. At the bottom of the page, there is a footer with copyright information and links to API Docs and End User License Agreement.

2. Use the drop-down menu to select a **Singleton Availability Zone**. The Ops Manager Director installs in this Availability Zone. For PKS, this will be the **AZ-MGMT** availability zone.
3. Use the drop-down menu to select a **Network** for BOSH Director. BOSH Director runs on the PKS Management Plane network. Select the **NET-MGMT-PKS** network.
4. Click **Save**.

The screenshot shows the PCF Ops Manager interface after the configuration has been saved. The top navigation bar and sidebar are identical to the previous screenshot. The main content area now features a green banner at the top with the message 'Successfully assigned Network and Availability Zone'. Below this, the 'Assign AZs and Networks' step is still highlighted with a grey arrow. The configuration fields for Availability Zone (AZ-MGMT) and Network (NET-MGMT-PKS) remain the same. The 'Save' button is visible. The footer at the bottom of the page includes copyright information and links to API Docs and End User License Agreement.

## Step 7: Configure Security

1. Select **Security**.
2. In **Trusted Certificates**, enter a custom certificate authority (CA) certificate to insert into your organization's certificate trust chain. This allows all BOSH-deployed components in your deployment to trust a custom root certificate. If you are using a private [Docker registry](#), such as VMware

Harbor, use this field to enter the certificate for the registry. See [Integrating Harbor Registry with PKS](#) for details.

3. Choose **Generate passwords** or **Use default BOSH password**. Pivotal recommends that you use the **Generate passwords** option for increased security.
4. Click **Save**. To view your saved Director password, click the **Credentials** tab.

## Step 8: Configure Logging

1. Select **Syslog**.
2. (Optional) To send BOSH Director system logs to a remote server, select **Yes**.
3. In the **Address** field, enter the IP address or DNS name for the remote server.
4. In the **Port** field, enter the port number that the remote server listens on.
5. In the **Transport Protocol** dropdown menu, select **TCP**, **UDP**, or **RELP**. This selection determines which transport protocol is used to send the logs to the remote server.
6. (Optional) Mark the **Enable TLS** checkbox to use TLS encryption when sending logs to the remote server.
  - In the **Permitted Peer** field, enter either the name or SHA1 fingerprint of the remote peer.
  - In the **SSL Certificate** field, enter the SSL certificate for the remote server.
7. Click **Save**.

## Step 9: Configure Resources

1. Select **Resource Config**.
2. Adjust any values as necessary for your deployment. Under the **Instances**, **Persistent Disk Type**, and **VM Type** fields, choose **Automatic** from the drop-down menu to allocate the recommended resources for the job. If the **Persistent Disk Type** field reads **None**, the job does not require persistent disk space.

 **Note:** Ops Manager requires a Director VM with at least 8 GB memory.

 **Note:** If you set a field to **Automatic** and the recommended resource allocation changes in a future version, Ops Manager automatically uses the updated recommended allocation.

3. Click **Save**.

## Step 10: Deploy BOSH

Follow the steps below to deploy BOSH:

1. Go to the Ops Manager [Installation Dashboard](#).

The screenshot shows the PCF Ops Manager interface. At the top, there's a navigation bar with links for 'INSTALLATION DASHBOARD', 'STEMCELL LIBRARY', and 'CHANGELOG'. On the right, it says 'admin ▾'. Below the navigation, there's a button 'Import a Product' and a 'REVIEW PENDING CHANGES' button. The main area is titled 'Installation Dashboard' and displays a card for 'BOSH Director for vSphere' from 'vmware'. The card includes the version 'v2.3-build.170'. At the bottom left, there's a link to 'Download PCF compatible products at Pivotal Network'. A 'Delete All Unused Products' button is also present. The footer contains copyright information: 'PCF Ops Manager v2.3-build.170; ©2013-2018 Pivotal Software, Inc; All Rights Reserved.' and 'API Docs | End User License Agreement'.

2. Click **Review Pending Changes**.

The screenshot shows the 'Review Pending Changes' screen. It has a header with 'PCF Ops Manager', 'INSTALLATION DASHBOARD', 'STEMCELL LIBRARY', 'CHANGELOG', and 'admin ▾'. Below the header, the title 'Review Pending Changes' is displayed. There's a checkbox 'Select All Products' followed by a list of selected products. One product is highlighted: 'BOSH Director' from 'vmware' (Version 2.3-build.170). Below this, a section 'Depends on' shows 'No Dependencies'. On the right, there's a large 'APPLY CHANGES' button. The footer contains copyright information: 'PCF Ops Manager 2.3-build.170; ©2013-2018 Pivotal Software, Inc; All Rights Reserved.' and 'API Docs | End User License Agreement'.

3. Click **Apply Changes**.

PCF Ops Manager    INSTALLATION DASHBOARD    STEMCELL LIBRARY    CHANGELOG    admin ▾

## Applying Changes

0%

**Installing BOSH**

- Uploading runtime config releases to the director
- Updating BOSH director with 2.0 cloud config
- Updating CPI configs
- Updating Internal UAA Configuration
- Putting Tile Credentials into CredHub
- Cleaning up BOSH director

```
===== 2018-10-15 17:14:50 UTC Running "/usr/local/bin/bosh --no-color --non-interactive --tty create-env /var/tempest/workspaces/default/deployments/bosh.yml"
Deployment manifest: '/var/tempest/workspaces/default/deployments/bosh.yml'
Deployment state: '/var/tempest/workspaces/default/deployments/bosh-state.json'

Started validating
Validating release 'bosh'... Finished (00:00:01)
Validating release 'bosh-vsphere-cpi'... Finished (00:00:00)
Validating release 'uaa'... Finished (00:00:05)
```

[Hide verbose output](#)

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4. Confirm changes applied successfully.

PCF Ops Manager    INSTALLATION DASHBOARD    STEMCELL LIBRARY    CHANGELOG    admin ▾

## Applying Changes

100%

**Changes Applied**

Your changes were successfully applied.  
We recommend that you export a backup of this installation from the actions menu.

[CLOSE](#)    [RETURN TO DASHBOARD](#)

Succeeded  

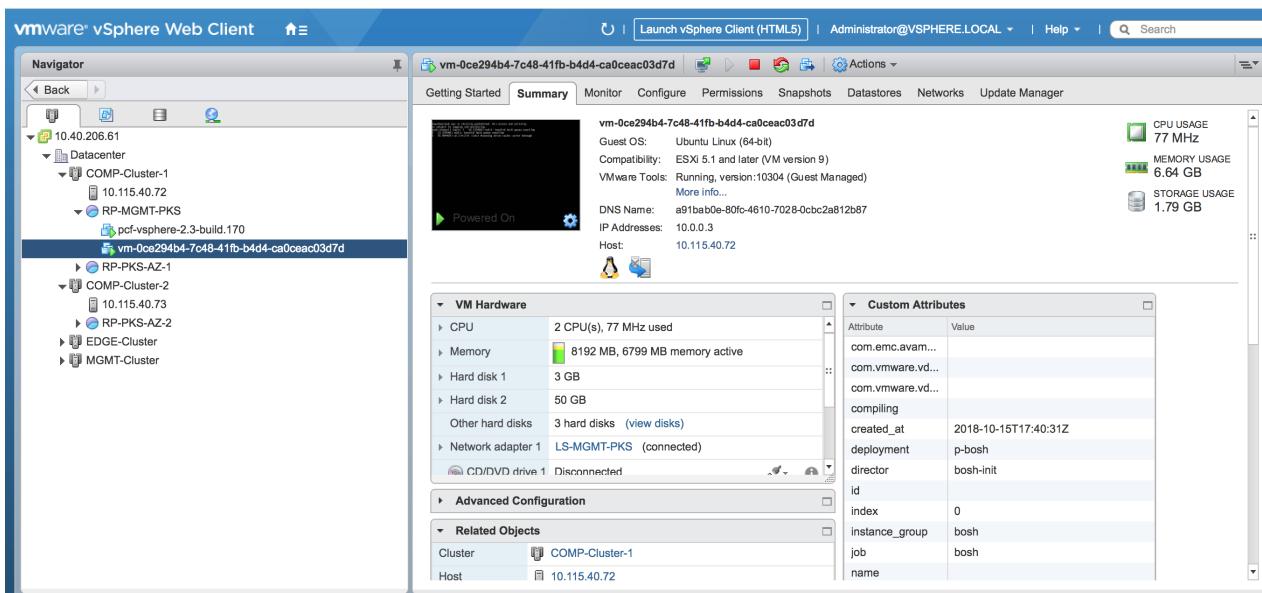
```
===== 2018-10-15 17:49:45 UTC Finished "/usr/local/bin/bosh --no-color --non-interactive --tty --environment=10.0.0.3 update-cpi-config /tmp/cpi_configs.yml[20181015-810-1m4gczz]" Duration: 0s; Exit Status: 0
===== 2018-10-15 17:49:46 UTC Running "/usr/local/bin/bosh --no-color --non-interactive --tty --environment=10.0.0.3 clean-up"
Using environment '10.0.0.3' as client 'ops_manager'
Task 2
Task 2 | 17:49:46 | Deleting dns blobs: DNS blobs (00:00:00)

Task 2 Started Mon Oct 15 17:49:46 UTC 2018
Task 2 Finished Mon Oct 15 17:49:46 UTC 2018
Task 2 Duration 00:00:00
Task 2 done

Succeeded
===== 2018-10-15 17:49:46 UTC Finished "/usr/local/bin/bosh --no-color --non-interactive --tty --environment=10.0.0.3 clean-up"; Duration: 0s; Exit Status: 0
Exited with 0.
```

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5. Check BOSH VM. Log in to vCenter and check for the `p-bosh` VM deployment in the PKS Management resource pool.



## Step 11: Update Network Availability Zones

After BOSH is successfully deployed, update the network you defined above (`NET-MGMT-PKS`) to include each of the COMPUTE AZs you defined. This will ensure that both the Management AZ and the Compute AZ(s) appear in the PKS tile for the Plans.

1. Return to the BOSH tile and select **Create Networks**.

**BOSH Director for vSphere**

- Settings
- Status
- Credentials

**Create Networks**

Warning: Pivotal recommends keeping the IP settings throughout the life of your installation. Ops Manager may prevent you from changing them in the future. Contact Pivotal support for help completing such a change.

**Verification Settings**

Enable ICMP checks

**Networks**

One or more IP ranges upon which your products will be deployed

**NET-MGMT-PKS**

Name\*:

Subnets

vSphere Network Name\*:

Add Network

Add Subnet

2. Edit the network (`NET-MGMT-PKS`) and each COMPUTE AZ.

Security

Syslog

Resource Config

NET-MGMT-PKS

Name\*  
NET-MGMT-PKS

Subnets

Add Subnet

vSphere Network Name\*  
LS-MGMT-PKS

CIDR\*  
10.0.0.0/24

Reserved IP Ranges  
10.0.0.1-10.0.0.2

DNS\*  
10.20.20.1

Gateway\*  
10.0.0.1

Availability Zones\*

AZ-MGMT

AZ-COMP-1

AZ-COMP-2

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3. Click Save.

PCF Ops Manager

INSTALLATION DASHBOARD STEMCELL LIBRARY CHANGELOG admin ▾

Settings updated

BOSH Director for vSphere

Settings Status Credentials

vCenter Config

Director Config

Create Availability Zones

Create Networks

Assign AZs and Networks

Security

Syslog

Resource Config

Create Networks

Warning: Pivotal recommends keeping the IP settings throughout the life of your installation. Ops Manager may prevent you from changing them in the future. Contact Pivotal support for help completing such a change.

Verification Settings

Enable ICMP checks

Networks

Add Network

One or many IP ranges upon which your products will be deployed

▶ NET-MGMT-PKS

Save

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4. Review pending changes and apply them to deploy BOSH.

## Next Step

[Generate and Register the NSX Manager Superuser Principal Identity Certificate and Key for PKS](#)

## Generating and Registering the NSX Manager Superuser Principal Identity Certificate and Key

Page last updated:

This topic describes how to generate and register the NSX Manager superuser principal identity certificate and key in preparation for installing Pivotal Container Service (PKS) on vSphere with NSX-T.

### Prerequisites

Before you begin this procedure, ensure that you have successfully completed all preceding steps for installing PKS on vSphere with NSX-T, including:

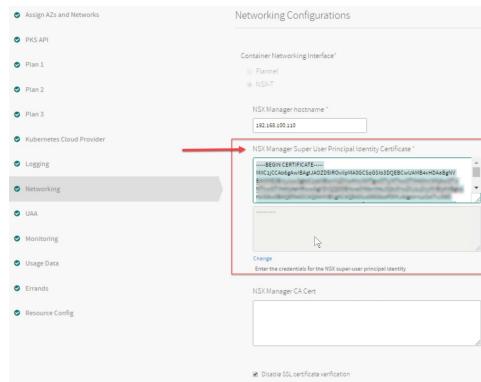
- [Deploying NSX-T for PKS](#)
- [Creating the PKS Management Plane](#)
- [Creating the PKS Compute Plane](#)
- [Deploying Ops Manager with NSX-T for PKS](#)
- [Generating and Registering the NSX Manager Certificate for PKS](#)
- [Configuring BOSH Director with NSX-T for PKS](#)

### About the NSX Manager Superuser Principal Identity

The PKS API uses the NSX Manager superuser to communicate with NSX-T to create, delete, and modify networking resources for Kubernetes cluster nodes.

When you configure PKS with NSX-T as the container networking interface, for security purposes you must provide the principal identity certificate and private key for the NSX Manager superuser in the **Networking** pane of the PKS tile.

See the **NSX Manager Super User Principal Identity Certificate** field in the following screenshot:



For more information, see the [Networking](#) section of *Installing PKS on vSphere with NSX-T*.

### Options for Generating the Certificate and Key

There are two options for generating the principal identity certificate and private key:

- **Option A:** Use the automatic **Generate RSA Certificate** option in the PKS tile.
- **Option B:** Run a script on a Linux host with OpenSSL installed that generates the certificate and private key.

Once you have generated the principal identity certificate and key, you must register both with the NSX Manager using an HTTPS POST operation on the NSX API. There is no user interface for this operation.

## Option A: Generate and Register the Certificate and Key Using the PKS Tile

### Step 1: Generate the Certificate and Key

To generate the certificate and key automatically in the **Networking** pane in the PKS tile, follow the steps below:

1. Navigate to the **Networking** pane in the PKS tile. For more information, see [Networking](#) in *Installing PKS on vSphere with NSX-T Integration*.
2. Click **Generate RSA Certificate** and provide a wildcard domain. For example, `*.nsx.pks.vmware.local`.

### Step 2: Copy the Certificate and Key to the Linux VM

To copy the certificate and key you generated to a Linux VM, follow the steps below:

**Note:** The Linux VM must have OpenSSL installed and have network access to the NSX Manager. For example, you can use the PKS client VM where you install the PKS CLI.

1. On the Linux VM you want to use to register the certificate, create a file named `pks-nsx-t-superuser.crt`. Copy the generated certificate into the file.
2. On the Linux VM you want to use to register the key, create a file named `pks-nsx-t-superuser.key`. Copy the generated private key into the file.
3. Save both files.

### Step 3: Export Environment Variables

On the Linux VM where you created the certificate and key files, export the environment variables below. Change the `NSX_MANAGER_IP`, `NSX_MANAGER_USERNAME`, and `NSX_MANAGER_PASSWORD` values to match your environment:

```
export NSX_MANAGER="NSX_MANAGER_IP"
export NSX_USER="NSX_MANAGER_USERNAME"
export NSX_PASSWORD="NSX_MANAGER_PASSWORD"
export PI_NAME="pks-nsx-t-superuser"
export NSX_SUPERUSER_CERT_FILE="pks-nsx-t-superuser.crt"
export NSX_SUPERUSER_KEY_FILE="pks-nsx-t-superuser.key"
export NODE_ID=$(cat /proc/sys/kernel/random/uuid)
```

### Step 4: Register the Certificate

1. On the same Linux VM, run the following commands to register the certificate with NSX Manager:

```
cert_request=$(cat <<END
{
  "display_name": "$PI_NAME",
  "pem_encoded": "$(awk '{printf "%s\\n", $0}' $NSX_SUPERUSER_CERT_FILE)"
}
END
)
```

```
curl -k -X POST \
"https://${NSX_MANAGER}/api/v1/trust-management/certificates?action=import" \
-u "$NSX_USER:$NSX_PASSWORD" \
-H 'content-type: application/json' \
-d "$cert_request"
```

2. Verify that the response includes the `CERTIFICATE_ID` value. You use this value in the following step.

### Step 5: Register the Principal Identity

1. On the same Linux VM, export the `CERTIFICATE_ID` environment variable, where the value is the response from the previous step:

```
export CERTIFICATE_ID="CERTIFICATE_ID"
```

2. Register the principal identity with NSX Manager by running the following commands:

```
pi_request=$(cat <<END
{
  "display_name": "$PI_NAME",
  "name": "$PI_NAME",
  "permission_group": "superusers",
  "certificate_id": "$CERTIFICATE_ID",
  "node_id": "$NODE_ID"
}
END
)
```

```
curl -k -X POST \
"https://${NSX_MANAGER}/api/v1/trust-management/principal-identities" \
-u "${NSX_USER}:${NSX_PASSWORD}" \
-H 'content-type: application/json' \
-d "$pi_request"
```

## Step 6: Verify the Certificate and Key

To verify that the certificate and key can be used with NSX-T, run the following command:

```
curl -k -X GET \
"https://${NSX_MANAGER}/api/v1/trust-management/principal-identities" \
--cert $(pwd)"/$NSX_SUPERUSER_CERT_FILE" \
--key $(pwd)"/$NSX_SUPERUSER_KEY_FILE"
```

## Option B: Generate and Register the Certificate and Key Using Scripts

This option uses Bash shell scripts to generate and register the NSX Manager superuser principal identity certificate and key.

**Note:** The Linux VM must have OpenSSL installed and have network access to the NSX Manager. For example, you can use the PKS client VM where you install the PKS CLI.

### Step 1: Generate and Register the Certificate and Key

Provided below is the `create_certificate.sh` script that generates a certificate and private key, and then uploads the certificate to the NSX Manager. Complete the following steps to run this script:

1. Log in to a Linux VM in your PKS environment. For example, you can use the PKS client VM.
2. To create an empty file for the first script, run `nano create_certificate.sh`.
3. Copy the following script contents into `create_certificate.sh`, updating the values for the first two lines to match your environment:
  - o `NSX_MANAGER_IP` : IP address of the NSX Manager host.
  - o `NSX_MANAGER_USERNAME` : Username for NSX Manager.

```

#!/bin/bash
#create_certificate.sh

NSX_MANAGER="NSX_MANAGER_IP"
NSX_USER="NSX_MANAGER_USERNAME"

PI_NAME="pks-nsx-t-superuser"
NSX_SUPERUSER_CERT_FILE="pks-nsx-t-superuser.crt"
NSX_SUPERUSER_KEY_FILE="pks-nsx-t-superuser.key"

stty -echo
printf "Password: "
read NSX_PASSWORD
stty echo

openssl req \
-newkey rsa:2048 \
-x509 \
-nodes \
-keyout "$NSX_SUPERUSER_KEY_FILE" \
-new \
-out "$NSX_SUPERUSER_CERT_FILE" \
-subj /CN=pks-nsx-t-superuser \
-extensions client_server_ssl \
-config <(
    cat /etc/ssl/openssl.cnf \
    <(printf '[client_server_ssl]\nextendedKeyUsage = clientAuth\n')
) \
-sha256 \
-days 730

cert_request=$(cat <<END
{
    "display_name": "$PI_NAME",
    "pem_encoded": "$ awk '{printf "%s\\n", $0}' $NSX_SUPERUSER_CERT_FILE"
}
END
)

curl -k -X POST \
"https://$NSX_MANAGER/api/v1/trust-management/certificates?action=import" \
-u "$NSX_USER:$NSX_PASSWORD" \
-H 'content-type: application/json' \
-d "$cert_request"

```

4. Save the script and run `bash create_certificate.sh`.

5. When prompted, enter the `NSX_MANAGER_PASSWORD` for the NSX user you specified in the script.

6. Complete the following steps to verify the results of the script:

- The certificate, `pks-nsx-t-superuser.crt`, and private key, `pks-nsx-t-superuser.key`, are generated in the directory where you ran the script.
- The certificate is uploaded to the NSX Manager and the `CERTIFICATE_ID` value is returned to the console. You need this ID for the second script.

## Step 2: Create and Register the Principal Identity

Provided below is the `create_pi.sh` script that creates the principal identity and registers it with the NSX Manager. This script requires the `CERTIFICATE_ID` returned from the `create_certificate.sh` script.

 **Note:** Perform these steps on the same Linux VM where you ran the `create_certificate.sh` script.

1. To create an empty file for the second script, run `nano create_pi.sh`.
2. Copy the following script contents into `create_pi.sh`, updating the values for the first three lines to match your environment:
  - `NSX_MANAGER_IP` : IP address of the NSX Manager host.
  - `NSX_MANAGER_USERNAME` : Username for NSX Manager.
  - `CERTIFICATE_ID` : Response from the `create_certificate.sh` script.

```

#!/bin/bash
#create_pi.sh

NSX_MANAGER="NSX_MANAGER_IP"
NSX_USER="NSX_MANAGER_USERNAME"
CERTIFICATE_ID='CERTIFICATE_ID'

PI_NAME="pks-nsx-t-superuser"
NSX_SUPERUSER_CERT_FILE="pks-nsx-t-superuser.crt"
NSX_SUPERUSER_KEY_FILE="pks-nsx-t-superuser.key"
NODE_ID=$(cat /proc/sys/kernel/random/uuid)

stty -echo
printf "Password: "
read NSX_PASSWORD
stty echo

pi_request=$(cat <<END
{
  "display_name": "$PI_NAME",
  "name": "$PI_NAME",
  "permission_group": "superusers",
  "certificate_id": "$CERTIFICATE_ID",
  "node_id": "$NODE_ID"
}
END
)

curl -k -X POST \
"https://${NSX_MANAGER}/api/v1/trust-management/principal-identities" \
-u "$NSX_USER:$NSX_PASSWORD" \
-H 'content-type: application/json' \
-d "$pi_request"

curl -k -X GET \
"https://${NSX_MANAGER}/api/v1/trust-management/principal-identities" \
--cert $(pwd)"/$NSX_SUPERUSER_CERT_FILE" \
--key $(pwd)"/$NSX_SUPERUSER_KEY_FILE"

```

3. Save the script and run `bash create_pi.sh`.
4. When prompted, enter the `NSX_MANAGER_PASSWORD` for the NSX user you specified in the script.
5. When you configure PKS for deployment, copy and paste the contents of `pks-nsx-t-superuser.crt` and `pks-nsx-t-superuser.key` to the **NSX Manager Super User Principal Identity Certificate** field in the **Networking** pane of the PKS tile. For more information, see the [Networking](#) section of *Installing PKS on vSphere with NSX-T*.

## Next Step

After you complete this procedure, follow the instructions in [Creating NSX-T Objects for PKS](#).

## Creating NSX-T Objects for PKS

Page last updated:

Installing PKS on vSphere with NSX-T requires the creation of NSX IP blocks for Kubernetes node and pod networks, as well as a Floating IP Pool from which you can assign routable IP addresses to cluster resources.

Create separate NSX-T [IP Blocks](#) for the [node networks](#) and the [pod networks](#). The subnets for both nodes and pods should have a size of 256 (/16). For more information, see [Plan IP Blocks](#) and [Reserved IP Blocks](#).

- **NODE-IP-BLOCK** is used by PKS to assign address space to Kubernetes master and worker nodes when new clusters are deployed or a cluster increases its scale.
- **POD-IP-BLOCK** is used by the NSX-T Container Plug-in (NCP) to assign address space to Kubernetes pods through the Container Networking Interface (CNI).

In addition, create a Floating IP Pool from which to assign routable IP addresses to components. This network provides your load balancing address space for each Kubernetes cluster created by PKS. The network also provides IP addresses for Kubernetes API access and Kubernetes exposed services. For example, `10.172.2.0/24` provides 256 usable IPs. This network is used when creating the virtual IP pools, or when the services are deployed. You enter this network in the **Floating IP Pool ID** field in the **Networking** pane of the PKS tile.

Complete the following instructions to create the required NSX-T network objects.

## Create the Pods IP Block

1. In NSX Manager, go to **Networking > IPAM**.

	ID	CIDR
<input type="checkbox"/> Nodes-ip-block-pks	b5d3..2e56	10.40.14.0/24
<input type="checkbox"/> ip-block-pks	e133..9540	172.16.0.0/16

2. Add a new IP Block for Pods. For example:

- **Name:** PKS-PODS-IP-BLOCK
- **CIDR:** 172.16.0.0/16

## New IP Block

Name \* PKS-POD-IP-BLOCK

Description

CIDR \* 172.16.0.0/16

**CANCEL** **ADD**

3. Verify creation of the Pods IP Block.

IPAM		
<a href="#">+ ADD</a> <a href="#">EDIT</a> <a href="#">DELETE</a> <a href="#">ACTIONS</a>		
	ID	CIDR
<input type="checkbox"/>	Nodes-ip-block-pks	10.40.14.0/24
<input checked="" type="checkbox"/>	PKS-POD-IP-BLOCK	172.16.0.0/16
<input type="checkbox"/>	ip-block-pks	172.16.0.0/16

4. Get the UUID of the Pods IP Block object. You use this UUID when you install PKS with NSX-T.

IPAM		
<a href="#">+ ADD</a> <a href="#">EDIT</a> <a href="#">DELETE</a> <a href="#">ACTIONS</a>		
	ID	CIDR
<input type="checkbox"/>	Nodes-ip-block-pks	10.40.14.0/24
<input checked="" type="checkbox"/>	PKS-POD-IP-BLOCK	172.16.0.0/16
<input type="checkbox"/>	ip-block-pks	172.16.0.0/16

## Create the Nodes IP Block

1. In NSX Manager, go to **Networking > IPAM**.

The screenshot shows the NSX Manager interface with the 'IPAM' tab selected. On the left is a sidebar with various icons. The main area has a header with '+ ADD', 'EDIT', 'DELETE', and 'ACTIONS'. Below is a table with columns 'ID' and 'CIDR'. There are four entries:

ID	CIDR
b5d3...2e56	10.40.14.0/24
84c6...c42e	172.16.0.0/16
e133...9540	172.16.0.0/16

2. Add a new IP Block for Nodes. For example:

- Name: PKS-NODES-IP-BLOCK
- CIDR: 192.168.0.0/16

The dialog is titled 'New IP Block' with a close button. It contains three fields: 'Name \*' with value 'PKS-NODES-IP-BLOCK', 'Description' with an empty text area, and 'CIDR \*' with value '192.168.0.0/16'. At the bottom are 'CANCEL' and 'ADD' buttons.

3. Verify creation of the Nodes IP Block.

The screenshot shows the NSX Manager interface with the title bar "vm NSX". On the left is a sidebar with various icons. The main area is titled "IPAM" and contains a table with the following data:

	ID	CIDR
<input type="checkbox"/> Nodes-ip-block-pks	b5d3...2e56	10.40.14.0/24
<input checked="" type="checkbox"/> PKS-NODES-IP-BLOCK	b910...07d0	192.168.0.0/16
<input type="checkbox"/> PKS-POD-IP-BLOCK	84c6...c42e	172.16.0.0/16
<input type="checkbox"/> ip-block-pks	e133...9540	172.16.0.0/16

At the bottom of the table are buttons for "COLUMNS", "REFRESH", and "Last Updated: Just Now". To the right are navigation buttons for "BACK", "NEXT", and "1 - 4 of 4 IP Blocks".

- Get the UUID of the Nodes IP Block object. You use this UUID when you install PKS with NSX-T.

This screenshot is similar to the one above, but the row for "PKS-NODES-IP-BLOCK" is highlighted with a yellow background. The UUID "b91093ee-2df8-4e12-8070-3cee338807d0" is displayed in a tooltip or a callout box over the row.

## Create Floating IP Pool

- In NSX Manager, go to **Inventory > Groups > IP Pool**.

ID	Subnets	Allocations
2e08...78ae	1	0 of 128
64fa...b337	1	0 of 128
104f...615c	1	6 of 10
86a7...411d	3	24 of 90

2. Add a new Floating IP Pool. For example:

- **Name:** PKS-FLOATING-IP-POOL
- **IP Ranges:** 10.40.14.10 - 10.40.14.253
- **Gateway:** 10.40.14.254
- **CIDR:** 10.40.14.0/24

IP Ranges*	Gateway	CIDR*	DNS Servers	DNS Suffix
10.40.14.10 - 10.40.14.253	10.40.14.254	10.40.14.0/24		

3. Verify creation of the Nodes IP Block.

	ID	Subnets	Allocations
<input type="checkbox"/>	78c6...f709	1	0 of 244
<input type="checkbox"/>	2e08...78ae	1	0 of 128
<input type="checkbox"/>	64fa...b337	1	0 of 128
<input type="checkbox"/>	104f...615c	1	6 of 10
<input type="checkbox"/>	86a7...411d	3	24 of 90

4. Get the UUID of the Floating IP Pool object. You use this UUID when you install PKS with NSX-T.

	ID	Subnets	Allocations
<input type="checkbox"/>	78c6966e-c832-44a4-82ec-ef112244f709	1	0 of 244
<input type="checkbox"/>	2e08...78ae	1	0 of 128
<input type="checkbox"/>	64fa...b337	1	0 of 128
<input type="checkbox"/>	104f...615c	1	6 of 10
<input type="checkbox"/>	86a7...411d	3	24 of 90

## Next Step

After you complete this procedure, follow the instructions in [Installing PKS on vSphere with NSX-T](#).

## Installing PKS on vSphere with NSX-T

Page last updated:

This topic describes how to install and configure Pivotal Container Service (PKS) on vSphere with NSX-T integration.

### Prerequisites

Before you begin this procedure, ensure that you have successfully completed all preceding steps for installing PKS on vSphere with NSX-T, including:

- [Deploying NSX-T for PKS](#)
- [Creating the PKS Management Plane](#)
- [Creating the PKS Compute Plane](#)
- [Deploying Ops Manager with NSX-T for PKS](#)
- [Generating and Registering the NSX Manager Certificate for PKS](#)
- [Configuring BOSH Director with NSX-T for PKS](#)
- [Generating and Registering the NSX Manager Superuser Principal Identity Certificate and Key for PKS](#)
- [Creating NSX-T Objects for PKS](#)

### Step 1: Install PKS

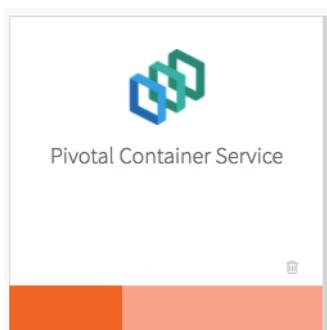
To install PKS, do the following:

1. Download the product file from [Pivotal Network](#).
2. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
3. Click **Import a Product** to upload the product file.
4. Under **Pivotal Container Service** in the left column, click the plus sign to add this product to your staging area.

### Step 2: Configure PKS

Click the orange **Pivotal Container Service** tile to start the configuration process.

 **Note:** Configuration of NSX-T or Flannel **cannot** be changed after initial installation and configuration of PKS.



 **WARNING:** When you configure the PKS tile, do not use spaces in any field entries. This includes spaces between characters as well as leading and trailing spaces. If you use a space in any field entry, the deployment of PKS fails.

### Assign AZs and Networks

Perform the following steps:

1. Click **Assign AZs and Networks**.
2. Select the availability zone (AZ) where you want to deploy the PKS API VM as a singleton job.

**Note:** You must select an additional AZ for balancing other jobs before clicking **Save**, but this selection has no effect in the current version of PKS.

Place singleton jobs in  
 us-west-2a  
 us-west-2b  
 us-west-2c

Balance other jobs in  
 us-west-2a  
 us-west-2b  
 us-west-2c

Network

Service Network

Management Network

**Save**

3. Under **Network**, select the PKS Management Network linked to the `ls-pks-mgmt` NSX-T logical switch you created in the [Create Networks Page](#) step of *Configuring Ops Manager on vSphere with NSX-T Integration*. This will provide network placement for the PKS API VM.
4. Under **Service Network**, your selection depends on whether you are upgrading from a previous PKS version or installing an original PKS deployment.
  - o If you are deploying PKS with NSX-T for the first time, the **Service Network** field does not apply because PKS creates the service network for you during the installation process. However, the PKS tile requires you to make a selection. Therefore, select the same network you specified in the **Network** field.
  - o If you are upgrading from a previous PKS version, select the **Service Network** linked to the `ls-pks-service` NSX-T logical switch that is created by PKS during installation. The service network provides network placement for the already existing on-demand Kubernetes cluster service instances created by the PKS broker.
5. Click **Save**.

## PKS API

Perform the following steps:

1. Click **PKS API**.
2. Navigate to your DNS provider and create an entry that points a fully qualified domain name (FQDN) within your system domain to the public IP address of the load balancer for the PKS API. For example, `api.pks.example.com`.

To retrieve the public IP address of the PKS API load balancer, log in to your IaaS console. If you used Terraform, you can also find the IP address in the `terraform.tfstate` file.

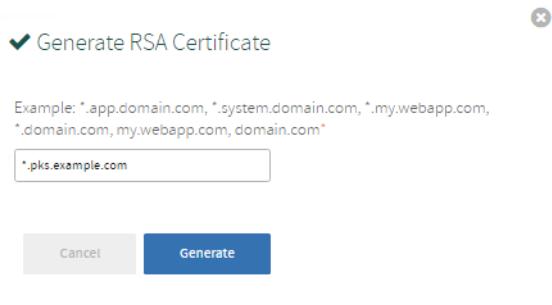
3. Under **Certificate to secure the PKS API**, provide your own certificate and private key pair.

The certificate that you supply should cover the domain that routes to the PKS API VM with TLS termination on the ingress.

If you do not have a certificate and private key pair, PKS can generate one for you by performing the following steps.

**Note:** If you configured Ops Manager Front End without a certificate, you can use this new certificate to complete Ops Manager configuration. To configure your Ops Manager Front End certificate, see [Configure Front End](#).

- Select the **Generate RSA Certificate** link.
- Enter the domain for your API hostname. This can be a standard FQDN or a wildcard domain.
- Click **Generate**.



- Under **API Hostname (FQDN)**, enter the FQDN that you have registered to point to the PKS API load balancer, such as `api.pks.example.com`.
- Under **Worker VM Max in Flight**, enter the maximum number of non-canary worker instances to create or resize in parallel within an availability zone.

This field sets the `max_in_flight` variable, which limits how many instances of a component can start simultaneously when a cluster is created or resized. The variable defaults to `1`, which means that only one component starts at a time.

- Click **Save**.

## Plans

To activate a plan, perform the following steps:

- Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.

**Note:** A plan defines a set of resource types used for deploying clusters. You can configure up to three plans. You must configure **Plan 1**.

- Select **Active** to activate the plan and make it available to developers deploying clusters.

**Plan\***

Active

**Name \***

**Description \***

Example: This plan will configure a lightweight kubernetes cluster. Not recommended for production workloads.

The plan description for the service instance

**Master/ETCD Node Instances ( min: 1, max: 3 ) \***

**Master/ETCD VM Type\***

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

**Master Persistent Disk Type\***

10 GB

**Master/ETCD Availability Zones \***

us-central1-f  
 us-central1-a  
 us-central1-c

3. Under **Name**, provide a unique name for the plan.
4. Under **Description**, edit the description as needed. The plan description appears in the Services Marketplace, which developers can access by using PKS CLI.
5. Under **Master/ETCD Node Instances**, select the default number of Kubernetes master/etc nodes to provision for each cluster. You can enter either **1** or **3**.

**Note:** If you deploy a cluster with multiple master/etc node VMs, confirm that you have sufficient hardware to handle the increased load on disk write and network traffic. For more information, see [Hardware recommendations](#) in the etcd documentation.

In addition to meeting the hardware requirements for a multi-master cluster, we recommend configuring monitoring for etcd to monitor disk latency, network latency, and other indicators for the health of the cluster. For more information, see [Monitoring Master/etc Node VMs](#).

- ⚠ WARNING:** To change the number of master/etc nodes for a plan, you must ensure that no existing clusters use the plan. PKS does not support changing the number of master/etc nodes for plans with existing clusters.
6. Under **Master/ETCD VM Type**, select the type of VM to use for Kubernetes master/etc nodes. For more information, see the [Master Node VM Size](#) section of *VM Sizing for PKS Clusters*.
  7. Under **Master Persistent Disk Type**, select the size of the persistent disk for the Kubernetes master node VM.
  8. Under **Master/ETCD Availability Zones**, select one or more AZs for the Kubernetes clusters deployed by PKS. If you select more than one AZ, PKS deploys the master VM in the first AZ and the worker VMs across the remaining AZs.
  9. Under **Maximum number of workers on a cluster**, set the maximum number of Kubernetes worker node VMs that PKS can deploy for each cluster.

**Note:** Clusters with more than 200 workers have not been validated.

Maximum number of workers on a cluster (min: 1) \*

Worker Node Instances (min: 1, max: 50) \*

Worker VM Type\*

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

Worker Persistent Disk Type\*

50 GB

Worker Availability Zones \*

us-central1-f  
 us-central1-a  
 us-central1-c

Errand VM Type\*

micro (cpu: 1, ram: 1 GB, disk: 8 GB)

- Under **Worker Node Instances**, select the default number of Kubernetes worker nodes to provision for each cluster.

If the user creating a cluster with the PKS Command Line Interface (CLI) does not specify a number of worker nodes, the cluster is deployed with the default number set in this field. This value cannot be greater than the maximum worker node value you set in the previous field. For more information about creating clusters, see [Creating Clusters](#).

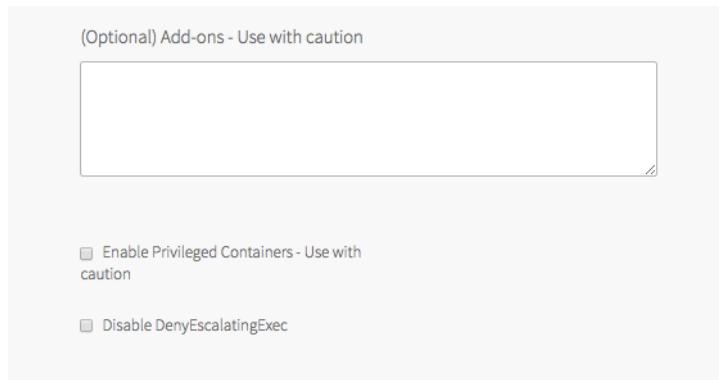
For high availability, create clusters with a minimum of three worker nodes, or two per AZ if you intend to use PersistentVolumes (PVs). For example, if you deploy across three AZs, you should have six worker nodes. For more information about PVs, see [PersistentVolumes](#) in *Maintaining Workload Uptime*. Provisioning a minimum of three worker nodes, or two nodes per AZ is also recommended for stateless workloads.

If you later reconfigure the plan to adjust the default number of worker nodes, the existing clusters that have been created from that plan are not automatically upgraded with the new default number of worker nodes.

- Under **Worker VM Type**, select the type of VM to use for Kubernetes worker node VMs. For more information, see the [Worker Node VM Number and Size](#) section of *VM Sizing for PKS Clusters*.

**Note:** If you install PKS in an NSX-T environment, we recommend that you select a **Worker VM Type** with a minimum disk size of 16 GB. The disk space provided by the default **medium** Worker VM Type is insufficient for PKS with NSX-T.

- Under **Worker Persistent Disk Type**, select the size of the persistent disk for the Kubernetes worker node VMs.
- Under **Worker Availability Zones**, select one or more AZs for the Kubernetes worker nodes. PKS deploys worker nodes equally across the AZs you select.
- Under **Errand VM Type**, select the size of the VM that contains the errand. The smallest instance possible is sufficient, as the only errand running on this VM is the one that applies the **Default Cluster App** YAML configuration.
- (Optional) Under **(Optional) Add-ons - Use with caution**, enter additional YAML configuration to add custom workloads to each cluster in this plan. You can specify multiple files using **---** as a separator. For more information, see [Adding Custom Workloads](#).



16. (Optional) To allow users to create pods with privileged containers, select the **Enable Privileged Containers - Use with caution** option. For more information, see [Pods](#) in the Kubernetes documentation.
17. (Optional) To disable the admission controller, select the **Disable DenyEscalatingExec** checkbox. If you select this option, clusters in this plan can create security vulnerabilities that may impact other tiles. Use this feature with caution.
18. Click **Save**.

To deactivate a plan, perform the following steps:

1. Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.
2. Select **Plan Inactive**.
3. Click **Save**.

## Kubernetes Cloud Provider

In the procedure below, you use credentials for vCenter master VMs. You must have provisioned the service account with the correct permissions. For more information, see [Create the Master Node Service Account](#) in *Preparing vSphere Before Deploying PKS*.

To configure your Kubernetes cloud provider settings, follow the procedure below:

1. Click **Kubernetes Cloud Provider**.
2. Under **Choose your IaaS**, select **vSphere**.
3. Ensure the values in the following procedure match those in the **vCenter Config** section of the **Ops Manager** tile.

Choose your IaaS\*

- GCP
- vSphere

vCenter Master Credentials \*

Username
Password

vCenter Host \*

--

Datacenter Name \*

--

Datastore Name \*

--

Stored VM Folder \*

--

- a. Enter your **vCenter Master Credentials**. Enter the username using the format `user@CF-EXAMPLE.com`. For more information about the master node service account, see [Preparing to Deploy PKS on vSphere](#).
- b. Enter your **vCenter Host**. For example, `vcenter.CF-EXAMPLE.com`.
- c. Enter your **Datacenter Name**. For example, `CF-EXAMPLE-dc`.
- d. Enter your **Datastore Name**. For example, `CF-EXAMPLE-ds`.
- e. Enter the **Stored VM Folders** so that the persistent stores know where to find the VMs. To retrieve the name of the folder, navigate to your BOSH Director tile, click **vCenter Config**, and locate the value for **VM Folder**. The default folder name is `pcf_vms`.



**Note:** We recommend using a shared datastore for multi-AZ and multi-cluster environments.

4. Click **Save**.

## (Optional) Logging

You can designate an external syslog endpoint for PKS component and cluster log messages.

To specify the destination for PKS log messages, do the following:

1. Click **Logging**.
2. To enable syslog forwarding, select **Yes**.

Enable Syslog for PKS?\*

No  
 Yes

Address \*

Port \*

Transport Protocol\*

Enable TLS

Permitted Peer

TLS Certificate

3. Under **Address**, enter the destination syslog endpoint.
4. Under **Port**, enter the destination syslog port.
5. Select a transport protocol for log forwarding.
6. (Optional) Pivotal strongly recommends that you enable TLS encryption when forwarding logs as they may contain sensitive information. For example, these logs may contain cloud provider credentials. To enable TLS, perform the following steps:
  - a. Under **Permitter Peer**, provide the accepted fingerprint (SHA1) or name of remote peer. For example, `*.YOUR-LOGGING-SYSTEM.com`.
  - b. Under **TLS Certificate**, provide a TLS certificate for the destination syslog endpoint.

**Note:** You do not need to provide a new certificate if the TLS certificate for the destination syslog endpoint is signed by a Certificate Authority (CA) in your BOSH certificate store.

7. You can manage logs using [VMware vRealize Log Insight \(vRLI\)](#). The integration pulls logs from all BOSH jobs and containers running in the cluster, including node logs from core Kubernetes and BOSH processes, Kubernetes event logs, and POD stdout and stderr.

**Note:** Before you configure the vRLI integration, you must have a vRLI license and vRLI must be installed, running, and available in your environment. You need to provide the live instance address during configuration. For instructions and additional information, see the [vRealize Log Insight documentation](#).

By default, vRLI logging is disabled. To enable and configure vRLI logging, under **Enable VMware vRealize Log Insight Integration?**, select **Yes** and

Enable VMware vRealize Log Insight Integration?\*

No  
 Yes

Host \*

Enable SSL?  
 Disable SSL certificate validation

CA certificate

Rate limiting \*

then perform the following steps:

- Under **Host**, enter the IP address or FQDN of the vRLI host.
- (Optional) Select the **Enable SSL?** checkbox to encrypt the logs being sent to vRLI using SSL.
- Choose one of the following SSL certificate validation options:
  - To skip certificate validation for the vRLI host, select the **Disable SSL certificate validation** checkbox. Select this option if you are using a self-signed certificate in order to simplify setup for a development or test environment.



**Note:** Disabling certificate validation is not recommended for production environments.

- To enable certificate validation for the vRLI host, clear the **Disable SSL certificate validation** checkbox.
- (Optional) If your vRLI certificate is not signed by a trusted CA root or other well known certificate, enter the certificate in the **CA certificate** field. Locate the PEM of the CA used to sign the vRLI certificate, copy the contents of the certificate file, and paste them into the field. Certificates must be in PEM-encoded format.
- Under **Rate limiting**, enter a time in milliseconds to change the rate at which logs are sent to the vRLI host. The rate limit specifies the minimum time between messages before the fluentd agent begins to drop messages. The default value (0) means the rate is not limited, which suffices for many deployments.



**Note:** If your deployment is generating a high volume of logs, you can increase this value to limit network traffic. Consider starting with a lower number, such as 10, and tuning to optimize for your deployment. A large number might result in dropping too many log entries.

- To enable clusters to drain app logs to sinks using `syslog://`, select the **Enable Sink Resources** checkbox. For more information about using sink resources, see [Creating Sink Resources](#).

Enable Sink Resources

**Save**

- Click **Save**. These settings apply to any clusters created after you have saved these configuration settings and clicked **Apply Changes**. If the **Upgrade all clusters errand** has been enabled, these settings are also applied to existing clusters.

**Note:** The PKS tile does not validate your vRLI configuration settings. To verify your setup, look for log entries in vRLI.

## Networking

To configure networking, do the following:

1. Click **Networking**.
2. Under **Container Networking Interface**, select **NSX-T**.

## Container Networking Interface\*

Flannel

NSX-T

### NSX Manager hostname \*

### NSX Manager credentials \*

  
Username  
Password

### NSX Manager CA Cert

Disable SSL certificate verification

NAT mode

- a. For **NSX Manager hostname**, enter the hostname or IP address of your NSX Manager.
- b. For **NSX Manager Super User Principal Identity Certificate**, copy and paste the contents and private key of the Principal Identity certificate you created in [Generating and Registering the NSX Manager Superuser Principal Identity Certificate and Key](#).
- c. (Optional) For **NSX Manager CA Cert**, copy and paste the contents of the NSX Manager CA certificate you created in [Generating and Registering the NSX Manager Certificate](#). Use this certificate and key to connect to the NSX Manager.
- d. The **Disable SSL certificate verification** checkbox is **not** selected by default. In order to disable TLS verification, select the checkbox. You may want to disable TLS verification if you did not enter a CA certificate, or if your CA certificate is self-signed.
- e. If you are using a NAT deployment topology, leave the **NAT mode** checkbox selected. If you are using a No-NAT topology, clear this checkbox. For more information, see [Deployment Topologies](#).

Pods IP Block ID \*

Nodes IP Block ID \*

T0 Router ID \*

Floating IP Pool ID \*

Nodes DNS \*

vSphere Cluster Names \*

HTTP/HTTPS Proxy (for vSphere only)\*

Disabled

Enabled

Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)

Enable outbound internet access

f. Enter the following IP Block settings:

- **Pods IP Block ID:** Enter the UUID of the IP block to be used for Kubernetes pods. PKS allocates IP addresses for the pods when they are created in Kubernetes. Each time a namespace is created in Kubernetes, a subnet from this IP block is allocated. The current subnet size that is created is /24, which means a maximum of 256 pods can be created per namespace.
- **Nodes IP Block ID:** Enter the UUID of the IP block to be used for Kubernetes nodes. PKS allocates IP addresses for the nodes when they are created in Kubernetes. The node networks are created on a separate IP address space from the pod networks. The current subnet size that is created is /24, which means a maximum of 256 nodes can be created per cluster. For more information, including sizes and the IP blocks to avoid using, see [Plan IP Blocks in Preparing NSX-T Before Deploying PKS](#).

g. For **T0 Router ID**, enter the `t0-pks` T0 router UUID. Locate this value in the NSX-T UI router overview.

h. For **Floating IP Pool ID**, enter the `ip-pool-vips` ID that you created for load balancer VIPs. For more information, see [Plan Network CIDRs](#). PKS uses the floating IP pool to allocate IP addresses to the load balancers created for each of the clusters. The load balancer routes the API requests to the master nodes and the data plane.

i. For **Nodes DNS**, enter one or more Domain Name Servers used by the Kubernetes nodes.

j. For **vSphere Cluster Names**, enter a comma-separated list of the vSphere clusters where you will deploy Kubernetes clusters. The NSX-T precheck errand uses this field to verify that the hosts from the specified clusters are available in NSX-T. You can specify clusters in this format: `cluster1,cluster2,cluster3`.

3. (Optional) Configure a global proxy for all outgoing HTTP and HTTPS traffic from your Kubernetes clusters and the PKS API server. See [Using Proxies with PKS on NSX-T](#) for instructions on how to enable a proxy.

4. Under **Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)**, ignore the **Enable outbound internet access** checkbox.

5. Click **Save**.

## UAA

To configure the UAA server, do the following:

1. Click **UAA**.
2. Under **PKS CLI Access Token Lifetime**, enter a time in seconds for the PKS CLI access token lifetime.

PKS API Access Token Lifetime (in seconds) \*

PKS API Refresh Token Lifetime (in seconds) \*

Enable UAA as OIDC provider

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA  
 LDAP Server

3. Under **PKS CLI Refresh Token Lifetime**, enter a time in seconds for the PKS CLI refresh token lifetime.

4. Select one of the following options:

- To use an internal user account store for UAA, select **Internal UAA**. Click **Save** and continue to [\(Optional\) Monitoring](#).
- To use an external user account store for UAA, select **LDAP Server** and continue to [Configure LDAP as an Identity Provider](#).

**Note:** Selecting **LDAP Server** allows admin users to give cluster access to groups of users. For more information about performing this procedure, see [Grant Cluster Access to a Group](#) in *Managing Users in PKS with UAA*.

## Configure LDAP as an Identity Provider

To integrate UAA with one or more LDAP servers, configure PKS with your LDAP endpoint information as follows:

1. Under **UAA**, select **LDAP Server**.

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA  
 LDAP Server

Server URL \*

LDAP Credentials \*

Username

Password

User Search Base \*

User Search Filter \*

Group Search Base

Group Search Filter \*

2. For **Server URL**, enter the URLs that point to your LDAP server. If you have multiple LDAP servers, separate their URLs with spaces. Each URL must include one of the following protocols:

- `ldap://` : Use this protocol if your LDAP server uses an unencrypted connection.
- `ldaps://` : Use this protocol if your LDAP server uses SSL for an encrypted connection. To support an encrypted connection, the LDAP server must hold a trusted certificate or you must import a trusted certificate to the JVM truststore.

3. For **LDAP Credentials**, enter the LDAP Distinguished Name (DN) and password for binding to the LDAP server. For example, `cn=administrator,ou=Users,dc=example,dc=com`. If the bind user belongs to a different search base, you must use the full DN.

**Note:** We recommend that you provide LDAP credentials that grant read-only permissions on the LDAP search base and the LDAP group search base.

4. For **User Search Base**, enter the location in the LDAP directory tree where LDAP user search begins. The LDAP search base typically matches your domain name.

For example, a domain named `cloud.example.com` may use `ou=Users,dc=example,dc=com` as its LDAP user search base.

5. For **User Search Filter**, enter a string to use for LDAP user search criteria. The search criteria allows LDAP to perform more effective and efficient searches. For example, the standard LDAP search filter `cn=Smith` returns all objects with a common name equal to `Smith`.

In the LDAP search filter string that you use to configure PKS, use `{0}` instead of the username. For example, use `cn={0}` to return all LDAP objects with the same common name as the username.

In addition to `cn`, other common attributes are `mail`, `uid` and, in the case of Active Directory, `sAMAccountName`.

**Note:** For information about testing and troubleshooting your LDAP search filters, see [Configuring LDAP Integration with Pivotal Cloud Foundry](#).

6. For **Group Search Base**, enter the location in the LDAP directory tree where the LDAP group search begins.

For example, a domain named `cloud.example.com` may use `ou=Groups,dc=example,dc=com` as its LDAP group search base.

Follow the instructions in the [Grant PKS Access to an External LDAP Group](#) section of *Managing Users in PKS with UAA* to map the groups under this search base to roles in PKS.

7. For **Group Search Filter**, enter a string that defines LDAP group search criteria. The standard value is `member={0}`.

8. For **Server SSL Cert**, paste in the root certificate from your CA certificate or your self-signed certificate.

Server SSL Cert

Server SSL Cert AltName

First Name Attribute

Last Name Attribute

Email Attribute \*

mail

Email Domain(s)

LDAP Referrals\*

Automatically follow any referrals

9. For **Server SSL Cert AltName**, do one of the following:

- o If you are using `ldaps://` with a self-signed certificate, enter a Subject Alternative Name (SAN) for your certificate.

- o If you are not using `ldaps://` with a self-signed certificate, leave this field blank.

- For **First Name Attribute**, enter the attribute name in your LDAP directory that contains user first names. For example, `cn`.
- For **Last Name Attribute**, enter the attribute name in your LDAP directory that contains user last names. For example, `sn`.
- For **Email Attribute**, enter the attribute name in your LDAP directory that contains user email addresses. For example, `mail`.
- For **Email Domain(s)**, enter a comma-separated list of the email domains for external users who can receive invitations to Apps Manager.
- For **LDAP Referrals**, choose how UAA handles LDAP server referrals to other user stores. UAA can follow the external referrals, ignore them without returning errors, or generate an error for each external referral and abort the authentication.
- For **External Groups Whitelist**, enter a comma-separated list of group patterns which need to be populated in the user's `id_token`. For further information on accepted patterns see the description of the `config.externalGroupsWhitelist` in the OAuth/OIDC [Identity Provider Documentation](#).

**Note:** When sent as a Bearer token in the Authentication header, wide pattern queries for users who are members of multiple groups, can cause the size of the `id_token` to extend beyond what is supported by web servers.

#### External Groups Whitelist

Comma-separated list of external groups from LDAP that get added as roles in the ID Token, required to allow access to cluster to groups

- Click **Save**.

#### (Optional) Configure OpenID Connect

You can use OpenID Connect (OIDC) to instruct Kubernetes to verify end-user identities based on authentication performed by an authorization server, such as UAA.

To configure PKS to use OIDC, select **Enable UAA as OIDC provider**. With OIDC enabled, Admin Users can grant cluster-wide access to Kubernetes end users.

PKS API Access Token Lifetime (in seconds) *	<input type="text" value="7200"/>
PKS API Refresh Token Lifetime (in seconds) *	<input type="text" value="21600"/>
<input checked="" type="checkbox"/> Enable UAA as OIDC provider	This will configure created clusters to use UAA as the OIDC provider.

For more information about configuring OIDC, see the table below:

Option	Description
OIDC disabled	If you do not enable OIDC, Kubernetes authenticates users against its internal user management system.
OIDC enabled	If you enable OIDC, Kubernetes uses the authentication mechanism that you selected in <a href="#">UAA</a> : <ul style="list-style-type: none"> <li>• If you selected <b>Internal UAA</b>, Kubernetes authenticates users against the internal UAA authentication mechanism.</li> <li>• If you selected <b>LDAP Server</b>, Kubernetes authenticates users against the LDAP server.</li> </ul>

For additional information on getting credentials with OIDC configured, see [Retrieve Cluster Credentials](#) in [Retrieving Cluster Credentials and Configuration](#).

**Note:** When you enable OIDC, existing PKS-provisioned Kubernetes clusters are upgraded to use OIDC. This invalidates your kubeconfig files. You must regenerate the files for all clusters.

## (Optional) Monitoring

You can monitor Kubernetes clusters and pods metrics externally using the integration with [Wavefront by VMware](#).

**Note:** Before you configure Wavefront integration, you must have an active Wavefront account and access to a Wavefront instance. You provide your Wavefront access token during configuration and enabling errands. For additional information, see [Pivotal Container Service Integration Details](#) in the Wavefront documentation.

By default, monitoring is disabled. To enable and configure Wavefront monitoring, do the following:

- Under **Wavefront Integration**, select **Yes**.

Pivotal Container Service

Configure PKS Monitoring Integration(s)

Wavefront Integration\*

No  Yes

Wavefront URL \* https://vmware.wavefront.com/api The URL of your Wavefront Subscription, ex: https://try.wavefront.com/api

Wavefront Access Token \* \*\*\*\*\* Change

Wavefront Alert Recipient

Monitoring  Save

Usage Data

- Under **Wavefront URL**, enter the URL of your Wavefront subscription. For example, `https://try.wavefront.com/api`.
- Under **Wavefront Access Token**, enter the API token for your Wavefront subscription.
- To configure Wavefront to send alerts by email, enter email addresses or Wavefront Target IDs separated by commas under **Wavefront Alert Recipient**. For example: `user@example.com,Wavefront_TargetID`. To create alerts, you must enable errands.
- In the **Errands** tab, enable **Create pre-defined Wavefront alerts errand** and **Delete pre-defined Wavefront alerts errand**.

The screenshot shows the PKS Tile configuration interface. On the left, a sidebar lists various configuration items with checkboxes. The 'Usage Data' item is selected and highlighted with a red box. Under 'Usage Data', the 'Errands' item is also highlighted with a red box. The main pane displays two errand settings with dropdown menus. The first dropdown, labeled '1', is for 'Create pre-defined Wavefront alerts errand' and has 'Default (Off)' selected. The second dropdown, labeled '2', is for 'Delete pre-defined Wavefront alerts errand' and also has 'Default (Off)' selected.

- Click **Save**. Your settings apply to any clusters created after you have saved these configuration settings and clicked **Apply Changes**.

**Note:** The PKS tile does not validate your Wavefront configuration settings. To verify your setup, look for cluster and pod metrics in Wavefront.

## Usage Data

VMware's Customer Experience Improvement Program (CEIP) and the Pivotal Telemetry Program (Telemetry) provides VMware and Pivotal with information that enables the companies to improve their products and services, fix problems, and advise you on how best to deploy and use our products. As part of the CEIP and Telemetry, VMware and Pivotal collect technical information about your organization's use of the Pivotal Container Service ("PKS") on a regular basis. Since PKS is jointly developed and sold by VMware and Pivotal, we will share this information with one another. Information collected under CEIP or Telemetry does not personally identify any individual.

Regardless of your selection in the **Usage Data** pane, a small amount of data is sent from Cloud Foundry Container Runtime (CFCR) to the PKS tile. However, that data is not shared externally.

To configure the **Usage Data** pane:

- Select the **Usage Data** side-tab.
- Read the **Usage Data** description.
- Make your selection.
  - To join the program, select **Yes, I want to join the CEIP and Telemetry Program for PKS**.
  - To decline joining the program, select **No, I do not want to join the CEIP and Telemetry Program for PKS**.
- Click **Save**.

**Note:** If you join the CEIP and Telemetry Program for PKS, open your firewall to allow outgoing access to <https://vcsa.vmware.com/ph-prd> on port 443.

## Errands

Errands are scripts that run at designated points during an installation.

To configure when post-deploy and pre-delete errands for PKS are run, make a selection in the dropdown next to the errand.

**⚠️ WARNING:** You must enable the NSX-T Validation errand to verify and tag required NSX-T objects.

Errands

Errands are scripts that run at designated points during an installation.

Post-Deploy Errands

NSX-T Validation errand Validates NSX-T configuration and tags resources  
On

Upgrade all clusters errand Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied  
Default (On)

Create pre-defined Wavefront alerts errand Create pre-defined Wavefront alerts  
Default (Off)

Pre-Delete Errands

Delete all clusters errand Deletes all clusters provisioned by PKS when the PKS tile is deleted  
Default (On)

Delete pre-defined Wavefront alerts errand Delete pre-defined Wavefront alerts errand  
Default (Off)

**Save**

For more information about errands and their configuration state, see [Managing Errands in Ops Manager](#).

**⚠️ WARNING:** Because PKS uses floating stemcells, updating the PKS tile with a new stemcell triggers the rolling of every VM in each cluster. Also, updating other product tiles in your deployment with a new stemcell causes the PKS tile to roll VMs. This rolling is enabled by the **Upgrade all clusters errand**. We recommend that you keep this errand turned on because automatic rolling of VMs ensures that all deployed cluster VMs are patched. However, automatic rolling can cause downtime in your deployment.

## Resource Config

To modify the resource usage of PKS, click **Resource Config** and edit the **Pivotal Container Service** job.

Resource Config

JOB	INSTANCES	PERSISTENT DISK TYPE	VM TYPE	LOAD BALANCERS	INTERNET CONNECTED
Pivotal Container Service	Automatic: 1	Automatic: 10 GB	Automatic: large	tcp:PKS-API	<input checked="" type="checkbox"/>

**💡 Note:** If you experience timeouts or slowness when interacting with the PKS API, select a **VM Type** with greater CPU and memory resources for the **Pivotal Container Service** job.

## Step 3: Apply Changes

After configuring the PKS tile, follow the steps below to deploy the tile:

1. Return to the Ops Manager Installation Dashboard.
2. Click **Review Pending Changes**. Select the product that you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).

 **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

3. Click **Apply Changes**.

## Step 4: Install the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## Step 5: Share the PKS API Endpoint

You must share the PKS API endpoint to allow your organization to use the API to create, update, and delete clusters. For more information, see [Creating Clusters](#).

1. When the installation is completed, retrieve the PKS endpoint by performing the following steps:
  - a. From the Ops Manager Installation Dashboard, click the **Pivotal Container Service** tile.
  - b. Click the **Status** tab and record the IP address assigned to the **Pivotal Container Service** job.
2. Create a DNAT rule on the `t1-pks-mgmt` T1 to map an external IP from the **PKS MANAGEMENT CIDR** to the PKS endpoint. For example, a DNAT rule that maps `10.172.1.4` to `172.31.0.4`, where `172.31.0.4` is PKS endpoint IP address on the `1s-pks-mgmt` NSX-T Logical Switch.

 **Note:** Ensure that you have no overlapping NAT rules. If your NAT rules overlap, you cannot reach Ops Manager from VMs in the vCenter network.

Developers should use the DNAT IP address when logging in with the PKS CLI. For more information, see [Using PKS](#).

## Step 6: Configure PKS API Access

Follow the procedures in [Configuring PKS API Access](#).

## Step 7: Configure Authentication for PKS

Configure authentication for PKS using User Account and Authentication (UAA). For information, see [Managing Users in PKS with UAA](#).

## Next Steps

After installing PKS on vSphere with NSX-T integration, you may want to do one or more of the following:

- Integrate VMware Harbor with PKS to store and manage container images. For more information, see [Integrating VMware Harbor Registry with PKS](#).
- Create your first PKS cluster. For more information, see [Creating Clusters](#).

## Implementing a Multi-Foundation PKS Deployment

Page last updated:

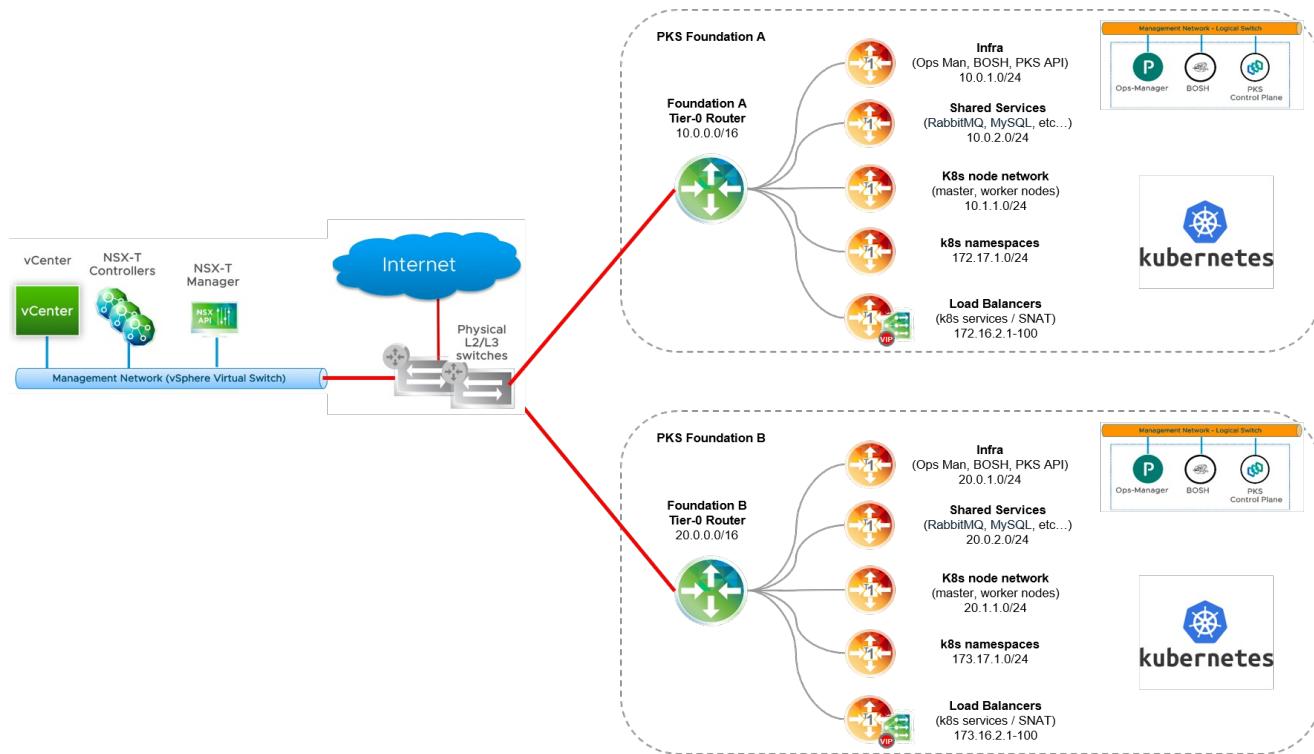
This topic describes how to deploy multiple instances of PKS on vSphere with NSX-T infrastructure.

### About Multi-Foundation PKS

A multi-foundation deployment of PKS lets you install and run multiple instances of PKS. The purpose of a multi-foundation deployment of PKS is to share a common vSphere and NSX-T infrastructure across multiple foundations, while providing complete networking isolation across foundations.

As shown in the diagram, with a multi-foundation PKS topology, each PKS instance is deployed to a dedicated NSX-T Tier-0 router. Foundation A T0 router with Management CIDR 10.0.0.0/16 connects to the vSphere and NSX-T infrastructure. Similarly, Foundation B T0 router with Management CIDR 20.0.0.0/16 connects to the same vSphere and NSX-T components.

As with a single instance deployment, PKS management components are deployed to a dedicated network, for example, 10.0.0.0/24 for PKS Foundation A; 20.0.0.0/24 for PKS Foundation B. When PKS is deployed, networks are defined for nodes, pods, and load balancers. Because of the dedicated Tier-0 router, there is complete networking isolation between each PKS instance.



## Requirements

To implement a multi-foundation PKS topology, adhere to the following requirements:

- One Tier-0 router for each PKS instance. For more information, see [Configuring Multiple Tier-0 Routers for Tenant Isolation](#).
- The Floating IP pool must not overlap. The CIDR range for each Floating IP Pool must be unique and not overlapping across foundations. For more information, see [Create Floating IP Pool](#).
- PKS instances can be deployed in NAT and no-NAT mode. If more than one PKS instance is deployed in no-NAT mode, the Nodes IP Block networks cannot overlap.
- For any Pods IP Block used to deploy Kubernetes clusters in no-NAT (routable) mode, the Pods IP Block cannot overlap across foundations.

The image below shows three PKS installations across three Tier-0 foundations. Key considerations to keep in mind with a multi-foundation PKS topology include the following:

- Each foundation must rely on a dedicated Tier-0 router

- You can mix-and-match NAT and no-NAT mode across foundations for Node and Pod networks
- If you are using non-routable Pods IP Block networks, the Pods IP Block addresses can overlap across foundations
- Because Kubernetes nodes are behind a dedicated Tier-0 router, if clusters are deployed in NAT mode the Nodes IP Block addresses can also overlap across foundations
- For each foundation you must define a unique Floating IP Pool with non-overlapping IPs

PKS Foundation A	PKS Foundation B	PKS Foundation C
<input checked="" type="checkbox"/> NAT mode	<input type="checkbox"/> NAT mode	<input type="checkbox"/> NAT mode
Pods IP Block ID *	927d2aff-fa86-4df8-bb21-c45b5314f547	1b81b967-e269-4a62-9ff5-e2e39a5feaae
Nodes IP Block ID *	3d577e5c-dcaf-4921-9458-d12b0e1318e6	3d577e5c-dcaf-4921-9458-d12b0e1318e6
T0 Router ID *	40445803-8c3c-417e-bb24-e84cf9a330b5	5c579a37-5318-4255-9658-1a2a99a1d1e9
Floating IP Pool ID *	86213c33-9b7a-4a91-b470-7145941bccb3	31e0fd4e-19e7-4122-b300-438d465a406f
Nodes DNS *	10.40.53.1	10.40.53.1
vSphere Cluster Names *	Cluster-A	Cluster-B
		Cluster-C

## Using Proxies with PKS on NSX-T

This topic describes how to use proxies with Pivotal Container Service (PKS) with NSX-T.

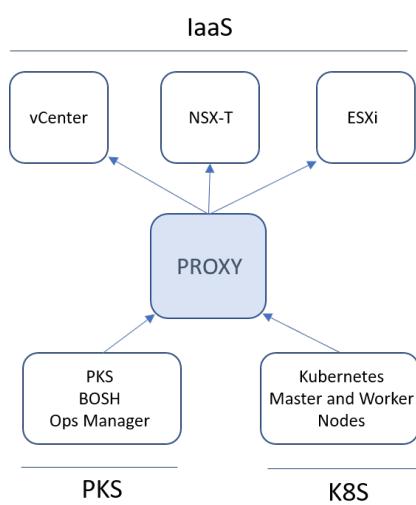
### Overview

If your environment includes HTTP proxies, you can configure PKS with NSX-T to use these proxies so that PKS-deployed Kubernetes master and worker nodes access public Internet services and other internal services through a proxy.

In addition, PKS proxy settings apply to the PKS API instance. When a PKS operator creates a Kubernetes cluster, the PKS API instance VM behind a proxy is able to manage NSX-T objects on the standard network.

You can also proxy outgoing HTTP/HTTPS traffic from Ops Manager and the BOSH Director so that all PKS components use the same proxy service.

The following diagram illustrates the network architecture:



### Enable PKS API and Kubernetes Proxy

To configure a global HTTP proxy for all outgoing HTTP/HTTPS traffic from the Kubernetes cluster nodes and the PKS API server, perform the following steps:

1. Navigate to Ops Manager and log in.
2. Click the PKS tile.
3. Click **Networking**.

HTTP/HTTPS Proxy (for vSphere only)\*

Disabled

Enabled

HTTP Proxy URL

HTTP Proxy Credentials  
 Username  
 Password

HTTPS Proxy URL

HTTPS Proxy Credentials  
 Username  
 Password

No Proxy

4. Under **HTTP/HTTPS proxy**, select **Enabled**. When this option is enabled, you can proxy HTTP traffic, HTTPS traffic, or both.
5. To proxy outgoing HTTP traffic, under **HTTP Proxy URL**, enter the HTTP URL of your proxy endpoint. For example, `http://myproxy.com:80`.
6. If the proxy for outgoing HTTP traffic uses basic authentication, enter the user name and password in the **HTTP Proxy Credentials** fields.
7. To proxy outgoing HTTPS traffic, under **HTTPS Proxy URL**, enter the HTTP URL of your proxy endpoint. For example, `http://myproxy.com:80`.

**Note:** Using an HTTPS connection to the proxy server is not supported. HTTP and HTTPS proxy options can only be configured with an HTTP connection to the proxy server. You cannot populate either of the proxy URL fields with an HTTPS URL. The proxy host and port can be different for HTTP and HTTPS traffic, but the proxy protocol must be HTTP.

8. If the proxy for outgoing HTTPS traffic uses basic authentication, enter the user name and password in the **HTTPS Proxy Credentials** fields.
9. Under **No Proxy**, enter the comma-separated list of IP addresses that must bypass the proxy to allow for internal PKS communication.

In addition to `127.0.0.1` and `localhost`, you must include your deployment network CIDR, your node network IP block, and your pod network IP block CIDR:

```
127.0.0.1,localhost,  
DEPLOYMENT-NETWORK-CIDR,  
NODE-NETWORK-IP-BLOCK-CIDR,  
POD-NETWORK-IP-BLOCK-CIDR
```

The **No Proxy** field in the PKS tile does not accept wildcard domain notation, such as `*.docker.io` and `*.docker.com`. You must specify the exact IP or FQDN to bypass the proxy. Typical FQDNs to include in the **No Proxy** field include the following common Docker repositories:

- `registry-1.docker.io`
- `auth.docker.io`
- `production.cloudflare.docker.com`
- `gcr.io`
- `storage.googleapis.com`

If you are upgrading and have an existing proxy configuration for reaching a Docker registry or other external services, add the following IP addresses to the **No Proxy** field to prevent the PKS to IaaS traffic from going through the proxy: NSX Manager, vCenter Server, and all ESXi hosts.

If a component is communicating with PKS or Harbor using a hostname instead of an IP address, you will need to add the corresponding FQDN to the **No Proxy** list. For example:

127.0.0.1,localhost,  
DEPLOYMENT-NETWORK-CIDR,  
NODE-NETWORK-IP-BLOCK-CIDR,  
POD-NETWORK-IP-BLOCK-CIDR,  
PKS-API-FQDN,HARBOR-API-FQDN

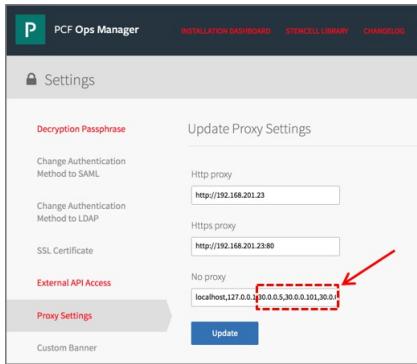
**Note:** By default, the `.internal`, `10.100.0.0/8`, and `10.200.0.0/8` IP address ranges are not proxied. This allows internal PKS communication.

10. Save the changes to the PKS tile.
11. Proceed with any remaining PKS tile configurations and deploy PKS. See [Installing PKS on vSphere with NSX-T](#).

## Enable Ops Manager and BOSH Proxy

To enable an HTTP proxy for outgoing HTTP/HTTPS traffic from Ops Manager and the BOSH Director, perform the following steps:

1. Navigate to Ops Manager and log in.
2. Select **User Name > Settings** in the upper right.
3. Click **Proxy Settings**.



4. Under **HTTP Proxy**, enter the FQDN or IP address of the HTTP proxy endpoint. For example, `http://myproxy.com:80`.
5. Under **HTTPS Proxy**, enter the FQDN or IP address of the HTTPS proxy endpoint. For example, `http://myproxy.com:80`.

**Note:** Using an HTTPS connection to the proxy server is not supported. Ops Manager and BOSH HTTP and HTTPS proxy options can be only configured with an HTTP connection to the proxy.

6. Under **No Proxy**, include the hosts that must bypass the proxy. This is required.

In addition to `127.0.0.1` and `localhost`, include the BOSH Director IP and the PKS VM IP. The BOSH Director IP is typically the first IP address in the deployment network CIDR, and the PKS VM IP is the second IP address in the deployment network CIDR. In addition, be sure to include the Ops Manager IP address in the **No Proxy** field as well.

127.0.0.1,localhost,BOSH-DIRECTOR-IP,PKS-VM-IP,OPS-MANAGER-IP

**Note:** Ops Manager does not allow the use of a CIDR range in the **No Proxy** field. You must specify each individual IP address to bypass the proxy.

The **No Proxy** field does not accept wildcard domain notation, such as `*.docker.io` and `*.docker.com`. You must specify the exact IP or FQDN to bypass the proxy, such as `registry-1.docker.io`.

7. Click **Save**.
8. Return to the Ops Manager Installation Dashboard and click **Review Pending Changes**.
9. Click **Apply Changes** to deploy Ops Manager and the BOSH Director with the updated proxy settings.



## Defining Network Profiles

Page last updated:

This topic describes how to define network profiles for Kubernetes clusters provisioned with Pivotal Container Service (PKS) on vSphere with NSX-T.

## About Network Profiles

Network profiles let you customize NSX-T configuration parameters at the time of cluster creation. Use cases for network profiles include the following:

Profile Type	Description
<a href="#">Load Balancer Sizing</a>	Customize the size of the NSX-T load balancer provisioned when a Kubernetes cluster is created using PKS.
<a href="#">Custom Pod Networks</a>	Assign IP addresses from a dedicated IP block to pods in your Kubernetes cluster.
<a href="#">Routable Pod Networks</a>	Assign routable IP addresses from a dedicated IP block to pods in your Kubernetes cluster.
<a href="#">Bootstrap Security Group for Kubernetes Master Nodes</a>	Specify an NSX-T Namespace Group where Kubernetes master nodes will be added to during cluster creation.
<a href="#">Pod Subnet Prefix</a>	Specify the size of the pod subnet.
<a href="#">Custom Floating IP</a>	Specify a custom floating IP pool.
<a href="#">Edge Router Selection</a>	Specify the NSX-T Tier-0 router where Kubernetes node and Pod networks will be connected to.

## Network Profile Format

Network profiles are defined using JSON. Here are example network profiles for two different customers:

```
np_customer_A.json
{
  "name": "np-cust-a",
  "description": "Network Profile for Customer A",
  "parameters": {
    "lb_size": "small",
    "t0_router_id": "5a7a82b2-37e2-4d73-9cb1-97a8329e1a90",
    "fip_pool_ids": [
      "e50e8f6e-1a7a-45dc-ad49-3a607baa7fa0"
    ],
    "pod_ip_block_ids": [
      "7056d707-accc-470e-88cf-66bb86fb439"
    ],
    "master_vms_nsgroup_id": "9b8d535a-d3b6-4735-9fd0-56305c4a5293",
    "pod_subnet_prefix": 27
  }
}
```

```
np_customer_B.json
{
  "name": "np-cust-b",
  "description": "Network Profile for Customer B",
  "parameters": {
    "lb_size": "medium",
    "t0_router_id": "5a7a82b2-37e2-4d73-9cb1-97a8329e1a92",
    "fip_pool_ids": [
      "e50e8f6e-1a7a-45dc-ad49-3a607baa7fa2"
    ],
    "pod_routable": "true",
    "pod_ip_block_ids": [
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee55",
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee56"
    ],
    "master_vms_nsgroup_id": "9b8d535a-d3b6-4735-9fd0-56305c4a5292",
    "pod_subnet_prefix": 26
  }
}
```

## Network Profile Parameters

Define a network profile configuration in a JSON file using the following parameters:

Parameter	Description
<code>name</code>	User-defined name for the network profile.
<code>description</code>	User-defined description for the network profile.
<code>parameters</code>	One or more name-value pairs.
<code>lb_size</code>	Size of the NSX-T load balancer deployed with the Kubernetes cluster: <code>small</code> , <code>medium</code> , or <code>large</code> .
<code>pod_ip_block_ids</code>	UUID of the IP block from NSX Manager; one or more, comma-separated.
<code>pod_routable</code>	<code>true</code> or <code>false</code> . Set the parameter to <code>true</code> to assign routable IP addresses to pods.
<code>master_vms_nsgroup_id</code>	UUID of an NSGroup.
<code>fip_pool_ids</code>	UUID of a floating IP pool.
<code>pod_subnet_prefix</code>	Prefix size of the custom Pods IP Block subnet.
<code>t0_router_id</code>	UUID of a dedicated Tier-0 router.

## Network Profile Creation

After the network profile is defined in a JSON file, a PKS administrator can create the network profile using the PKS CLI. The Kubernetes administrator can use the network profile when creating a cluster.

For more information, see the [Create and Use Network Profiles](#) section of [Using Network Profiles \(NSX-T Only\)](#).

## Load Balancer Sizing

When you deploy a Kubernetes cluster using PKS on NSX-T, an NSX-T load balancer is automatically provisioned. By default the size of this load balancer is small. Using a network profile, you can customize the size of the load balancer. For more information, see [Load Balancers in PKS Deployments on vSphere with NSX-T](#).

NSX-T load balancers run on edge nodes. There are various form factors for edge nodes. PKS supports the large edge VM and the bare metal edge. The large VM edge node must run on Intel processors. The large load balancer requires a bare metal edge node. For more information about edge nodes, see [Scaling Load Balancer Resources](#) in the NSX-T documentation.

The NSX-T load balancer is a logical load balancer that handles a number of functions using virtual servers and pools. For more information, see [Supported Load Balancer Features](#) in the NSX-T documentation.

The following virtual servers are required for PKS:

- 1 TCP layer 4 virtual server for each Kubernetes service of `type:LoadBalancer`
- 2 HTTP and HTTPS layer 7 global virtual servers for Kubernetes ingress resources
- 1 global virtual server for the PKS API

The following network profile, `np-lb-med`, defines a medium load balancer:

```
{
  "name": "np-lb-med",
  "description": "Network profile for medium NSX-T load balancer",
  "parameters": {
    "lb_size": "medium"
  }
}
```

The following network profile, `np-lb-large`, defines a large load balancer:

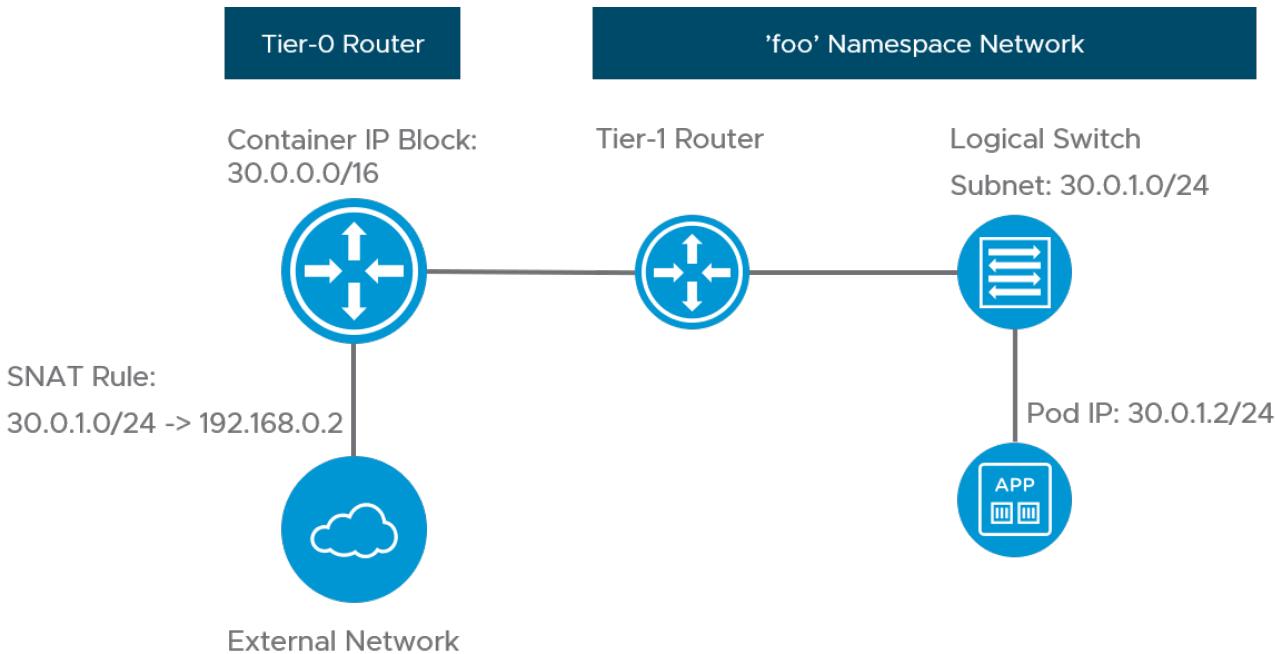
```
{
  "name": "np-lb-large",
  "description": "Network profile for large NSX-T load balancer",
  "parameters": {
    "lb_size": "large"
  }
}
```

**Note:** The large load balancer requires a bare metal NSX Edge Node.

## Custom Pod Networks

When you configure your NSX-T infrastructure for PKS, you must create a **Pods IP Block**. For more information, see the [Plan IP Blocks](#) section of *Planning, Preparing, and Configuring NSX-T for PKS*.

By default, this subnet is non-routable. When a Kubernetes cluster is deployed, each pod receives an IP address from the **Pods IP Block** you created. Because the pod IP addresses are non-routable, NSX-T creates a SNAT rule on the Tier-0 router to allow network egress from the pods. This configuration is shown in the diagram below:



You can use a network profile to override the global **Pods IP Block** that you specify in the PKS tile with a custom IP block. To use a custom pods network, do the following after you deploy PKS:

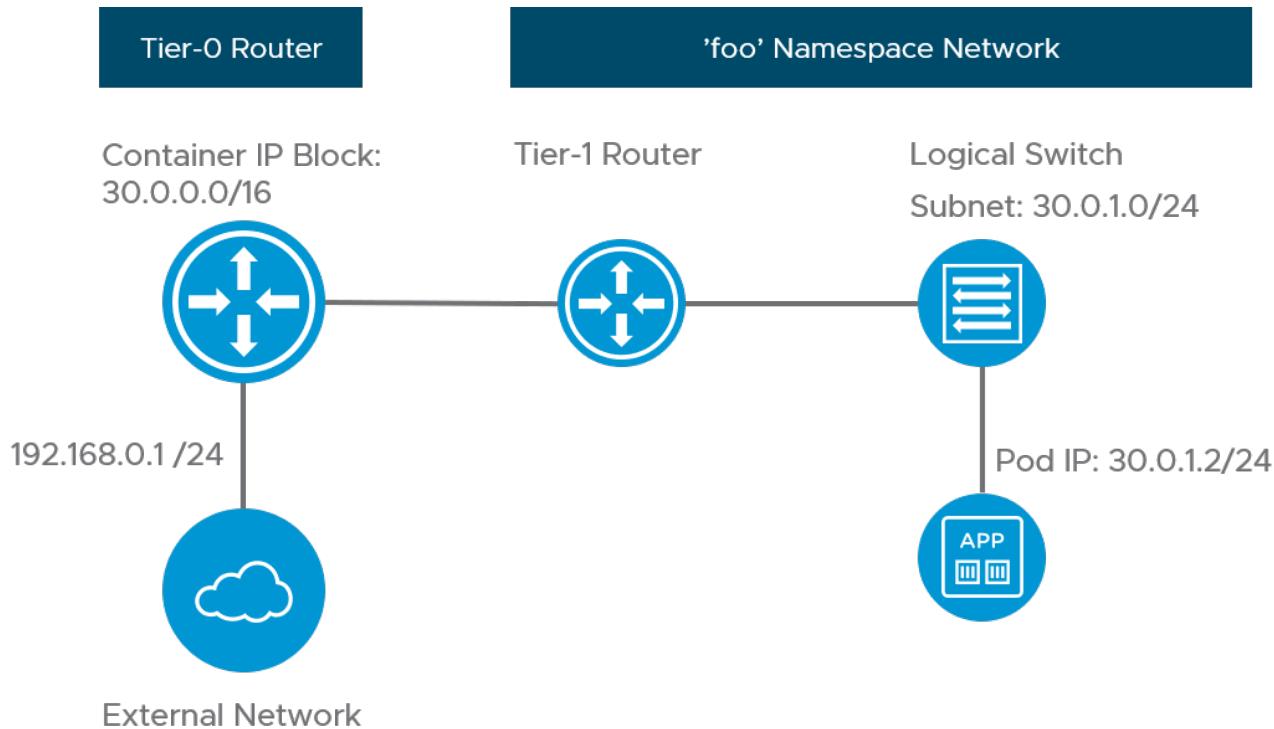
1. Define a custom IP block in NSX-T. For more information, see [Creating NSX-T Objects for PKS](#).
2. Define a network profile that references the custom pods IP block. For example, the following network profile defines non-routable pod addresses from two IP blocks:

```
{
  "description": "Network profile with two non-routable pod networks",
  "name": "non-routable-pod",
  "parameters": {
    "pod_ip_block_ids": [
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee55",
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee56"
    ]
  }
}
```

**Note:** If you define multiple custom Pods IP Blocks, the IP addresses must not overlap.

## Routable Pod Networks

Using a network profile, you can assign routable IP addresses from a dedicated routable IP block to pods in your Kubernetes cluster. When a cluster is deployed using that network profile, the routable IP block overrides the default non-routable IP block described created for deploying PKS. When you deploy a Kubernetes cluster using that network profile, each pod receives a routable IP address. This configuration is shown in the diagram below. If you use routable pods, the SNAT rule is not created.



To use routable pods, do the following after you deploy PKS:

1. Define a routable IP block in NSX-T. For more information, see [Creating NSX-T Objects for PKS](#).
2. Define a network profile that references the routable IP block. For example, the following network profile defines routable pod addresses from two IP blocks:

```
{
  "description": "Network profile with small load balancer and two routable pod networks",
  "name": "small-routable-pod",
  "parameters": {
    "pod_routable": "true",
    "pod_ip_block_ids": [
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee55",
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee56"
    ]
  }
}
```

**Note:** If you define multiple routable Pods IP Blocks, the IP addresses must not overlap.

## Bootstrap Security Group

Most of the NSX-T virtual interface tags used by PKS are added to the Kubernetes master node or nodes during the node initialization phase of cluster provisioning. To add tags to virtual interfaces, the Kubernetes master node needs to connect to the NSX-T Manager API. Network security rules provisioned prior to cluster creation time do not allow nodes to connect to NSX-T if the rules are based on a Namespace Group (NSGroup) managed by PKS.

To address this bootstrap issue, PKS exposes an optional configuration parameter in Network Profiles to systematically add Kubernetes master nodes to a pre-provisioned NSGroup. The BOSH vSphere cloud provider interface (CPI) has the ability to use the NSGroup to automatically manage members following the BOSH VM lifecycle for Kubernetes master nodes.

To configure a Bootstrap Security Group, complete the following steps:

1. Create the NSGroup in NSX Manager prior to provisioning a Kubernetes cluster using PKS. For more information, see [Create an NSGroup](#) in the NSX-T documentation.
2. Define a network profile that references the NSGroup UUID that the BOSH CPI can use to bootstrap the master node or nodes. For example, the following network profile specifies an NSGroup for the BOSH CPI to use to dynamically update Kubernetes master node memberships:

```
{
  "name": "np-boot-nsgroups",
  "description": "Network Profile for Customer B",
  "parameters": {
    "master_vms_nsgroup_id": "9b8d535a-d3b6-4735-9fd0-56305c4a5293"
  }
}
```

## Pod Subnet Prefix

Each time a Kubernetes namespace is created, a subnet from the pods IP block is allocated. The size of the subnet carved from this block for such purposes is /24. For more information, see the [Pods IP Block](#) section of *Planning, Preparing, and Configuring NSX-T for PKS*.

You can define a Network Profile using the `pod_subnet_prefix` parameter to customize the size of the pod subnet reserved for namespaces. For example, the following network profile specifies /27 for the size of the pods IP block subnet:

```
{
  "name": "np-pod-prefix",
  "description": "Network Profile for Customizing Pod Subnet Size",
  "parameters": {
    "pod_subnet_prefix": 27
  }
}
```

## Custom Floating IP Pool

To deploy PKS to vSphere with NSX-T, you must define a floating IP pool in NSX Manager. The IP addresses in this floating IP pool are assigned to load balancers automatically provisioned by NSX-T when you deploy a Kubernetes cluster using PKS. For more information, see the [Plan Network CIDRs](#) section of *Planning, Preparing, and Configuring NSX-T for PKS*.

You can define a network profile that specifies a custom floating IP pool to use instead of the default pool specified in the PKS tile.

To define a custom floating IP pool, follow the steps below:

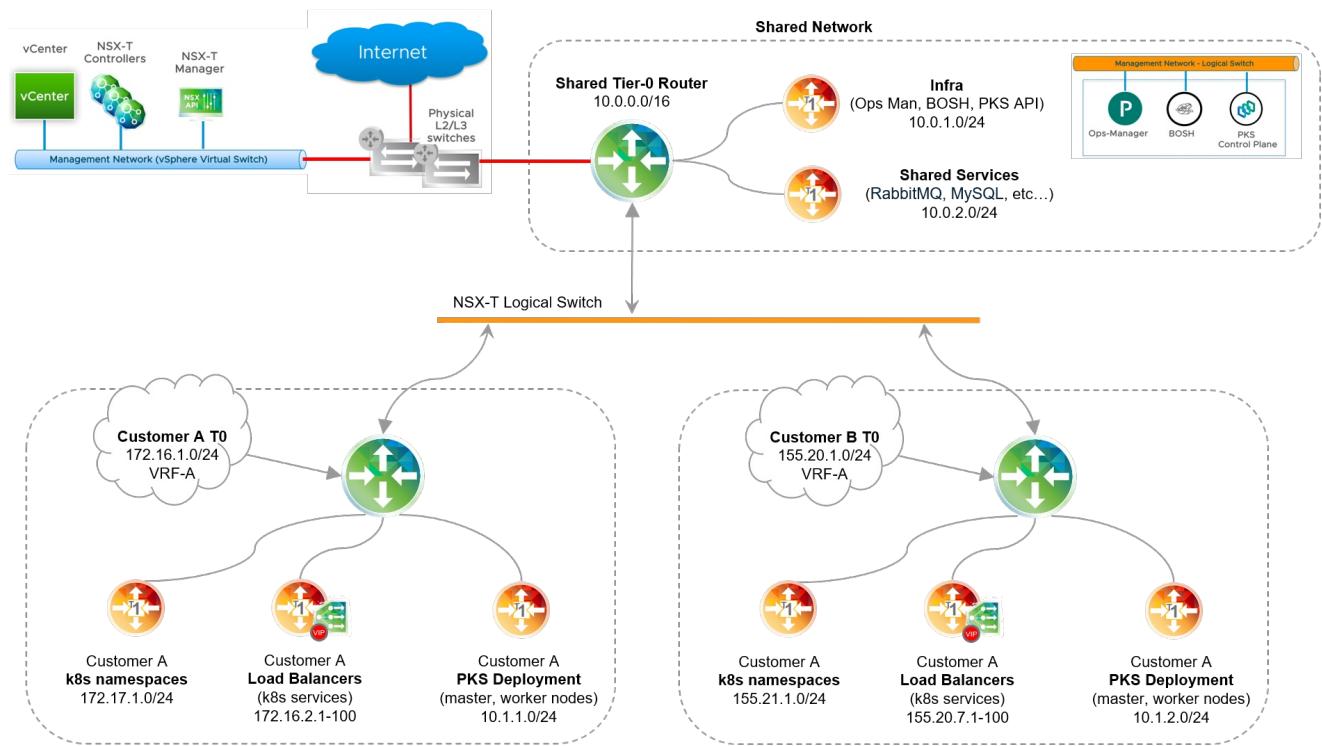
1. Create a floating IP pool using NSX Manager prior to provisioning a Kubernetes cluster using PKS. For more information, see [Create IP Pool](#) in the NSX-T documentation.
2. Define a network profile that references the floating IP pool UUID that you defined. For example:

```
{
  "name": "np-custom-fip",
  "description": "Network Profile for Custom Floating IP Pool",
  "parameters": {
    "fip_pool_ids": [
      "e50e8f6e-1a7a-45dc-ad49-3a607baa7fa0",
      "ebe78a74-a5d5-4dde-ba76-9cf4067eee55"
    ]
  }
}
```

The example above defines two floating IP pools. With this configuration, if the first pool of IP addresses, `e50e8f6e-1a7a-45dc-ad49-3a607baa7fa0`, is exhausted, the system will use the IP addresses in the next IP pool that is listed, `ebe78a74-a5d5-4dde-ba76-9cf4067eee55`.

## Edge Router Selection

Using PKS on vSphere with NSX-T, you can deploy Kubernetes clusters on dedicated Tier-0 routers, creating a multi-tenant environment for each Kubernetes cluster. As shown in the diagram below, with this configuration a shared Tier-0 router hosts the PKS control plane and connects to each customer Tier-0 router using BGP. To support multi-tenancy, configure firewall rules and security settings in NSX Manager.



To deploy Kubernetes clusters on tenancy-based Tier-0 router(s), follow the steps below:

1. For each Kubernetes tenant, create a dedicated Tier-0 router, and configure static routes, BGP, NAT and Edge Firewall security rules as required by each tenant. For instructions, see [Configuring Multiple Tier-0 Routers for Tenant Isolation](#).
2. Define a network profile per tenant that references the Tier-0 router UUID provisioned for that tenant. For example, the following network profiles define two tenant Tier-0 routers with a NATed topology.

```
np_customer_A-NAT.json
{
  "description": "network profile for Customer A",
  "name": "network-profile-Customer-A",
  "parameters": {
    "lb_size": "medium",
    "t0_router_id": "82e766f7-67f1-45b2-8023-30e2725600ba",
    "fip_pool_ids": ["8ec655f-009a-79b7-ac22-40d37598c0ff"],
    "pod_ip_block_ids": ["fce766f7-aaf1-49b2-d023-90e272e600ba"]
  }
}
```

```
np_customer_B-NAT.json
{
  "description": "network profile for Customer B",
  "name": "network-profile-Customer-B",
  "parameters": {
    "lb_size": "small",
    "t0_router_id": "a4e766cc-87ff-15bd-9052-a0e2425612b7",
    "fip_pool_ids": ["4ec625f-b09b-29b4-dc24-10d37598c0d1"],
    "pod_ip_block_ids": ["91e7a3a1-c5f1-4912-d023-90e272260090"]
  }
}
```

The following network profiles define two customer Tier-0 routers for a no-NAT topology:

```
np_customer_A.json
{
  "description": "network profile for Customer A",
  "name": "network-profile-Customer-A",
  "parameters": {
    "lb_size": "medium",
    "t0_router_id": "82e766f7-67f1-45b2-8023-30e2725600ba",
    "fip_pool_ids": [
      "8ec655f-009a-79b7-ac22-40d37598c0ff",
      "7ec625f-b09b-29b4-dc24-10d37598c0e0"
    ],
    "pod_routable": "true",
    "pod_ip_block_ids": [
      "fce766f7-aaf1-49b2-d023-90e272e600ba",
      "6faf46fd-ccce-4332-92d2-d918adccccce0"
    ]
  }
}
```

```
np_customer_B.json
{
  "description": "network profile for Customer B",
  "name": "network-profile-Customer-B",
  "parameters": {
    "lb_size": "small",
    "t0_router_id": "a4e766cc-87ff-15bd-9052-a0e2425612b7",
    "fip_pool_ids": [
      "4ec625f-b09b-29b4-dc24-10d37598c0d1",
      "6ec625f-b09b-29b4-dc24-10d37598dDd1"
    ],
    "pod_routable": "true",
    "pod_ip_block_ids": [
      "91e7a3a1-c5f1-4912-d023-90e272260090",
      "6faf46fd-ccce-4332-92d2-d918adccccce0"
    ]
  }
}
```

**Note:** The `pod_routable` parameter controls the routing behavior of a tenant Tier-0 router. If the parameter is set to `true`, the custom Pods IP Block subnet is routable and NAT is not used. If `pod_routable` is not present or is set to `false`, the custom Pods IP Block is not routable and the tenant Tier-0 is deployed in NAT mode.

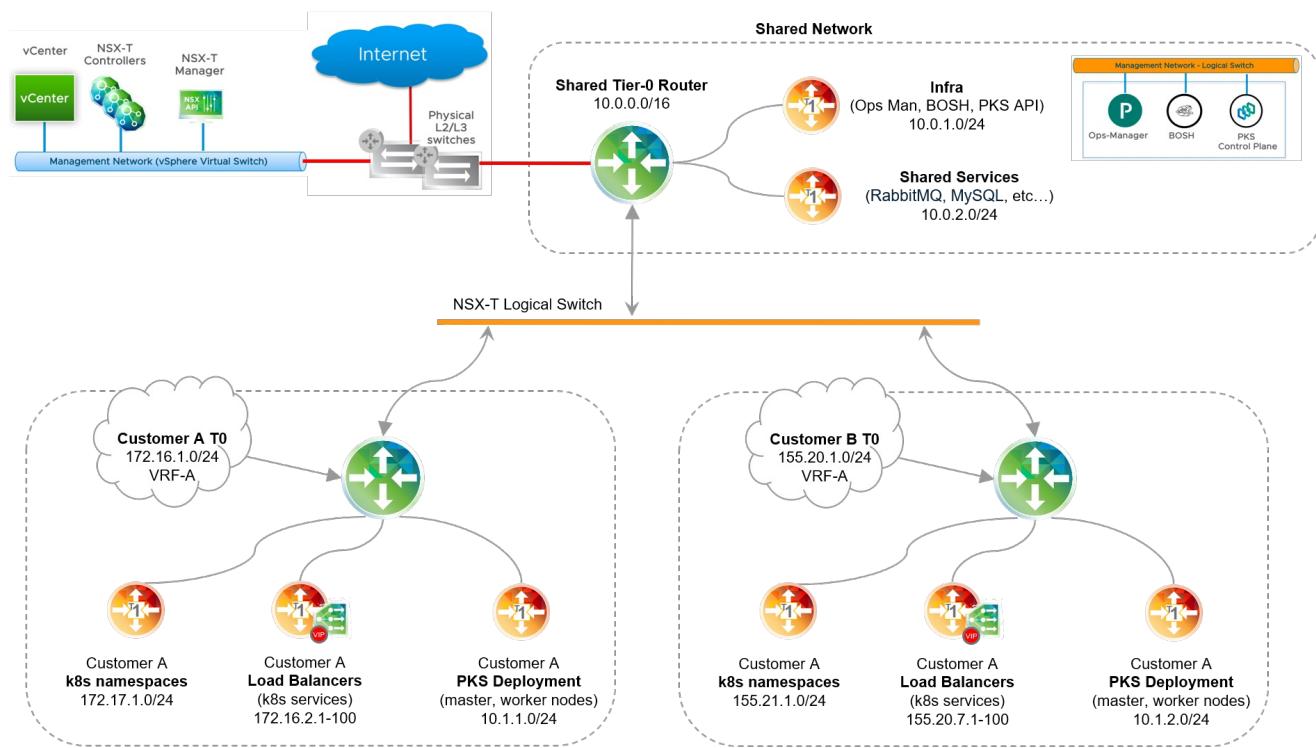
## Configuring Multiple Tier-0 Routers for Tenant Isolation

Page last updated:

This topic describes how to create multiple NSX-T Tier-0 (T0) logical routers for use with PKS multi-tenant environments.

### About Multi-T0 Router for Tenant Isolation

PKS multi-T0 lets you provision, manage, and secure Kubernetes cluster deployments on isolated tenant networks. As shown in the diagram below, instead of having a single T0 router, there are multiple T0 routers. The Shared Tier-0 router handles traffic between the PKS management network and the vSphere standard network where vCenter and NSX Manager are deployed. There are two Tenant Tier-0 routers that connect to the Shared Tier-0 over an NSX-T logical switch using a VLAN or Overlay transport zone. Using each dedicated T0, Kubernetes clusters are deployed in complete isolation on each tenant network.



### Prerequisites

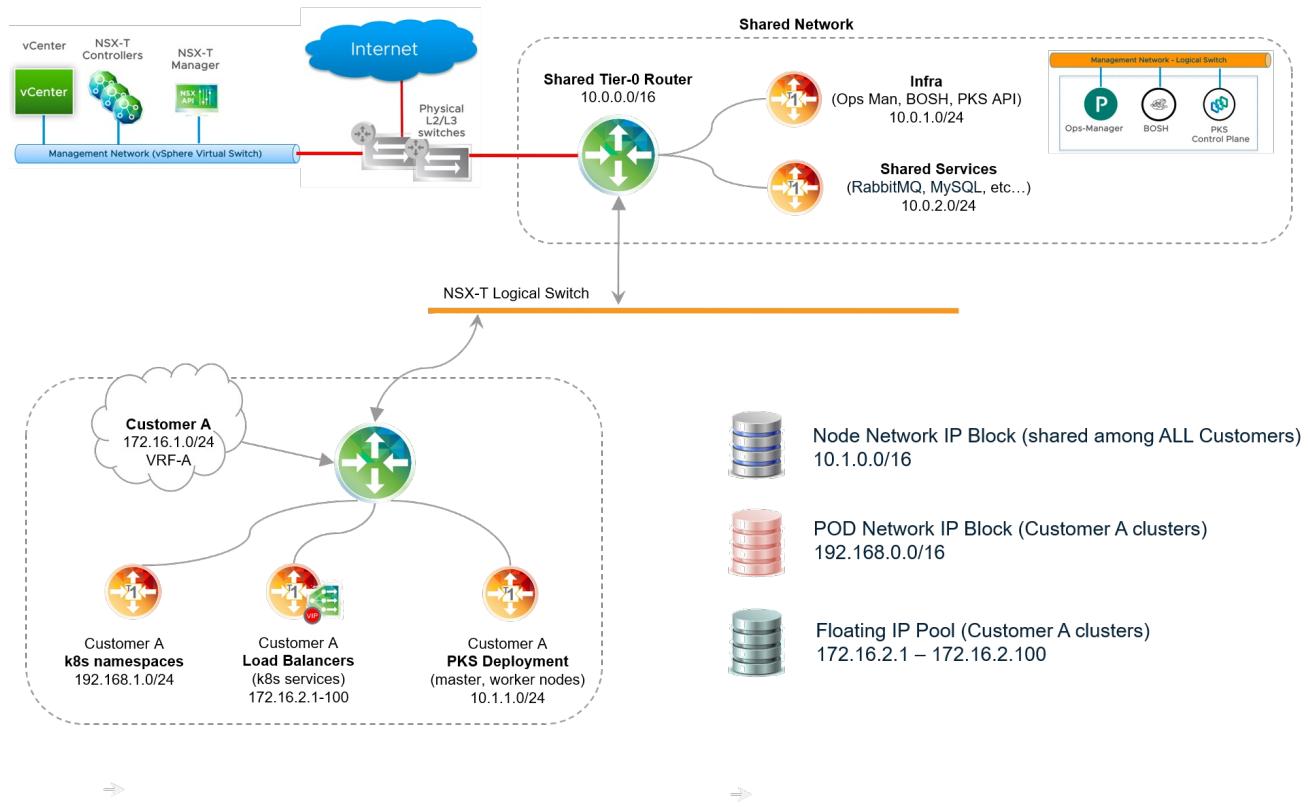
To implement Multi-T0, verify the following prerequisites:

- Supported version of vSphere IaaS is installed. See [PKS with NSX-T requirements](#).
- VMware NSX-T Data Center 2.3, Build 10085361 (18 SEP 2018), is installed.
- NSX-T v2.3.0.2 hot-patch is applied. For more information, see [ESX hosts lose network connectivity rendering the host inaccessible from network \(60293\)](#) in the [VMware Knowledge Base](#).
- PKS v1.2.4 is installed. For more information, see [Installing PKS on vSphere with NSX-T](#).
- If you are using NAT mode for the Shared Tier-0 router, review [Considerations for NAT Topology on Shared Tier-0](#) and [Considerations for NAT Topology on Tenant Tier-0](#) before proceeding.

### Base Configuration

#### Step 1: Plan and Provision Additional NSX Edge Nodes for Each Multi-T0 Router

Multi-T0 requires a minimum of four NSX Edge Nodes: Two nodes per T0 operating in active-standby mode. Use the T0 attached to the PKS management plane as the Shared Tier-0 router that connects all T0 routers. In addition, deploy an additional T0 router for each tenant you want to isolate.



Each Tenant Tier-0 router requires a minimum of two NSX Edge Nodes. The formula for determining the minimum number of nodes for all tenants is as follows:

$$2 + (\text{TENANTS} \times 2)$$

Where **TENANTS** is the number of tenants you want to isolate.

For example, if you want to isolate three tenants, use the following calculation:

$$2 + (3 \times 2) = 8 \text{ NSX Edge Nodes}$$

To isolate ten tenants, use the following calculation:

$$2 + (10 \times 2) = 22 \text{ NSX Edge Nodes}$$

Using the NSX Manager interface, deploy at least the minimum number of Edge Nodes you need for each Tenant Tier-0 and join these Edge Nodes to an Edge Cluster. For more information, see [Deploying NSX-T for PKS](#).

**Note:** An Edge Cluster can have a maximum of 10 Edge Nodes. If the provisioning requires more Edge Nodes than what a single Edge Cluster can support, multiple Edge Clusters must be deployed.

## Step 2: Configure Inter-T0 Logical Switch

All NSX-T Edge Nodes must be connected by a dedicated network provisioned on the physical infrastructure. This network is used to transport traffic across the T0 routers. Plan to allocate a network of sufficient size to accommodate all Tier-0 router interfaces that need to be connected to such network. You must allocate each T0 router one or more IP addresses from that range.

For example, if you plan to deploy two Tenant Tier-0 routers, a subnet with prefix size /28 may be sufficient, such as 50.0.0.0/28.

Once you have physically connected the Edge Nodes, define a logical switch to connect the Shared Tier-0 router to the Tenant Tier-0 router or routers.

To define a logical switch based on an Overlay or VLAN transport zone, follow the steps below:

1. In NSX Manager, go to **Networking > Switching > Switches**.
2. Click **Add** and create a logical switch (LS).
3. Name the switch descriptively, such as `inter-t0-logical-switch`.
4. Connect the logical switch to the transport zone defined when deploying NSX-T. For more information, see [Deploying NSX-T for PKS](#).

## Step 3: Configure a New Uplink Interface on the Shared Tier-0 Router

The Shared Tier-0 router already has a uplink interface to the external (physical) network that was configured when it was created. For more information, see [Create T0 Logical Router](#).

To enable Multi-T0, you must configure a second uplink interface on the Shared Tier-0 router that connects to the inter-T0 network (`inter-t0-logical-switch`, for example). To do this, complete the following steps:

1. In NSX Manager, go to **Networking > Routers**.
2. Select the Shared Tier-0 router.
3. Select **Configuration > Router Ports** and click **Add**.
4. Configure the router port as follows:
  - a. For the logical switch, select the inter-T0 logical switch you created in the previous step (for example, `inter-t0-logical-switch`).
  - b. Provide an IP address from the allocated range. For example, `50.0.0.1/24`.

## Step 4: Provision Tier-0 Router for Each Tenant

Create a Tier-0 logical router for each tenant you want to isolate. For more information, see [Tier-0 Logical Router](#) in the NSX-T documentation.

For instructions, see [Create T0 Router](#). When creating each Tenant Tier-0 router, make sure you set the router to be active/passive, and be sure to name the logical switch descriptively, such as `t0-router-customer-A`.

## Step 5: Create Two Uplink Interfaces on Each Tenant Tier-0 Router

Similar to the Shared Tier-0 router, each Tenant Tier-0 router requires at a minimum two uplink interfaces.

- The first uplink interface provides an uplink connection from the Tenant Tier-0 router to the tenant's corporate network.
- The second uplink interface provides an uplink connection to the Inter-T0 logical switch that you configured. For example, `inter-t0-logical-switch`.

For instructions, see [Create T0 Router](#). When creating the uplink interface that provides an uplink connection to the Inter-T0 logical switch, be sure to give this uplink interface an IP address from the allocated pool of IP addresses.

## Step 6: Verify the Status of the Shared and Tenant Tier-0 Routers

When you have completed the configuration of the Shared and Tenant Tier-0 routers as described above, verify your progress up to this point. On the Shared Tier-0 router, you should have two uplink interfaces, one to the external network and the other to the inter-T0 logical switch. On the Tenant Tier-0 router, you should have two uplink interfaces, one to the inter-T0 logical switch and the other to the external network. Each uplink interface is connected to a transport node.

The images below provide an example checkpoint for verifying the uplink interfaces for the Shared and Tenant Tier-0 routers. In this example, the Shared Tier-0 has one uplink interface at `10.40.206.10/25` on the transport Edge Node `edge-TN1`, and the second uplink interface at `110.40.206.9/25` on the transport Edge Node `edge-TN2`.

<input type="checkbox"/>	Uplink-2	585e.....	Uplink	10.40.206.9/25	↔ uplink-LS1 ( <a href="#">8f0831de-01f1...</a> )	edge-TN2	
<input type="checkbox"/>	Uplink1	e1f5...e...	Uplink	10.40.206.10/25	↔ uplink-LS1 ( <a href="#">uplink1-port</a> )	edge-TN1	

Similarly, the Tenant Tier-0 has one uplink interface at [10.40.206.13/25](#) on the transport Edge Node [edge-TN3](#), and the second uplink interface at [10.40.206.14/25](#) on the transport Edge Node [edge-TN4](#).

<input type="checkbox"/> Logical Router ID	Type	IP Address/mask	Connected To	Transport Node	Relay Service	Statistics
<input type="checkbox"/> TO-2-u...	4238.....	Uplink	10.40.206.13/25	↔ uplink-LS1 ( <a href="#">311a54cb-48d...</a> )	edge-TN3	
<input type="checkbox"/> TO-2-u...	8f15...f...	Uplink	10.40.206.14/24	↔ uplink-LS1 ( <a href="#">974cbf11-0b3...</a> )	edge-TN4	

## Step 7: Configure Static Routes

For each T0 router, including the Shared Tier-0 and all Tenant Tier-0 routers, define a static route to the external network. For instructions, see [Configure a Static Route](#) in the NSX-T documentation.

For the Shared Tier-0 router, the default static route points to the external management components such as vCenter and NSX Manager and provides internet connectivity. As shown in the image below, the Shared Tier-0 defines a static route for vCenter and NSX Manager as [192.168.201.0/24](#), and the static route for internet connectivity as [0.0.0.0/0](#):

tier0-shared		
<a href="#">Overview</a> <a href="#">Configuration</a> <a href="#">Routing</a> <b>Routing</b> <a href="#">Services</a>		
Static Routes		
+ ADD		DELETE
<input type="checkbox"/> Network	ID	Next Hop
<input type="checkbox"/> 0.0.0.0/0	Oea...9e7c	90.0.0.1
<input type="checkbox"/> 192.168.201.0/24	d495...b030	90.0.0.1

For each Tenant Tier-0 router, the default static route should point to the tenant's corporate network. As shown in the image below, the Tenant Tier-0 defines a static route to the corporate network as [0.0.0.0/0](#):

tier0-customer-A		
<a href="#">Overview</a> <a href="#">Configuration</a> <a href="#">Routing</a> <b>Routing</b> <a href="#">Services</a>		
Static Routes		
+ ADD		DELETE
<input type="checkbox"/> Network	ID	Next Hop
<input type="checkbox"/> 0.0.0.0/0	4ace...9e9d	70.0.0.1

## Step 8: Considerations for NAT Topology on Shared Tier-0

The Multi-T0 configuration steps documented here apply to deployments where NAT mode is **not** used on the Shared Tier-0 router. For more information, see [NSX-T Deployment Topologies for PKS](#).

For deployments where NAT-mode is used on the Shared Tier-0 router, additional provisioning steps must be followed to preserve NAT functionality to external networks while bypassing NAT rules for traffic flowing from the Shared Tier-0 router to each Tenant Tier-0 router.

Existing PKS deployments where NAT mode is configured on the Shared Tier-0 router cannot be repurposed to support a Multi-T0 deployment following this documentation.

## Step 9: Considerations for NAT Topology on Tenant Tier-0

**Note:** This step only applies to NAT topologies on the Tenant Tier-0 router. For more information on NAT mode, see [NSX-T Deployment Topologies for PKS](#).

**Note:** NAT mode for Tenant Tier-0 routers is enabled by defining a non-routable custom Pods IP Block using a Network Profile. For more information, see [Defining Network Profiles](#).

In a Multi-T0 environment with NAT mode, traffic on the Tenant Tier-0 network going from Kubernetes cluster nodes to PKS management components residing on the Shared Tier-0 router must bypass NAT rules. This is required because PKS-managed components such as BOSH Director connect to Kubernetes nodes based on routable connectivity without NAT.

To avoid NAT rules being applied to this class of traffic, you need to create two high-priority NO\_SNAT rules on each Tenant Tier-0 router. These NO\_SNAT rules allow “selective” bypass of NAT for the relevant class of traffic, which in this case is connectivity from Kubernetes node networks to PKS management components such as the PKS API, Ops Manager, and BOSH Director, as well as to infrastructure components such as vCenter and NSX Manager.

For each Tenant Tier-0 router, define two NO\_SNAT rules to classify traffic. The source for both rules is the [Nodes IP Block](#) CIDR. The destination for one rule is the PKS Management network where PKS, Ops Manager, and BOSH Director are deployed. The destination for the other rule is the external network where NSX Manager and vCenter are deployed.

For example, the following image shows two NO\_SNAT rules created on a Tenant Tier-0 router. The first rule un-NATs traffic from Kubernetes nodes ([30.0.128.0/17](#)) to the PKS management network ([30.0.0.0/24](#)). The second rule un-NATs traffic from Kubernetes nodes ([30.0.128.0/17](#)) to the external network ([192.168.201.0/24](#)).

New NAT Rule ×

Priority	1024	▼
Action*	NO_SNAT	▼
Protocol	<input checked="" type="radio"/> Any Protocol <input type="radio"/> Specific Protocol	
Source IP*	30.0.128.0/17	
Destination IP	30.0.0.0/24	
Applied To	t0-t0-cluster-1-vlan-uplink-1-Internet-vlan-1 <span style="float: right;">x</span> <span style="float: right;">▼</span>	
Status	<input checked="" type="checkbox"/> Enabled	
Logging	<input type="checkbox"/> Disabled	
Firewall Bypass	<input checked="" type="checkbox"/> Enabled	
<span style="border: 1px solid #ccc; padding: 2px 10px; margin-right: 10px;">CANCEL</span> <span style="background-color: #0070C0; color: white; border: 1px solid #0070C0; padding: 2px 10px; border-radius: 5px; cursor: pointer; position: relative;"> <span style="position: absolute; left: -5px; top: -5px; width: 10px; height: 10px; background-color: inherit; border-radius: 50%;"></span> <span style="font-size: 1.5em; margin-right: 5px;">ADD</span> <span style="position: absolute; left: 50%; top: 50%; transform: translate(-50%, -50%);"> </span> </span>		

## New NAT Rule

Priority: 1024

Action\*: NO\_SNAT

Protocol: Any Protocol

Source IP\*: 30.0.128.0/17

Destination IP: 192.168.201.0/24

Applied To: t0-t0-cluster-1-vlan-uplink-1-internet-vlan-1

Status: Enabled

Logging: Disabled

Firewall Bypass: Enabled

**CANCEL** **ADD**



The end result is two NO\_SNAT rules on each Tenant Tier-0 router that bypass the NAT rules for the specified traffic.

tier0-customer-A										
Overview Configuration v Routing v Services v										
NAT   REFRESH										
Total Rule Statistics   Last Updated: 11/12/2018, 3:51:22 PM										
4 Active sessions 11177882 Packet count 14 GB Data										
<b>+ ADD</b> <b>EDIT</b> <b>DELETE</b>										
ID	Action	Match				Translated		Applied To		
		Protocol	Source IP	Source Ports	Destination IP	Destination Ports	IP	Ports		
▼ Priority: 1022										
3261	NO_SNAT	Any	30.0.128.0/17	Any	30.0.0.0/24	Any	Any	Any	inter-tier0	
3266	NO_SNAT	Any	30.0.128.0/17	Any	192.168.201.0/24	Any	Any	Any	inter-tier0	
▼ Priority: 1024										
3315	SNAT	Any	30.0.128.0/24	Any	Any	Any	71.0.0.11	Any		
3318	SNAT	Any	40.0.0.0/24	Any	Any	Any	71.0.0.13	Any		
3320	SNAT	Any	40.0.1.0/24	Any	Any	Any	71.0.0.14	Any		
3322	SNAT	Any	40.0.2.0/24	Any	Any	Any	71.0.0.15	Any		
3326	SNAT	Any	40.0.3.0/24	Any	Any	Any	71.0.0.16	Any		

## Step 10: Configure BGP on Each Tenant Tier-0 Router

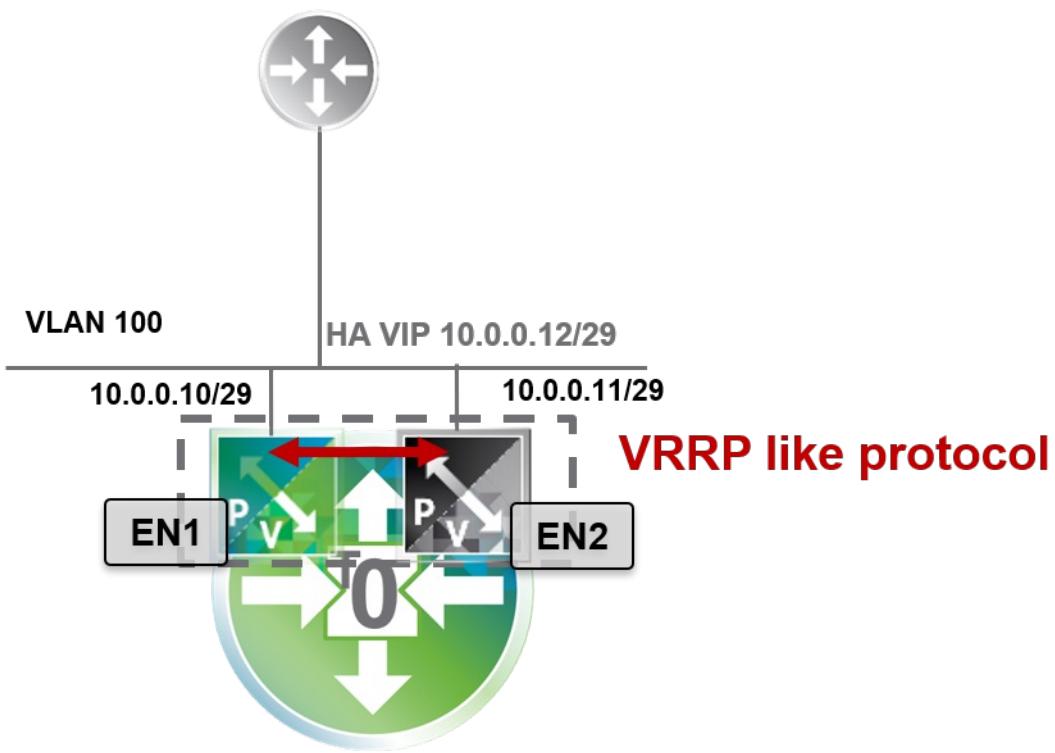
The Border Gateway Protocol (BGP) is used for route redistribution and filtering across all Tier-0 routers. BGP allows the Shared Tier-0 router to dynamically discover the location of Kubernetes clusters (Node networks) deployed on each Tenant Tier-0 router.

In a Multi-T0 deployment, all Tier-0 routers are deployed in Active/Standby mode. As such, special consideration must be given to the network design to preserve reliability and fault tolerance of the Shared and Tenant Tier-0 routers.

Failover of a logical router is triggered when the router is losing all of its BGP sessions. If multiple BGP sessions are established across different uplink interfaces of a Tier-0 router, failover will only occur if **all** such sessions are lost. Thus, to ensure high availability on the Shared and Tenant Tier-0 routers, BGP can only be configured on uplink interfaces facing the Inter-Tier-0 network. This configuration is shown in the diagram below.

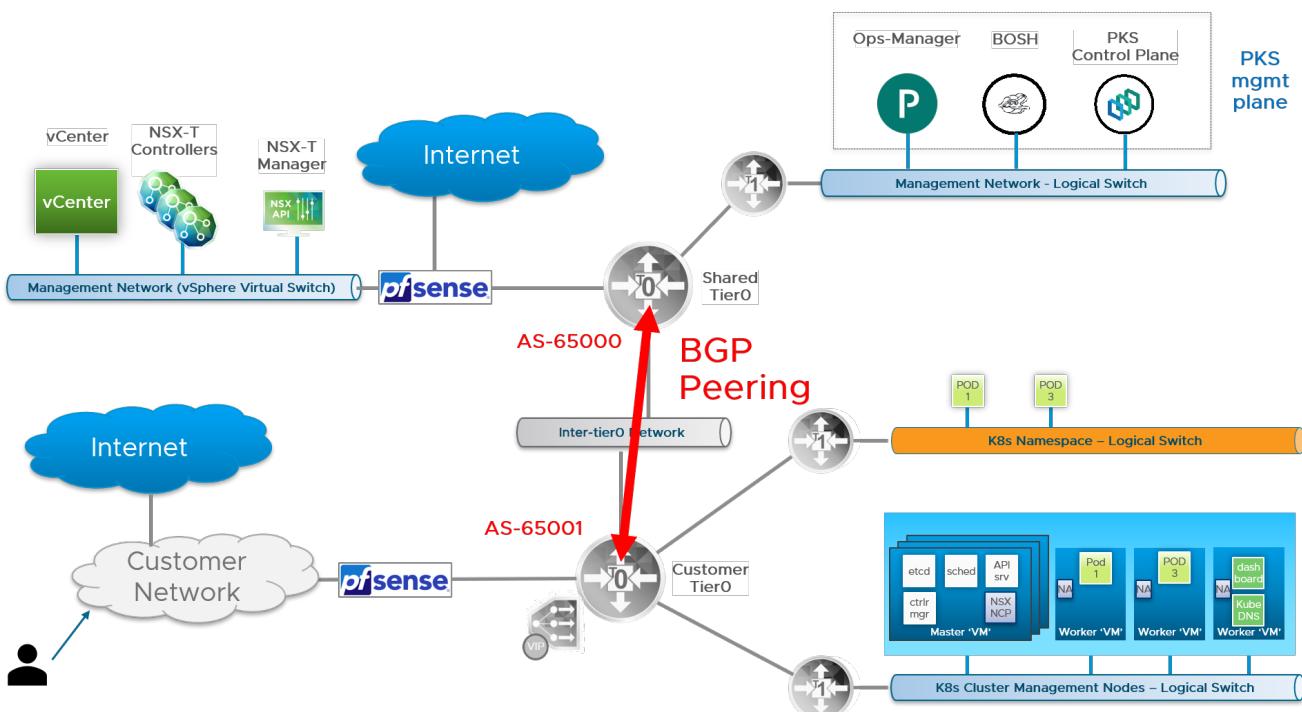
**Note:** In a Multi-T0 deployment, BGP cannot be configured on external uplink interfaces. Uplink external connectivity must use VIP-HA with NSX-T to provide high availability for external interfaces. For more information, see [Configure Edge Nodes for HA](#).

## Physical World



You must configure BGP routing on each Tier-0 router. The steps that follow are for each Tenant Tier-0 router. The instructions for the Shared Tier-0 are provided in subsequent steps. As a prerequisite, assign a unique Autonomous System Number to each Tier-0 router. Each AS number you assign must be private within the range [64512-65534](#). For more information, see [Configure BGP on a Tier-0 Logical Router](#) in the NSX-T documentation.

**Note:** To configure BGP for the Tenant Tier-0, you will need to use the Shared Tier-0 AS number. As such, identify the AS numbers you will use for the Tenant and Shared Tier-0 routers before proceeding.



### Configure BGP AS Number

Once you have chosen the AS number for the Tenant Tier-0 router, configure BGP with the chosen AS number as follows:

1. In NSX Manager, select **Networking > Routers**.
2. Select the Tenant Tier-0 router.
3. Select **Routing > BGP**, the click **ADD**.
4. Add the AS number to the BGP configuration in the `local AS` field.
5. Click on the `enabled` slider to activate BGP.
6. Lastly, disable the ECMP slider.

## Configure BGP Route Distribution

To configure BGP route distribution for each Tenant Tier-0 router, follow the steps below:

1. In NSX Manager, select the Tenant Tier-0 router.
2. Select **Routing > Route Redistribution**.

## Routing

Logical Router Port	Type
LinkedPort... (c152...e...)	Linked
external (fc43...d...)	Uplink
external (fc43...d...)	Uplink

3. Click **Add** and configure as follows:
  - a. **Name:** NSX Static Route Redistribution
  - b. **Sources:** Select **Static**, **NSX Static**, and **NSX Connected**

## Configure IP Prefix Lists

In this step you define an **IP Prefix List** for each Tenant Tier-0 router to advertise any Kubernetes node network of standard prefix size /24, as specified by the less-than-or-equal-to (le) and greater-than-or-equal-to (ge) modifiers in the configuration. The CIDR range to use for the definition of the list entry is represented by the Nodes IP Block network, for example `30.0.0.0/16`.

For more information about IP Prefix Lists, see [Create an IP Prefix List](#) in the NSX-T documentation.

To configure an IP Prefix List for each Tenant Tier-0 router, follow the steps below:

1. In NSX Manager, select the Tenant Tier-0 router.
2. Select **Routing > IP Prefix Lists**.
3. Click **Add** and configure as follows:
  - a. **Name:** Enter a descriptive name.
  - b. Click **Add** and create a **Permit** rule that allows redistribution of the exact /24 network, carved from the **Nodes IP Block**.

- c. Click **Add** and create a **Deny** rule that denies everything else on the network `0.0.0.0/0`.

## New IP Prefix List



Name *	tenant-to-IP-prefix-list			
Prefixes				
<span>+ ADD</span> <span>DELETE</span> <span>UP</span> <span>DOWN</span>				
<input type="checkbox"/> Network *	Action *	ge	le	
<input type="checkbox"/> 30.0.0.0/16	Permit	24	24	
<input type="checkbox"/> 0.0.0.0/0	Deny			
<span>CANCEL</span> <span>ADD</span>				

### Configure BGP Peer

To configure BGP peering for each Tenant Tier-0 router, follow the steps below:

1. In NSX Manager, select the Tenant Tier-0 router.
2. Go to **Routing > BGP**.
3. Click **Add** and configure the BGP rule as follows:
  - a. **Neighbor Address:** Enter the IP address of the Shared Tier-0 router.
  - b. **Local Address:** Select the individual uplink interfaces facing the inter-tier0 logical switch.
  - c. **Address Families:** Click **Add** and configure as follows:
    - i. **Type:** IPV4\_UNICAST
    - ii. **State:** Enabled
    - iii. **Out Filter:** Select the IP Prefix List created above.
    - iv. Click **Add**.
  - d. Back at the **Routing > BGP** screen:
    - i. Enter the Shared Tier-0 AS number.
    - ii. After creating the BGP neighbor, select **Edit** and click **Enable BGP**.

## Step 11: Configure BGP on the Shared Tier-0 Router

The configuration of BGP on the Shared Tier-0 is similar to the BGP configuration each Tenant Tier-0, with the exception of the IP Prefix list that permits traffic to the PKS management network where PKS, BOSH, and Ops Manager are located.

As with each Tenant Tier-0 router, you will need to assign a unique private AS number within the private range `64512-65534` to the Shared Tier-0 router. Once the AS number is assigned, use NSX Manager to configure the following BGP rules for the Shared Tier-0 router.

### Configure BGP AS Number

To configure BGP on the Shared Tier-0 with the AS number, complete the corresponding set of instructions in the tenant BGP section above.

### Configure BGP Route Distribution

To configure BGP route distribution for the Shared Tier-0 router, complete the corresponding set of instructions in the BGP tenant section above.

### Configure IP Prefix Lists

To configure IP prefix lists for each Tenant Tier-0 router, follow the steps below:

1. In NSX Manager, select the Tenant Tier-0 router.
2. Select **Routing > IP Prefix Lists**.
3. Click **Add** and configure as follows:
  - a. **Name:** Enter a descriptive name.
  - b. Click **Add** and create a **Permit** rule for the infrastructure components vCenter and NSX Manager.
  - c. Click **Add** and create a **Permit** rule for the PKS management components (PKS, Ops Manager, and BOSH).
  - d. Click **Add** and create a **Deny** rule that denies everything else on the network `0.0.0.0/0`.

Edit IP Prefix List - shared-prefix-list ? X

Name \*

Prefixes

+ ADD DELETE UP DOWN

<input type="checkbox"/> Network*	Action *	ge	le
<input type="checkbox"/> 30.0.0.0/24	Permit		
<input type="checkbox"/> 192.168.201.0/24	Permit		
<input type="checkbox"/> 0.0.0.0/0	Deny		

CANCEL SAVE

### Configure BGP Peer

1. In NSX Manager, select the Tenant Tier-0 router.
2. Go to **Routing > BGP**.
3. Click **Add** and configure the BGP rule as follows:

- a. **Neighbor Address:** Enter the IP address of the Shared Tier-0 router.
- b. **Local Address:** Select **All Uplinks**.
- c. **Address Families:** Click **Add** and configure as follows:
  - i. **Type:** IPV4\_UNICAST
  - ii. **State:** Enabled
  - iii. **Out Filter:** Select the IP Prefix List that includes the network where vCenter and NSX Manager are deployed, as well as the network where the PKS management plane is deployed.
  - iv. Click **Add**.
- d. Back at the **Routing > BGP** screen:
  - i. Enter the Tenant Tier-0 AS number.
  - ii. After creating the BGP neighbor, select **Edit** and click **Enable BGP**.

 **Note:** You must repeat this step for each Tenant Tier-0 router you want to peer with the Shared Tier-0 router.

## Step 12: Test the Base Configuration

Perform the following validation checks for all Tier-0 routers. You should perform the validation checks on the Shared Tier-0 first followed by each Tenant Tier-0 router. For each Tier-0, the validation should alternate among checking for the BGP summary and the router Routing Table.

### Shared Tier-0 Validation

Verify that the Shared Tier-0 has an active peer connection to each Tenant Tier-0 router. To verify BGP Peering.

- In NSX Manager, select the Shared Tier-0 router and choose **Actions > Generate BGP Summary**.
- Validate that the Shared Tier-0 router has one active peer connection to each Tenant Tier-0 router.

Verify that the Shared Tier-0 routing table includes all BGP routes to each Shared Tier-0.

- In NSX Manager, select **Networking > Routers > Routing**.
- Select the Shared Tier-0 router and choose **Actions > Download Routing Table**.
- Download the routing table for the Shared Tier-0 and verify the routes.

### Tenant Tier-0 Validation

Verify that the Shared Tier-0 has an active peer connection to each Tenant Tier-0 router. To verify BGP Peering.

- In NSX Manager, select the Tenant Tier-0 router and choose **Actions > Generate BGP Summary**.
- Validate that the Tenant Tier-0 router has one active peer connection to the Shared Tier-0 router.
- Repeat for all other Tenant Tier-0 routers.

Verify that the T0 routing table for each Tenant Tier-0 includes all BGP routes to reach vCenter, NSX Manager, and the PKS management network.

- In NSX Manager, select **Networking > Routers > Routing**.
- Select the T0 router and choose **Actions > Download Routing Table**.
- Download the routing table for each of the Tenant Tier-0 routers.

 **Note:** At this point, the Shared Tier-0 has no BGP routes because you have not deployed any Kubernetes clusters. The Shared Tier-0 will show BGP routes when you deploy Kubernetes clusters to the Tenant Tier-0 routers. Each Tenant Tier-0 router shows a BGP exported route that makes each Tenant Tier-0 router aware of the PKS management network and other external networks where NSX-T and vCenter are deployed.

## Security Configuration

Security configuration involves configuring NSX-T to secure traffic between tenants. The objective of these configurations is to isolate each tenant so that the traffic between the Tenant Tier-0s and the Shared Tier-0 is restricted to the legitimate traffic path.

## Step 1: Define IP Sets

In NSX-T an **IP Set** is a group of IP addresses that you can use as sources and destinations in firewall rules. For a Multi-T0 deployment you need to create several IP Sets as described below. For more information about creating IP Sets, see [Create an IP Set](#) in the NSX-T documentation.

The image below shows a summary of the three required IP Sets you will need to create for securing Multi-T0 deployments:

Groups		Groups	IP Sets	IP Pools	MAC Sets
		+ ADD	EDIT	DELETE	ACTIONS ▾
<input type="checkbox"/>	IP Set ↑				ID
<input type="checkbox"/>	inter-tier0-CIDR				9c95...54fe
<input type="checkbox"/>	NSX/vCenter				d5c5...ac2b
<input type="checkbox"/>	pks-admin-CIDR				4b88...b917

First, define an IP Set that includes the IP addresses for the NSX Manager and vCenter hosts. In the following IP Set example, `192.168.201.51` is the IP address for NSX and `192.168.201.20` is the IP address for vCenter.

NSX/vCenter

Overview Related ▾

> Summary | EDIT

Members | EDIT

192.168.201.51  
192.168.201.20

Next, define an IP Set that includes the network CIDR for PKS management components. In the following IP Set example, `30.0.0.0/24` is the CIDR block for the PKS Management network.

pks-admin-CIDR

Overview Related ▾

> Summary | EDIT

Members | EDIT

30.0.0.0/24

Lastly, define an IP Set for the Inter-T0 CIDR created during the base configuration.

inter-tier0-CIDR

**Overview**   **Related** ▾

> Summary | **EDIT**

▽ Members | **EDIT**

50.0.0.1/24

**Note:** These are the minimum IP Sets you need to create. You may want to define additional IP Sets for convenience.

## Step 2: Create Edge Firewall

NSX-T Data Center uses Edge Firewall sections and rules to specify traffic handling in and out of the network. A firewall section is a collection of firewall rules. For more information, see [About Firewall Rules](#) in the NSX-T documentation.

For each Tenant Tier-0 router, create an Edge Firewall and section as follows:

1. In NSX Manager, go to **Networking > Routers**.
2. Select the Tenant Tier-0 router and click **Services > Edge Firewall**.
3. Select the **Default LR Layer 3 Section**.
4. Click **Add Section > Add Section Above**.

#	ID	Sources	Destination	Services
	3990c366-d614-4173-83ff-43a03...	Stateful		

5. Configure the section as follows:
  - a. **Section Name:** Enter a unique name for the firewall section.
  - b. **State:** **Stateful**

## Add Section

Section Name \* Customer-A-Firewall

Description

State  Stateful  Stateless

**CANCEL** **ADD** 

### Step 3: Add Firewall Rules

The last step is to define several firewall rules for the Edge Firewall. The firewall rules allow only legitimate control plane traffic to traverse the inter-Tier-0 logical switch, and deny all other traffic.

The following image shows a summary of the five firewall rules you will create:

tier0-customer-A									
Overview Configuration v Routing v Services v									
Edge Firewall   REFRESH DISABLE FIREWALL									
+ ADD RULE v		ADD SECTION v		DELETE v		ACTIONS v		OBJECTS	
#	Name	ID	Direction	Sources	Destinations	Services	Action	Applied To	
1	InterTier0 PKS Firewall Rules	bd7edeb2-fb1b-4413-be27-1881b...	Stateful						
1	BGP	3159	IN_OUT	 inter-tier0...	 inter-ti...	Any	ALLOW	inter-tier0	
2	ClusterA Masters to NSX/vCenter	3157	OUT	 lb-pks-d3...	 NSX/v...	Any	ALLOW	inter-tier0	
3	k8s Nodes to BOSH	3158	OUT	 all-pks-no...	 BOSH	Any	ALLOW	inter-tier0	
4	PKS to k8s Nodes	3154	IN	 pks-admi...	 all-pks...	Any	ALLOW	inter-tier0	
5	Deny All	3153	IN_OUT	Any	Any	Any	DROP	inter-tier0	

 Note: All firewall rules are applied to the Inter-T0-Uplink interface.

Select the Edge Firewall **Section** you just created, then select **Add Rule**. Add the following five firewall rules:

#### BGP Firewall Rule

- **Name:** `BGP`
- **Direction:** in and out
- **Source:** IP Set defined for the Inter-T0 CIDR
- **Destination:** IP Set for Inter-T0 CIDR
- **Service:** Any
- **Action:** Allow
- Apply the rule to the Inter-T0-Uplink interface.
- Save the firewall rule.

## Clusters Masters Firewall Rule

The source for this firewall rule is a Namespace Group (NSGroup) you define in NSX Manager. The NSGroup is the Bootstrap Security Group specified in the Network Profile associated with this tenant. See [Bootstrap Security Group \(NSGroup\)](#).

Once you have defined the NSGroup, configure the firewall rule as follows.

- **Name:** `Clusters-Masters-to-NSX-and-VC`
- **Direction:** out
- **Source:** NSGroup for Kubernetes Master Nodes
- **Destination:** IP Set for Inter-T0 CIDR
- **Service:** Any
- **Action:** Allow
- Apply the rule to the Inter-T0-Uplink interface.
- Save the firewall rule.

## Node Network to Management Firewall Rule

This firewall rule allows Kubernetes node traffic to reach PKS management VMs and the standard network.

- **Name:** `Node-Network-to-Management`
- **Direction:** out
- **Source:** IP Set defined for the Nodes IP Block network
- **Destination:** IP Sets defined for vCenter, NSX Manager, and PKS management plane components
- **Service:** Any
- **Action:** Allow
- Apply the rule to the Inter-T0-Uplink interface.
- Save the firewall rule.

## PKS Firewall Rule

This firewall rule allows PKS management plane components to talk to Kubernetes nodes.

- **Name:** `PKS-to-Node-Network`
- **Direction:** ingress
- **Source:** IP Set defined for the PKS management network
- **Destination:** IP Set defined for the Nodes IP Block network
- **Service:** Any
- **Action:** Allow
- Apply the rule to the Inter-T0-Uplink interface.
- Save the firewall rule.

## Deny All Firewall Rule

- **Name:** Deny All . This setting drops all other traffic that does not meet the criteria of the first three rules.
- **Direction:** in and out
- **Source:** Any
- **Destination:** Any
- **Service:** Any
- **Action:** Drop
- Apply the rule to the Inter-T0-Uplink interface.
- Save the firewall rule.

## Google Cloud Platform (GCP)

This topic lists the steps to follow when installing Pivotal Container Service (PKS) on Google Cloud Platform (GCP).

 **Note:** The topics below provide the manual procedures for deploying Ops Manager on GCP, not the Terraform procedures. The manual procedures are the currently supported path for deploying Ops Manager on GCP for use with PKS.

See the following topics:

- [GCP Prerequisites and Resource Requirements](#)
- Deploying Ops Manager on GCP:
  - [Preparing GCP ↗](#)
  - [Deploying BOSH and Ops Manager to GCP ↗](#)
  - [Configuring BOSH Director on GCP ↗](#)
- [Creating Service Accounts in GCP for PKS](#)
- [Creating a GCP Load Balancer for the PKS API](#)
- [Installing PKS on GCP](#)

## Installing the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## GCP Prerequisites and Resource Requirements

Page last updated:

This topic describes the prerequisites and resource requirements for installing Pivotal Container Service (PKS) on Google Cloud Platform (GCP).

### Prerequisites

Before you install PKS, you must install one of the following:

- Pivotal Ops Manager v2.2.3 or later
- Pivotal Ops Manager v2.3.1 or later
- Pivotal Ops Manager v2.4.x

 **Note:** You use Ops Manager to install and configure PKS. Each version of Ops Manager supports multiple versions of PKS. To confirm that your Ops Manager version supports the version of PKS that you install, see [PKS Release Notes](#).

You must also create service accounts for Kubernetes master and worker nodes and create a load balancer to access the PKS API.

### Install and Configure Ops Manager

To install an Ops Manager version that is compatible with the PKS version you intend to use, follow the instructions in the corresponding version of the Ops Manager documentation.

 **Note:** The topics below provide the manual procedures for deploying Ops Manager on GCP, not the Terraform procedures. The manual procedures are the currently supported path for deploying Ops Manager on GCP for use with PKS.

Version	
Ops Manager v2.2	<ul style="list-style-type: none"><li>• <a href="#">Preparing to Deploy PCF on GCP</a></li><li>• <a href="#">Deploying BOSH and Ops Manager to GCP</a></li><li>• <a href="#">Configuring BOSH Director on GCP</a></li></ul>
Ops Manager v2.3	<ul style="list-style-type: none"><li>• <a href="#">Preparing to Deploy PCF on GCP</a></li><li>• <a href="#">Deploying BOSH and Ops Manager to GCP</a></li><li>• <a href="#">Configuring BOSH Director on GCP</a></li></ul>
Ops Manager v2.4	<ul style="list-style-type: none"><li>• <a href="#">Preparing to Deploy PCF on GCP</a></li><li>• <a href="#">Deploying BOSH and Ops Manager to GCP</a></li><li>• <a href="#">Configuring BOSH Director on GCP</a></li></ul>

### Create Service Accounts for Kubernetes

After you install and configure Ops Manager, you must create service accounts for Kubernetes master and worker node VMs in your PKS deployment. To create the service accounts, follow the procedures in [Creating Service Accounts in GCP for PKS](#).

### Create a Load Balancer for the PKS API

Before you install PKS, you must create an external TCP load balancer so that you can access the PKS API from outside the network. This load balancer allows you to run `pks` commands from your local workstation. You must create the load balancer before you install PKS, and then complete the load balancer configuration after you install PKS.

To create a load balancer in GCP, follow the procedures in [Creating a GCP Load Balancer for the PKS API](#).

## Resource Requirements

Installing Ops Manager and PKS requires the following virtual machines (VMs):

VM	CPU	RAM	Storage
Pivotal Container Service	2	8 GB	16 GB
Pivotal Ops Manager	1	8 GB	160 GB
BOSH Director	2	8 GB	16 GB

Each Kubernetes cluster provisioned through PKS deploys the VMs listed below. If you deploy more than one Kubernetes cluster, you must scale your allocated resources appropriately.

VM Name	Number	CPU Cores	RAM	Ephemeral Disk	Persistent Disk
master	1	2	4 GB	32 GB	5 GB
worker	1	2	4 GB	32 GB	50 GB

## Creating Service Accounts in GCP for PKS

Page last updated:

This topic describes the steps required to create service accounts for Pivotal Container Service (PKS) on Google Cloud Platform (GCP).

In order for Kubernetes to create load balancers and attach persistent disks to pods, you must create service accounts with sufficient permissions.

You need separate service accounts for Kubernetes cluster master and worker node VMs. Pivotal recommends configuring each service account with the least permissive privileges and unique credentials.

### Create the Master Node Service Account

1. From the GCP Console, select **IAM & admin > Service accounts**
2. Click **Create Service Account**.
3. Enter a name for the service account, and add the following roles:
  - o **Compute Engine**
    - **Compute Instance Admin (v1)**
    - **Compute Network Admin**
    - **Compute Security Admin**
    - **Compute Storage Admin**
    - **Compute Viewer**
  - o **Service Accounts**
    - **Service Account User**
4. Click **Create**.

### Create the Worker Node Service Account

1. From the GCP Console, select **IAM & admin > Service accounts**
2. Click **Create Service Account**.
3. Enter a name for the service account, and add the **Compute Engine > Compute Viewer** role.
4. Click **Create**.

After you create both service accounts for Kubernetes, follow the procedures in [Installing PKS on GCP](#).

## Creating a GCP Load Balancer for the PKS API

Page last updated:

This topic describes how to create a load balancer for the PKS API using Google Cloud Platform (GCP).

Before you install PKS, you must configure an external TCP load balancer to access the PKS API from outside the network. You can use any external TCP load balancer of your choice.

Refer to the procedures in this topic to create a load balancer using GCP. If you choose to use a different load balancer, use the configuration in this topic as a guide.

 **Note:** This procedure uses example commands which you should modify to represent the details of your PKS installation.

### Step 1: Create a Load Balancer

To create a load balancer using GCP, perform the following steps:

1. In a browser, navigate to the [GCP console](#).
2. Navigate to **Network Services > Load balancing** and click **CREATE LOAD BALANCER**.
3. Under **TCP Load Balancing**, click **Start configuration**.
4. Under **Internet facing or internal only**, select **From Internet to my VMs**.
5. Under **Multiple regions or single region**, select **Single region only**.
6. Click **Continue**.
7. Name your load balancer. Pivotal recommends naming your load balancer `pks-api`.
8. Select **Backend configuration**.
  - Under **Region**, select the region where you deployed Ops Manager.
  - Under **Backends**, select **Select existing instances**. This will be automatically configured when updating the Resource Config section of the PKS tile.
  - (Optional) Under **Backup pool**, select a backup pool. If you select a backup pool, set a **Failover ratio**.
  - (Optional) Under **Health check**, select whether or not you want to create a health check.
  - Under **Session affinity**, select a session affinity configuration.
  - (Optional) Select **Advanced configurations** to configure the **Connection draining timeout**.
9. Select **Frontend configuration**.
  - (Optional) Name your frontend.
  - (Optional) Click **Add a description** and provide a description.
  - Select **Create IP address** to reserve an IP address for the PKS API endpoint.
    1. Enter a name for your reserved IP address. For example, `pks-api-ip`. GCP assigns a static IP address that appears next to the name.
    2. (Optional) Enter a description.
    3. Click **Reserve**.
- Under **Port**, enter `9021`. Your external load balancer forwards traffic to the PKS control plane VM using the UAA endpoint on port 8443 and the PKS API endpoint on port 9021.
- Click **Done**.
- Click **New Frontend IP and Port**.
  1. Enter a name for the frontend IP-port mapping, such as `pks-api-uaa`.
  2. (Optional) Add a description.
  3. Under **IP** select the same static IP address that GCP assigned in the previous step.
  4. Under **Port**, enter `8443`.
  5. Click **Done**.
10. Click **Review and finalize** to review your load balancer configuration.

11. Click **Create**.

## Step 2: Create a Firewall Rule

To create a firewall rule that allows traffic between the load balancer and the PKS API VM, do the following:

1. From the GCP console, navigate to **VPC Network > Firewall rules** and click **CREATE FIREWALL RULE**.
2. Configure the following:
  - Name your firewall rule.
  - (Optional) Provide a description for your firewall rule.
  - Under **Network**, select the VPC network you created in the [Create a GCP Network with Subnets](#) step of *Preparing GCP*.
  - Under **Priority**, enter a priority number between `0` and `65535`.
  - Under **Direction of traffic**, select **Ingress**.
  - Under **Action on match**, select **Allow**.
  - Under **Targets**, select **Specified target tags**.
  - Under **Target tags**, enter `pks-api`.
  - Under **Source filter**, select **IP ranges**.
  - Under **Source IP ranges**, enter `0.0.0.0/0`.
  - Under **Protocols and ports**, select **Specified protocols and ports** and enter `tcp:8443,9021`.
3. Click **Create**.

## Step 3: Install PKS

Follow the instructions in [Installing PKS on GCP](#) to deploy PKS. After you finish installing PKS, continue to the following sections to complete the PKS API load balancer configuration.

## Step 4: Create a Network Tag for the Firewall Rule

To apply the firewall rule to the VM that hosts the PKS API, the VM must have the `pks-api` tag in GCP. Do the following:

1. From the GCP console, navigate to **Compute Engine > VM instances**.
2. Locate the your PKS control plane VM.
3. Click the name of the VM to open the **VM instance details** menu.
4. Click **Edit**.
5. Verify that the **Network tags** field contains the `pks-api` tag. Add the tag if it does not appear in the field.
6. Scroll to the bottom of the screen and click **Save**.

## Step 5: Create a Wildcard DNS Entry

To create a wildcard DNS entry in GCP for your PKS API domain, do the following:

1. From the GCP console, navigate to **Network Services > Cloud DNS**.
2. If you do not already have a DNS zone, click **Create zone**.
  - Provide a **Zone name** and a **DNS name**.
  - Specify whether the **DNSSEC** state of the zone is **Off**, **On**, or **Transfer**.
  - (Optional) Enter a **Description**.
  - Click **Create**.
3. Click **Add record set**.

4. Under **DNS Name**, enter a subdomain for the load balancer. For example, to use `pks-api.example.com` as your PKS API hostname, enter `pks-api` in this field.
5. Under **Resource Record Type**, select **A** to create a DNS address record.
6. Enter a value for **TTL** and select a **TTL Unit**.
7. Enter the static IP address that GCP assigned when you created the load balancer in [Create a Load Balancer](#).
8. Click **Create**.

## Next Steps

After you complete this procedure, follow the instructions in [Installing PKS on GCP](#).

## Installing PKS on GCP

Page last updated:

This topic describes how to install and configure Pivotal Container Service (PKS) on Google Cloud Platform (GCP).

### Prerequisites

Before performing the procedures in this topic, you must have deployed and configured Ops Manager. For more information, see [GCP Prerequisites and Resource Requirements](#).

If you use an instance of Ops Manager that you configured previously to install other runtimes, confirm the following settings before you install PKS:

1. Navigate to Ops Manager.
2. Open the **Director Config** pane.
3. Select the **Enable Post Deploy Scripts** checkbox.
4. Clear the **Disable BOSH DNS server for troubleshooting purposes** checkbox.
5. Click the **Installation Dashboard** link to return to the Installation Dashboard.
6. Click **Review Pending Changes**. Select all products you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).

 **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

7. Click **Apply Changes**.

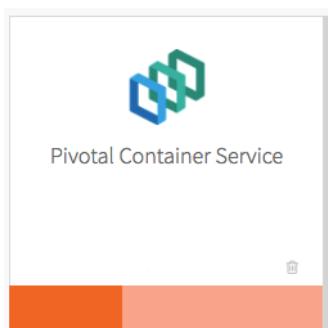
### Step 1: Install PKS

To install PKS, do the following:

1. Download the product file from [Pivotal Network](#).
2. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
3. Click **Import a Product** to upload the product file.
4. Under **Pivotal Container Service** in the left column, click the plus sign to add this product to your staging area.

### Step 2: Configure PKS

Click the orange **Pivotal Container Service** tile to start the configuration process.



**⚠️ WARNING:** When you configure the PKS tile, do not use spaces in any field entries. This includes spaces between characters as well as leading and trailing spaces. If you use a space in any field entry, the deployment of PKS fails.

## Assign AZs and Networks

Perform the following steps:

1. Click **Assign AZs and Networks**.
2. Select the availability zone (AZ) where you want to deploy the PKS API VM as a singleton job.

**Note:** You must select an additional AZ for balancing other jobs before clicking **Save**, but this selection has no effect in the current version of PKS.

The screenshot shows a configuration dialog for placing singleton jobs. It includes sections for selecting availability zones (AZs) for singleton jobs and balancing other jobs, as well as dropdown menus for Network and Service Network, and a Save button.

Place singleton jobs in

- us-west-2a
- us-west-2b
- us-west-2c

Balance other jobs in

- us-west-2a
- us-west-2b
- us-west-2c

Network

Service Network

Save

3. Under **Network**, select the infrastructure subnet you created for the PKS API VM.
4. Under **Service Network**, select the services subnet you created for Kubernetes cluster VMs.
5. Click **Save**.

## PKS API

Perform the following steps:

1. Click **PKS API**.
2. Navigate to your DNS provider and create an entry that points a fully qualified domain name (FQDN) within your system domain to the public IP address of the load balancer for the PKS API. For example, `api.pks.example.com`.

To retrieve the public IP address of the PKS API load balancer, log in to your IaaS console. If you used Terraform, you can also find the IP address in the `terraform.tfstate` file.

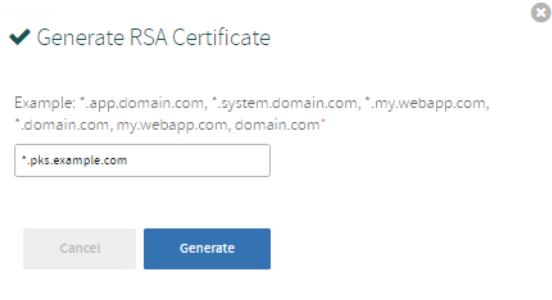
3. Under **Certificate to secure the PKS API**, provide your own certificate and private key pair.

The certificate that you supply should cover the domain that routes to the PKS API VM with TLS termination on the ingress.

If you do not have a certificate and private key pair, PKS can generate one for you by performing the following steps.

**Note:** If you configured Ops Manager Front End without a certificate, you can use this new certificate to complete Ops Manager configuration. To configure your Ops Manager Front End certificate, see [Configure Front End](#).

- Select the **Generate RSA Certificate** link.
- Enter the domain for your API hostname. This can be a standard FQDN or a wildcard domain.
- Click **Generate**.



- Under **API Hostname (FQDN)**, enter the FQDN that you have registered to point to the PKS API load balancer, such as `api.pks.example.com`.
- Under **Worker VM Max in Flight**, enter the maximum number of non-canary worker instances to create or resize in parallel within an availability zone.

This field sets the `max_in_flight` variable, which limits how many instances of a component can start simultaneously when a cluster is created or resized. The variable defaults to `1`, which means that only one component starts at a time.

- Click **Save**.

## Plans

To activate a plan, perform the following steps:

- Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.

**Note:** A plan defines a set of resource types used for deploying clusters. You can configure up to three plans. You must configure **Plan 1**.

- Select **Active** to activate the plan and make it available to developers deploying clusters.

**Plan\***

Active

**Name \***

**Description \***

Example: This plan will configure a lightweight kubernetes cluster. Not recommended for production workloads.

The plan description for the service instance

**Master/ETCD Node Instances ( min: 1, max: 3 ) \***

**Master/ETCD VM Type\***

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

**Master Persistent Disk Type\***

10 GB

**Master/ETCD Availability Zones \***

us-central1-f  
 us-central1-a  
 us-central1-c

3. Under **Name**, provide a unique name for the plan.
4. Under **Description**, edit the description as needed. The plan description appears in the Services Marketplace, which developers can access by using PKS CLI.
5. Under **Master/ETCD Node Instances**, select the default number of Kubernetes master/etc nodes to provision for each cluster. You can enter either **1** or **3**.

**Note:** If you deploy a cluster with multiple master/etc node VMs, confirm that you have sufficient hardware to handle the increased load on disk write and network traffic. For more information, see [Hardware recommendations](#) in the etcd documentation.

In addition to meeting the hardware requirements for a multi-master cluster, we recommend configuring monitoring for etcd to monitor disk latency, network latency, and other indicators for the health of the cluster. For more information, see [Monitoring Master/etc Node VMs](#).

- ⚠ WARNING:** To change the number of master/etc nodes for a plan, you must ensure that no existing clusters use the plan. PKS does not support changing the number of master/etc nodes for plans with existing clusters.
6. Under **Master/ETCD VM Type**, select the type of VM to use for Kubernetes master/etc nodes. For more information, see the [Master Node VM Size](#) section of *VM Sizing for PKS Clusters*.
  7. Under **Master Persistent Disk Type**, select the size of the persistent disk for the Kubernetes master node VM.
  8. Under **Master/ETCD Availability Zones**, select one or more AZs for the Kubernetes clusters deployed by PKS. If you select more than one AZ, PKS deploys the master VM in the first AZ and the worker VMs across the remaining AZs.
  9. Under **Maximum number of workers on a cluster**, set the maximum number of Kubernetes worker node VMs that PKS can deploy for each cluster.

**Note:** Clusters with more than 200 workers have not been validated.

The screenshot shows a configuration interface for a Kubernetes cluster. It includes the following fields:

- Maximum number of workers on a cluster (min: 1)\***: A text input field containing "50".
- Worker Node Instances (min: 1, max: 50)\***: A text input field containing "1".
- Worker VM Type\***: A dropdown menu showing "medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)".
- Worker Persistent Disk Type\***: A dropdown menu showing "50 GB".
- Worker Availability Zones\***: A list of checkboxes for availability zones:
  - us-central1-f
  - us-central1-a
  - us-central1-c
- Errand VM Type\***: A dropdown menu showing "micro (cpu: 1, ram: 1 GB, disk: 8 GB)".

- Under **Worker Node Instances**, select the default number of Kubernetes worker nodes to provision for each cluster.

If the user creating a cluster with the PKS Command Line Interface (CLI) does not specify a number of worker nodes, the cluster is deployed with the default number set in this field. This value cannot be greater than the maximum worker node value you set in the previous field. For more information about creating clusters, see [Creating Clusters](#).

For high availability, create clusters with a minimum of three worker nodes, or two per AZ if you intend to use PersistentVolumes (PVs). For example, if you deploy across three AZs, you should have six worker nodes. For more information about PVs, see [PersistentVolumes](#) in *Maintaining Workload Uptime*. Provisioning a minimum of three worker nodes, or two nodes per AZ is also recommended for stateless workloads.

If you later reconfigure the plan to adjust the default number of worker nodes, the existing clusters that have been created from that plan are not automatically upgraded with the new default number of worker nodes.

- Under **Worker VM Type**, select the type of VM to use for Kubernetes worker node VMs. For more information, see the [Worker Node VM Number and Size](#) section of *VM Sizing for PKS Clusters*.

**Note:** If you install PKS in an NSX-T environment, we recommend that you select a **Worker VM Type** with a minimum disk size of 16 GB. The disk space provided by the default **medium** Worker VM Type is insufficient for PKS with NSX-T.

- Under **Worker Persistent Disk Type**, select the size of the persistent disk for the Kubernetes worker node VMs.
- Under **Worker Availability Zones**, select one or more AZs for the Kubernetes worker nodes. PKS deploys worker nodes equally across the AZs you select.
- Under **Errand VM Type**, select the size of the VM that contains the errand. The smallest instance possible is sufficient, as the only errand running on this VM is the one that applies the **Default Cluster App** YAML configuration.
- (Optional) Under **(Optional) Add-ons - Use with caution**, enter additional YAML configuration to add custom workloads to each cluster in this plan. You can specify multiple files using **---** as a separator. For more information, see [Adding Custom Workloads](#).

(Optional) Add-ons - Use with caution

Enable Privileged Containers - Use with caution

Disable DenyEscalatingExec

16. (Optional) To allow users to create pods with privileged containers, select the **Enable Privileged Containers - Use with caution** option. For more information, see [Pods](#) in the Kubernetes documentation.
17. (Optional) To disable the admission controller, select the **Disable DenyEscalatingExec** checkbox. If you select this option, clusters in this plan can create security vulnerabilities that may impact other tiles. Use this feature with caution.

18. Click **Save**.

To deactivate a plan, perform the following steps:

1. Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.
2. Select **Plan Inactive**.
3. Click **Save**.

## Kubernetes Cloud Provider

To configure your Kubernetes cloud provider settings, follow the procedures below:

1. Click **Kubernetes Cloud Provider**.
2. Under **Choose your IaaS**, select **GCP**.
3. Ensure the values in the following procedure match those in the **Google Config** section of the **Ops Manager** tile as follows:

Choose your IaaS\*

GCP

GCP Project ID \*

VPC Network \*

GCP Master Service Account ID \*

GCP Worker Service Account ID \*

vSphere

- a. Enter your **GCP Project Id**, which is the name of the deployment in your Ops Manager environment. To find the project ID, go to **BOSH Director for GCP > Google Config > Project ID**.
- b. Enter your **VPC Network**, which is the VPC network name for your Ops Manager environment.
- c. Enter your **GCP Master Service Account ID**. This is the email address associated with the master node service account. For information about configuring this account, see [Create the Master Node Service Account](#) in *Creating Service Accounts in GCP for PKS*.

- d. Enter your **GCP Worker Service Account ID**. This is the email address associated with the worker node service account. For information about configuring this account, see [Create the Worker Node Service Account](#) in *Creating Service Accounts in GCP for PKS*.

4. Click **Save**.

## (Optional) Logging

You can designate an external syslog endpoint for PKS component and cluster log messages.

To specify the destination for PKS log messages, do the following:

1. Click **Logging**.
2. To enable syslog forwarding, select **Yes**.

Enable Syslog for PKS?\*

No  
 Yes

Address \*

Port \*

Transport Protocol\*

Enable TLS

Permitted Peer

TLS Certificate

3. Under **Address**, enter the destination syslog endpoint.
4. Under **Port**, enter the destination syslog port.
5. Select a transport protocol for log forwarding.
6. (Optional) Pivotal strongly recommends that you enable TLS encryption when forwarding logs as they may contain sensitive information. For example, these logs may contain cloud provider credentials. To enable TLS, perform the following steps:
  - a. Under **Permitter Peer**, provide the accepted fingerprint (SHA1) or name of remote peer. For example, `*.YOUR-LOGGING-SYSTEM.com`.
  - b. Under **TLS Certificate**, provide a TLS certificate for the destination syslog endpoint.

**Note:** You do not need to provide a new certificate if the TLS certificate for the destination syslog endpoint is signed by a Certificate Authority (CA) in your BOSH certificate store.

7. To enable clusters to drain app logs to sinks using `syslog://`, select the **Enable Sink Resources** checkbox. For more information about using sink resources, see [Creating Sink Resources](#).

Enable Sink Resources

**Save**

8. Click **Save**.

## Networking

To configure networking, do the following:

1. Click **Networking**.

Container Networking Interface\*

Flannel  
 NSX-T

HTTP/HTTPS Proxy (for vSphere only)\*

Disabled  
 Enabled

Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)  
 Enable outbound internet access

2. Under **Container Networking Interface**, select **Flannel**.

3. (Optional) If you do not use a NAT instance, select **Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)**. Enabling this functionality assigns external IP addresses to VMs in clusters.

4. Click **Save**.

## UAA

To configure the UAA server, do the following:

1. Click **UAA**.

2. Under **PKS CLI Access Token Lifetime**, enter a time in seconds for the PKS CLI access token lifetime.

PKS API Access Token Lifetime (in seconds) \*

600

PKS API Refresh Token Lifetime (in seconds) \*

21600

Enable UAA as OIDC provider

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA  
 LDAP Server

3. Under **PKS CLI Refresh Token Lifetime**, enter a time in seconds for the PKS CLI refresh token lifetime.

4. Select one of the following options:

- To use an internal user account store for UAA, select **Internal UAA**. Click **Save** and continue to [\(Optional\) Monitoring](#).
- To use an external user account store for UAA, select **LDAP Server** and continue to [Configure LDAP as an Identity Provider](#).

**Note:** Selecting **LDAP Server** allows admin users to give cluster access to groups of users. For more information about performing this procedure, see [Grant Cluster Access to a Group](#) in *Managing Users in PKS with UAA*.

## Configure LDAP as an Identity Provider

To integrate UAA with one or more LDAP servers, configure PKS with your LDAP endpoint information as follows:

- Under **UAA**, select **LDAP Server**.

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA  
 LDAP Server

Server URL \*

`ldaps://example.com`

LDAP Credentials \*

Username  
Password

User Search Base \*

`ou=Groups,dc=example,dc=com`

User Search Filter \*

`cn={0}`

Group Search Base

`ou=Groups,dc=example,dc=com`

Group Search Filter \*

`member={0}`

- For **Server URL**, enter the URLs that point to your LDAP server. If you have multiple LDAP servers, separate their URLs with spaces. Each URL must include one of the following protocols:

- `ldap://`: Use this protocol if your LDAP server uses an unencrypted connection.
- `ldaps://`: Use this protocol if your LDAP server uses SSL for an encrypted connection. To support an encrypted connection, the LDAP server must hold a trusted certificate or you must import a trusted certificate to the JVM truststore.

- For **LDAP Credentials**, enter the LDAP Distinguished Name (DN) and password for binding to the LDAP server. For example, `cn=administrator,ou=Users,dc=example,dc=com`. If the bind user belongs to a different search base, you must use the full DN.

**Note:** We recommend that you provide LDAP credentials that grant read-only permissions on the LDAP search base and the LDAP group search base.

- For **User Search Base**, enter the location in the LDAP directory tree where LDAP user search begins. The LDAP search base typically matches your domain name.

For example, a domain named `cloud.example.com` may use `ou=Users,dc=example,dc=com` as its LDAP user search base.

- For **User Search Filter**, enter a string to use for LDAP user search criteria. The search criteria allows LDAP to perform more effective and efficient searches. For example, the standard LDAP search filter `cn=Smith` returns all objects with a common name equal to `Smith`.

In the LDAP search filter string that you use to configure PKS, use `{0}` instead of the username. For example, use `cn={0}` to return all LDAP objects with the same common name as the username.

In addition to `cn`, other common attributes are `mail`, `uid` and, in the case of Active Directory, `sAMAccountName`.

**Note:** For information about testing and troubleshooting your LDAP search filters, see [Configuring LDAP Integration with Pivotal Cloud Foundry](#).

- For **Group Search Base**, enter the location in the LDAP directory tree where the LDAP group search begins.

For example, a domain named `cloud.example.com` may use `ou=Groups,dc=example,dc=com` as its LDAP group search base.

Follow the instructions in the [Grant PKS Access to an External LDAP Group](#) section of *Managing Users in PKS with UAA* to map the groups under this

search base to roles in PKS.

7. For **Group Search Filter**, enter a string that defines LDAP group search criteria. The standard value is `member={0}`.

8. For **Server SSL Cert**, paste in the root certificate from your CA certificate or your self-signed certificate.

Server SSL Cert

Server SSL Cert AltName

First Name Attribute

Last Name Attribute

Email Attribute \*

mail

Email Domain(s)

LDAP Referrals\*

Automatically follow any referrals

9. For **Server SSL Cert AltName**, do one of the following:

- If you are using `ldaps://` with a self-signed certificate, enter a Subject Alternative Name (SAN) for your certificate.
- If you are not using `ldaps://` with a self-signed certificate, leave this field blank.

10. For **First Name Attribute**, enter the attribute name in your LDAP directory that contains user first names. For example, `cn`.

11. For **Last Name Attribute**, enter the attribute name in your LDAP directory that contains user last names. For example, `sn`.

12. For **Email Attribute**, enter the attribute name in your LDAP directory that contains user email addresses. For example, `mail`.

13. For **Email Domain(s)**, enter a comma-separated list of the email domains for external users who can receive invitations to Apps Manager.

14. For **LDAP Referrals**, choose how UAA handles LDAP server referrals to other user stores. UAA can follow the external referrals, ignore them without returning errors, or generate an error for each external referral and abort the authentication.

15. For **External Groups Whitelist**, enter a comma-separated list of group patterns which need to be populated in the user's `id_token`. For further information on accepted patterns see the description of the `config.externalGroupsWhitelist` in the OAuth/OIDC [Identity Provider Documentation](#).

**Note:** When sent as a Bearer token in the Authentication header, wide pattern queries for users who are members of multiple groups, can cause the size of the `id_token` to extend beyond what is supported by web servers.

## External Groups Whitelist

\*

Comma-separated list of external groups from LDAP that get added as roles in the ID Token, required to allow access to cluster to groups

16. Click **Save**.

## (Optional) Configure OpenID Connect

You can use OpenID Connect (OIDC) to instruct Kubernetes to verify end-user identities based on authentication performed by an authorization server, such as UAA.

To configure PKS to use OIDC, select **Enable UAA as OIDC provider**. With OIDC enabled, Admin Users can grant cluster-wide access to Kubernetes end users.

The screenshot shows a configuration form for PKS. It includes fields for 'PKS API Access Token Lifetime (in seconds)' (set to 7200), 'PKS API Refresh Token Lifetime (in seconds)' (set to 21600), and a checked checkbox for 'Enable UAA as OIDC provider'. A note next to the checkbox states: 'This will configure created clusters to use UAA as the OIDC provider.'

For more information about configuring OIDC, see the table below:

Option	Description
OIDC disabled	If you do not enable OIDC, Kubernetes authenticates users against its internal user management system.
OIDC enabled	If you enable OIDC, Kubernetes uses the authentication mechanism that you selected in <a href="#">UAA</a> : <ul style="list-style-type: none"><li>• If you selected <b>Internal UAA</b>, Kubernetes authenticates users against the internal UAA authentication mechanism.</li><li>• If you selected <b>LDAP Server</b>, Kubernetes authenticates users against the LDAP server.</li></ul>

For additional information on getting credentials with OIDC configured, see [Retrieve Cluster Credentials](#) in *Retrieving Cluster Credentials and Configuration*.

**Note:** When you enable OIDC, existing PKS-provisioned Kubernetes clusters are upgraded to use OIDC. This invalidates your kubeconfig files. You must regenerate the files for all clusters.

## (Optional) Monitoring

You can monitor Kubernetes clusters and pods metrics externally using the integration with [Wavefront by VMware](#).

**Note:** Before you configure Wavefront integration, you must have an active Wavefront account and access to a Wavefront instance. You provide your Wavefront access token during configuration and enabling errands. For additional information, see [Pivotal Container Service Integration Details](#) in the Wavefront documentation.

By default, monitoring is disabled. To enable and configure Wavefront monitoring, do the following:

1. Under **Wavefront Integration**, select **Yes**.

Pivotal Container Service

- [Settings](#)
- [Status](#)
- [Credentials](#)
- [Logs](#)

Configure PKS Monitoring Integration(s)

Assign AZs and Networks

PKS API

Plan 1

Plan 2

Plan 3

Kubernetes Cloud Provider

Logging

Networking

UAA

Monitoring

Usage Data

Wavefront Integration\*

No

Yes

Wavefront URL \*

1

The URL of your Wavefront Subscription, ex: https://try.wavefront.com/api

Wavefront Access Token \*

2

[Change](#)

Wavefront Alert Recipient

3

[Save](#)

2. Under **Wavefront URL**, enter the URL of your Wavefront subscription. For example, `https://try.wavefront.com/api`.
3. Under **Wavefront Access Token**, enter the API token for your Wavefront subscription.
4. To configure Wavefront to send alerts by email, enter email addresses or Wavefront Target IDs separated by commas under **Wavefront Alert Recipient**. For example: `user@example.com,Wavefront_TargetID`. To create alerts, you must enable errands.
5. In the **Errands** tab, enable **Create pre-defined Wavefront alerts errand** and **Delete pre-defined Wavefront alerts errand**.

PKS API

Errands are scripts that run at designated points during an installation.

Plan 1

Post-Deploy Errands

Plan 2

NSX-T Validation errand

On

Plan 3

Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied

Off

Kubernetes Cloud Provider

Create pre-defined Wavefront alerts errand

Default (Off)

1

Logging

Networking

UAA

Monitoring

Usage Data

Errands

Pre-Delete Errands

Delete all clusters errand

Default (On)

2

Resource Config

Delete pre-defined Wavefront alerts errand

Default (Off)

6. Click **Save**. Your settings apply to any clusters created after you have saved these configuration settings and clicked **Apply Changes**.

 **Note:** The PKS tile does not validate your Wavefront configuration settings. To verify your setup, look for cluster and pod metrics in

Wavefront.

## Usage Data

VMware's Customer Experience Improvement Program (CEIP) and the Pivotal Telemetry Program (Telemetry) provides VMware and Pivotal with information that enables the companies to improve their products and services, fix problems, and advise you on how best to deploy and use our products. As part of the CEIP and Telemetry, VMware and Pivotal collect technical information about your organization's use of the Pivotal Container Service ("PKS") on a regular basis. Since PKS is jointly developed and sold by VMware and Pivotal, we will share this information with one another. Information collected under CEIP or Telemetry does not personally identify any individual.

Regardless of your selection in the **Usage Data** pane, a small amount of data is sent from Cloud Foundry Container Runtime (CFCR) to the PKS tile. However, that data is not shared externally.

To configure the **Usage Data** pane:

1. Select the **Usage Data** side-tab.
2. Read the Usage Data description.
3. Make your selection.
  - a. To join the program, select **Yes, I want to join the CEIP and Telemetry Program for PKS**.
  - b. To decline joining the program, select **No, I do not want to join the CEIP and Telemetry Program for PKS**.
4. Click **Save**.

 **Note:** If you join the CEIP and Telemetry Program for PKS, open your firewall to allow outgoing access to <https://vcsa.vmware.com/ph-prd> on port 443

## Errands

Errands are scripts that run at designated points during an installation.

To configure when post-deploy and pre-delete errands for PKS are run, make a selection in the dropdown next to the errand. For a typical PKS deployment, we recommend that you leave the default settings.

## NSX-T Validation errand

Default (Off)

Validates NSX-T configuration and tags resources

## Upgrade all clusters errand

Default (On)

Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied

## Create pre-defined Wavefront alerts errand

Default (Off)

Create pre-defined Wavefront alerts

## Pre-Delete Errands

### Delete all clusters errand

Default (On)

Deletes all clusters provisioned by PKS when the PKS tile is deleted

### Delete pre-defined Wavefront alerts errand

Default (Off)

Delete pre-defined Wavefront alerts errand

For more information about errands and their configuration state, see [Managing Errands in Ops Manager](#).

**WARNING:** Because PKS uses floating stemcells, updating the PKS tile with a new stemcell triggers the rolling of every VM in each cluster. Also, updating other product tiles in your deployment with a new stemcell causes the PKS tile to roll VMs. This rolling is enabled by the **Upgrade all clusters errand**. We recommend that you keep this errand turned on because automatic rolling of VMs ensures that all deployed cluster VMs are patched. However, automatic rolling can cause downtime in your deployment.

If you are upgrading PKS, you must enable the **Upgrade All Clusters** errand.

## Resource Config

To modify the resource usage of PKS and specify your PKS API load balancer, follow the steps below:

1. Select **Resource Config**.
2. In the **Load Balancers** column, enter a name for your PKS API load balancer that begins with `tcp:`. For example, `tcp:pks-api`, where `pks-api` is the name that you configured in the [Create a Load Balancer](#) section of *Creating a GCP Load Balancer for the PKS API*.
 

 **Note:** After you click **Apply Changes** for the first time, BOSH assigns the PKS VM an IP address. BOSH uses the name you provide in the **Load Balancers** column to locate your load balancer, and then connect the load balancer to the PKS VM using its new IP address.
3. (Optional) Edit resources used by the **Pivotal Container Service** job.

Resource Config					
JOB	INSTANCES	PERSISTENT DISK TYPE	VM TYPE	LOAD BALANCERS	INTERNET CONNECTED
Pivotal Container Service	Automatic: 1	Automatic: 10 GB	Automatic: large	tcp:pks-api	<input checked="" type="checkbox"/>

 **Note:** If you experience timeouts or slowness when interacting with the PKS API, select a **VM Type** with greater CPU and memory resources for the **Pivotal Container Service** job.

## Step 3: Apply Changes

1. Return to the Ops Manager Installation Dashboard.
2. Click **Review Pending Changes**. Select the product that you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).
-  **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.
3. Click **Apply Changes**.

## Step 4: Retrieve the PKS API Endpoint

You must share the PKS API endpoint to allow your organization to use the API to create, update, and delete clusters. For more information, see [Creating Clusters](#).

To retrieve the PKS API endpoint, do the following:

1. Navigate to the Ops Manager Installation Dashboard.
2. Click the Pivotal Container Service tile.
3. Click the **Status** tab and locate the **Pivotal Container Service** job. The IP address of the Pivotal Container Service job is the PKS API endpoint.

## Step 5: Configure External Load Balancer

Follow the procedure in the [Create a Network Tag for the Firewall Rule](#) section of *Creating a GCP Load Balancer for the PKS API*.

## Step 6: Install the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## Step 7: Configure PKS API Access

Follow the procedures in [Configuring PKS API Access](#).

## Step 8: Configure Authentication for PKS

Configure authentication for PKS using User Account and Authentication (UAA). For information, see [Managing Users in PKS with UAA](#).

## Next Steps

After installing PKS on GCP, you may want to do one or more of the following:

- Create a load balancer for your PKS clusters. For more information, see [Creating and Configuring a GCP Load Balancer for PKS Clusters](#).
- Create your first PKS cluster. For more information, see [Creating Clusters](#).

## Amazon Web Services (AWS)

This topic outlines the steps for installing Pivotal Container Service (PKS) on Amazon Web Services (AWS). See the following sections:

 **Note:** The topics below provide the Terraform procedures for deploying Ops Manager on AWS, not the manual procedures. The Terraform procedures are the currently supported path for deploying Ops Manager on AWS for use with PKS.

- [AWS Prerequisites and Resource Requirements](#)
- Deploying Ops Manager on AWS:
  - [Preparing to Deploy PCF v2.2 on AWS Using Terraform](#) or
  - [Preparing to Deploy PCF v2.3 on AWS Using Terraform](#)
  - [Preparing to Deploy PCF v2.4 on AWS Using Terraform](#)
- Configuring Ops Manager on AWS:
  - [Configuring BOSH Director v2.2 on AWS Using Terraform](#) or
  - [Configuring BOSH Director v2.3 on AWS Using Terraform](#)
  - [Configuring BOSH Director v2.4 on AWS Using Terraform](#)
- [Installing PKS on AWS](#)
- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## AWS Prerequisites and Resource Requirements

Page last updated:

This topic describes the prerequisites and resource requirements for installing Pivotal Container Service (PKS) on Amazon Web Services (AWS).

### Prerequisites

Before you install PKS, you must install one of the following:

- Pivotal Ops Manager v2.2.3 or later
- Pivotal Ops Manager v2.3.1 or later
- Pivotal Ops Manager v2.4.x

 **Note:** You use Ops Manager to install and configure PKS. Each version of Ops Manager supports multiple versions of PKS. To confirm that your Ops Manager version supports the version of PKS that you install, see [PKS Release Notes](#).

To install an Ops Manager version that is compatible with the PKS version you intend to use, follow the instructions in the corresponding version of the Ops Manager documentation.

 **Note:** The topics below provide the Terraform procedures for deploying Ops Manager on AWS, not the manual procedures. The Terraform procedures are the currently supported path for deploying Ops Manager on AWS for use with PKS.

Version	
Ops Manager v2.2	<ul style="list-style-type: none"> <li>• <a href="#">Preparing to Deploy PCF on AWS Using Terraform</a></li> <li>• <a href="#">Configuring BOSH Director on AWS Using Terraform</a></li> </ul>
Ops Manager v2.3	<ul style="list-style-type: none"> <li>• <a href="#">Preparing to Deploy PCF on AWS Using Terraform</a></li> <li>• <a href="#">Configuring BOSH Director on AWS Using Terraform</a></li> </ul>
Ops Manager v2.4	<ul style="list-style-type: none"> <li>• <a href="#">Preparing to Deploy PCF on AWS Using Terraform</a></li> <li>• <a href="#">Configuring BOSH Director on AWS Using Terraform</a></li> </ul>

### Resource Requirements

Installing Ops Manager and PKS requires the following virtual machines (VMs):

VM Name	VM Type	Default VM Count
Pivotal Container Service	m4.large	1
BOSH Director	m4.large	1

Each Kubernetes cluster provisioned through PKS deploys the VMs listed below. If you deploy more than one Kubernetes cluster, you must scale your allocated resources appropriately.

VM Name	Number	CPU Cores	RAM	Ephemeral Disk	Persistent Disk
master	1	2	4 GB	32 GB	5 GB
worker	1	2	4 GB	32 GB	50 GB

## Installing PKS on AWS

Page last updated:

This topic describes how to install and configure Pivotal Container Service (PKS) on Amazon Web Services (AWS).

### Prerequisites

Before performing the procedures in this topic, you must have deployed and configured Ops Manager. For more information, see [AWS Prerequisites and Resource Requirements](#).

If you use an instance of Ops Manager that you configured previously to install other runtimes, confirm the following settings before you install PKS:

1. Navigate to Ops Manager.
2. Open the **Director Config** pane.
3. Select the **Enable Post Deploy Scripts** checkbox.
4. Clear the **Disable BOSH DNS server for troubleshooting purposes** checkbox.
5. Click the **Installation Dashboard** link to return to the Installation Dashboard.
6. Click **Review Pending Changes**. Select all products you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).

 **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

7. Click **Apply Changes**.

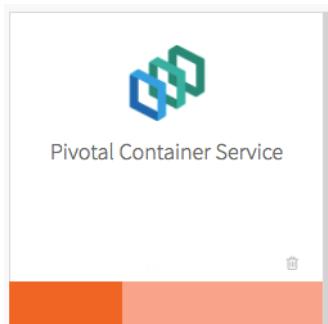
### Step 1: Install PKS

To install PKS, do the following:

1. Download the product file from [Pivotal Network](#).
2. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
3. Click **Import a Product** to upload the product file.
4. Under **Pivotal Container Service** in the left column, click the plus sign to add this product to your staging area.

### Step 2: Configure PKS

Click the orange **Pivotal Container Service** tile to start the configuration process.



**⚠️ WARNING:** When you configure the PKS tile, do not use spaces in any field entries. This includes spaces between characters as well as leading and trailing spaces. If you use a space in any field entry, the deployment of PKS fails.

## Assign AZs and Networks

Perform the following steps:

1. Click **Assign AZs and Networks**.
2. Select the availability zone (AZ) where you want to deploy the PKS API VM as a singleton job.

**Note:** You must select an additional AZ for balancing other jobs before clicking **Save**, but this selection has no effect in the current version of PKS.

The screenshot shows a configuration dialog for assigning AZs and networks. It includes fields for selecting availability zones (us-west-2a, us-west-2b, us-west-2c), balancing other jobs (us-west-2a, us-west-2b, us-west-2c), and selecting network subnets (pks-infrastructure, pks-services). A 'Save' button is at the bottom.

Place singleton jobs in

us-west-2a  
 us-west-2b  
 us-west-2c

Balance other jobs in

us-west-2a  
 us-west-2b  
 us-west-2c

Network

pks-infrastructure

Service Network

pks-services

**Save**

3. Under **Network**, select the infrastructure subnet you created for the PKS API VM.
4. Under **Service Network**, select the services subnet you created for Kubernetes cluster VMs.
5. Click **Save**.

## PKS API

Perform the following steps:

1. Click **PKS API**.
2. Navigate to your DNS provider and create an entry that points a fully qualified domain name (FQDN) within your system domain to the public IP address of the load balancer for the PKS API. For example, `api.pks.example.com`.

To retrieve the public IP address of the PKS API load balancer, log in to your IaaS console. If you used Terraform, you can also find the IP address in the `terraform.tfstate` file.

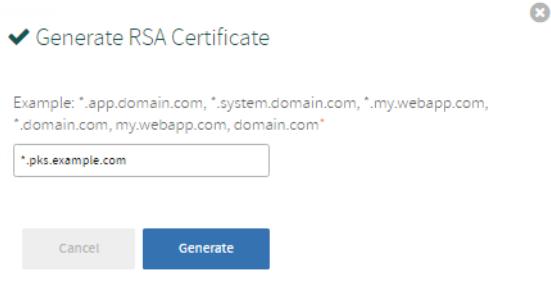
3. Under **Certificate to secure the PKS API**, provide your own certificate and private key pair.

The certificate that you supply should cover the domain that routes to the PKS API VM with TLS termination on the ingress.

If you do not have a certificate and private key pair, PKS can generate one for you by performing the following steps.

**Note:** If you configured Ops Manager Front End without a certificate, you can use this new certificate to complete Ops Manager configuration. To configure your Ops Manager Front End certificate, see [Configure Front End](#).

- Select the **Generate RSA Certificate** link.
- Enter the domain for your API hostname. This can be a standard FQDN or a wildcard domain.
- Click **Generate**.



- Under **API Hostname (FQDN)**, enter the FQDN that you have registered to point to the PKS API load balancer, such as `api.pks.example.com`.
- Under **Worker VM Max in Flight**, enter the maximum number of non-canary worker instances to create or resize in parallel within an availability zone.

This field sets the `max_in_flight` variable, which limits how many instances of a component can start simultaneously when a cluster is created or resized. The variable defaults to `1`, which means that only one component starts at a time.

- Click **Save**.

## Plans

To activate a plan, perform the following steps:

- Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.

**Note:** A plan defines a set of resource types used for deploying clusters. You can configure up to three plans. You must configure **Plan 1**.

- Select **Active** to activate the plan and make it available to developers deploying clusters.

**Plan\***

Active

**Name \***

**Description \***

Example: This plan will configure a lightweight kubernetes cluster. Not recommended for production workloads.

The plan description for the service instance

**Master/ETCD Node Instances ( min: 1, max: 3 ) \***

**Master/ETCD VM Type\***

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

**Master Persistent Disk Type\***

10 GB

**Master/ETCD Availability Zones \***

us-central1-f  
 us-central1-a  
 us-central1-c

3. Under **Name**, provide a unique name for the plan.
4. Under **Description**, edit the description as needed. The plan description appears in the Services Marketplace, which developers can access by using PKS CLI.
5. Under **Master/ETCD Node Instances**, select the default number of Kubernetes master/etcd nodes to provision for each cluster. You can enter either **1** or **3**.

**Note:** If you deploy a cluster with multiple master/etcd node VMs, confirm that you have sufficient hardware to handle the increased load on disk write and network traffic. For more information, see [Hardware recommendations](#) in the etcd documentation.

In addition to meeting the hardware requirements for a multi-master cluster, we recommend configuring monitoring for etcd to monitor disk latency, network latency, and other indicators for the health of the cluster. For more information, see [Monitoring Master/etcd Node VMs](#).

- ⚠ WARNING:** To change the number of master/etcd nodes for a plan, you must ensure that no existing clusters use the plan. PKS does not support changing the number of master/etcd nodes for plans with existing clusters.
6. Under **Master/ETCD VM Type**, select the type of VM to use for Kubernetes master/etcd nodes. For more information, see the [Master Node VM Size](#) section of *VM Sizing for PKS Clusters*.
  7. Under **Master Persistent Disk Type**, select the size of the persistent disk for the Kubernetes master node VM.
  8. Under **Master/ETCD Availability Zones**, select one or more AZs for the Kubernetes clusters deployed by PKS. If you select more than one AZ, PKS deploys the master VM in the first AZ and the worker VMs across the remaining AZs.
  9. Under **Maximum number of workers on a cluster**, set the maximum number of Kubernetes worker node VMs that PKS can deploy for each cluster.

**Note:** Clusters with more than 200 workers have not been validated.

Maximum number of workers on a cluster (min: 1) \*

Worker Node Instances (min: 1, max: 50) \*

Worker VM Type\*

medium.disk (cpu: 2, ram: 4 GB, disk: 32 GB)

Worker Persistent Disk Type\*

50 GB

Worker Availability Zones \*

us-central1-f  
 us-central1-a  
 us-central1-c

Errand VM Type\*

micro (cpu: 1, ram: 1 GB, disk: 8 GB)

- Under **Worker Node Instances**, select the default number of Kubernetes worker nodes to provision for each cluster.

If the user creating a cluster with the PKS Command Line Interface (CLI) does not specify a number of worker nodes, the cluster is deployed with the default number set in this field. This value cannot be greater than the maximum worker node value you set in the previous field. For more information about creating clusters, see [Creating Clusters](#).

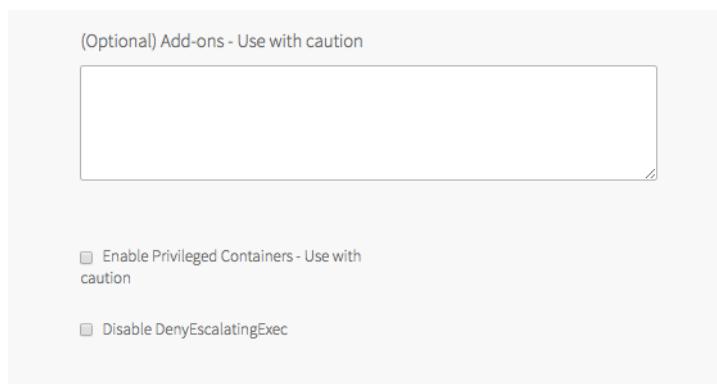
For high availability, create clusters with a minimum of three worker nodes, or two per AZ if you intend to use PersistentVolumes (PVs). For example, if you deploy across three AZs, you should have six worker nodes. For more information about PVs, see [PersistentVolumes](#) in *Maintaining Workload Uptime*. Provisioning a minimum of three worker nodes, or two nodes per AZ is also recommended for stateless workloads.

If you later reconfigure the plan to adjust the default number of worker nodes, the existing clusters that have been created from that plan are not automatically upgraded with the new default number of worker nodes.

- Under **Worker VM Type**, select the type of VM to use for Kubernetes worker node VMs. For more information, see the [Worker Node VM Number and Size](#) section of *VM Sizing for PKS Clusters*.

**Note:** If you install PKS in an NSX-T environment, we recommend that you select a **Worker VM Type** with a minimum disk size of 16 GB. The disk space provided by the default **medium** Worker VM Type is insufficient for PKS with NSX-T.

- Under **Worker Persistent Disk Type**, select the size of the persistent disk for the Kubernetes worker node VMs.
- Under **Worker Availability Zones**, select one or more AZs for the Kubernetes worker nodes. PKS deploys worker nodes equally across the AZs you select.
- Under **Errand VM Type**, select the size of the VM that contains the errand. The smallest instance possible is sufficient, as the only errand running on this VM is the one that applies the **Default Cluster App** YAML configuration.
- (Optional) Under **(Optional) Add-ons - Use with caution**, enter additional YAML configuration to add custom workloads to each cluster in this plan. You can specify multiple files using **---** as a separator. For more information, see [Adding Custom Workloads](#).



16. (Optional) To allow users to create pods with privileged containers, select the **Enable Privileged Containers - Use with caution** option. For more information, see [Pods](#) in the Kubernetes documentation.
17. (Optional) To disable the admission controller, select the **Disable DenyEscalatingExec** checkbox. If you select this option, clusters in this plan can create security vulnerabilities that may impact other tiles. Use this feature with caution.

18. Click **Save**.

To deactivate a plan, perform the following steps:

1. Click the **Plan 1**, **Plan 2**, or **Plan 3** tab.
2. Select **Plan Inactive**.
3. Click **Save**.

## Kubernetes Cloud Provider

To configure your Kubernetes cloud provider settings, follow the procedures below:

1. Click **Kubernetes Cloud Provider**.
2. Under **Choose your IaaS**, select **AWS**.

Choose your IaaS\*

- GCP
- vSphere
- AWS

AWS Master Instance Profile IAM \*

AWS Worker Instance Profile IAM \*

3. Enter your **AWS Master Instance Profile IAM**. This is the instance profile name associated with the master node. To retrieve the instance profile name, run `terraform output` and locate the value for the field `pks_master_iam_instance_profile_name`.
4. Enter your **AWS Worker Instance Profile IAM**. This is the instance profile name associated with the worker node. To retrieve the instance profile name, run `terraform output` and locate the value for the field `pks_worker_iam_instance_profile_name`.
5. Click **Save**.

## (Optional) Logging

You can designate an external syslog endpoint for PKS component and cluster log messages.

To specify the destination for PKS log messages, do the following:

1. Click **Logging**.
2. To enable syslog forwarding, select **Yes**.

Enable Syslog for PKS?\*

No  
 Yes

Address \*

Port \*

Transport Protocol\*

TCP

Enable TLS

Permitted Peer

TLS Certificate

3. Under **Address**, enter the destination syslog endpoint.
4. Under **Port**, enter the destination syslog port.
5. Select a transport protocol for log forwarding.
6. (Optional) Pivotal strongly recommends that you enable TLS encryption when forwarding logs as they may contain sensitive information. For example, these logs may contain cloud provider credentials. To enable TLS, perform the following steps:
  - a. Under **Permitter Peer**, provide the accepted fingerprint (SHA1) or name of remote peer. For example, `*.YOUR-LOGGING-SYSTEM.com`.
  - b. Under **TLS Certificate**, provide a TLS certificate for the destination syslog endpoint.

**Note:** You do not need to provide a new certificate if the TLS certificate for the destination syslog endpoint is signed by a Certificate Authority (CA) in your BOSH certificate store.

7. To enable clusters to drain app logs to sinks using `syslog://`, select the **Enable Sink Resources** checkbox. For more information about using sink resources, see [Creating Sink Resources](#).

Enable Sink Resources

Save

8. Click **Save**.

## Networking

To configure networking, do the following:

1. Click **Networking**.

Container Networking Interface\*

Flannel  
 NSX-T

HTTP/HTTPS Proxy (for vSphere only)\*

Disabled  
 Enabled

Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)  
 Enable outbound internet access

2. Under **Container Networking Interface**, select **Flannel**.

3. (Optional) Enter values for **Kubernetes Pod Network CIDR Range** and **Kubernetes Service Network CIDR Range**

- Ensure that the CIDR ranges do not overlap and have sufficient space for your deployed services.
- Ensure that the CIDR range for the **Kubernetes Pod Network CIDR Range** is large enough to accommodate the expected maximum number of pods.

4. (Optional) If you do not use a NAT instance, select **Allow outbound internet access from Kubernetes cluster vms (IaaS-dependent)**. Enabling this functionality assigns external IP addresses to VMs in clusters.

5. Click **Save**.

## UAA

To configure the UAA server, do the following:

1. Click **UAA**.

2. Under **PKS CLI Access Token Lifetime**, enter a time in seconds for the PKS CLI access token lifetime.

PKS API Access Token Lifetime (in seconds) \*

600

PKS API Refresh Token Lifetime (in seconds) \*

21600

Enable UAA as OIDC provider

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA  
 LDAP Server

3. Under **PKS CLI Refresh Token Lifetime**, enter a time in seconds for the PKS CLI refresh token lifetime.

4. Select one of the following options:

- To use an internal user account store for UAA, select **Internal UAA**. Click **Save** and continue to [\(Optional\) Monitoring](#).
- To use an external user account store for UAA, select **LDAP Server** and continue to [Configure LDAP as an Identity Provider](#).



**Note:** Selecting **LDAP Server** allows admin users to give cluster access to groups of users. For more information about performing this procedure, see [Grant Cluster Access to a Group](#) in *Managing Users in PKS with UAA*.

## Configure LDAP as an Identity Provider

To integrate UAA with one or more LDAP servers, configure PKS with your LDAP endpoint information as follows:

1. Under **UAA**, select **LDAP Server**.

Configure your UAA user account store with either internal or external authentication mechanisms \*

Internal UAA

LDAP Server

Server URL \*

`ldaps://example.com`

LDAP Credentials \*

Username

Password

User Search Base \*

`ou=Groups,dc=example,dc=com`

User Search Filter \*

`cn={0}`

Group Search Base

`ou=Groups,dc=example,dc=com`

Group Search Filter \*

`member={0}`

2. For **Server URL**, enter the URLs that point to your LDAP server. If you have multiple LDAP servers, separate their URLs with spaces. Each URL must include one of the following protocols:

- `ldap://`: Use this protocol if your LDAP server uses an unencrypted connection.
- `ldaps://`: Use this protocol if your LDAP server uses SSL for an encrypted connection. To support an encrypted connection, the LDAP server must hold a trusted certificate or you must import a trusted certificate to the JVM truststore.

3. For **LDAP Credentials**, enter the LDAP Distinguished Name (DN) and password for binding to the LDAP server. For example, `cn=administrator,ou=Users,dc=example,dc=com`. If the bind user belongs to a different search base, you must use the full DN.

 **Note:** We recommend that you provide LDAP credentials that grant read-only permissions on the LDAP search base and the LDAP group search base.

4. For **User Search Base**, enter the location in the LDAP directory tree where LDAP user search begins. The LDAP search base typically matches your domain name.

For example, a domain named `cloud.example.com` may use `ou=Users,dc=example,dc=com` as its LDAP user search base.

5. For **User Search Filter**, enter a string to use for LDAP user search criteria. The search criteria allows LDAP to perform more effective and efficient searches. For example, the standard LDAP search filter `cn=Smith` returns all objects with a common name equal to `Smith`.

In the LDAP search filter string that you use to configure PKS, use `{0}` instead of the username. For example, use `cn={0}` to return all LDAP objects with the same common name as the username.

In addition to `cn`, other common attributes are `mail`, `uid` and, in the case of Active Directory, `sAMAccountName`.

 **Note:** For information about testing and troubleshooting your LDAP search filters, see [Configuring LDAP Integration with Pivotal Cloud Foundry](#).

6. For **Group Search Base**, enter the location in the LDAP directory tree where the LDAP group search begins.

For example, a domain named `cloud.example.com` may use `ou=Groups,dc=example,dc=com` as its LDAP group search base.

Follow the instructions in the [Grant PKS Access to an External LDAP Group](#) section of *Managing Users in PKS with UAA* to map the groups under this search base to roles in PKS.

7. For **Group Search Filter**, enter a string that defines LDAP group search criteria. The standard value is `member={0}`.

8. For **Server SSL Cert**, paste in the root certificate from your CA certificate or your self-signed certificate.

Server SSL Cert

Server SSL Cert AltName

First Name Attribute

Last Name Attribute

Email Attribute \*

mail

Email Domain(s)

LDAP Referrals\*

Automatically follow any referrals

9. For **Server SSL Cert AltName**, do one of the following:

- If you are using `ldaps://` with a self-signed certificate, enter a Subject Alternative Name (SAN) for your certificate.
- If you are not using `ldaps://` with a self-signed certificate, leave this field blank.

10. For **First Name Attribute**, enter the attribute name in your LDAP directory that contains user first names. For example, `cn`.

11. For **Last Name Attribute**, enter the attribute name in your LDAP directory that contains user last names. For example, `sn`.

12. For **Email Attribute**, enter the attribute name in your LDAP directory that contains user email addresses. For example, `mail`.

13. For **Email Domain(s)**, enter a comma-separated list of the email domains for external users who can receive invitations to Apps Manager.

14. For **LDAP Referrals**, choose how UAA handles LDAP server referrals to other user stores. UAA can follow the external referrals, ignore them without returning errors, or generate an error for each external referral and abort the authentication.

15. For **External Groups Whitelist**, enter a comma-separated list of group patterns which need to be populated in the user's `id_token`. For further information on accepted patterns see the description of the `config.externalGroupsWhitelist` in the OAuth/OIDC [Identity Provider Documentation](#).

**Note:** When sent as a Bearer token in the Authentication header, wide pattern queries for users who are members of multiple groups, can cause the size of the `id_token` to extend beyond what is supported by web servers.

#### External Groups Whitelist

\*

Comma-separated list of external groups from LDAP that get added as roles in the ID Token, required to allow access to cluster to groups

16. Click **Save**.

## (Optional) Configure OpenID Connect

You can use OpenID Connect (OIDC) to instruct Kubernetes to verify end-user identities based on authentication performed by an authorization server, such as UAA.

To configure PKS to use OIDC, select **Enable UAA as OIDC provider**. With OIDC enabled, Admin Users can grant cluster-wide access to Kubernetes end users.

The screenshot shows a configuration form for PKS. It includes fields for 'PKS API Access Token Lifetime (in seconds)' set to 7200, 'PKS API Refresh Token Lifetime (in seconds)' set to 21600, and a checked checkbox for 'Enable UAA as OIDC provider'. A note next to the checkbox states: 'This will configure created clusters to use UAA as the OIDC provider.'

For more information about configuring OIDC, see the table below:

Option	Description
OIDC disabled	If you do not enable OIDC, Kubernetes authenticates users against its internal user management system.
OIDC enabled	If you enable OIDC, Kubernetes uses the authentication mechanism that you selected in <a href="#">UAA</a> : <ul style="list-style-type: none"><li>• If you selected <b>Internal UAA</b>, Kubernetes authenticates users against the internal UAA authentication mechanism.</li><li>• If you selected <b>LDAP Server</b>, Kubernetes authenticates users against the LDAP server.</li></ul>

For additional information on getting credentials with OIDC configured, see [Retrieve Cluster Credentials](#) in *Retrieving Cluster Credentials and Configuration*.

**Note:** When you enable OIDC, existing PKS-provisioned Kubernetes clusters are upgraded to use OIDC. This invalidates your kubeconfig files. You must regenerate the files for all clusters.

## (Optional) Monitoring

You can monitor Kubernetes clusters and pods metrics externally using the integration with [Wavefront by VMware](#).

**Note:** Before you configure Wavefront integration, you must have an active Wavefront account and access to a Wavefront instance. You provide your Wavefront access token during configuration and enabling errands. For additional information, see [Pivotal Container Service Integration Details](#) in the Wavefront documentation.

By default, monitoring is disabled. To enable and configure Wavefront monitoring, do the following:

1. Under **Wavefront Integration**, select **Yes**.

Pivotal Container Service

- [Settings](#)
- [Status](#)
- [Credentials](#)
- [Logs](#)

Configure PKS Monitoring Integration(s)

Assign AZs and Networks

PKS API

Plan 1

Plan 2

Plan 3

Kubernetes Cloud Provider

Logging

Networking

UAA

Monitoring

Usage Data

Wavefront Integration\*

No

Yes

Wavefront URL \*

1

The URL of your Wavefront Subscription, ex: https://try.wavefront.com/api

Wavefront Access Token \*

2

Change

Wavefront Alert Recipient

3

Save

2. Under **Wavefront URL**, enter the URL of your Wavefront subscription. For example, `https://try.wavefront.com/api`.
3. Under **Wavefront Access Token**, enter the API token for your Wavefront subscription.
4. To configure Wavefront to send alerts by email, enter email addresses or Wavefront Target IDs separated by commas under **Wavefront Alert Recipient**. For example: `user@example.com,Wavefront_TargetID`. To create alerts, you must enable errands.
5. In the **Errands** tab, enable **Create pre-defined Wavefront alerts errand** and **Delete pre-defined Wavefront alerts errand**.

PKS API

Errands are scripts that run at designated points during an installation.

Plan 1

Post-Deploy Errands

Plan 2

NSX-T Validation errand

On

Validates NSX-T configuration and tags resources

Plan 3

Upgrade all clusters errand

Off

Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied

Kubernetes Cloud Provider

Create pre-defined Wavefront alerts errand

Default (Off)

1

Create pre-defined Wavefront alerts errand

Logging

Networking

UAA

Monitoring

Usage Data

Errands

Pre-Delete Errands

Delete all clusters errand

Default (On)

Deletes all clusters provisioned by PKS when the PKS tile is deleted

Resource Config

Delete pre-defined Wavefront alerts errand

Default (Off)

2

Delete pre-defined Wavefront alerts errand

6. Click **Save**. Your settings apply to any clusters created after you have saved these configuration settings and clicked **Apply Changes**.

**Note:** The PKS tile does not validate your Wavefront configuration settings. To verify your setup, look for cluster and pod metrics in

Wavefront.

## Usage Data

VMware's Customer Experience Improvement Program (CEIP) and the Pivotal Telemetry Program (Telemetry) provides VMware and Pivotal with information that enables the companies to improve their products and services, fix problems, and advise you on how best to deploy and use our products. As part of the CEIP and Telemetry, VMware and Pivotal collect technical information about your organization's use of the Pivotal Container Service ("PKS") on a regular basis. Since PKS is jointly developed and sold by VMware and Pivotal, we will share this information with one another. Information collected under CEIP or Telemetry does not personally identify any individual.

Regardless of your selection in the **Usage Data** pane, a small amount of data is sent from Cloud Foundry Container Runtime (CFCR) to the PKS tile. However, that data is not shared externally.

To configure the **Usage Data** pane:

1. Select the **Usage Data** side-tab.
2. Read the Usage Data description.
3. Make your selection.
  - a. To join the program, select **Yes, I want to join the CEIP and Telemetry Program for PKS**.
  - b. To decline joining the program, select **No, I do not want to join the CEIP and Telemetry Program for PKS**.
4. Click **Save**.

 **Note:** If you join the CEIP and Telemetry Program for PKS, open your firewall to allow outgoing access to <https://vcsa.vmware.com/ph-prd> on port 443

## Errands

Errands are scripts that run at designated points during an installation.

To configure when post-deploy and pre-delete errands for PKS are run, make a selection in the dropdown next to the errand. For a typical PKS deployment, we recommend that you leave the default settings.

## NSX-T Validation errand

Default (Off)

Validates NSX-T configuration and tags resources

## Upgrade all clusters errand

Default (On)

Upgrades all Kubernetes clusters provisioned by PKS after the PKS Tile upgrade is applied

## Create pre-defined Wavefront alerts errand

Default (Off)

Create pre-defined Wavefront alerts

## Pre-Delete Errands

### Delete all clusters errand

Default (On)

Deletes all clusters provisioned by PKS when the PKS tile is deleted

### Delete pre-defined Wavefront alerts errand

Default (Off)

Delete pre-defined Wavefront alerts errand

For more information about errands and their configuration state, see [Managing Errands in Ops Manager](#).

**WARNING:** Because PKS uses floating stemcells, updating the PKS tile with a new stemcell triggers the rolling of every VM in each cluster. Also, updating other product tiles in your deployment with a new stemcell causes the PKS tile to roll VMs. This rolling is enabled by the [Upgrade all clusters errand](#). We recommend that you keep this errand turned on because automatic rolling of VMs ensures that all deployed cluster VMs are patched. However, automatic rolling can cause downtime in your deployment.

If you are upgrading PKS, you must enable the [Upgrade All Clusters](#) errand.

## Resource Config

To modify the resource usage of PKS and specify your PKS API load balancer, follow the steps below:

1. Select [Resource Config](#).
2. In the **Load Balancers** column, enter `pks-api`. Terraform created this load balancer when you ran `terraform apply plan` in [Preparing to Deploy PCF on AWS Using Terraform](#).
 

**Note:** After you click **Apply Changes** for the first time, BOSH assigns the PKS VM an IP address. BOSH uses the name you provide in the **Load Balancers** column to locate your load balancer, and then connect the load balancer to the PKS VM using its new IP address.
3. (Optional) Edit other resources used by the [Pivotal Container Service](#) job.

Resource Config

JOB	INSTANCES	PERSISTENT DISK TYPE	VM TYPE	LOAD BALANCERS	INTERNET CONNECTED
Pivotal Container Service	Automatic: 1	Automatic: 10 GB	Automatic: r4.large (cpu: 2, ram: 15.3 GB, c	pks-api	<input checked="" type="checkbox"/>

**Save**

**Note:** If you experience timeouts or slowness when interacting with the PKS API, select a **VM Type** with greater CPU and memory resources for the **Pivotal Container Service** job.

## Step 3: Apply Changes

1. Return to the Ops Manager Installation Dashboard.
  2. Click **Review Pending Changes**. Select the product that you intend to deploy and review the changes. For more information, see [Reviewing Pending Product Changes](#).
  3. Click **Apply Changes**.
- Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

## Step 4: Retrieve the PKS API Endpoint

You must share the PKS API endpoint to allow your organization to use the API to create, update, and delete clusters. For more information, see [Creating Clusters](#).

To retrieve the PKS API endpoint, do the following:

1. Navigate to the Ops Manager Installation Dashboard.
2. Click the Pivotal Container Service tile.
3. Click the **Status** tab and locate the **Pivotal Container Service** job. The IP address of the Pivotal Container Service job is the PKS API endpoint.

## Step 5: Install the PKS and Kubernetes CLIs

The PKS and Kubernetes CLIs help you interact with your PKS-provisioned Kubernetes clusters and Kubernetes workloads. To install the CLIs, follow the instructions below:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

## Step 6: Configure PKS API Access

Follow the procedures in [Configuring PKS API Access](#).

## Step 7: Configure Authentication for PKS

Configure authentication for PKS using User Account and Authentication (UAA). For information, see [Managing Users in PKS with UAA](#).

## Next Steps

After installing PKS on AWS, you may want to do one or more of the following:

- Create a load balancer for your PKS clusters. For more information, see [Creating and Configuring an AWS Load Balancer for PKS Clusters](#).
- Create your first PKS cluster. For more information, see [Creating Clusters](#).

## Installing the PKS CLI

Page last updated:

This topic describes how to install the Pivotal Container Service Command Line Interface (PKS CLI).

To install the PKS CLI, follow the procedures for your operating system to download the PKS CLI from [Pivotal Network](#). Binaries are only provided for 64-bit architectures.

### Mac OS X

1. Navigate to [Pivotal Network](#) and log in.
2. Click **Pivotal Container Service (PKS)**.
3. Select your desired release version from the **Releases** dropdown.
4. Click **PKS CLI**.
5. Click **PKS CLI - Mac** to download the Mac OS X binary.
6. Rename the downloaded binary file to `pks`.
7. On the command line, run the following command to make the PKS binary act as an executable file:

```
$ chmod +x pks
```

8. Move the binary file into your `PATH`.

For example, you can run the following command:

```
$ mv pks /usr/local/bin/pks
```

### Linux

1. Navigate to [Pivotal Network](#) and log in.
2. Click **Pivotal Container Service (PKS)**.
3. Select your desired release version from the **Releases** dropdown.
4. Click **PKS CLI**.
5. Click **PKS CLI - Linux** to download the Linux binary.
6. Rename the downloaded binary file to `pks`.
7. On the command line, run the following command to make the PKS binary executable:

```
$ chmod +x pks
```

8. Move the binary file into your `PATH`.

For example, you can run the following command:

```
$ mv pks /usr/local/bin/pks
```

### Windows

1. Navigate to [Pivotal Network](#) and log in.
2. Click **Pivotal Container Service (PKS)**.
3. Select your desired release version from the **Releases** dropdown.
4. Click **PKS CLI**.
5. Click **PKS CLI - Windows** to download the Windows executable file.
6. Rename the downloaded binary file to `pks.exe`.
7. Move the binary file into your `PATH`.

## Log in to PKS CLI

Use the command in this section to log in as an individual user. The login procedure is the same for users created in UAA or users from external LDAP groups.

On the command line, run the following command in your terminal to log in to the PKS CLI:

```
pks login -a PKS-API -u USERNAME -p PASSWORD --ca-cert CERT-PATH
```

Replace the placeholder values in the command as follows:

- `PKS-API` is the domain name for the PKS API that you entered in **Ops Manager > Pivotal Container Service > PKS API > API Hostname (FQDN)**. For example, `api.pks.example.com`.
- `USERNAME` and `PASSWORD` belong to the account you created in the [Grant PKS Access to a User](#) section of *Managing Users in PKS with UAA*. If you do not use `-p` to provide a password, the CLI prompts for the password interactively. Pivotal recommends running the login command without the `-p` flag for added security.
- `CERT-PATH` is the path to your root CA certificate. Provide the certificate to validate the PKS API certificate with SSL.

For example:

```
$ pks login -a api.pks.example.com -u alana \
--ca-cert /var/tempest/worksaces/default/root_ca_certificate
```

If you are logging in to a trusted environment, you can use `-k` to skip SSL verification instead of `--ca-cert CERT-PATH`.

For example:

```
$ pks login -a api.pks.example.com -u alana -k
```

Upon successful login, the PKS CLI generates a `creds.yml` file containing the API endpoint, CA certificate (if applicable), refresh token, and access token.

By default, `creds.yml` is saved in your `~/.pks` directory. You can use the `PKS_HOME` environment variable to override this location and use `creds.yml` from any directory.

## Installing the Kubernetes CLI

Page last updated:

This topic describes how to install the Kubernetes Command Line Interface (kubectl).

To install kubectl, follow the procedures for your operating system to download kubectl from [Pivotal Network](#). Binaries are only provided for 64-bit architectures.

### Mac OS X

1. Navigate to [Pivotal Network](#) and log in.
2. Click **Pivotal Container Service (PKS)**.
3. Click **Kubectl CLIs**.
4. Click **kubectl CLI - Mac** to download the kubectl binary.
5. Rename the downloaded binary to `kubectl`.
6. On the command line, run the following command to make the kubectl binary executable:

```
$ chmod +x kubectl
```

7. Move the binary into your `PATH`. For example:

```
$ mv kubectl /usr/local/bin/kubectl
```

### Linux

1. Navigate to [Pivotal Network](#) and log in.
2. Click **Pivotal Container Service (PKS)**.
3. Click **Kubectl CLIs**.
4. Click **kubectl CLI - Linux** to download the kubectl binary.
5. Rename the downloaded binary to `kubectl`.
6. On the command line, run the following command to make the kubectl binary executable:

```
$ chmod +x kubectl
```

7. Move the binary into your `PATH`. For example:

```
$ mv kubectl /usr/local/bin/kubectl
```

### Windows

1. Navigate to [Pivotal Network](#) and log in.
2. Click **Pivotal Container Service (PKS)**.
3. Click **Kubectl CLIs**.
4. Click **kubectl CLI - Windows** to download the kubectl executable file.

5. Rename the downloaded binary to `kubectl.exe`.

6. Move the binary into your `PATH`.

## Upgrading PKS Overview

Page last updated:

This section describes how to upgrade the Pivotal Container Service (PKS) tile. See the following topics:

- [What Happens During PKS Upgrades](#)
- [Upgrading PKS](#)
- [Upgrading PKS with NSX-T](#)
- [Maintaining Workload Uptime](#)
- [Configuring the Upgrade Pipeline](#)

## What Happens During PKS Upgrades

This topic explains what happens to Kubernetes clusters provisioned by Pivotal Container Service (PKS) during PKS upgrades.

### Introduction

PKS enables you to upgrade either the PKS tile and all PKS-provisioned Kubernetes clusters or only the PKS tile.

- [Upgrades of the PKS Tile and PKS-Provisioned Clusters](#)
- [Upgrades of the PKS Tile Only](#)

During an upgrade of the PKS tile, your configuration settings are automatically migrated to the new tile version. For upgrading instructions, see [Upgrading PKS](#).

### Canary Instances

The PKS tile is a BOSH deployment. When you deploy or upgrade a product using BOSH, the number of canary instances can affect the deployment.

BOSH-deployed products can set a number of canary instances to upgrade first, before the rest of the deployment VMs. BOSH continues the upgrade only if the canary instance upgrade succeeds. If the canary instance encounters an error, the upgrade stops running and other VMs are not affected.

The PKS tile uses one canary instance when deploying or upgrading PKS.

### Upgrades of the PKS Tile and PKS-Provisioned Clusters

During an upgrade of the PKS tile and PKS-provisioned clusters, the following occurs:

1. The PKS API server is recreated. For more information, see [PKS API Server](#).
2. Each of your Kubernetes clusters is recreated, one at a time. This includes the following stages for each cluster:
  - a. Master nodes are recreated. For more information, see [Master Nodes](#).
  - b. Worker nodes are recreated. For more information, see [Worker Nodes](#).

 **Note:** When PKS is set to upgrade both the PKS tile and PKS-provisioned clusters, updating any stemcell in your deployment rolls every VM in each Kubernetes cluster. This ensures that all the VMs are patched. With the recommended resource configuration described above, no workload downtime is expected. For information about maintaining your Kubernetes workload uptime, see [Maintaining Workload Uptime](#).

### PKS API Server

When the PKS API server is recreated, you cannot interact with the PKS control plane or manage Kubernetes clusters. These restrictions prevent you from performing the following actions:

- Logging in through the PKS CLI
- Retrieving information about clusters
- Creating and deleting clusters
- Resizing clusters

Recreating the PKS API server does not affect deployed Kubernetes clusters and their workloads. You can still interact with them through the Kubernetes Command Line Interface, `kubectl`.

For more information about the PKS control plane, see [PKS Control Plane Overview](#) in [PKS Cluster Management](#).

### Master Nodes

When PKS recreates a single-master cluster during an upgrade, you cannot interact with your cluster, use `kubectl`, or push new workloads.

 **Note:** To avoid this loss of functionality, Pivotal recommends using multi-master clusters.

## Worker Nodes

When PKS recreates worker nodes, the upgrade runs on a single VM at a time. During the upgrade, the VM stops running containers. If your workloads run on a single VM, your apps will experience downtime.

 **Note:** To avoid downtime for stateless workloads, Pivotal recommends using at least one worker node per availability zone (AZ). For stateful workloads, Pivotal recommends using a minimum of two worker nodes per AZ.

## Upgrades of the PKS Tile Only

During an upgrade of the PKS tile only, the PKS API server is recreated.

When the PKS API server is recreated, you cannot interact with the PKS control plane or manage Kubernetes clusters. These restrictions prevent you from performing the following actions:

- Logging in through the PKS CLI
- Retrieving information about clusters
- Creating and deleting clusters
- Resizing clusters

Recreating the PKS API server does not affect deployed Kubernetes clusters and their workloads. You can still interact with them through the Kubernetes Command Line Interface, `kubectl`.

To upgrade the PKS tile only, set the **Upgrade all clusters errand** to **Off** before you begin the upgrade. For more information, see [Upgrade the PKS Tile](#) in [Upgrading PKS](#).

For more information about the PKS control plane, see [PKS Control Plane Overview](#) in [PKS Cluster Management](#).

 **Note:** When PKS is set to upgrade only the PKS tile and not the clusters, the Kubernetes cluster version falls behind the PKS tile version. If the clusters fall more than one version behind the tile, PKS cannot upgrade the clusters. The clusters must be upgraded to match the PKS tile version before the next tile upgrade.

## Upgrading PKS

Page last updated:

This topic explains how to upgrade the Pivotal Container Service (PKS) tile and existing Kubernetes clusters.

For conceptual information about upgrading the PKS tile and PKS-provisioned Kubernetes clusters, see [What Happens During PKS Upgrades](#).

 **WARNING:** Do not manually upgrade your Kubernetes version. The PKS service includes the compatible Kubernetes version.

For information about upgrading PKS on vSphere with NSX-T integration, see [Upgrading PKS with NSX-T](#).

## Before You Upgrade

This section describes the activities you must perform before upgrading PKS.

### Determine Your Upgrade Path

Use the following table to determine your upgrade path to PKS v1.2.x.

If your current version of PKS is...	Then use the following upgrade path:
v1.1.4 or earlier	<ol style="list-style-type: none"><li>Upgrade to PKS v1.1.5 or later.</li><li>Upgrade to Ops Manager v2.2.3 or later, or Ops Manager v2.3.1 or later.</li><li>Upgrade to PKS v1.2.x.</li><li>(Optional) For PKS v1.2.4 and later, upgrade to Ops Manager v2.4.x.</li></ol>
v1.1.5 or later	<ol style="list-style-type: none"><li>Upgrade to Ops Manager v2.2.3 or later, or Ops Manager v2.3.1 or later.</li><li>Upgrade to PKS v1.2.x.</li><li>(Optional) For PKS v1.2.4 and later, upgrade to Ops Manager v2.4.x.</li></ol>

## Prepare to Upgrade

Before you begin upgrading the PKS tile, perform the following steps:

- Review the [Release Notes](#) for the version or versions of PKS you are upgrading to.
- Review [What Happens During PKS Upgrades](#), and consider your workload capacity and uptime requirements.
- View your workload resource usage in Dashboard. For more information, see [Accessing Dashboard](#).
  - If workers are operating too close to their capacity, the PKS upgrade can fail. To prevent workload downtime during a cluster upgrade, Pivotal recommends running your workload on at least three worker VMs, using multiple replicas of your workloads spread across those VMs. For more information, see [Maintaining Workload Uptime](#).
  - If your clusters are near capacity for your existing infrastructure, Pivotal recommends scaling up your clusters before you upgrade. Scale up your cluster by running `pks resize` or create a cluster using a larger plan. For more information, see [Scaling Existing Clusters](#).
- Verify that your Kubernetes environment is healthy. To verify the health of your Kubernetes environment, see [Verifying Deployment Health](#).
- (Optional) Back up the PKS v1.1 control plane. For more information, see [Backing Up and Restoring PKS](#).

## During the Upgrade

This section describes the steps required to upgrade to PKS v1.2.x.

## Step 1: Upgrade to PKS v1.1.5 or Later

Skip this step if you are already running PKS v1.1.5+.

Follow the procedures detailed in [Upgrading PKS](#) in the PKS v1.1 documentation.

## Step 2: Upgrade to Ops Manager v2.2.3+ or v2.3.1+

Before you upgrade to PKS v1.2.x, you must upgrade to Ops Manager v2.2.3+ or v2.3.1+.

1. Follow the procedures in [Upgrade Ops Manager and Installed Products to v2.2](#) or [Upgrade Ops Manager and Installed Products to v2.3](#).
2. Verify that the PKS control plane remains functional by performing the following steps:
  - a. Add more workloads and create an additional cluster. For more information about performing those actions, see [About Workload Upgrades](#) in [Maintaining Workload Uptime](#) and [Creating Clusters](#).
  - b. Monitor the PKS control plane VM by clicking the **Pivotal Container Service tile**, selecting **Status** tab, and reviewing the **Pivotal Container Service** VM's data points. If any data points are at capacity, scale your deployment accordingly.

## Step 3: Upgrade to PKS v1.2.x

To upgrade to PKS v1.2.x, follow the same Ops Manager process that you use to install the tile for the first time.

Your configuration settings migrate to the new version automatically. Follow the steps below to perform an upgrade.

1. Review the [Release Notes](#) for the version you are upgrading to.
2. Download the desired version of the product from [Pivotal Network](#).
3. Navigate to the Ops Manager Installation Dashboard and click **Import a Product** to upload the product file.
4. Under the **Import a Product** button, click + next to **Pivotal Container Service**. This adds the tile to your staging area.

## Step 4: Download and Import the Stemcell

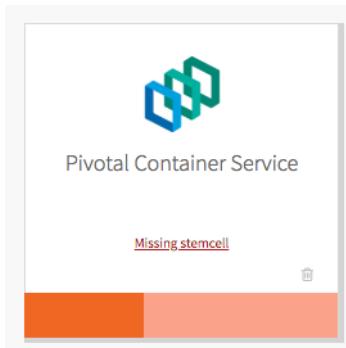
PKS v1.2.x uses a [Xenial stemcell](#).

If Ops Manager does not have the Xenial stemcell required for PKS, the PKS tile displays the message **Missing stemcell**.

**Note:** If the **Stemcell Library** in Ops Manager already has a compatible Xenial stemcell, the **Missing stemcell** link does not appear. You do not need to download or import a new stemcell and can skip this step.

To download and import a new Xenial stemcell, follow the steps below:

1. On the **Pivotal Container Service** tile, click on the **Missing stemcell** link.



2. In the **Stemcell Library**, locate Pivotal Container Service and note the required stemcell version.
3. Visit the [Stemcells for PCF \(Ubuntu Xenial\)](#) page on Pivotal Network, and download the required stemcell version appropriate for your IaaS.
4. Return to the **Installation Dashboard** in Ops Manager, and click on **Stemcell Library**.
5. On the **Stemcell Library** page, click **Import Stemcell** and select the stemcell file you downloaded from Pivotal Network.
6. Select Pivotal Container Service and click **Apply Stemcell to Products**.
7. Verify that Ops Manager successfully applied the stemcell. The stemcell version you imported and applied appears in the **Staged** column for Pivotal Container Service.
8. Select the **Installation Dashboard** link to return to the Installation Dashboard.

## Step 5: Verify Errand Configuration

To verify that errands are configured correctly in the PKS tile, perform the following steps.

1. Click the newly-added **Pivotal Container Service** tile.
2. Click **Errands**.
3. Under **Post-Deploy Errands**, verify that the **Upgrade all clusters errand** is set to **Default (On)**. The errand upgrades a single Kubernetes cluster at a time. Upgrading PKS Kubernetes clusters can temporarily interrupt the service, as described in [Service Interruptions](#).  
**⚠ WARNING:** If you are upgrading PKS, you must enable the **Upgrade All Clusters** errand.
4. Review the other configuration panes. Click **Save** on any panes where you make changes.  
**💡 Note:** When you upgrade PKS, you must place singleton jobs in the AZ you selected when you first installed the PKS tile. You cannot move singleton jobs to another AZ.

## Step 6: Apply Changes to the PKS Tile

Perform the following steps to complete the upgrade to the PKS tile.

1. Return to the **Installation Dashboard** in Ops Manager.
2. If you are using Ops Manager v2.2, click **Review Pending Changes [BETA]**. For more information about this Ops Manager page, see [Reviewing Pending Product Changes](#).
3. If you are using Ops Manager v2.3, click **Review Pending Changes**. For more information about this Ops Manager page, see [Reviewing Pending Product Changes](#).
4. Click **Apply Changes**.
- (Optional) To monitor the progress of the **Upgrade all clusters errand** using the BOSH CLI, do the following:
  - a. Log in to the BOSH Director by running `bosh -e MY-ENVIRONMENT log-in` from a VM that can access your PKS deployment. For more information, see [Managing PKS Deployments with BOSH](#).
  - b. Run `bosh -e MY-ENVIRONMENT tasks`.
  - c. Locate the task number for the errand in the # column of the BOSH output.
  - d. Run `bosh task TASK-NUMBER`, replacing `TASK-NUMBER` with the task number you located in the previous step.

## (Optional) Step 7: Upgrade to Ops Manager v2.4.x

To upgrade to Ops Manager v2.4.x, perform the following steps:

1. Follow the procedures in [Upgrade Ops Manager and Installed Products to v2.4](#).
2. Verify that the PKS control plane remains functional by performing the following steps:

- a. Add more workloads and create an additional cluster. For more information about performing those actions, see [About Workload Upgrades](#) in [Maintaining Workload Uptime](#) and [Creating Clusters](#).
- b. Monitor the PKS control plane VM by clicking the **Pivotal Container Service tile**, selecting **Status tab**, and reviewing the **Pivotal Container Service** VM's data points. If any data points are at capacity, scale your deployment accordingly.

## After the Upgrade

After you complete the upgrade to PKS v1.3.x, complete the following verifications and upgrades.

### Update PKS and Kubernetes CLIs

Update the PKS and Kubernetes CLIs on any local machine where you run commands that interact with your upgraded version of PKS.

To update your CLIs, download and re-install the PKS and Kubernetes CLI distributions that are provided with PKS on Pivotal Network.

For more information about installing the CLIs, see the following topics:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

### Verify the Upgrade

After you apply changes to the PKS tile and the upgrade is complete, perform the following steps:

1. Verify that your Kubernetes environment is healthy. To verify the health of your Kubernetes environment, see [Verifying Deployment Health](#).
2. Verify that the PKS control plane remains functional by performing the following steps:
  - a. Add more workloads and create an additional cluster. For more information about performing those actions, see [About Workload Upgrades](#) in [Maintaining Workload Uptime](#) and [Creating Clusters](#).
  - b. Monitor the PKS control plane VM by clicking the **Pivotal Container Service tile**, selecting **Status tab**, and reviewing the **Pivotal Container Service** VM's data points. If any data points are at capacity, scale your deployment accordingly.

### (Optional) Upgrade vSphere

If you are deploying PKS on vSphere, consult [vSphere Version Requirements](#) and upgrade vSphere if necessary.

## Upgrading PKS with NSX-T

Page last updated:

This topic explains how to upgrade the Pivotal Container Service (PKS) for environments using vSphere with NSX-T.

### Before You Upgrade

This section describes the activities you must perform before upgrading PKS.

### Consult Compatibility Charts

For information about PKS with NSX-T and Ops Manager compatibility, refer to the compatibility chart below:

PKS Version	Compatible NSX-T Versions	Compatible Ops Manager Versions
v1.2.x	v2.2, v2.3	v2.2.3+, v2.3.1+
v1.1.6	v2.1, v2.2	v2.1.x, 2.2.x
v1.1.5	v2.1, v2.2	v2.1.x, v2.2.x
v1.1.4	v2.1	v2.1.x, 2.2.x
v1.1.3	v2.1	v2.1.0 - 2.1.6
v1.1.2	v2.1	v2.1.x, 2.2.x
v1.1.1	v2.1 - Advanced Edition	v2.1.0 - 2.1.6

For more information on NSX-T product compatibility, see the [VMware Product Interoperability Matrix](#) for PKS in the VMware documentation.

### Determine Your Upgrade Path

Use the following table to determine your upgrade path to PKS v1.2 with NSX-T. PKS v1.2 supports NSX-T v2.3, which is the recommended NSX-T version.

If your current version of PKS is...	Then use the following upgrade path:
v1.1.4 or earlier	<ol style="list-style-type: none"><li>Upgrade to PKS v1.1.5 or later.</li><li>Upgrade to NSX-T v2.2.</li><li>Upgrade to Ops Manager v2.2.3 or later, or Ops Manager v2.3.1 or later.</li><li>Upgrade to PKS v1.2.x.</li><li>Upgrade to NSX-T v2.3.</li><li>(Optional) For PKS v1.2.4 and later, upgrade to Ops Manager v2.4.x.</li></ol>
v1.1.5 or later	<ol style="list-style-type: none"><li>Upgrade to NSX-T v2.2.</li><li>Upgrade to Ops Manager v2.2.3 or later, or Ops Manager v2.3.1 or later.</li><li>Upgrade to PKS v1.2.x.</li><li>Upgrade to NSX-T v2.3.</li><li>(Optional) For PKS v1.2.4 and later, upgrade to Ops Manager v2.4.x.</li></ol>

### Prepare to Upgrade

Before you begin upgrading the PKS tile, follow the steps below:

1. Review the [Release Notes](#) for the version or versions of PKS you are upgrading to.
2. Verify that your Kubernetes environment is healthy. To verify the health of your Kubernetes environment, see [Verifying Deployment Health](#).
3. Make sure there are no issues with vSphere by following the steps below:
  - a. Verify that datastores have enough space.
  - b. Verify that hosts have enough memory.
  - c. Verify that there are no alarms.
  - d. Verify that hosts are in a good state.
4. Verify that NSX Edge is configured for high availability using Active/Standby mode.

 **Note:** Workloads in your Kubernetes cluster are unavailable while the NSX Edge nodes run the upgrade unless you configure NSX Edge for high availability. For more information, see the [Configure NSX Edge for High Availability \(HA\)](#) section of *Preparing NSX-T Before Deploying PKS*.

5. (Optional) Back up the environment using the procedures in the following topics:

- o [Backup PKS](#)
- o [Backup NSX-T](#)
- o [Backup vCenter](#)

 **Note:** If you choose not to back up PKS, NSX-T, or vCenter, we recommend backing up the NSX-T and NSX-T Container Plugin (NCP) logs. For more information, see [PKS Logs for NSX-T and NCP](#) below.

## During the Upgrade

This section describes the steps required to upgrade to PKS v1.2 with NSX-T v2.3.

### Step 1: Upgrade to PKS v1.1.5 or Later

Skip this step if you are already running PKS v1.1.5+.

Follow the procedures detailed in [Upgrading PKS with NSX-T](#) in the PKS v1.1 documentation.

 **Note:** PKS v1.1.5 with NSX-T introduces architectural changes that require larger sized worker node VMs. Before you upgrade to PKS v1.1.5 or later, you must increase the size of the Kubernetes worker node VM. For more information on how to increase the worker node VM size, see [Increase the Kubernetes Worker Node VM Size](#) in the PKS v1.1 documentation. For more information about the architectural changes in PKS v1.1.5 with NSX-T, see [NSX-T Architectural Changes](#) in the PKS v1.1.5 Release Notes.

### Step 2: Upgrade to NSX-T v2.2

Skip this step if you are already running NSX-T v2.2.

To upgrade to NSX-T v2.2, follow the procedures detailed in [Upgrading NSX-T](#) in the VMware documentation.

### Step 3: Upgrade to Ops Manager v2.2.3+ or v2.3.1+

Before you upgrade to PKS v1.2.x, you must upgrade to Ops Manager v2.2.3+ or v2.3.1+.

1. Follow the procedures detailed in [Upgrade Ops Manager and Installed Products to v2.2](#) or [Upgrade Ops Manager and Installed Products to v2.3](#).
2. Verify that the PKS control plane remains functional by performing the following steps:
  - a. Add more workloads and create an additional cluster. For more information about performing those actions, see [About Workload Upgrades](#) in [Maintaining Workload Uptime](#) and [Creating Clusters](#).

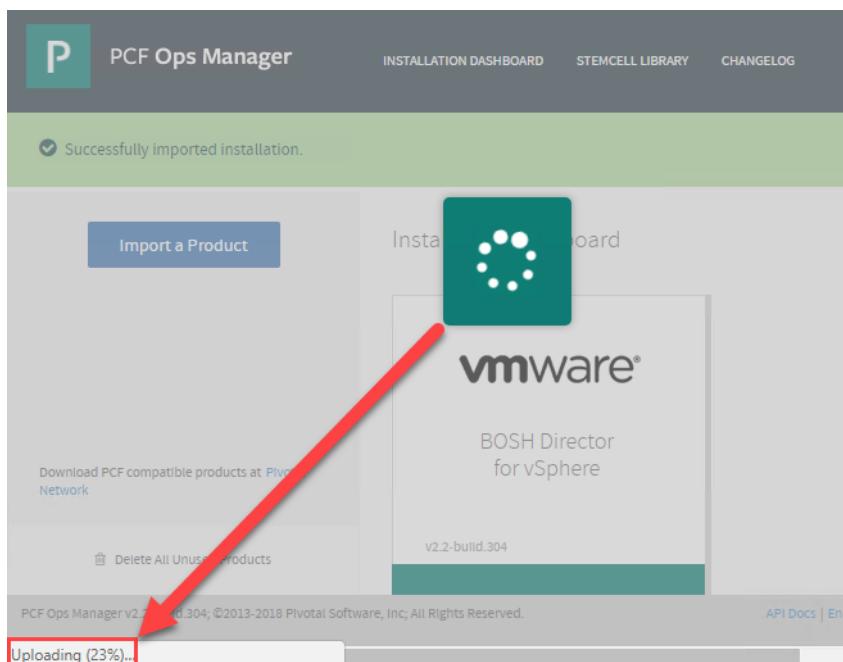
- b. Monitor the PKS control plane VM by clicking the **Pivotal Container Service tile**, selecting **Status tab**, and reviewing the **Pivotal Container Service** VM's data points. If any data points are at capacity, scale your deployment accordingly.

## Step 4: Upgrade to PKS v1.2.x

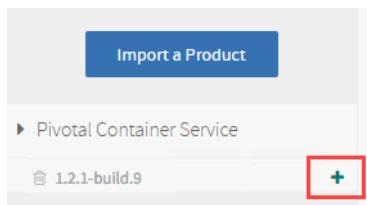
To upgrade PKS, you follow the same Ops Manager process that you use to install the tile for the first time.

Your configuration settings migrate to the new version automatically. Follow the steps below to perform an upgrade.

1. Review the [Release Notes](#) for the version you are upgrading to.
2. Download the desired version of the product from [Pivotal Network](#).
3. Navigate to the Ops Manager Installation Dashboard and click **Import a Product**.
4. Browse to the PKS product file and select it. Uploading the file takes several minutes.



5. Under the **Import a Product** button, click + next to **Pivotal Container Service**. This adds the tile to your staging area.



## Step 5: Download and Import the Stemcell

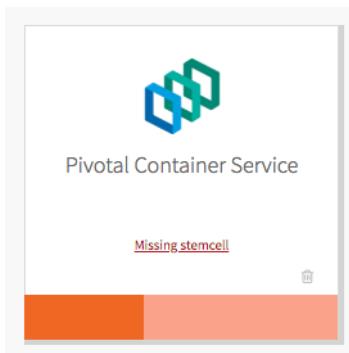
PKS v1.2.x uses a [Xenial stemcell](#).

If Ops Manager does not have the Xenial stemcell required for PKS, the PKS tile displays the message **Missing stemcell**.

**Note:** If the **Stemcell Library** in Ops Manager already has a compatible Xenial stemcell, the **Missing stemcell** link does not appear. You do not need to download or import a new stemcell and can skip this step.

To download and import a new Xenial stemcell, follow the steps below:

1. On the **Pivotal Container Service** tile, click on the **Missing stemcell** link.



2. In the **Stemcell Library**, locate Pivotal Container Service and note the required stemcell version.
3. Visit the [Stemcells for PCF \(Ubuntu Xenial\)](#) page on Pivotal Network, and download the required stemcell version for vSphere.
4. Return to the **Installation Dashboard** in Ops Manager, and click on **Stemcell Library**.
5. On the **Stemcell Library** page, click **Import Stemcell** and select the stemcell file you downloaded from Pivotal Network.

The screenshot shows the "Stemcell Library" page in the Ops Manager interface. At the top, there is a breadcrumb navigation with "← INSTALLATION DASHBOARD". Below the title "Stemcell Library", there are two products listed:

Product	Required	Deployed	Staged
VMware Harbor Registry	ubuntu-trusty 3468	3468.42	<input type="text" value="3468.42"/> <input checked="" type="checkbox"/> Latest stemcell.
Pivotal Container Service	ubuntu-xenial 97.17	3586.36	<b>IMPORT STEMCELL</b> No compatible stemcell available.

At the top right of the table, there are two buttons: "IMPORT STEMCELL" and "SAVE".

6. Select the PKS product and click **Apply Stemcell to Products**.

The screenshot shows a modal dialog titled "IMPORT STEMCELL". The text inside the dialog reads: "Select the products you want to stage with light-bosh-stemcell-97.17-vsphere-esxi-ubuntu-xenial". There are two checkboxes at the bottom of the list:  
 Product  
 Pivotal Container Service v1.2.1-build.9

At the bottom of the dialog, there are two buttons: "DISMISS" and "APPLY STEMCELL TO PRODUCTS".

7. Verify that Ops Manager successfully applied the stemcell.

Product	Required	Deployed	Staged
VMware Harbor Registry	ubuntu-trusty 3468	3468.42	3468.42 <input checked="" type="button"/> Latest stemcell.
Pivotal Container Service	ubuntu-xenial 97.17	3586.36	97.17 <input checked="" type="button"/> Latest stemcell.

8. Select the **Installation Dashboard** link to return to the Installation Dashboard.

**Import a Product**

### Installation Dashboard

vSphere®  
v2

Pivotal Container Service  
v1.

VMware Harbor Registry  
v1.

▶ UPDATE Pivotal Container Service  
▶ UPDATE STEMCELL Pivotal Container Service

Revert

Apply changes

▶ Review Pending Changes

BETA

## Step 6: Verify Errand Configuration

To verify that errands are configured correctly in the PKS tile, perform the following steps.

- In the PKS tile, click **Errands**.
- Under **Post-Deploy Errands**, verify that the listed errands are configured as follows:
  - NSX-T Validation errand:** Set to **On**
  - Upgrade all clusters errand:** Set to **Default (On)**
  - Create pre-defined Wavefront alerts errand:** Set to **Default (Off)**

**⚠ WARNING:** If you set the **Upgrade all clusters errand** to **Off**, your Kubernetes cluster version will fall behind the PKS tile version. If your clusters fall more than one version behind the tile, you can no longer upgrade the clusters. You must upgrade your clusters to match the PKS tile version.

tile version before the next tile upgrade.

3. If you make any changes, click **Save**.

## Step 6: Apply Changes to the PKS Tile

Perform the following steps to complete the upgrade to the PKS tile.

1. Return to the **Installation Dashboard** in Ops Manager.
2. If you are using Ops Manager v2.2, click **Review Pending Changes [BETA]**. For more information about this Ops Manager page, see [Reviewing Pending Product Changes ↗](#).
3. If you are using Ops Manager v2.3, click **Review Pending Changes**. For more information about this Ops Manager page, see [Reviewing Pending Product Changes ↗](#).
4. Click **Apply Changes**.

## Step 7: Upgrade to NSX-T v2.3

NSX-T v2.3 is the recommended version of NSX-T to use with PKS v1.2.

To upgrade to NSX-T v2.3, follow the procedures detailed in [Upgrading NSX-T Data Center ↗](#).

## (Optional) Step 8: Upgrade to Ops Manager v2.4.x

To upgrade to Ops Manager v2.4.x, perform the following steps:

1. Follow the procedures in [Upgrade Ops Manager and Installed Products to v2.4 ↗](#).
2. Verify that the PKS control plane remains functional by performing the following steps:
  - a. Add more workloads and create an additional cluster. For more information about performing those actions, see [About Workload Upgrades in Maintaining Workload Uptime](#) and [Creating Clusters](#).
  - b. Monitor the PKS control plane VM by clicking the **Pivotal Container Service tile**, selecting **Status tab**, and reviewing the **Pivotal Container Service** VM's data points. If any data points are at capacity, scale your deployment accordingly.

## After the Upgrade

After you complete the upgrade to PKS v1.2.x and NSX-T v2.3, complete the following verifications and upgrades.

### Update PKS and Kubernetes CLIs

Update the PKS and Kubernetes CLIs on any local machine where you run commands that interact with your upgraded version of PKS.

To update your CLIs, download and re-install the PKS and Kubernetes CLI distributions that are provided with PKS on Pivotal Network.

For more information about installing the CLIs, see the following topics:

- [Installing the PKS CLI](#)
- [Installing the Kubernetes CLI](#)

### Verify the Upgrade

After you apply changes to the PKS tile and the upgrade is complete, verify that your Kubernetes environment is healthy and confirm that NCP is running on the master node VM.

To verify the health of your Kubernetes environment and NCP, see [Verifying Deployment Health](#).

## (Optional) Upgrade vSphere

Upgrade vSphere from version 6.5 or 6.5 U1 to 6.5 U2 or 6.7. VMware vSphere 6.7 is only supported with Ops Manager v2.3.1 or later and NSX-T v2.3.

For more information, see [vSphere Version Requirements](#) in PKS documentation and [Upgrading vSphere in an NSX Environment](#) in the VMware documentation.

## Maintaining Workload Uptime

Page last updated:

This topic describes how you can maintain workload uptime for Kubernetes clusters deployed with Pivotal Container Service (PKS).

To maintain workload uptime, configure the following settings in your deployment manifest:

1. Configure [workload replicas](#) to handle traffic during rolling upgrades.
2. Define an [anti-affinity rule](#) to evenly distribute workloads across the cluster.

To increase uptime, you can also refer to the documentation for the services that run on your clusters, and configure your workload based on the recommendations of the software vendor.

## About Workload Upgrades

The PKS tile contains an errand that upgrades all Kubernetes clusters. Upgrades run on a single VM at a time. While one worker VM runs an upgrade, the workload on that VM goes down. The additional worker VMs continue to run replicas of your workload, maintaining the uptime of your workload.

 **Note:** Ensure that your pods are bound to a *ReplicaSet* or *Deployment*. Naked pods are not rescheduled in the event of a node failure. For more information, see [Configuration Best Practices](#) in the Kubernetes documentation.

To prevent workload downtime during a cluster upgrade, Pivotal recommends running your workload on at least three worker VMs and using multiple replicas of your workloads spread across those VMs. You must edit your manifest to define the replica set and configure an anti-affinity rule to ensure that the replicas run on separate worker nodes.

## Set Workload Replicas

Set the number of workload replicas to handle traffic during rolling upgrades. To replicate your workload on additional worker VMs, deploy the workload using a replica set.

Edit the `spec.replicas` value in your deployment manifest:

```
kind: Deployment
metadata:
# ...
spec:
replicas: 3
template:
metadata:
labels:
app: APP-NAME
```

See the following table for more information about this section of the manifest:

Key-Value Pair	Description
<code>spec: replicas: 3</code>	Set this value to at least 3 to have at least three instances of your workload running at any time.
<code>app: APP-NAME</code>	Use this app name when you define the anti-affinity rule later in the spec.

## Define an Anti-Affinity Rule

To distribute your workload across multiple worker VMs, you must use anti-affinity rules. If you do not define an anti-affinity rule, the replicated pods can be assigned to the same worker node. See the [Kubernetes documentation](#) for more information about anti-affinity rules.

To define an anti-affinity rule, add the `spec.template.spec.affinity` section to your deployment manifest:

```
kind: Deployment
metadata:
# ...
spec:
replicas: 3
template:
metadata:
labels:
app: APP-NAME
spec:
containers:
- name: MY-APP
image: MY-IMAGE
ports:
- containerPort: 12345
affinity:
podAntiAffinity:
requiredDuringSchedulingIgnoredDuringExecution:
- labelSelector:
matchExpressions:
- key: "app"
operator: In
values:
- APP-NAME
topologyKey: "kubernetes.io/hostname"
```

See the following table for more information:

Key-Value Pair	Description
<code>podAntiAffinity: requiredDuringSchedulingIgnoredDuringExecution</code>	<ul style="list-style-type: none"> <li>When you set <code>podAntiAffinity</code> to the <code>requiredDuringSchedulingIgnoredDuringExecution</code> value, the pod is eligible to be scheduled only on worker nodes that are not running a replica of this pod. If the requirement cannot be met, scheduling fails.</li> <li>Alternatively, you can set <code>podAntiAffinity</code> to the <code>preferredDuringSchedulingIgnoredDuringExecution</code> value. With this rule, the scheduler tries to schedule pod replicas on different worker nodes. If it is not possible, the scheduler assigns more than one pod to the same worker node.</li> </ul>
<code>matchExpressions: - key: "app"</code>	This value matches <code>spec.template.metadata.labels.app</code> .
<code>values: - APP-NAME</code>	This value matches the <code>APP-NAME</code> you defined earlier in the spec.

## Multi-AZ Worker

Kubernetes evenly spreads pods in a replication controller over multiple Availability Zones (AZs). For more granular control over scheduling pods, add an `Anti-Affinity Rule` to the deployment spec by replacing `"kubernetes.io/hostname"` with `"failure-domain.beta.kubernetes.io/zone"`.

For more information on scheduling pods, see [Advanced Scheduling in Kubernetes](#) on the Kubernetes Blog.

## PersistentVolumes

If an AZ goes down, PersistentVolumes (PVs) and their data also go down and cannot be automatically re-attached. To preserve your PV data in the event of a fallen AZ, your persistent workload needs to have a failover mechanism in place.

Depending on the underlying storage type, PVs are either completely free of zonal information or can have multiple AZ labels attached. Both options enable a PV to travel between AZs.

To ensure the uptime of your PVs during a cluster upgrade, Pivotal recommends that you have at least two nodes per AZ. By configuring your workload as suggested, Kubernetes reschedules pods in the other node of the same AZ while BOSH is performing the upgrade.

For information about configuring PVs in PKS, see [Configuring PersistentVolumes](#).

For information about using dynamic PVs in PKS, see [Using Dynamic PersistentVolumes](#).

For information about the supported storage topologies for PKS on vSphere, see [PersistentVolume Storage Options on vSphere](#).

## Configuring the Upgrade Pipeline

Page last updated:

This topic describes how to set up a Concourse pipeline to perform automatic upgrades of a Pivotal Container Service (PKS) installation.

When you configure the upgrade pipeline, the pipeline upgrades your installation when a new PKS release becomes available on Pivotal Network.

By default, the pipeline upgrades when a new major patch version is available.

For more information about configuring and using Concourse for continuous integration (CI), see the [Concourse documentation](#).

## Download the Upgrade Pipeline

Perform the following steps:

1. From a browser, log in to [Pivotal Network](#).
2. Navigate to the **PCF Platform Automation with Concourse** product page to download the upgrade-tile pipeline.

 **Note:** If you cannot access PCF Platform Automation with Concourse on Pivotal Network, contact Pivotal Support.

3. (Optional) Edit [params.yml](#) to configure the pipeline.
  - For example, edit the `product_version_regex` value to follow minor version updates.
4. Set the pipeline using the `fly` CLI for Concourse. See the [upgrade-tile pipeline documentation](#) for more information.

## Managing PKS

Page last updated:

This section describes how to manage Pivotal Container Service (PKS). See the following topics:

- [Configuring PKS API Access](#)
- [Managing Users in PKS with UAA](#)
- [Managing PKS Deployments with BOSH](#)
- [Configuring a GCP Load Balancer for PKS Clusters](#)
- [Configuring an AWS Load Balancer for PKS Clusters](#)
- [PersistentVolume Storage Options on vSphere](#)
- [Adding Custom Workloads](#)
- [Configuring an Ingress Controller](#)
- [Using Proxies with PKS on NSX-T](#)
- [Deleting PKS](#)

## Configuring PKS API Access

Page last updated:

This topic describes how to configure access to the Pivotal Container Service (PKS) API. See [PKS API Authentication](#) for more information about how the PKS API and UAA interact with your PKS deployment.

### Configure Access to the PKS API

1. Locate your Ops Manager root CA certificate.
  - If Ops Manager generated your certificate, refer to the [Retrieve the Ops Manager Root Certificate](#) section of *Managing Certificates*.
  - If you provided your own certificate, copy and paste the certificate you entered in the PKS API pane into a file.
2. Target your UAA server by running the following command:

```
uaac target https://PKS-API:8443 --ca-cert ROOT-CA-Filename
```

Replace the following values:

- **PKS-API**: enter the fully qualified domain name (FQDN) you use to access the PKS API. You configured this URL in the PKS API section of *Installing PKS* for your IaaS. For example, see [Installing PKS on vSphere](#).
- **ROOT-CA-Filename**: enter the path for the certificate file you downloaded in a previous step. For example:

```
$ uaac target api.pks.example.com:8443 --ca-cert my-cert.cert
```

Including `https://` in the PKS API URL is optional.

3. Run `uaac token client get admin -s UAA-ADMIN-SECRET` to request a token from the UAA server. Replace `UAA-ADMIN-SECRET` with your UAA admin secret. Refer to [Ops Manager > Pivotal Container Service > Credentials > Pks Uaa Management Admin Client](#) to retrieve this value.
4. Grant cluster access to new or existing users with UAA. For more information on granting cluster access to users or creating users, see the [Grant PKS Access to a User](#) section of *Managing Users in PKS with UAA*.

### Log in to the PKS CLI as a User

For information about logging in to the PKS CLI as a user, see the [Log in to PKS CLI](#) section of *Installing the PKS CLI*.

### Log in to PKS as an Automated Client

On the command line, run the following command to log in to the PKS CLI as an automated client for a script or service:

```
pks login -a PKS-API --client-name CLIENT-NAME --client-secret CLIENT-SECRET --ca-cert CERTIFICATE-PATH
```

Where:

- **PKS-API** is the domain name for the PKS API that you entered in [Ops Manager > Pivotal Container Service > PKS API > API Hostname \(FQDN\)](#). For example, `api.pks.example.com`.
- **CLIENT-NAME** is your OAuth client ID.
- **CLIENT-SECRET** is your OAuth client secret.
- **CERTIFICATE-PATH** is the path to your root CA certificate. Provide the certificate to validate the PKS API certificate with SSL.

For example:

```
$ pk login -a api.pks.example.com \
--client-name automated-client \
--client-secret randomly-generated-secret \
--ca-cert /var/tempest/worksheets/default/root_ca_certificate
```

## Managing PKS Deployments with BOSH

Page last updated:

This topic describes how to manage your Pivotal Container Service (PKS) deployment using BOSH.

### Set a BOSH Environment Alias

To set a BOSH alias for your PKS deployment environment, follow the steps below:

1. Gather credential and IP address information for your BOSH Director and SSH into the Ops Manager VM. See [Advanced Troubleshooting with the BOSH CLI](#) for more information.
2. To create a BOSH alias for your PKS environment, run the following command:

```
bosh alias-env ENVIRONMENT \
-e BOSH-DIRECTOR-IP \
--ca-cert /var/tempest/workspaces/default/root_ca_certificate
```

Where:

- `ENVIRONMENT` is an alias of your choice. For example, `pks`.
- `BOSH-DIRECTOR-IP` is the BOSH Director IP address you located in the first step. For example, `10.0.0.3`.

For example:

```
$ bosh alias-env pks -e 10.0.0.3 \
--ca-cert /var/tempest/workspaces/default/root_ca_certificate
```

3. To log in to the BOSH Director using the alias you set, run the following command:

```
bosh -e ENVIRONMENT login
```

For example:

```
$ bosh -e pks login
```

### SSH into the PKS VM

To SSH into the PKS VM using BOSH, follow the steps below:

1. Gather credential and IP address information for your BOSH Director, SSH into the Ops Manager VM, and use BOSH CLI to log in to the BOSH Director from the Ops Manager VM. For more information, see [Advanced Troubleshooting with the BOSH CLI](#).
2. To identify your PKS deployment's name, run the following command:

```
bosh -e ENVIRONMENT deployments
```

Where `ENVIRONMENT` is the BOSH environment alias you set in [Set a BOSH Environment Alias](#).

For example:

```
$ bosh -e pks deployments
```

Your PKS deployment name begins with `pivotal-container-service` and includes a BOSH-generated hash.

3. To identify your PKS VM's name, run the following command:

```
bosh -e ENVIRONMENT -d DEPLOYMENT vms
```

Where:

- `ENVIRONMENT` is the BOSH environment alias.
- `DEPLOYMENT` is your PKS deployment name.

For example:

```
$ bosh -e pk -d pivotal-container-service/a1b2c333d444e5f66a77 vms
```

Your PKS VM name begins with `pivotal-container-service` and includes a BOSH-generated hash.

 **Note:** The PKS VM hash value is different from the hash in your PKS deployment name.

#### 4. To SSH into the PKS VM, run the following command:

```
bosh -e ENVIRONMENT -d DEPLOYMENT ssh PKS-VM
```

Where:

- `ENVIRONMENT` is the BOSH environment alias.
- `DEPLOYMENT` is your PKS deployment name.
- `PKS-VM` is your PKS VM name.

For example:

```
$ bosh -e pk -d pivotal-container-service/a1b2c333d444e5f66a77 \
ssh pivotal-container-service/000a1111-222b-3333-4cc5-de66f7a8899b
```

## Configuring a GCP Load Balancer for PKS Clusters

Page last updated:

This topic describes how to configure a Google Cloud Platform (GCP) load balancer for a Kubernetes cluster deployed by Pivotal Container Service (PKS).

A load balancer is a third-party device that distributes network and application traffic across resources. You can use a load balancer to access a PKS cluster from outside the network using the PKS API and `kubectl`. Using a load balancer can also prevent individual network components from being overloaded by high traffic.

You can configure GCP load balancers only for PKS clusters that are deployed on GCP.

### Prerequisites

The procedures in this topic have the following prerequisites:

- To complete these procedures, you must have already configured a load balancer to access the PKS API. For more information, see [Creating a GCP Load Balancer for the PKS API](#).
- The version of the PKS CLI you are using must match the version of the PKS tile you are installing.

### Configure GCP Load Balancer

Follow the procedures in this section to create and configure a load balancer for PKS-deployed Kubernetes clusters using GCP. Modify the example commands in these procedures to match your PKS installation.

#### Step 1: Create a GCP Load Balancer

Perform the following steps to create a GCP load balancer for your PKS clusters:

1. Navigate to the [Google Cloud Platform console](#).
2. In the sidebar menu, select **Network Services > Load balancing**.
3. Click **Create a Load Balancer**.
4. In the **TCP Load Balancing** pane, click **Start configuration**.
5. Click **Continue**. The **New TCP load balancer** menu opens.
6. Give the load balancer a name. For example, `my-cluster`.
7. Click **Frontend configuration** and configure the following settings:
  - a. Click **IP**.
  - b. Select **Create IP address**.
  - c. Give the IP address a name. For example, `my-cluster-ip`.
  - d. Click **Reserve**. GCP assigns an IP address.
  - e. In the **Port** field, enter `8443`.
  - f. Click **Done** to complete frontend configuration.
8. Review your load balancer configuration and click **Create**.

#### Step 2: Create the Cluster

Follow the procedures in the [Create a Kubernetes Cluster](#) section of *Creating Clusters*. Use the GCP-assigned IP address from the previous step as the external hostname when you run the `pkcs create-cluster` command.

## Step 3: Configure Load Balancer Backend

Perform the following steps to configure the backend of the load balancer:

1. Navigate to the [Google Cloud Platform console](#).
2. In the sidebar menu, select **Network Services > Load balancing**.
3. Select the load balancer you created for the cluster and select **Configure**.
4. Click **Backend configuration** and configure the following settings:
  - a. Select all master VMs for your cluster from the dropdown. To locate the IP addresses and VM IDs of the master VMs, see [Identify Kubernetes Cluster Master VMs](#) in *Creating Clusters*.

 **Breaking Change:** If master VMs are recreated for any reason, such as a stemcell upgrade, you must reconfigure the load balancer to target the new master VMs. For more information, see the [Reconfiguring a GCP Load Balancer](#) section below.

- b. Specify any other configuration options you require and click **Update** to complete backend configuration.

 **Note:** For clusters with multiple master node VMs, health checks on port 8443 are recommended.

## Step 4: Access the Cluster

Perform the following steps to complete cluster configuration:

1. From your local workstation, run `pks get-credentials CLUSTER-NAME`. This command creates a local `kubeconfig` that allows you to manage the cluster. For more information about the `pks get-credentials` command, see [Retrieving Cluster Credentials and Configuration](#).
2. Run `kubectl cluster-info` to confirm you can access your cluster using the Kubernetes CLI.

See [Managing PKS](#) for information about checking cluster health and viewing cluster logs.

## Step 5: Create a Network Tag

Perform the following steps to create a network tag:

1. In the Google Cloud Platform sidebar menu, select **Compute Engine > VM instances**.
2. Filter to find the master instances of your cluster. Type `master` in the **Filter VM Instances** search box and press **Enter**.
3. Click the name of the master instances. The **VM instance details** menu opens.
4. Click **Edit**.
5. Click in the **Network tags** field and type a human-readable name in lower case letters. Press **Enter** to create the network tag.
6. Scroll to the bottom of the screen and click **Save**.

## Step 6: Create Firewall Rules

Perform the following steps to create firewall rules:

1. In the Google Cloud Platform sidebar menu, select **VPC Network > Firewall Rules**.
2. Click **Create Firewall Rule**. The **Create a firewall rule** menu opens.
3. Give your firewall rule a human-readable name in lower case letters. For ease of use, you may want to align this name with the name of the load balancer you created in [Step 1: Create a GCP Load Balancer](#).
4. In the **Network** menu, select the VPC network on which you have deployed the PKS tile.

5. In the **Direction of traffic** field, select **Ingress**.
6. In the **Action on match** field, select **Allow**.
7. Confirm that the **Targets** menu is set to **Specified target tags** and enter the tag you made in [Step 5: Create a Network Tag](#) in the **Target tags** field.
8. In the **Source filter** field, choose an option to filter source traffic.
9. Based on your choice in the **Source filter** field, specify IP addresses, Subnets, or Source tags to allow access to your cluster.
10. In the **Protocols and ports** field, choose **Specified protocols and ports** and enter the port number you specified in [Step 1: Create a GCP Load Balancer](#), prepended by `tcp:`. For example: `tcp:8443`.
11. Specify any other configuration options you require and click **Done** to complete frontend configuration.
12. Click **Create**.

## Reconfigure Load Balancer

If Kubernetes master node VMs are recreated for any reason, you must reconfigure your cluster load balancers to point to the new master VMs. For example, after a stemcell upgrade, BOSH recreates the VMs in your deployment.

To reconfigure your GCP cluster load balancer to use the new master VMs, do the following:

1. Locate the VM IDs of the new master node VMs for the cluster. For information about locating the VM IDs, see [Identify Kubernetes Cluster Master VMs](#) in [Creating Clusters](#).
2. Navigate to the [GCP console](#).
3. In the sidebar menu, select **Network Services > Load balancing**.
4. Select your cluster load balancer and click **Edit**.
5. Click **Backend configuration**.
6. Click **Select existing instances**.
7. Select the new master VM IDs from the dropdown. Use the VM IDs you located in the first step of this procedure.
8. Click **Update**.

## Configuring an AWS Load Balancer for PKS Clusters

This topic describes how to configure a Amazon Web Services (AWS) load balancer for your Pivotal Container Service (PKS) cluster. Using an AWS load balancer is optional, but adding one to your Kubernetes cluster can make it easier to manage the cluster using the PKS API and `kubectl`.

A load balancer is a third-party device that distributes network and application traffic across resources. You can use a load balancer to secure and facilitate access to a PKS cluster from outside the network. Using a load balancer can also prevent individual network components from being overloaded by high traffic.

You can also [reconfigure](#) your AWS load balancers. If Kubernetes master node VMs are recreated for any reason, you must reconfigure your cluster load balancers to point to the new master VMs.

### Prerequisite

The version of the PKS CLI you are using must match the version of the PKS tile you are installing.

 **Note:** This procedure uses example commands which you should modify to represent the details of your PKS installation.

## Configure AWS Load Balancer

### Step 1: Define Load Balancer

To define your load balancer using AWS, you must provide a name, select a VPC, specify listeners, and select subnets where you want to create the load balancer.

Perform the following steps:

1. In a browser, navigate to the [AWS Management Console](#).
2. Under **Compute**, click **EC2**.
3. In the **EC2 Dashboard**, under **Load Balancing**, click **Load Balancers**.
4. Click **Create Load Balancer**.
5. Under **Classic Load Balancer**, click **Create**.
6. On the **Define Load Balancer** page, complete the **Basic Configuration** section as follows:
  7. **Load Balancer name:** Name the load balancer. Pivotal recommends that you name your load balancer `k8s-master-CLUSTERNAME` where `CLUSTERNAME` is a unique name that you provide when creating the cluster. For example, `k8s-master-mycluster`.
    - a. **Create LB inside:** Select the VPC where you installed Ops Manager.
    - b. **Create an internal load balancer:** Do not enable this checkbox. The cluster load balancer must be internet-facing.
  8. Complete the **Listeners Configuration** section as follows:
    - a. Configure the first listener as follows:
      - Under **Load Balancer Protocol**, select **TCP**.
      - Under **Load Balancer Port**, enter `8443`.
      - Under **Instance Protocol**, select **TCP**.
      - Under **Instance Port**, enter `8443`.
    9. Under **Select Subnets**, select the public subnets for your load balancer in the availability zones where you want to create the load balancer.
  10. Click **Next: Assign Security Groups**.

## Step 2: Assign Security Groups

Perform the following steps to assign security groups:

1. On the **Assign Security Groups** page, select one of the following:
  - o **Create a new security group:** Complete the security group configuration as follows:
    1. **Security group name:** Name your security group.
    2. Confirm that your security group includes **Protocol** `TCP` with **Ports** `8443`.
  - o **Select an existing security group:** Select the default security group. The default security group includes **Protocol** `TCP` with **Ports** `8443`.
2. Click **Next: Configure Security Settings**.

## Step 3: Configure Security Settings

On the **Configure Security Settings** page, ignore the warning. SSL termination is done on the Kubernetes API.

## Step 4: Configure Health Check

Perform the following steps to configure the health check:

1. On the **Configure Health Check** page, set the **Ping Protocol** to `TCP`.
2. For **Ping Port**, enter `8443`.
3. Click **Next: Add EC2 Instances**.

## Step 5: Add EC2 Instances

Perform the following steps:

1. Verify the settings under **Availability Zone Distribution**.
2. Click **Add Tags**.

## (Optional) Step 6: Add Tags

Perform the following steps to add tags:

1. Add tags to your resources to help organize and identify them. Each tag consists of a case-sensitive key-value pair.
2. Click **Review and Create**.

## Step 7: Review and Create the Load Balancer

Perform the following steps to review your load balancer details and create your load balancer:

1. On the **Review** page, review your load balancer details and edit any as necessary.
2. Click **Create**.

## Step 8: Create a Cluster

Create a Kubernetes cluster using the AWS-assigned address of your load balancer as the external hostname when you run the `pks create-cluster` command.

For example:

```
$ pks create-cluster my-cluster \
--external-hostname example111a6511e9a099028c856be95-155233362.eu-west-1.elb.amazonaws.com \
--plan small --num-nodes 10
```

For more information, see [Create a Kubernetes Cluster](#) section of *Creating Clusters*.

## Step 9: Point the Load Balancer to All Master VMs

1. Locate the VM IDs of all master node VMs for your cluster. For information about locating the VM IDs, see [Identify Kubernetes Cluster Master VMs](#) in *Creating Clusters*.
2. Navigate to the [AWS console](#).
3. Under EC2, select **Load balancers**.
4. Select the load balancer.
5. On the **Instances** tab, click **Edit instances**.
6. Select all master nodes in the list of VMs.
7. Click **Save**.

## Reconfigure AWS Load Balancer

If Kubernetes master node VMs are recreated for any reason, you must reconfigure your cluster load balancers to point to the new master VMs. For example, after a stemcell upgrade, BOSH recreates the VMs in your deployment.

To reconfigure your AWS cluster load balancer to use the new master VMs, do the following:

1. Locate the VM IDs of the new master node VMs for the cluster. For information about locating the VM IDs, see [Identify Kubernetes Cluster Master VMs](#) in *Creating Clusters*.
2. Navigate to the [AWS console](#).
3. Under EC2, select **Load balancers**.
4. Select the load balancer.
5. On the **Instances** tab, click **Edit instances**.
6. Select the new master nodes in the list of VMs.
7. Click **Save**.

## Managing Users in PKS with UAA

Page last updated:

This topic describes how to manage users in Pivotal Container Service (PKS) with User Account and Authentication (UAA). Create and manage users in UAA with the UAA Command Line Interface (UAAC).

### How to Use UAAC

Use the UAA Command Line Interface (UAAC) to interact with the UAA server. You can either run UAAC commands from the Ops Manager VM or install UAAC on your local workstation.

To run UAAC commands from the Ops Manager VM, see the following SSH procedures for [vSphere](#) or [Google Cloud Platform \(GCP\)](#).

To install UAAC locally, see [Component: User Account and Authentication \(UAA\) Server](#).

### SSH into the Ops Manager VM on vSphere

To SSH into the Ops Manager VM on vSphere, you need the credentials used to import the PCF .ova or .ovf file into your virtualization system. You set these credentials when you installed Ops Manager.

**Note:** If you lose your credentials, you must shut down the Ops Manager VM in the vSphere UI and reset the password. See [vCenter Password Requirements and Lockout Behavior](#) in the vSphere documentation for more information.

- From a command line, run the following command to SSH into the Ops Manager VM:

```
ssh ubuntu@OPS-MANAGER-FQDN
```

Where `OPS-MANAGER-FQDN` is the fully qualified domain name (FQDN) of Ops Manager.

- When prompted, enter the password that you set during the .ova deployment into vCenter. For example:

```
$ ssh ubuntu@my-opsmanager-fqdn.example.com  
Password: *****
```

- Proceed to the [Log in as an Admin](#) section to manage users with UAAC.

### SSH into the Ops Manager VM on GCP

To SSH into the Ops Manager VM in GCP, do the following:

- Confirm that you have installed the gcloud CLI. See [Downloading gcloud](#) in the Google Cloud Platform documentation for more information.
- From the GCP console, click **Compute Engine**.
- Locate the Ops Manager VM in the **VM Instances** list.
- Click the **SSH** menu button.
- Copy the SSH command that appears in the popup window.
- Paste the command into your terminal window to SSH to the Ops Manager VM. For example:

```
$ gcloud compute ssh om-pcf-1a --zone us-central1-b
```

- Run `sudo su - ubuntu` to switch to the `ubuntu` user.
- Proceed to the [Log in as an Admin](#) section to manage users with UAAC.

## SSH into the Ops Manager VM on AWS

To SSH into the Ops Manager VM on AWS, you need the key pair you used when you created the Ops Manager VM. To see the name of the key pair, click on the Ops Manager VM in the AWS console and locate the `key pair name` in the properties.

To SSH into the Ops Manager VM on AWS, do the following:

1. From the AWS console, locate the Ops Manager fully qualified domain name on the [AWS EC2 instances](#) page.
2. Run `chmod 600 ops_mgr.pem` to change the permissions on the `.pem` file to be more restrictive. For example:

```
$ chmod 600 ops_mgr.pem
```

3. Run the following command to SSH into the Ops Manager VM:

```
ssh -i ops_mgr.pem ubuntu@OPS-MANAGER-FQDN
```

Where `OPS-MANAGER-FQDN` is the fully qualified domain name of Ops Manager. For example:

```
$ ssh -i ops_mgr.pem ubuntu@my-opsmanager-fqdn.example.com
```

4. Proceed to the [Log in as an Admin](#) section to manage users with UAAC.

## Log in as a UAA Admin

To retrieve the PKS UAA management admin client secret, do the following:

1. In a web browser, navigate to the fully qualified domain name of Ops Manager and click the **Pivotal Container Service** tile.
2. Click **Credentials**.
3. To view the secret, click **Link to Credential** next to **Pks Uaa Management Admin Client**. The client username is `admin`.
4. On the command line, run the following command to target your UAA server:

```
uaac target https://PKS-API:8443 --ca-cert ROOT-CA-FILENAME
```

Where:

- o `PKS-API` is the URL to your PKS API server. You configured this URL in the PKS API section of *Installing PKS* for your IaaS. For example, see [Installing PKS on vSphere](#).
- o `ROOT-CA-FILENAME` is the certificate file you downloaded in [Configuring PKS API Access](#).

For example:

```
$ uaac target api.pks.example.com:8443 --ca-cert my-cert.cert
```

 **Note:** If you receive an `Unknown key: Max-Age = 86400` warning message, you can safely ignore it because it has no impact.

5. Run the following command to authenticate with UAA using the secret you retrieved in a previous step:

```
uaac token client get admin -s ADMIN-CLIENT-SECRET
```

Where `ADMIN-CLIENT-SECRET` is your PKS UAA management admin client secret.

## Grant PKS Access

PKS access gives users the ability to deploy and manage Kubernetes clusters. As an Admin user, you can assign the following UAA scopes to users, external LDAP groups, and clients:

- `pks.clusters.manage` : Accounts with this scope can create and access their own clusters.

- `pks.clusters.admin`: Accounts with this scope can create and access all clusters.

## Grant PKS Access to a User

You can create a new UAA user with PKS access by performing the following steps:

1. Log in as the UAA admin using the procedure in [Log in as a UAA Admin](#).
2. To create a new user, run the following command:

```
uaac user add USERNAME --emails USER-EMAIL -p USER-PASSWORD
```

For example:

```
$ uaac user add alana --emails alana@example.com -p password
```

3. Run the following command to assign a scope to the user to allow them to access Kubernetes clusters:

```
uaac member add UAA-SCOPE USERNAME
```

Where `UAA-SCOPE` is one of the UAA scopes defined in [Grant PKS Access](#). For example:

```
$ uaac member add pks.clusters.admin alana
```

## Grant PKS Access to an External LDAP Group

Connecting PKS to a LDAP external user store allows the User Account and Authentication (UAA) server to delegate authentication to existing enterprise user stores.

 **Note:** When integrating with an external identity provider such as LDAP, authentication within the UAA becomes chained. UAA first attempts to authenticate with a user's credentials against the UAA user store before the external provider, LDAP. For more information, see [Chained Authentication](#) in the *User Account and Authentication LDAP Integration* GitHub documentation.

For more information about the process used by the UAA Server when it attempts to authenticate a user through LDAP, see the [Configuring LDAP Integration with Pivotal Cloud Foundry](#) Knowledge Base article.

To grant PKS access to an external LDAP group, perform the following steps:

1. Log in as the UAA admin using the procedure in [Log in as a UAA Admin](#).
2. To assign the `pks.clusters.manage` scope to all users in an LDAP group, run the following command:

```
uaac group map --name pks.clusters.manage GROUP-DISTINGUISHED-NAME
```

Where `GROUP-DISTINGUISHED-NAME` is the LDAP Distinguished Name (DN) for the group. For example:

```
$ uaac group map --name pks.clusters.manage cn=operators,ou=groups,dc=example,dc=com
```

For more information about LDAP DNSs, see the [LDAP DNs and RDNs](#) in the LDAP documentation.

3. (Optional) To assign the `pks.clusters.admin` scope to all users in an LDAP group, run the following command:

```
uaac group map --name pks.clusters.admin GROUP-DISTINGUISHED-NAME
```

Where `GROUP-DISTINGUISHED-NAME` is the LDAP DN for the group. For example:

```
$ uaac group map --name pks.clusters.admin cn=operators,ou=groups,dc=example,dc=com
```

## Grant PKS Access to a Client

To grant PKS access to an automated client for a script or service, perform the following steps:

1. Log in as the UAA admin using the procedure [Log in as a UAA Admin](#).
2. Run the following command to create a client with the desired scopes:

```
uaac client add CLIENT-NAME -s CLIENT-SECRET \
--authorized_grant_types client_credentials \
--authorities UAA-SCOPES
```

Where:

- `CLIENT-NAME` and `CLIENT-SECRET` are the client credentials.
- `UAA-SCOPES` is fines one or more of the UAA scopes defined in [Grant PKS Access](#), separated by a comma. For example:

```
$ uaac client add automated-client \
-s randomly-generated-secret
--authorized_grant_types client_credentials \
--authorities pks.clusters.admin.pks.clusters.manage
```

## Grant Cluster Access

You can grant a user or a group access to an entire cluster with a `ClusterRole` or to a namespace within a given cluster with a `Role`.

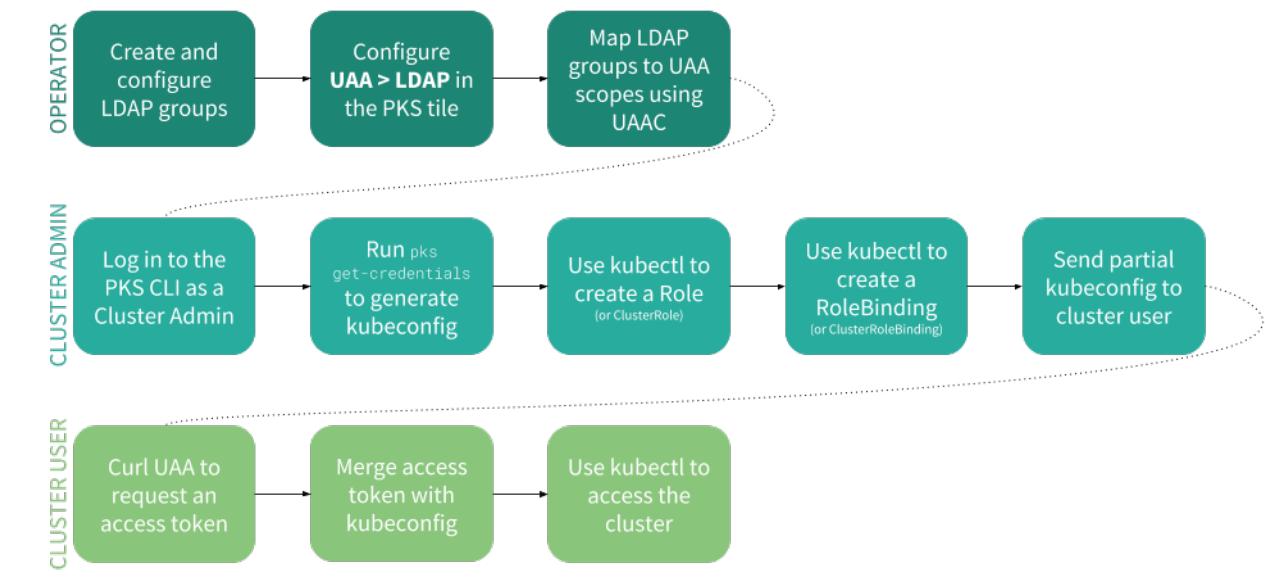
The admin of the cluster must then create a `ClusterRoleBinding` or a `RoleBinding` for that Kubernetes end user.

For more information, see [RoleBinding and ClusterRoleBinding](#) in the Kubernetes documentation.

### Grant Cluster Access to a User

After being granted cluster access, the Kubernetes end user can use the Kubernetes Command Line Interface (`kubectl`) to connect to the cluster and perform actions as configured by their cluster admin. However, even with this access, Kubernetes end users cannot create, resize, or delete clusters.

The following diagram outlines the workflow you use to grant cluster access to a user who belongs to an LDAP group:



**Note:** In order for cluster admins to grant cluster access to Kubernetes end users, cluster admins must ensure that they have selected **Enable UAA as OIDC provider** in the UAA section of the PKS tile. Once you enable OIDC, you must run `get-credentials` again to update your existing kubeconfig.

To grant cluster access to other users, the cluster admin must perform the following actions:

1. Run the following command to log in to PKS client using LDAP credentials:

```
pkcs login -u LDAP-NAME -p LDAP-PASSWORD -a PKS-API --ca-cert ROOT-CA-FILENAME
```

Where:

- `LDAP-USER-NAME` is the cluster admin's LDAP username.
- `LDAP-PASSWORD` is the cluster admin's LDAP password.
- `PKS-API` is the fully qualified domain name you use to access the PKS API.

2. Run the following command to confirm that you can successfully connect to a cluster and use kubectl as a cluster admin:

```
pkcs get-credentials CLUSTER-NAME
```

This step creates a `ClusterRoleBinding` for the LDAP cluster admin.

3. When prompted, re-enter your LDAP password.

4. Create a spec YML file with either the `Role` or `ClusterRole` for your Kubernetes end user.

```
kind: ROLE-TYPE
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  namespace: NAMESPACE
  name: ROLE-OR-CLUSTER-ROLE-NAME
rules:
- apiGroups:
  resources: RESOURCE
  verbs: API-REQUEST-VERB
```

Where:

- `ROLE-TYPE` is the type of role you are creating. This must be either `Role` or `ClusterRole`.
- `NAMESPACE` is the namespace within the cluster. This is omitted when creating a `ClusterRole`.
- `ROLE-OR-CLUSTER-ROLE-NAME` is the name of the `Role` or `ClusterRole` you are creating. This name is created by the cluster admin.
- `RESOURCE` is the resource you are granting access to. It must be specified in a comma-separated array. An example resource could be `["pod-reader"]`.
- `API-REQUEST-VERB` is used to specify resource requests. For more information, see [Determine the Request Verb](#) in the Kubernetes documentation.

5. Run the following command to create the `Role` or `ClusterRole` resource based on your spec file:

```
kubectl create -f ROLE-SPEC.yml
```

6. Create a spec YML file containing either a `ClusterRoleBinding` or `RoleBinding` for the Kubernetes end user.

```
kind: ROLE-BINDING-TYPE
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: ROLE-OR-CLUSTER-ROLE-BINDING-NAME
  namespace: NAMESPACE
subjects:
- kind: User
  name: USERNAME
  apiGroup: rbac.authorization.k8s.io
roleRef:
  kind: ROLE-TYPE
  name: ROLE-OR-CLUSTER-ROLE-BINDING-NAME
  apiGroup: rbac.authorization.k8s.io
```

Where:

- `ROLE-BINDING-TYPE` is the type of role binding you are creating. This must be either `RoleBinding` or `ClusterRoleBinding`.
- `ROLE-OR-CLUSTER-ROLE-BINDING-NAME` is the name of the role binding. This name is created by the cluster admin.
- `NAMESPACE` is the namespace within the cluster. This is omitted when creating a `ClusterRole`.
- `USERNAME` is the Kubernetes end user's username. If your organization uses LDAP, for example, this is your LDAP username.
- `ROLE-TYPE` is the type of role you created in the previous step. This must be either `Role` or `ClusterRole`.
- `ROLE-OR-CLUSTER-ROLE-NAME` is the name of the `Role` or `ClusterRole` you are creating.

7. Run the following command to create the above defined `ClusterRoleBinding` resource in the cluster:

```
kubectl apply -f ROLE-BINDING-SPEC.yml
```

8. The cluster admin partially completes the `kubeconfig` by detailing the following:

- o `clusters.cluster.certificate-authority-data`
- o `clusters.cluster.server`
- o `cluster.name`
- o `contexts.context.cluster`
- o `contexts.context.name`
- o `current-context`
- o `users.user.auth-provider.config.idp-issuer-url`

9. The cluster admin sends the partially completed `kubeconfig` to their Kubernetes end user. Review the example kubeconfig file below. For more information about organizing information using kubeconfig, see [Organizing Cluster Access Using kubeconfig Files](#) in the Kubernetes documentation.

```
apiVersion: v1
clusters:
- cluster:
  certificate-authority-data: PROVIDED-BY-ADMIN
  server: PROVIDED-BY-ADMIN
  name: PROVIDED-BY-ADMIN
contexts:
- context:
  cluster: PROVIDED-BY-ADMIN
  user: PROVIDED-BY-USER
  name: PROVIDED-BY-ADMIN
  current-context: PROVIDED-BY-ADMIN
kind: Config
preferences: {}
users:
- name: PROVIDED-BY-USER
  user:
    auth-provider:
      config:
        client-id: pks_cluster_client
        cluster_client_secret: ""
        id-token: PROVIDED-BY-USER
        idp-issuer-url: <span>https://</span>PROVIDED-BY-ADMIN:8443/oauth/token
        refresh-token: PROVIDED-BY-USER
        name: oidc
```

## Obtain Cluster Access as a User

To obtain cluster access, the end user must perform the following actions:

1. Run the following command to obtain the `users.user.auth-provider.config.id-token` and `users.user.auth-provider.config.refresh-token`:

```
curl 'https://PKS-API:8443/oauth/token' -k -XPOST -H
'Accept: application/json' -d "client_id=pks_cluster_client&client_secret=""&grant_type=password
&username=UAA-USERNAME&response_type=id_token" --data-urlencode password=UAA-PASSWORD
```

Where:

- o `PKS-API` is the FQDN you use to access the PKS API.
- o `UAA-USERNAME` is the Kubernetes end user's UAA username.
- o `UAA-PASSWORD` is the Kubernetes end user's UAA password.

2. Edit the `kubeconfig` by providing the following:

- o `contexts.context.user`
- o `users.name`
- o `users.user.auth-provider.config.id-token`
- o `users.user.auth-provider.config.refresh-token`

3. Save the `kubeconfig` to the `$HOME/.kube/config` directory. After doing so, the Kubernetes end user can connect to the cluster using `kubectl`.

 Note: To automate this process, follow the instructions in one of the following Knowledge Base Articles:

- [Script to automate generation of the kubeconfig for the kubernetes user](#)
- [Powershell script to automate generation of kubeconfig for the kubernetes user](#)

## Grant Cluster Access to a Group

Cluster admins can also grant cluster-wide access to an LDAP Group by creating a `ClusterRoleBinding` for that LDAP group. This feature is only available if LDAP is used as your identity provider for UAA.

 **Note:** You must confirm that the group you are referencing in your `ClusterRoleBinding` has been whitelisted in the PKS tile. To do so, review the **External Groups Whitelist** field in the UAA section of the PKS tile.

The process for granting cluster access to an LDAP is similar to the process described in [Grant Cluster Access to a User](#).

The only difference is that when the cluster admin is creating the spec file containing the `RoleBinding` or `ClusterRoleBinding` for a group, the spec file must reflect the following:

```
kind: ROLE-BINDING-TYPE
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: ROLE-OR-CLUSTER-ROLE-BINDING-NAME
  namespace: NAMESPACE
subjects:
- kind: Group
  name: NAME-OF-GROUP
  apiGroup: rbac.authorization.k8s.io
roleRef:
  kind: ROLE-TYPE
  name: ROLE-OR-CLUSTER-ROLE-NAME
  apiGroup: rbac.authorization.k8s.io
```

Where:

- `ROLE-BINDING-TYPE` is the type of role binding you are creating. This must be either `RoleBinding` or `ClusterRoleBinding`.
- `ROLE-OR-CLUSTER-ROLE-BINDING-NAME` is the name of your `RoleBinding` or `ClusterRoleBinding`. This is created by the cluster admin.
- `NAME-OF-GROUP` is the LDAP group name. This name is case sensitive.
- `ROLE-TYPE` is the type of role you are creating. This must be either `Role` or `ClusterRole`.
- `ROLE-OR-CLUSTER-ROLE-NAME` is the name of your `Role` or `ClusterRole`. This is created by the cluster admin.

## PersistentVolume Storage Options on vSphere

Page last updated:

This topic describes options for configuring Pivotal Container Service (PKS) on vSphere to support stateful apps using PersistentVolumes (PVs).

 **Note:** This topic assumes that you have strong familiarity with PVs and workloads in Kubernetes.

For procedural information about configuring PVs, see [Configuring PersistentVolumes](#).

## Considerations for Running Stateful Apps in Kubernetes

There are several factors to consider when running stateful apps in Kubernetes:

- **Pods are ephemeral by nature.** Data that needs to be persisted must be accessible on restart and rescheduling of a pod.
- **When a pod is rescheduled, it may be on a different host** Storage must be available on the new host for the pod to start gracefully.
- **The app should not manage the volume and data.** The underlying infrastructure should handle the complexity of unmounting and mounting.
- **Certain apps have a strong sense of identity.** When a container with a certain ID uses a disk, the disk becomes tied to that container. If a pod with a certain ID gets rescheduled, the disk associated with that ID must be reattached to the new pod instance.

## Persistent Volume Provisioning Support in Kubernetes

Kubernetes provides two ways to provision persistent storage for stateful applications:

- **Static provisioning:** A Kubernetes administrator creates the Virtual Machine Disk (VMDK) and PVs. Developers issue PersistentVolumeClaims (PVCs) on the pre-defined PVs.
- **Dynamic provisioning:** Developers issue PVCs against a StorageClass object. The provisioning of the persistent storage depends on the infrastructure. With PKS on vSphere, the vSphere Cloud Provider (VCP) automatically provisions the VMDK and PVs.

For more information about PVs in Kubernetes, refer to the [Kubernetes documentation](#).

PVs can be used with two types of Kubernetes workloads:

- [Deployments](#)
- [StatefulSets](#)

## vSphere Support for Static and Dynamic PVs

With PKS on vSphere, you can choose one of two storage options to support stateful apps:

- vSAN datastores
- Network File Share (NFS) or VMFS over Internet Small Computer Systems Interface (iSCSI), or fiber channel (FC) datastores

Refer to the [vSAN documentation](#) and the [VMFS documentation](#) for more information about these storage options.

 **Note:** This topic assumes that you have strong familiarity vSAN and VMFS storage technologies on the vSphere platform.

In PKS, an availability zone (AZ) corresponds to a vSphere cluster and a resource pool within that cluster. A resource pool is a vSphere construct that is not linked to a particular ESXi host. Resource pools can be used in testing environments to enable a single vSphere cluster to support multiple AZs. As a recommended practice, deploy multiple AZs across different vSphere clusters to afford best availability in production.

The vSAN datastore boundary is delimited by the vSphere cluster. All ESXi hosts in the same vSphere cluster belong to the same vSAN datastore. ESXi hosts in a different vSphere cluster belong to a different vSAN datastore. Each vSphere cluster has its own vSAN datastore.

The table below summarizes PKS support for PVs in Kubernetes when deployed on vSphere:

Storage Mechanism	vSAN datastores	NFS or VMFS over iSCSI/FC datastores
Cloud Native PersistentVolume	Yes	No

<ul style="list-style-type: none"> <li>Single vSphere compute cluster with a cluster-wide datastore</li> <li>Single AZ using a resource pool</li> </ul>	Both static and dynamic PV provisioning are supported.	Both static and dynamic PV provisioning are supported.
<ul style="list-style-type: none"> <li>Multiple vSphere compute clusters with cluster-wide datastores</li> <li>Multiple AZs</li> </ul>	Neither static nor dynamic PV provisioning are supported.	Neither static nor dynamic PV provisioning are supported.
<ul style="list-style-type: none"> <li>Multiple vSphere compute clusters with a shared datastore</li> <li>Multiple AZs</li> </ul>	vSAN does not support sharing datastores across vSphere clusters.	Both static and dynamic PV provisioning are supported.

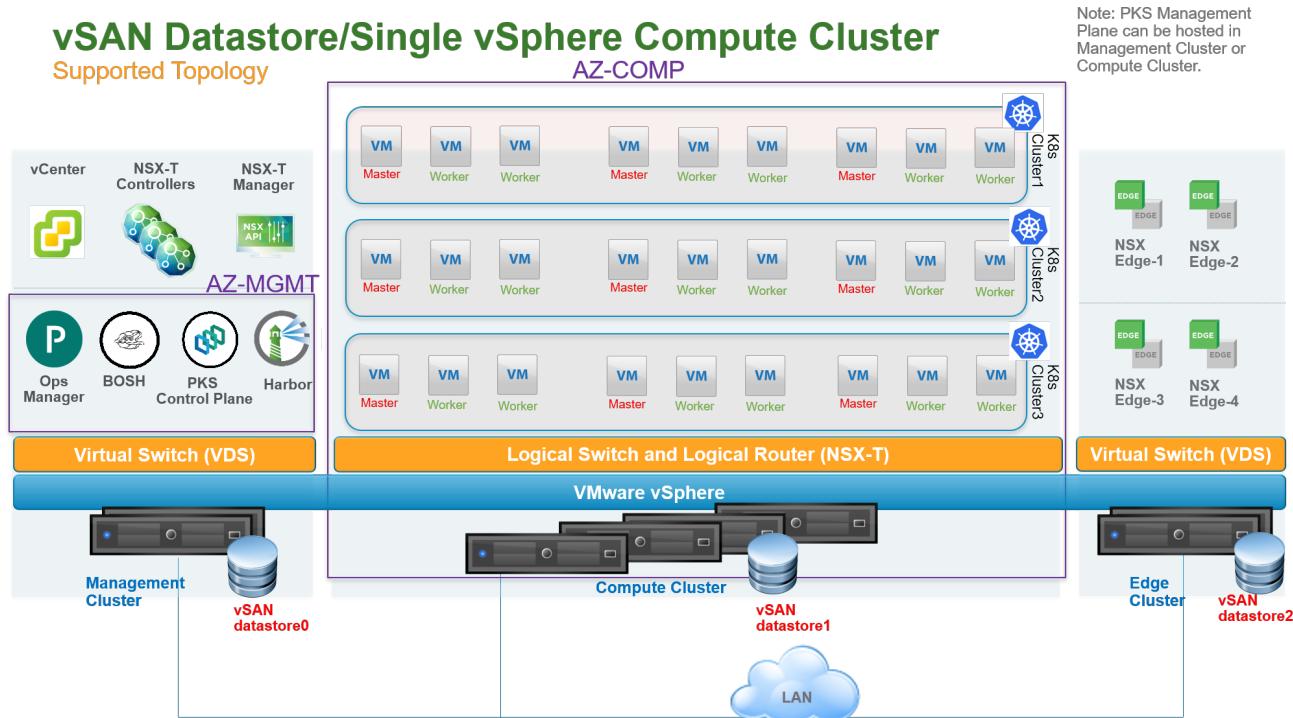
**Note:** This information assumes that the underlying vSphere infrastructure is a single locality environment where all vSphere compute clusters are closed in terms of distance from one to the others. It does not apply to multi-site or vSAN stretched cluster configurations.

## Single vSphere Compute Cluster with a Cluster-wide Datastore

This section describes PKS support for PVs in a single vSphere compute cluster with a cluster-wide datastore.

### Single vSphere Compute Cluster with a vSAN Datastore

The following diagram illustrates a vSphere environment with a single compute cluster and a local vSAN datastore. This topology is also supported for environments with a single AZ or multiple AZs using multiple resource pools under the same vSphere cluster. For this topology, PKS supports both static and dynamic PV provisioning. Dynamic PV provisioning is recommended.



In this topology, a single vSphere compute cluster hosts all Kubernetes clusters. vSAN is enabled on the compute cluster which exposes a single unique vSAN datastore. In the above diagram, this datastore is labeled **vSAN datastore1**.

You can configure a single computer cluster in the following ways:

- If you use a single PKS foundation, create an AZ that is mapped directly to the single cluster.
- If you use multiple PKS foundations, create an AZ that is mapped to this single cluster and a Resource Pool.

With this topology, you can create multiple vSAN datastores on the same compute cluster using different disk groups on each ESXi host. PVs, backed by

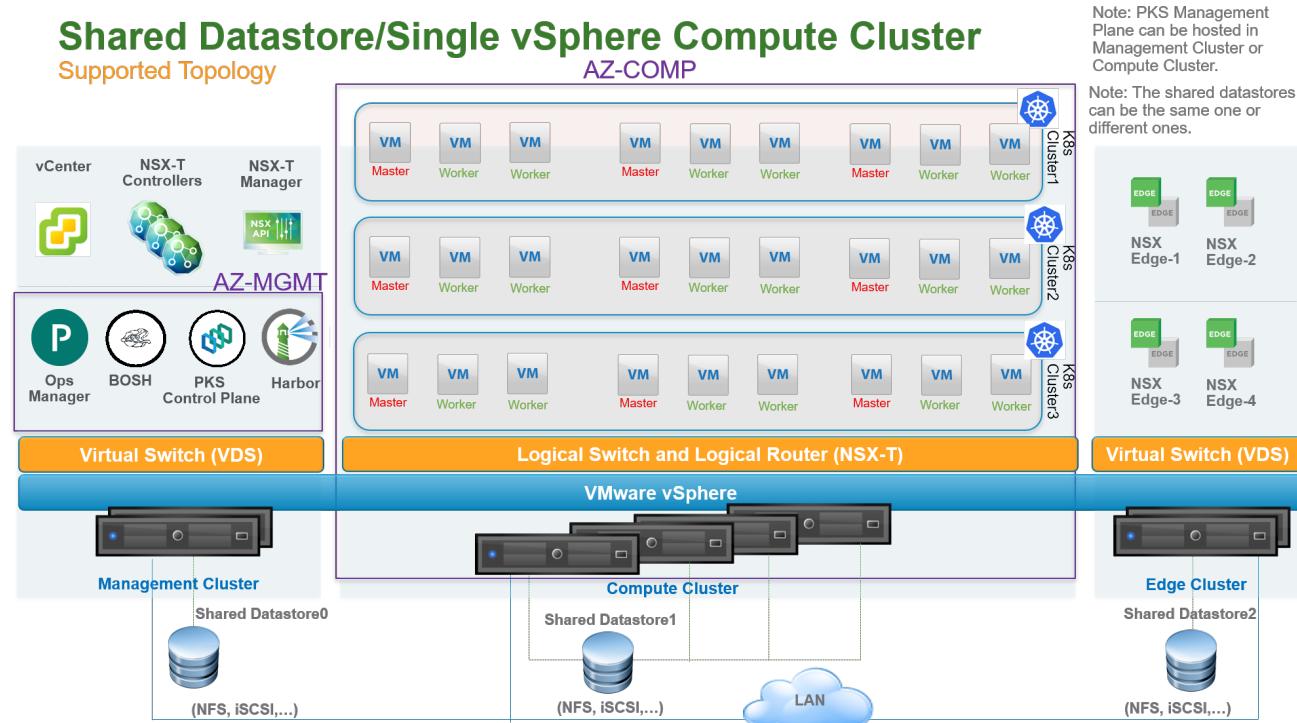
respective VMDK files, can be dispatched across the datastores to mitigate the impact of datastore failure. For StatefulSets, all PVs used by different instances of the replica land in the same datastore.

This topology has the following failover scenarios:

- **Disks on ESXi hosts are down:** If the failure is within the limit of the vSAN `failure to tolerate` value, there is no impact on PVs.
- **ESXi hosts are down:** If the failure is within the limit of the vSAN `failure to tolerate` value, there is no impact on PVs.
- **Datastore is down:** PVs on the down datastore are unreachable.

## Single vSphere Compute Cluster with a VMFS Datastore

The following diagram illustrates a vSphere environment with a single vSphere compute cluster and a shared datastore using NFS or VMFS over iSCSI, or FC. For this topology, PKS supports both static and dynamic PV provisioning. Dynamic PV provisioning is recommended.



In this topology, a single vSphere compute cluster hosts all Kubernetes clusters. The shared datastore is used with the compute cluster. In the above diagram, this datastore is labeled **Shared Datastore1**.

One or more AZs can be instantiated on top of the compute cluster. With this configuration, one or more AZs are mapped to vSphere resource pools. The AZ is not bound to a failure domain because its resource pool is not linked to a particular ESXi host.

With this topology, you can create multiple shared datastores connected to the same compute cluster. PVs, backed by respective VMDK files, can be dispatched across the datastores to mitigate the impact of datastore failure. For StatefulSets, all PVs used by different instances of the replica land in the same datastore.

This topology has the following failover scenarios:

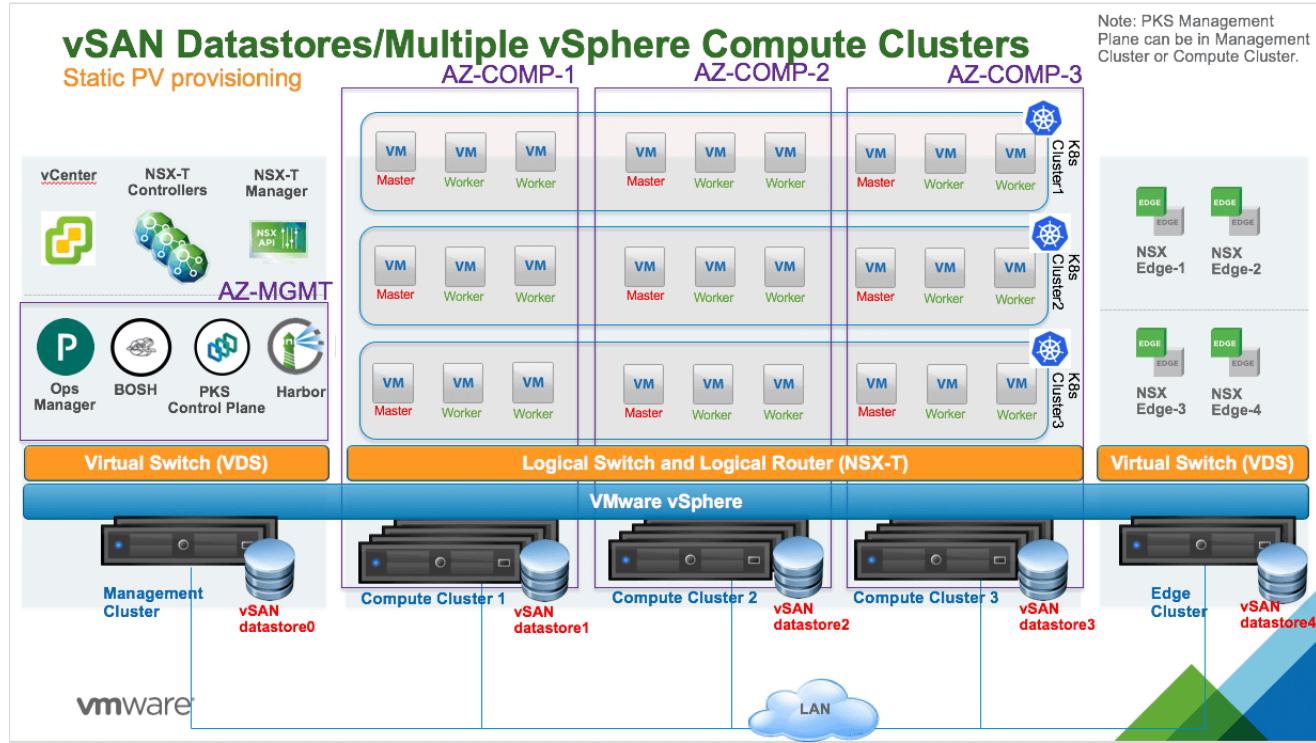
- **ESXi hosts are down:** No impact on PVs.
- **Datastore is down:** PVs on the down datastore are unreachable.

## Multiple vSphere Compute Clusters with Cluster-wide Datastores

This section describes PKS support for PVs in an environment with multiple vSphere compute clusters with datastores that are local to each compute cluster.

## Multiple vSphere Compute Clusters with Local vSAN Datastores

The following diagram illustrates a vSphere environment with multiple vSphere compute clusters with vSAN datastores that are local to each compute cluster.



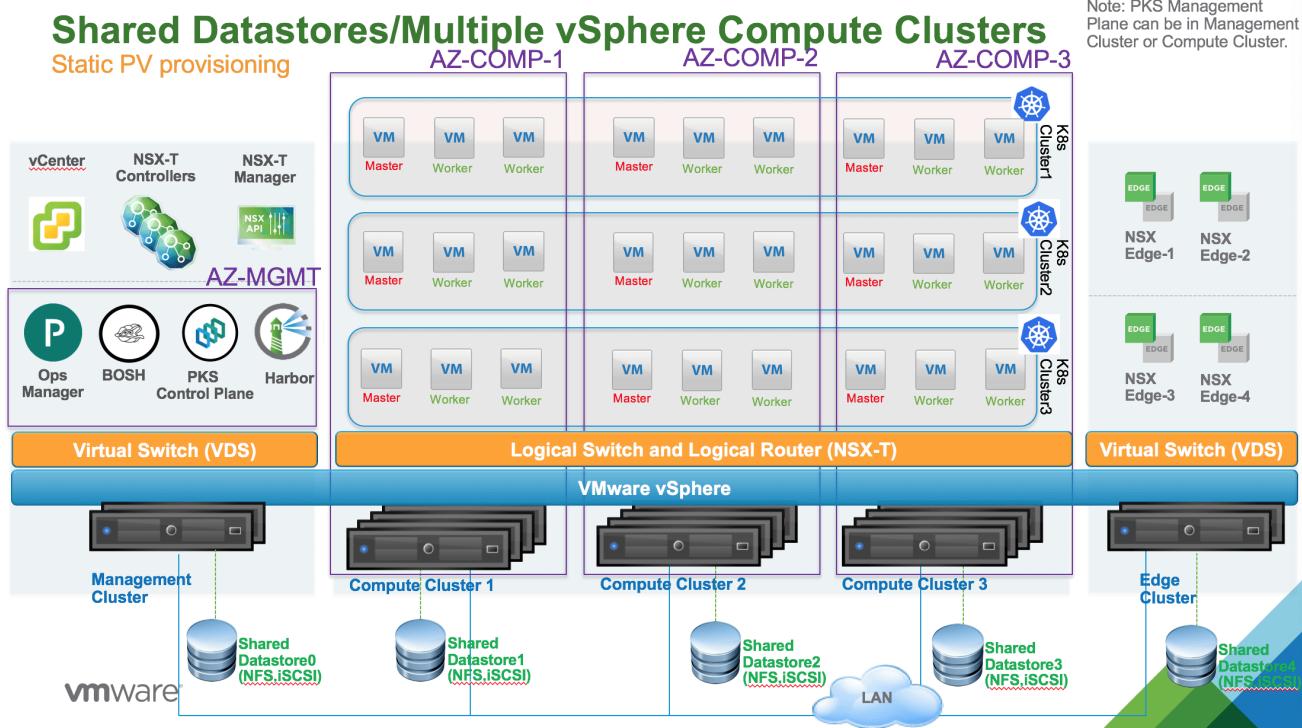
In this topology, vSAN is enabled on each compute cluster. There is one local vSAN datastore per compute cluster. For example, in the above diagram, vSAN datastore1 is provisioned for Compute Cluster 1 and vSAN datastore2 is provisioned for Compute Cluster 2.

One or more AZs can be instantiated. Each AZ is mapped to a vSphere compute cluster. The AZ is bound to a failure domain which is typically the physical rack where the compute cluster is hosted.

## Multiple vSphere Compute Clusters with Local VMFS Datastores

The following diagram illustrates a vSphere environment with multiple vSphere compute clusters with NFS or VMFS over iSCSI, or FC local datastores.

Note: PKS Management Plane can be in Management Cluster or Compute Cluster.



In this topology, multiple vSphere compute clusters are used to host all Kubernetes clusters. A unique shared datastore is used per vSphere compute cluster. For example, in the above diagram, Shared Datastore1 is connected to Compute Cluster 1 and Shared Datastore2 is connected to Compute Cluster 2.

One or more AZs can be instantiated. Each AZ is mapped to a vSphere compute cluster. The AZ is bound to a failure domain which is typically the physical rack where the compute cluster is hosted.

## Multiple vSphere Compute Clusters with Shared Datastores

This section describes PKS support for vSphere environments with multiple compute clusters with datastores shared across all vSphere compute clusters.

### Multiple vSphere Compute Clusters with Local vSAN Datastores and at least one Shared VMFS/NFS Datastore

With this topology, each vSAN datastore is only visible from each vSphere compute cluster. It is not possible to have a vSAN datastore shared across all vSphere compute clusters.

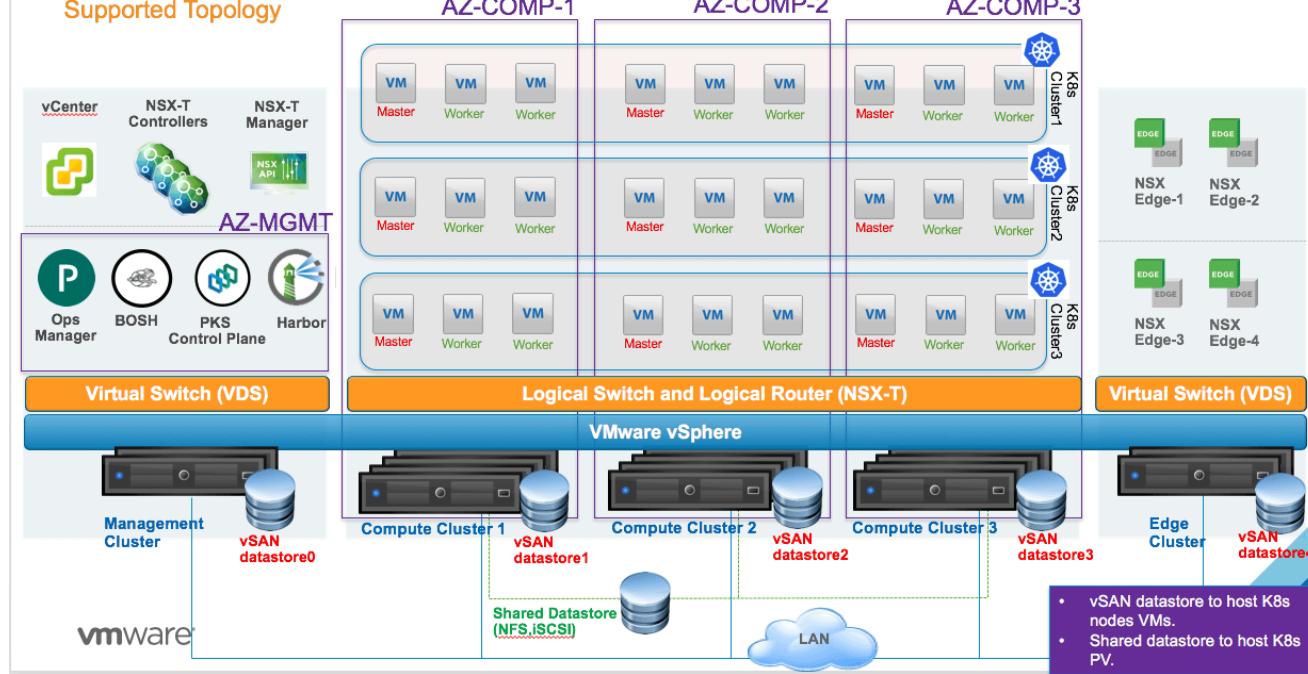
You can insert a shared NFS, iSCSI (VMFS), or FC (VMFS) datastore across all vSAN-based vSphere compute clusters to support both static and dynamic PV provisioning.

Refer to the following diagram:

## vSAN Datastores/Multiple vSphere Compute Clusters

Supported Topology

Note: PKS Management Plane can be in Management Cluster or Compute Cluster.



## Multiple vSphere Compute Clusters with Shared VMFS Datastores

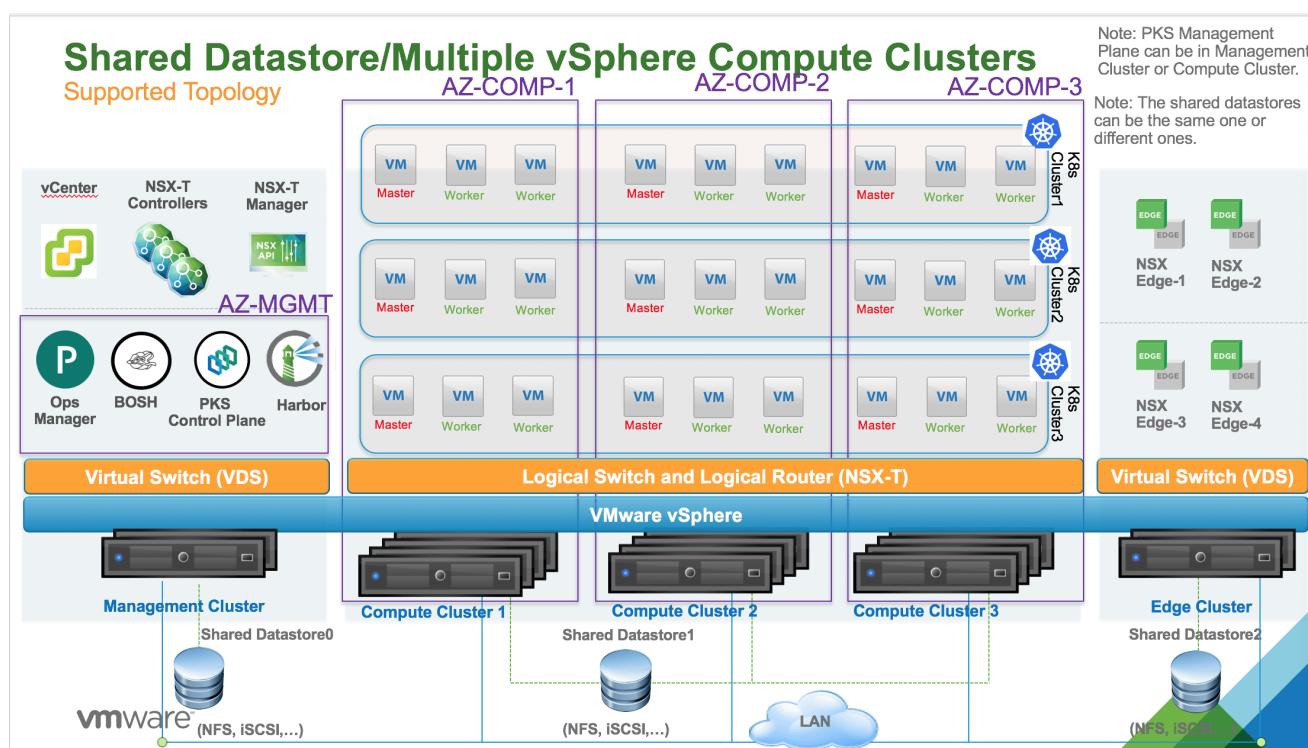
The following diagram illustrates a vSphere environment with multiple compute clusters with VMFS over NFS, iSCSI, or FC datastores shared across all vSphere compute clusters. For this topology, PKS supports both static and dynamic PV provisioning. Dynamic PV provisioning is recommended.

## Shared Datastore/Multiple vSphere Compute Clusters

Supported Topology

Note: PKS Management Plane can be in Management Cluster or Compute Cluster.

Note: The shared datastores can be the same one or different ones.



In this topology, multiple vSphere compute clusters are used to host all Kubernetes clusters. A unique shared datastore that uses NFS, or VMFS over iSCSI/FC is used across all compute clusters. In the above diagram, this datastore is labeled **Shared Datastore1**.

One or more AZs can be instantiated. Each AZ is mapped to a compute cluster. The AZ is bound to a failure domain which is typically the physical rack where the compute cluster is hosted.

You can have multiple shared datastores connected across all the vSphere compute clusters. PVs, backed by respective VMDK files, can then be

dispatched across those datastores to mitigate the impact of datastore failure. For StatefulSets, all PVs used by different instances of the replica land in the same datastore.

This topology has the following failover scenarios:

- **ESXi hosts are down:** No impact on PVs.
- **One shared datastore is down:** PVs on the down datastore are unreachable.

## Adding Custom Workloads

Page last updated:

This topic describes how to add custom workloads to Pivotal Container Service (PKS) clusters.

Custom workloads define what a cluster includes out of the box. For example, you can use custom workloads to configure metrics or logging.

### Create YAML Configuration

Create a YAML configuration for your custom workloads. Consult the following example from the [Kubernetes documentation](#):

```
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 2 # tells deployment to run 2 pods matching the template
  template: # create pods using pod definition in this template
    metadata:
      # unlike pod-nginx.yaml, the name is not included in the meta data as a unique name is
      # generated from the deployment name
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: nginx:1.7.9
          ports:
            - containerPort: 80
```

### Apply Custom Workloads

To apply custom Kubernetes workloads to every cluster created on a plan, enter your YAML configuration in the **(Optional) Add-ons - Use with caution** field in the pane for configuring a plan in the PKS tile.

For more information, see the *Plans* section of the *Installing PKS* topic for your IaaS. For example, [Plans](#) in *Installing PKS on vSphere*.

## Configuring an Ingress Controller

Page last updated:

This topic provides resources for configuring an ingress controller on Pivotal Container Service (PKS).

In Kubernetes, an ingress is an API object that manages external access to the services in a cluster. The cluster must have an ingress controller running. For more information, see [Ingress](#) in the Kubernetes documentation.

To configure an ingress controller for PKS on Google Cloud Platform (GCP), see [How to set up an Ingress Controller for a PKS cluster](#) in the Pivotal Knowledge Base.

## Deleting PKS

To delete the Pivotal Container Service (PKS) tile, perform the steps in the section below that corresponds to the version of Ops Manager in your deployment.

### Ops Manager v2.2

1. Navigate to the Ops Manager Installation Dashboard.
2. Click the trash can icon on the PKS tile.
3. Click **Confirm**.
4. (Optional) By default, deleting the PKS tile also deletes all the clusters created by PKS. To preserve the clusters, click the **Delete all clusters errand** under **Pending Changes** and select **Off**.
5. Click **Apply Changes**.

### Ops Manager v2.3

1. Navigate to the Ops Manager Installation Dashboard.
2. Click the trash can icon on the PKS tile.
3. Click **Confirm**.
4. Click **Review Pending Changes**.
5. (Optional) By default, deleting the PKS tile also deletes all the clusters created by PKS. To preserve the clusters, click **Errands** and deselect the **Delete all clusters errand**.
6. Click **Apply Changes**.

## Managing Clusters

Page last updated:

This section describes how to manage Pivotal Container Service (PKS) clusters.

See the following topics:

- [Creating Clusters](#)
- [Retrieving Cluster Credentials and Configuration](#)
- [Viewing Cluster Lists](#)
- [Viewing Cluster Details](#)
- [Viewing Cluster Plans](#)
- [Scaling Existing Clusters](#)
- [Deleting Clusters](#)

## Creating Clusters

Page last updated:

This topic describes how to create a Kubernetes cluster with Pivotal Container Service (PKS) using the PKS Command Line Interface (CLI).

## Configure Cluster Access

Cluster access configuration differs by the type of PKS deployment.

### vSphere with NSX-T

PKS deploys a load balancer automatically when clusters are created. The load balancer is configured automatically when workloads are being deployed on these Kubernetes clusters. For more information, see [Load Balancers in PKS Deployments with NSX-T](#).

### GCP, AWS, or vSphere without NSX-T

When you create a Kubernetes cluster, you must configure external access to the cluster by creating an external TCP or HTTPS load balancer. This load balancer allows you to run PKS CLI commands on the cluster from your local workstation. For more information, see [Load Balancers in PKS Deployments without NSX-T](#).

You can configure any load balancer of your choice. If you use GCP, AWS, or vSphere without NSX-T, you can create a load balancer using your cloud provider console.

For more information about configuring a cluster load balancer, see the following:

- [Configuring a GCP Load Balancer for PKS Clusters](#)
- [Configuring an AWS Load Balancer for PKS Clusters](#)

Create the load balancer before you create the cluster. Use the load balancer IP address as the external hostname, and then point the load balancer to the IP address of the master virtual machine (VM) after cluster creation. If the cluster has multiple master nodes, you must configure the load balancer to point to all master VMs for the cluster.

If you are creating a cluster in a non-production environment, you can choose to create a cluster without a load balancer. Create a DNS entry that points to the IP address of the cluster's master VM after cluster creation.

To locate the IP addresses and VM IDs of the master VMs, see [Identify the Kubernetes Cluster Master VM](#) below.

## Create a Kubernetes Cluster

Perform the following steps:

1. Grant cluster access to a new or existing user in UAA. See the [Grant PKS Access to a User](#) section of *Managing Users in PKS with UAA* for more information.
2. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

3. Run the following command to create a cluster:

```
pks create-cluster CLUSTER-NAME \
--external-hostname HOSTNAME \
--plan PLAN-NAME \
[--num-nodes WORKER-NODES]
```

Replace the placeholder values in the command as follows:

- `CLUSTER-NAME`: Enter a unique name for your cluster.
- `HOSTNAME`: Enter an external hostname for your cluster. You can use any fully qualified domain name (FQDN) or IP address you own. For example, `my-cluster.example.com` or `10.0.0.1`. If you created an external load balancer, use its IP address.
- `PLAN-NAME`: Choose a plan for your cluster. Run `pks plans` to list your available plans.
- (Optional) `WORKER-NODES`: Choose the number of worker nodes for the cluster.

For high availability, create clusters with a minimum of three worker nodes, or two per AZ if you intend to use PersistentVolumes (PVs). For example, if you deploy across three AZs, you should have six worker nodes. For more information about PVs, see [PersistentVolumes](#) in *Maintaining Workload Uptime*. Provisioning a minimum of three worker nodes, or two nodes per AZ is also recommended for stateless workloads.

The maximum value you can specify is configured in the **Plans** pane of the PKS tile. If you do not specify a number of worker nodes, the cluster is deployed with the default number, which is also configured in the **Plans** pane. For more information, see the *Installing PKS* topic for your IaaS, such as [Installing PKS on vSphere](#).

For example:

```
$ pks create-cluster my-cluster \
--external-hostname my-cluster.example.com \
--plan large --num-nodes 3
```

 **Note:** It can take up to 30 minutes to create a cluster.

4. Track the cluster creation process by running `pks cluster CLUSTER-NAME`. Replace `CLUSTER-NAME` with the unique name for your cluster. For example:

```
$ pks cluster my-cluster
Name:      my-cluster
Plan Name:    large
UUID:      01a234bc-d56e-7f89-01a2-3b4cde5f6789
Last Action:  CREATE
Last Action State: succeeded
Last Action Description: Instance provisioning completed
Kubernetes Master Host: my-cluster.example.com
Kubernetes Master Port: 8443
Worker Instances: 3
Kubernetes Master IP(s): 192.168.20.7
```

If the value for **Last Action State** is `error`, troubleshoot cluster creation by logging in to the BOSH Director and running `bosh tasks`. See [Advanced Troubleshooting with the BOSH CLI](#) for more information.

5. Depending on your deployment:

- For **vSphere with NSX-T**, choose one of the following:
  - Specify the hostname or FQDN and register the FQDN with the IP provided by PKS after cluster deployment. You can do this using `resolv.conf` or via DNS registration.
  - Specify a temporary placeholder value for FQDN, then replace the FQDN in the `kubeconfig` with the IP address assigned to the load balancer dedicated to the cluster.

To retrieve the IP address to access the Kubernetes API and UI services, use the `pks cluster CLUSTER-NAME` command.

- For **vSphere without NSX-T and AWS**, configure external access to the cluster's master nodes using either DNS records or an external load balancer. Use the output from the `pks cluster` command to locate the master node IP addresses and ports.
- For **GCP**, use the output from the `pks cluster` command to locate the master node IP addresses and ports, and then continue to [Step 3: Configure Load Balancer Backend](#) in *Configuring a GCP Load Balancer for PKS Clusters*

 **Note:** For clusters with multiple master node VMs, health checks on port 8443 are recommended.

6. To access your cluster, run `pks get-credentials CLUSTER-NAME`. This command creates a local `kubeconfig` that allows you to manage the cluster. For more information about the `pks get-credentials` command, see [Retrieving Cluster Credentials and Configuration](#).
7. Run `kubectl cluster-info` to confirm you can access your cluster using the Kubernetes CLI.

See [Managing PKS](#) for information about checking cluster health and viewing cluster logs.

## Identify Kubernetes Cluster Master VMs

**Note:** This section applies only to PKS deployments on GCP or on vSphere without NSX-T. Skip this section if your PKS deployment is on vSphere with NSX-T. For more information, see [Load Balancers in PKS](#).

To reconfigure the load balancer or DNS record for an existing cluster, you may need to locate VM ID and IP address information for the cluster's master VMs. Use the information you locate in this procedure when configuring your load balancer backend.

To locate the IP addresses and VM IDs for the master VMs of an existing cluster, do the following:

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. To locate the cluster ID and master node IP addresses, run `pks cluster CLUSTER-NAME`. From the output of this command, record the following items:

- o **UUID:** This value is your cluster ID.
- o **Kubernetes Master IP(s):** This value lists the IP addresses of all master nodes in the cluster.

3. Gather credential and IP address information for your BOSH Director, SSH into the Ops Manager VM, and use the BOSH CLI to log in to the BOSH Director from the Ops Manager VM. For more information, see [Advanced Troubleshooting with the BOSH CLI](#).

4. Identify the name of your cluster deployment. For example:

```
$ bosh -e pks deployments
```

Your cluster deployment name begins with `service-instance` and includes the UUID you located in a previous step.

5. Identify the master VM IDs by listing the VMs in your cluster. For example:

```
$ bosh -e pks -d service-instance-aa1234567bc8de9f0a1c vms
```

Your master VM IDs appear in the `VM CID` column.

6. Use the information you gathered in this procedure to configure your load balancer backend. For example, if you use GCP, use the master VM IDs from the previous step in [Reconfiguring a GCP Load Balancer](#).

## Retrieving Cluster Credentials and Configuration

This topic describes how to use the `pks get-credentials` command in Pivotal Container Service (PKS) using the PKS Command Line Interface (CLI).

The `pks get-credentials` command performs the following actions:

- Fetch the cluster's kubeconfig
- Add the cluster's kubeconfig to the existing kubeconfig
- Create a new kubeconfig, if none exists
- Switch the context to the `CLUSTER-NAME` provided

When you run `pks get-credentials CLUSTER-NAME`, PKS sets the context to the cluster you provide as the `CLUSTER-NAME`. PKS binds your username to the cluster and populates the kubeconfig file on your local workstation with cluster credentials and configuration.

The default path for your kubeconfig is `$HOME/.kube/config`.

If you access multiple clusters, you can choose to use a custom kubeconfig file for each cluster. To save cluster credentials to a custom kubeconfig, use the `KUBECONFIG` environment variable when you run `pks get-credentials`. For example:

```
$ KUBECONFIG=/path/to/my-cluster.config pks get-credentials my-cluster
```

## Retrieve Cluster Credentials

Perform the following steps to populate your local kubeconfig with cluster credentials and configuration:

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. Run the following command:

```
pks get-credentials CLUSTER-NAME
```

Replace `CLUSTER-NAME` with the unique name for your cluster. For example:

```
$ pks get-credentials my-cluster
```

 **Note:** If you enable OpenID Connect (OIDC) in the PKS tile, PKS requires your password to run the `pks get-credentials CLUSTER-NAME` command. This allows PKS to retrieve valid tokens for the kubeconfig file. You can provide your password at the prompt or as the `PKS_USER_PASSWORD` environment variable. For more information, see the *Configure OpenID Connect* section of [Installing PKS](#) for your IaaS.

## Run kubectl Commands

After PKS populates your kubeconfig, you can use the Kubernetes Command Line Interface (kubectl) to run commands against your Kubernetes clusters.

See [Installing the Kubernetes CLI](#) for information about installing kubectl.

For information about using kubectl, refer to the [Kubernetes documentation](#).

## Viewing Cluster Lists

Follow the steps below to view the list of deployed Kubernetes cluster with the PKS CLI.

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. Run the following command to view the list of deployed clusters, including cluster names and status:

```
$ pks clusters
```

## Viewing Cluster Details

Follow the steps below to view the details of an individual cluster using the PKS CLI.

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. Run the following command to view the details of an individual cluster:

```
pks cluster CLUSTER-NAME
```

Replace `CLUSTER-NAME` with the unique name for your cluster. For example:

```
$ pks cluster my-cluster
```

## Viewing Cluster Plans

Follow the steps below to view information about the available plans for deploying a cluster using the PKS CLI.

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. Run the following command to view information about the available plans for deploying a cluster:

```
$ pks plans
```

The response lists details about the available plans, including plan names and descriptions:

Name	ID	Description
default		Default plan for K8s cluster

## Scaling Existing Clusters

Follow the steps below to scale up an existing cluster using the PKS CLI.

 **Note:** You cannot scale the number of worker nodes down. You can only scale the number of worker nodes up.

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. Run the following command below to scale up your cluster. You cannot scale the number of worker nodes down.

 **Note:** This command may roll additional VMs in the cluster, affecting workloads if the worker nodes are at capacity. This issue will be resolved in a future release of PKS.

```
pks resize CLUSTER-NAME --num-nodes WORKER-NODES
```

Replace the placeholder values in the command as follows:

- o `CLUSTER-NAME` is the name of your cluster.
- o `WORKER-NODES` is the number of worker nodes for the cluster. The maximum number of worker nodes is 50. For example:

```
$ pks resize my-cluster --num-nodes 5
```

## Deleting Clusters

Follow the steps below to delete a cluster using the PKS CLI. Running the `pks delete-cluster` command automatically deletes all NSX objects.

1. On the command line, run the following command to log in:

```
pks login -a PKS-API -u USERNAME -k
```

See [Log in to the PKS CLI](#) for more information about the `pks login` command.

2. Run `pks delete-cluster CLUSTER-NAME` to delete a cluster. Replace `CLUSTER-NAME` with the unique name for your cluster. For example:

```
$ pks delete-cluster my-cluster
```

## Using PKS

Page last updated:

This section describes how to use Pivotal Container Service (PKS).

 **Note:** Because PKS does not currently support the Kubernetes Service Catalog or the GCP Service Broker, binding clusters to Kubernetes services is not supported.

The procedures for using PKS have the following prerequisites:

- You must have an external TCP or HTTPS load balancer configured to forward traffic to the PKS API endpoint. For more information, see the [Configure External Load Balancer](#) section of *Installing PKS* for your IaaS.
- You must know the address of your PKS API endpoint and have a UAA-created user account that has been granted PKS cluster access. For more information, see [Managing Users in PKS with UAA](#).

 **Note:** If your PKS installation is integrated with NSX-T, use the DNAT IP address assigned in the [Retrieve the PKS Endpoint](#) section of *Installing PKS on vSphere with NSX-T Integration*.

See the following sections:

- [Creating Clusters](#)
- [Using Network Profiles \(NSX-T Only\)](#)
- [Retrieving Cluster Credentials and Configuration](#)
- [Viewing Cluster Lists](#)
- [Viewing Cluster Details](#)
- [Viewing Cluster Plans](#)
- [Configuring PersistentVolumes](#)
- [Using Dynamic PersistentVolumes](#)
- [Scaling Existing Clusters](#)
- [Accessing Dashboard](#)
- [Deploying and Accessing Basic Workloads](#)
- [Creating Sink Resources](#)
- [Using Helm with PKS](#)
- [Logging Out of the PKS Environment](#)

## Using Network Profiles (NSX-T Only)

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This topic describes how to use network profiles for Kubernetes clusters provisioned with Pivotal Container Service (PKS) on vSphere with NSX-T integration. Network profiles let you customize NSX-T configuration parameters.

### Assign a Network Profile to a Cluster

You can assign a network profile to a Kubernetes cluster at the time of cluster creation. To assign a network profile to a Kubernetes cluster, you must do the following:

1. Define a network profile configuration in a JSON file. For instructions on how to define network profile configurations, see [Defining Network Profiles](#).
2. Create a network profile using the JSON file. For instructions on how to create network profiles, see [Create a Network Profile](#).
3. Create a Kubernetes cluster with the network profile. For instructions on how to create a Kubernetes cluster with a network profile, see [Create a Cluster with a Network Profile](#).

**Note:** Only PKS cluster administrators can create and delete network profiles. Cluster managers can list existing network profiles and assign them to clusters.

### Create a Cluster with a Network Profile

To create a PKS-provisioned Kubernetes cluster with a network profile, run the following command:

```
pks create-cluster CLUSTER-NAME --external-hostname HOSTNAME --plan PLAN-NAME --network-profile NETWORK-PROFILE-NAME
```

Where:

- `CLUSTER-NAME` is a unique name for your cluster.
- `HOSTNAME` is your external hostname used for accessing the Kubernetes API.
- `PLAN-NAME` is the name of the PKS plan you want to use for your cluster.
- `NETWORK-PROFILE-NAME` is the name of the network profile you want to use for your cluster.

## Manage Network Profiles

This section describes how to create, list, and delete network profiles.

### Create a Network Profile

After you define your network profile configuration as described in [Defining Network Profiles](#), run the following command:

```
pks create-network-profile PATH-TO-YOUR-NETWORK-PROFILE-CONFIGURATION
```

Where `PATH-TO-YOUR-NETWORK-PROFILE-CONFIGURATION` is the path to the JSON file you created when defining the network profile.

For example:

```
$ pks create-network-profile np-routable-pods.json  
Network profile small-routable-pod successfully created
```

Only cluster administrators, `pks.clusters.admin`, can create network profiles. If a cluster manager, `pks.clusters.manage`, attempts to create a network profile,

the following error occurs:

```
You do not have enough privileges to perform this action. Please contact the PKS administrator.
```

## List Network Profiles

To list your network profiles, run the following command:

```
pks network-profiles
```

For example:

```
$ pks network-profiles
Name          Description
lb-profile-medium Network profile for medium size NSX-T load balancer
small-routable-pod Network profile with small load balancer and two routable pod networks
```

## Delete a Network Profile

To delete a network profile, run the following command:

```
pks delete-network-profile NETWORK-PROFILE-NAME
```

Where `NETWORK-PROFILE-NAME` is the name of the network profile you want to delete.

 **Note:** You cannot delete a network profile that is in use.

Only cluster administrators, `pks.clusters.admin`, can delete network profiles. If a cluster manager, `pks.clusters.manage`, attempts to delete a network profile, the following error occurs:

```
You do not have enough privileges to perform this action. Please contact the PKS administrator.
```

## Configuring PersistentVolumes

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This topic describes how to provision static and dynamic PersistentVolumes (PVs) for Pivotal Container Service (PKS) to run stateful apps.

For more information about the supported vSphere topologies for PV storage, see [vSphere PersistentVolume Storage Options on vSphere](#).

For static PV provisioning, you do not need to specify a StorageClass. The PersistentVolumeClaim (PVC) does not need to reference a StorageClass. For dynamic PV provisioning, you must specify a StorageClass and define the PVC using a reference to that StorageClass.

### Provision a Static PV

To provision a static PV, you manually create a Virtual Machine Disk (VMDK) file to use as a storage backend for the PV. When the PV is created, Kubernetes knows which volume instance is ready for use. When a PVC or volumeClaimTemplate is requested, Kubernetes chooses an available PV in the system and allocates it to the Deployment or StatefulSets workload.

#### Provision a Static PV for a Deployment Workload

To provision a static PV for a Deployment workload, the procedure is as follows:

1. Create VMDK files, replacing `[DATASTORE]` with your datastore directory name:

```
[root@ESXi-1:~] cd /vmfs  
[root@ESXi-1:vmfs] cd volumes/  
[root@ESXi-1:vmfs/volumes] cd DATASTORE/  
[root@ESXi-1:vmfs/volumes/DATASTORE] cd kubevol/  
[root@ESXi-1:vmfs/volumes/DATASTORE/kubevol] vmkfstools -c 2G redis-master.vmdk
```

2. Define a PV using a YAML manifest file that contains a reference to the VMDK file. For example, create a file named `redis-master-pv.yaml` with the following contents:

```
apiVersion: v1  
kind: PersistentVolume  
metadata:  
  name: redis-master-pv  
spec:  
  capacity:  
    storage: 2Gi  
  accessModes:  
    - ReadWriteOnce  
  persistentVolumeReclaimPolicy: Retain  
  vsphereVolume:  
    volumePath: "[DATASTORE] kubevol/redis-master"  
    fsType: ext4
```

3. Define a PVC using a YAML manifest file. For example, create a file named `redis-master-claim.yaml` with the following contents:

```
kind: PersistentVolumeClaim  
apiVersion: v1  
metadata:  
  name: redis-master-claim  
spec:  
  accessModes:  
    - ReadWriteOnce  
  resources:  
    requests:  
      storage: 2Gi
```

4. Define a deployment using a YAML manifest file that references the PVC. For example, create a file named `redis-master.yaml` with the following contents:

```

apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: redis-master
...
spec:
  template:
    spec:
      volumes:
        - name: redis-master-data
          persistentVolumeClaim:
            claimName: redis-master-claim

```

## Provision a Static PV for a StatefulSets Workload

To provision a static PV for a StatefulSets workload with three replicas, the procedure is as follows:

1. Create VMDK files, replacing `[DATASTORE]` with your datastore directory name:

```

[root@ESXi-1:~] cd /vmfs
[root@ESXi-1:/vmfs] cd volumes/
[root@ESXi-1:/vmfs/volumes] cd DATASTORE/
[root@ESXi-1:/vmfs/volumes/DATASTORE] cd kubevols/
[root@ESXi-1:/vmfs/volumes/DATASTORE/kubevols] vmkfstools -c 10G mysql-pv-1.vmdk
[root@ESXi-1:/vmfs/volumes/DATASTORE/kubevols] vmkfstools -c 10G mysql-pv-2.vmdk
[root@ESXi-1:/vmfs/volumes/DATASTORE/kubevols] vmkfstools -c 10G mysql-pv-3.vmdk

```

2. Define a PV for the first replica using a YAML manifest file that contains a reference to the VMDK file. For example, create a file named `mysql-pv-1.yaml` with the following contents:

```

apiVersion: v1
kind: PersistentVolume
metadata:
  name: mysql-pv-1
spec:
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Retain
  vsphereVolume:
    volumePath: "[DATASTORE] kubevols/mysql-pv-1"
    fsType: ext4

```

3. Define a PV for the second replica using a YAML manifest file that contains a reference to the VMDK file. For example, create a file named `mysql-pv-2.yaml` with the following contents:

```

apiVersion: v1
kind: PersistentVolume
metadata:
  name: mysql-pv-2
spec:
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Retain
  vsphereVolume:
    volumePath: "[DATASTORE] kubevols/mysql-pv-2"
    fsType: ext4

```

4. Define a PV for the third replica using a YAML manifest file that contains a reference to the VMDK file. For example, create a file named `mysql-pv-3.yaml` with the following contents:

```

apiVersion: v1
kind: PersistentVolume
metadata:
  name: mysql-pv-3
spec:
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Retain
  vsphereVolume:
    volumePath: "[DATASTORE] kubevols/mysql-pv-3"
    fsType: ext4

```

- Define a StatefulSets object using a YAML manifest file. For example, create a file named `mysql-statefulsets.yaml` with the following contents:

```

apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: mysql
spec:
  selector:
    matchLabels:
      app: mysql
  serviceName: mysql
  replicas: 3
...
volumeClaimTemplates:
- metadata:
    name: data
  spec:
    accessModes: ["ReadWriteOnce"]
    resources:
      requests:
        storage: 10Gi

```

**Note:** In previous steps you created a total of three PVs. The `spec.replicas: 3` field defines three replicas. Each replica is attached to one PV.

**Note:** In the volumeClaimTemplates section, you must specify the required storage size for each replica. Do not refer to a StorageClass.

## Provision a Dynamic PV

For dynamic PV provisioning, the procedure is to define and create a PVC that automatically triggers the creation of the PV and its backend VMDK file. When the PV is created, Kubernetes knows which volume instance is available for use. When a PVC or volumeClaimTemplate is requested, Kubernetes chooses an available PV and allocates it to the Deployment or StatefulSets workload.

For usage instructions, see [Using Dynamic PersistentVolumes](#).

## Provision a Dynamic PV for Deployment Workloads

For the Deployment workload with dynamic PV provisioning, the procedure is as follows:

- Define a StorageClass using a YAML manifest file. For example, create a file named `redis-sc.yaml` with the following contents:

```

kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: thin-disk
provisioner: kubernetes.io/vsphere-volume
parameters:
  datastore: Datastore-NFS-VM
  diskformat: thin
  fstype: ext3

```

- Define a PVC using a YAML manifest file that references the StorageClass. For example, create a file named `redis-master-claim.yaml` with the following contents:

```

kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: redis-master-claim
  annotations:
    volume.beta.kubernetes.io/storage-class: thin-disk
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 2Gi

```

 **Note:** When you deploy the PVC, the vSphere Cloud Provider plugin automatically creates the PV and associated VMDK file.

3. Define a Deployment using a YAML manifest file that references the PVC. For example, create a file named `redis-master.yaml` with the following contents:

```

apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: redis-master
...
spec:
  template:
    spec:
      volumes:
        - name: redis-master-data
          persistentVolumeClaim:
            claimName: redis-master-claim

```

## Provision a Dynamic PV for StatefulSets Workloads

To provision a static PV for a StatefulSets workload with three replicas, the procedure is as follows:

1. Define a StorageClass using a YAML manifest file. For example, create a file named `mysql-sc.yaml` with the following contents:

```

kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: my-storage-class
provisioner: kubernetes.io/vsphere-volume
parameters:
  datastore: Datastore-NFS-VM
  diskformat: thin
  fstype: ext3

```

2. Define a StatefulSets object using a YAML manifest file that references the StorageClass. For example, create a file named `mysql-statefulsets.yaml` with the following contents:

```

apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: mysql
spec:
  ...
volumeClaimTemplates:
  - metadata:
      name: data
    spec:
      accessModes: ["ReadWriteOnce"]
      storageClassName: "my-storage-class"
    resources:
      requests:
        storage: 10Gi

```

 **Note:** In the volumeClaimTemplates, specify the required storage size for each replica. Unlike static provisioning, you must explicitly refer to the desired StorageClass when you use dynamic PV provisioning.



## Using Dynamic PersistentVolumes

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When using PKS, you can choose to pre-provision persistent storage or create on-demand PersistentVolumes (PVs). Refer to the [Kubernetes documentation](#) for more information about storage management.

Perform the steps in this section to define a PersistentVolumeClaim (PVC) that you can apply to newly-created pods.

1. Download the StorageClass spec for your cloud provider.

- o GCP:

```
$ wget https://raw.githubusercontent.com/cloudfoundry-incubator/kubo-ci/master/specs/storage-class-gcp.yml
```

- o vSphere:

```
$ wget https://raw.githubusercontent.com/cloudfoundry-incubator/kubo-ci/master/specs/storage-class-vsphere.yml
```

After downloading the vSphere StorageClass spec, replace the contents of the file with the following to create the correct StorageClass:

```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: thin
  annotations:
    storageclass.kubernetes.io/is-default-class: "true"
  provisioner: kubernetes.io/vsphere-volume
parameters:
  diskformat: thin
```

- o AWS:

```
$ wget https://raw.githubusercontent.com/cloudfoundry-incubator/kubo-ci/master/specs/storage-class-aws.yml
```

2. Apply the spec by running `kubectl create -f STORAGE-CLASS-SPEC.yml`. Replace `STORAGE-CLASS-SPEC` with the name of the file you downloaded in the previous step. For example:

```
$ kubectl create -f storage-class-gcp.yml
```

3. Run the following command to download the example PVC:

```
$ wget https://raw.githubusercontent.com/cloudfoundry-incubator/kubo-ci/master/specs/persistent-volume-claim.yml
```

4. Run the following command to apply the PVC:

```
$ kubectl create -f persistent-volume-claim.yml
```

- o To confirm you applied the PVC, run the following command:

```
$ kubectl get pvc -o wide
```

5. To use the dynamic PV, create a pod that uses the PVC. See the [pv-guestbook.yml configuration file](#) as an example.

## Accessing Dashboard

This topic describes how to access Dashboard, a web-based Kubernetes user interface, for your Pivotal Container Service (PKS) deployment.

### Overview

You can use Dashboard to deploy containerized applications to a Kubernetes cluster, troubleshoot containerized apps, manage the cluster and its resources, initiate rolling updates, and restart pods. Dashboard also provides information about the state of Kubernetes resources in the cluster.

### Prerequisites

You must have `kubectl` credentials to access Dashboard. This requirement prevents unauthorized admin access to the Kubernetes cluster through a browser.

### Access Dashboard

To access Dashboard, navigate to `http://localhost:8001/api/v1/namespaces/kube-system/services/https:kubernetes-dashboard:/proxy/` in a browser.

### Use Dashboard

For information on how to use Dashboard, see the [Web UI \(Dashboard\)](#) topic of the Kubernetes documentation.

## Deploying and Accessing Basic Workloads

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This topic describes how to deploy and access basic workloads in Pivotal Container Service (PKS).

If you use Google Cloud Platform (GCP), Amazon Web Services (AWS), or vSphere with NSX-T integration, your cloud provider can configure an external load balancer for your workload. See [Access Workloads Using an External Load Balancer](#).

If you use AWS, you can also access your workload using an internal load balancer. See the [AWS Prerequisites](#) section, and then [Access Workloads Using an Internal AWS Load Balancer](#).

If you use vSphere without NSX-T, you can choose to configure your own external load balancer or expose static ports to access your workload without a load balancer. See [Access Workloads without a Load Balancer](#).

### AWS Prerequisites

If you use AWS, perform the following steps before you create a load balancer:

1. In the [AWS Management Console](#), create or locate a public subnet for each availability zone (AZ) you are deploying to. A public subnet has a route table that directs Internet-bound traffic to the Internet gateway.
2. On the command line, run `pks cluster CLUSTER-NAME`, replacing `CLUSTER-NAME` with the name of your cluster.
3. Record the unique identifier for the cluster.
4. In the [AWS Management Console](#), tag each public subnet based on the table below, replacing `CLUSTER-UUID` with the unique identifier of the cluster. Leave the **Value** field blank.

Key	Value
<code>kubernetes.io/cluster/service-instance_ CLUSTER-UUID</code>	empty

 **Note:** AWS limits the number of tags on a subnet to 100.

### Access Workloads Using an External Load Balancer

If you use GCP, AWS, or vSphere with NSX-T, follow the steps below to deploy and access basic workloads using a load balancer configured by your cloud provider.

 **Note:** This approach creates a dedicated load balancer for each workload. This may be an inefficient use of resources in clusters with many apps.

1. Expose the workload using a Service with `type: LoadBalancer`. See the [Kubernetes documentation](#) for more information about the `LoadBalancer` Service type.
2. Download the spec for a basic NGINX app from the [cloudfoundry-incubator/kubo-ci](#) GitHub repository.
3. Run `kubectl create -f nginx.yml` to deploy the basic NGINX app. This command creates three pods (replicas) that span three worker nodes.
4. Wait until your cloud provider creates a dedicated load balancer and connects it to the worker nodes on a specific port.
5. Run `kubectl get svc nginx` and retrieve the load balancer IP address and port number.
6. On the command line of a server with network connectivity and visibility to the IP address of the worker node, run `curl http://EXTERNAL-IP:PORT` to access the app. Replace `EXTERNAL-IP` with the IP address of the load balancer and `PORT` with the port number.

### Access Workloads Using an Internal AWS Load Balancer

If you use AWS, follow the steps below to deploy and access basic workloads using an internal load balancer configured by your cloud provider.

 **Note:** This approach creates a dedicated load balancer for each workload. This may be an inefficient use of resources in clusters with many apps.

1. Expose the workload using a Service with `type: LoadBalancer`. See the [Kubernetes documentation](#) for more information about the `LoadBalancer` Service type.
2. Download the spec for a basic NGINX app from the [cloudfoundry-incubator/kubo-ci](#) GitHub repository.
3. In the services metadata section of the manifest, add an `annotations` tag.

For example:

```
apiVersion: v1
kind: Service
metadata:
  labels:
    name: nginx
  annotations:
    service.beta.kubernetes.io/aws-load-balancer-internal: 0.0.0.0/0
  name: nginx
spec:
  ports:
    - port: 80
  selector:
    app: nginx
  type: LoadBalancer
```

4. Run `kubectl create -f nginx.yml` to deploy the basic NGINX app. This command creates three pods (replicas) that span three worker nodes.
5. Wait until your cloud provider creates a dedicated load balancer and connects it to the worker nodes on a specific port.
6. Run `kubectl get svc nginx` and retrieve the load balancer IP address and port number.
7. On the command line of a server with network connectivity and visibility to the IP address of the worker node, run `curl http://EXTERNAL-IP:PORT` to access the app. Replace `EXTERNAL-IP` with the IP address of the load balancer and `PORT` with the port number.

## Access Workloads without a Load Balancer

If you use vSphere without NSX-T integration, you do not have a load balancer configured by your cloud provider. You can choose to [configure your own external load balancer](#) or follow the procedures in this section to access your workloads without a load balancer.

If you do not use an external load balancer, you can configure the NGINX service to expose a static port on each worker node. From outside the cluster, you can reach the service at `http://NODE-IP:NODE-PORT`.

To expose a static port on your workload, perform the following steps:

1. Download the spec for a basic NGINX app from the [cloudfoundry-incubator/kubo-ci](#) GitHub repository.
2. Run `kubectl create -f nginx.yml` to deploy the basic NGINX app. This command creates three pods (replicas) that span three worker nodes.
3. Expose the workload using a Service with `type: NodePort`. See the [Kubernetes documentation](#) for more information about the `NodePort` Service type.
4. Retrieve the IP address for a worker node with a running NGINX pod.

 **Note:** If you deployed more than four worker nodes, some worker nodes may not contain a running NGINX pod. Select a worker node that contains a running NGINX pod.

You can retrieve the IP address for a worker node with a running NGINX pod in one of the following ways:

- o On the command line, run `kubectl get nodes -l spec.ip`.
  - o On the Ops Manager command line, run `bosh vms` to find the IP address.
5. On the command line, run `kubectl get svc nginx`. Find the node port number in the `3XXXX` range.
  6. On the command line of a server with network connectivity and visibility to the IP address of the worker node, run `curl http://NODE-IP:NODE-PORT` to access the app. Replace `NODE-IP` with the IP address of the worker node, and `NODE-PORT` with the node port number.



## Creating Sink Resources

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This topic describes how to create a sink resource for a Kubernetes cluster provisioned with Pivotal Container Service (PKS) or for a namespace within a cluster.

Sink resources enable PKS users to configure destinations for logs transported following the Syslog Protocol defined in [RFC 5424](#).

### Prerequisites

Before you can create a sink resource for a namespace within a PKS-provisioned Kubernetes cluster, you must ensure that the **Enable Sink Resources** checkbox is selected in the PKS tile. Selecting this checkbox enables namespaces to send logs to sinks.

For more information, see the *Logging* section of the PKS installation topic for your IaaS:

- [Installing PKS on vSphere](#)
- [Installing PKS on vSphere with NSX-T Integration](#)
- [Installing PKS on GCP](#)
- [Installing PKS on AWS](#)

 **Note:** The commands in this topic require that you install the Kubernetes Command Line Interface (CLI), `kubectl`. For installation instructions, see [Installing the Kubernetes CLI](#).

### Define Sink Resources

You can create sinks for clusters and namespaces. A namespace sink filters logs by namespace within a cluster.

- If you want to create a cluster sink, see [ClusterSink Resource](#).
- If you want to create a namespace sink, see [Sink Resource](#).

#### ClusterSink Resource

 **Note:** If you upgrade to PKS v1.2.1, creating a ClusterSink fails. This issue occurs only after an upgrade to PKS v1.2.1 and does not apply to new installations of PKS v1.2.1 or later. For more information, see the corresponding [Knowledge Base](#) article.

To define a `ClusterSink` resource, create a YAML file that specifies your log destination in the following format:

```
apiVersion: apps.pivotal.io/v1beta1
kind: ClusterSink
metadata:
  name: YOUR-SINK
spec:
  type: syslog
  host: YOUR-LOG-DESTINATION
  port: YOUR-LOG-DESTINATION-PORT
  enable_tls: true
```

Where:

- `YOUR-SINK` is a name you choose for your sink.
- `YOUR-LOG-DESTINATION` is the URL of your log management service.
- `YOUR-LOG-DESTINATION-PORT` is the port number of your log management service.

#### Sink Resource

To define a `Sink` resource, create a YAML file that specifies your log destination in the following format:

```
apiVersion: apps.pivot.al.io/v1beta1
kind: Sink
metadata:
  name: YOUR-SINK
  namespace: YOUR-NAMESPACE
spec:
  type: syslog
  host: YOUR-LOG-DESTINATION
  port: YOUR-LOG-DESTINATION-PORT
  enable_tls: true
```

Where:

- `YOUR-SINK` is a name you choose for your sink.
- `YOUR-NAMESPACE` is the name of your namespace.
- `YOUR-LOG-DESTINATION` is the URL of your log management service.
- `YOUR-LOG-DESTINATION-PORT` is the port number of your log management service.

## Create Sink Resources

To create the `ClusterSink` or `Sink` resource that you defined in the previous step, run the following command:

```
kubectl apply -f MY-SINK.yml
```

Where `MY-SINK.yml` is the name of your YAML file.

For example:

```
$ kubectl apply -f example-sink.yml
```

## Manage Sinks

To list and delete sinks, use the following commands:

### Cluster Sinks

- `kubectl get clustersinks`. List the sink resources deployed to your cluster.
- `kubectl delete clustersink YOUR-SINK`. Delete a sink, where `YOUR-SINK` is the name of your sink.

### Namespace Sinks

- `kubectl get sinks`. List the sink resources deployed to a namespace.
- `kubectl delete sink YOUR-SINK`. Delete a sink, where `YOUR-SINK` is the name of your sink.

## Using Helm with PKS

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This topic describes how to use the package manager [Helm](#) for your Kubernetes apps running on Pivotal Container Service (PKS).

## Overview

Helm includes the following components:

Component	Role	Location
helm	Client	Runs on your local workstation
tiller	Server	Runs inside your Kubernetes cluster

Helm packages are called **charts**. For more information, see [Charts](#) in the Helm documentation.

Examples of charts:

- [Concourse](#) for CI/CD pipelines
- [Datadog](#) for monitoring
- [MySQL](#) for storage

For more charts, see the [Helm Charts repository](#) on GitHub.

## Configure Tiller

If you want to use Helm with PKS, you must configure Tiller.

Tiller runs inside the Kubernetes cluster and requires access to the Kubernetes API.

If you use role-based access control (RBAC) in PKS, perform the steps in this section to grant Tiller permission to access the API.

1. Create a service account for Tiller and bind it to the `cluster-admin` role by adding the following section to `rbac-config.yaml`:

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: tiller
  namespace: kube-system
---
apiVersion: rbac.authorization.k8s.io/v1beta1
kind: ClusterRoleBinding
metadata:
  name: tiller
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: cluster-admin
subjects:
  - kind: ServiceAccount
    name: tiller
    namespace: kube-system
```

2. Apply the service account and role by running the following command:

```
$ kubectl create -f rbac-config.yaml
```

3. Download and install the [Helm CLI](#).

4. Deploy Helm using the service account by running the following command:

```
$ helm init --service-account tiller
```

5. Run `helm ls` to verify that the permissions are configured.

To apply more granular permissions to the Tiller service account, see the [Helm RBAC](#) documentation.

## Logging Out of the PKS Environment

On the command line, run `pks logout` to log out of your PKS environment.

After logging out, you must run `pks login` before you can run any other `pks` commands.

## Logging and Monitoring PKS

This section describes how to monitor Pivotal Container Service (PKS) deployments.

See the following topics:

- [Viewing Usage Data](#)
- [Downloading Cluster Logs](#)
- [Monitoring Master/etcd Node VMs](#)

For information about monitoring PKS with VMware Wavefront, see [VMware PKS Integration](#).

## Viewing and Exporting Usage Data

Page last updated:

**Note:** The procedures in this topic apply to PKS v1.2 and earlier only. To view usage data in later versions of PKS, see the [Viewing Usage Data](#) topic in the documentation for PKS v1.3 or later.

This topic describes how operators can view and export usage information from their Pivotal Container Service (PKS) deployment. Operators can use this data to calculate billed usage, perform customer chargebacks, and generate usage reports.

The PKS database stores the following pod usage data:

- **Watermark:** the number of pods that run at a single time.
- **Consumption:** the memory and CPU usage of pods.

To extract either type of usage data from your PKS deployment, you must `bosh ssh` into your PKS VM.

## About Usage Data

This section describes the usage data records you can view and export from the PKS VM. The agent pod collects both watermark and consumption data for the deployment and sends the data to the PKS aggregator agent. The aggregator agent then stores the data in the PKS database. You can access the PKS database from the PKS VM and export the usage data for your deployment.

### Watermark Data

The PKS database stores comma-separated watermark data about the number of pods that run simultaneously in your PKS deployment. You can view the watermark data on the command line or export it to a comma-separated values (`.csv`) file.

The following is an example of a watermark usage data export:

```
id,collect_time,day,month,year,agent,agent_pod_cnt,total_pod_cnt,high_watermark_since_install_pod_cnt,high_watermark_since_install_date
1,2018-06-08 01:16:22,7,6,2018,Service-instance_61916de4-8abe-4ec7-a67b-e2568c83dbe0,1,1,1,2018-06-08 01:16:22
2,2018-06-09 01:16:24,8,6,2018,service-instance_61916de4-8abe-4ec7-a67b-e2568c83dbe0,1,1,1,2018-06-08 01:16:22
3,2018-06-10 01:16:34,9,6,2018,service-instance_61916de4-8abe-4ec7-a67b-e2568c83dbe0,1,1,1,2018-06-08 01:16:22
4,2018-06-12 01:12:25,11,6,2018,service-instance_61916de4-8abe-4ec7-a67b-e2568c83dbe0,1,1,1,2018-06-12 01:12:25
5,2018-06-26 01:16:38,25,6,2018,service-instance_748709f7-41be-4c5f-9123-78874caeb602,3,3,3,2018-06-26 01:16:38
6,2018-06-28 01:16:59,27,6,2018,service-instance_748709f7-41be-4c5f-9123-78874caeb602,3,3,3,2018-06-28 01:16:59
```

The following table describes the database fields related to watermark usage data:

Field Name	Description
<code>id</code>	Unique record identifier
<code>collect_time</code>	The date when the agent collects the record
<code>day</code>	The day that corresponds to the record
<code>month</code>	The month that corresponds to the record
<code>year</code>	The year that corresponds to the record
<code>agent</code>	The name of the pod that contains the agent
<code>agent_pod_cnt</code>	The maximum number of pods in the cluster on the given day
<code>total_pod_cnt</code>	The maximum number of pods in the deployment on the given day
<code>high_watermark_since_install_pod_cnt</code>	The maximum number of pods in the deployment since installation
<code>high_watermark_since_install_date</code>	The date when the agent logs the maximum number of pods in the deployment

### Consumption Data

The PKS database stores resource consumption data for all pods in a deployment. You can view the uptime and pod count for each cluster in your PKS deployment as well as memory and CPU usage for each pod by accessing the database on the command line.

The following table describes the database fields related to consumption usage data:

Field Name	Description
<code>id</code>	Unique record identifier
<code>agent</code>	Unique cluster name
<code>collect_time</code>	The date when the agent collects the record
<code>pod_id</code>	Unique pod identifier
<code>pod_name</code>	Unique pod name
<code>memory_used</code>	Pod memory usage
<code>cpu_used</code>	Pod CPU usage
<code>pod_cnt</code>	The number of pods in the cluster

## SSH into the PKS VM

To SSH into your PKS VM using BOSH, follow the steps below:

1. Gather credential and IP address information for your BOSH Director, SSH into the Ops Manager VM, and use BOSH CLI to log in to the BOSH Director from the Ops Manager VM. For more information, see [Advanced Troubleshooting with the BOSH CLI](#).
2. To identify your PKS deployment's name, run the following command:

```
bosh -e ENVIRONMENT deployments
```

Where `ENVIRONMENT` is the BOSH environment alias you set in [Set a BOSH Environment Alias](#).

For example:

```
$ bosh -e pks deployments
```

Your PKS deployment name begins with `pivotal-container-service` and includes a BOSH-generated hash.

3. To identify your PKS VM's name, run the following command:

```
bosh -e ENVIRONMENT -d DEPLOYMENT vms
```

Where:

- `ENVIRONMENT` is the BOSH environment alias.
- `DEPLOYMENT` is your PKS deployment name.

For example:

```
$ bosh -e pks -d pivotal-container-service/a1b2c333d444e5f66a77 vms
```

Your PKS VM name begins with `pivotal-container-service` and includes a BOSH-generated hash.

 **Note:** The PKS VM hash value is different from the hash in your PKS deployment name.

4. To SSH into the PKS VM, run the following command:

```
bosh -e ENVIRONMENT -d DEPLOYMENT ssh PKS-VM
```

Where:

- `ENVIRONMENT` is the BOSH environment alias.
- `DEPLOYMENT` is your PKS deployment name.
- `PKS-VM` is your PKS VM name.

For example:

```
$ bosh -e pkss \
-d pivotal-container-service/a1b2c333d444e5f66a77 \
ssh pivotal-container-service/000a111-222b-3333-4cc5-de66f7a8899b
```

## View and Export Watermark Usage Data

To view and export the watermark usage data for your PKS deployment, follow the steps below:

1. From the PKS VM, create a new file named `print-watermark.sh`.
2. Paste the following contents into the `print-watermark.sh` file:

```
#!/bin/bash

set -e

db_username=$(grep 'DBName: telemetry' -A2 /var/vcap/jobs/mysql/config/mariadb_ctl_config.yml | grep 'User' | tr -d '"' | cut -d':' -f2)
db_password=$(grep 'DBName: telemetry' -A2 /var/vcap/jobs/mysql/config/mariadb_ctl_config.yml | grep 'Password' | tr -d '"' | cut -d':' -f2)

mysql_cmd="/var/vcap/packages/mariadb/bin/mysql -u$db_username -h 127.0.0.1 -p$db_password"

watermark_select_result=$(($mysql_cmd --execute="use telemetry; select * from pkswatermark order by collect_time"))

watermark_csv=$(echo "$watermark_select_result" | tr '\t' ',')
echo "$watermark_csv"
```

3. To print all watermark data to the terminal window, run the following command:

```
bash print-watermark.sh
```

 **Note:** To print only the most recent watermark data entries, append `tail -nNUMBER` to the above command. For example, to display the five most recent watermarks, run `bash print-watermark.sh | tail -n5`.

4. (Optional) To write the data to a `.csv` file, run the following command:

```
bash print-watermark.sh > watermarks-$(date -u +"%Y-%m-%dT%H:%M:%SZ").csv
```

## View Consumption Usage Data

To view the consumption data for your PKS deployment, follow the steps below:

1. On the command line, connect to your PKS database. You can locate your database credentials in `/var/vcap/jobs/mysql/config/mariadb_ctl_config.yml`.
2. To view the `pksdata` table, run `describe pksdata;`.

For example:

```
MariaDB [telemetry]> describe pksdata;
+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra          |
+-----+-----+-----+-----+
| id    | int(11) | NO | PRI | NULL   | auto_increment |
| agent | char(253) | YES | | NULL   |               |
| collect_time | timestamp | NO | | CURRENT_TIMESTAMP | on update CURRENT_TIMESTAMP |
| pod_id | char(253) | YES | | NULL   |               |
| pod_name | char(253) | YES | | NULL   |               |
| memory_used | bigint(20) | NO | | NULL   |               |
| cpu_used | bigint(20) | NO | | NULL   |               |
| pod_cnt | bigint(20) | NO | | NULL   |               |
+-----+-----+-----+-----+
```

3. Continue to the following sections to run specific queries.

## View Pod Counts by Cluster in a Given Time Window

To view the pod counts by cluster for a given time window, run the following query:

```
select agent,count(distinct pod_name) from pkldata where collect_time between
'BEGINNING-TIMESTAMP' and 'ENDING-TIMESTAMP' group by agent;
```

Where `BEGINNING-TIMESTAMP` and `ENDING-TIMESTAMP` represent the beginning and ending times for your search window. Use the `YYYY-MM-DD HH:MM:SS` format for both timestamps.

For example:

```
MariaDB [telemetry]> select agent,count(distinct pod_name) from pkldata where collect_time between '2018-08-14 00:00:00' and '2018-08-14 01:00:00' group by agent;
+-----+-----+
| agent | count(distinct pod_name) |
+-----+-----+
| service-instance_1a8617eb-a582-45b5-8749-3b18fb1d661c | 9 |
| service-instance_1c025915-0ef7-4621-b1eb-aff1c549feb9 | 8 |
| service-instance_209cae63-87da-47b7-81db-8b978249f80a | 7 |
| service-instance_3eb8c734-dce5-4de3-b971-88792d5262d0 | 12 |
| service-instance_483fa035-c2ee-47c4-b2bd-79329155d6b2 | 3 |
| service-instance_66deded63-7265-4af8-bfbb-b51f4b1e310a | 2 |
| service-instance_789f7c3f-33f6-4914-88f5-0359c39bf856 | 24 |
| service-instance_988f7e11-940e-4ffd-9abb-117370dcaaf3 | 12 |
| service-instance_e3139ecc-5567-4232-9707-1c16e3cdf571 | 10 |
+-----+-----+
```

## View Running Pod Hours for the Current Day

To view the running pod count by cluster for the current day, run the following query:

```
select agent,timestampdiff(HOUR,min(collect_time), max(collect_time)) + 1 as
"hours today", pod_name from pkldata where collect_time > curdate() -1 group by pod_name;
```

For example:

```
MariaDB [telemetry]> select agent,timestampdiff(HOUR,min(collect_time), max(collect_time)) + 1 as "hours today", pod_name from pkldata where collect_time > curdate() -1 group by pod_name
+-----+-----+-----+
| agent | hours today | pod_name |
+-----+-----+-----+
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-create-bucket-mtlpr |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-minio-7d6647dcd-f62wx |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 1 | my-release-spinnaker-clouddriver-c4d56c6b-fd227 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-spinnaker-deck-5f7c94d6b8-qm49n |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-spinnaker-echo-75655dd8bb-hkc2t |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-spinnaker-front50-8f58449b6-pwpdd |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 1 | my-release-spinnaker-gate-c66c8996-xxt5h |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-spinnaker-igor-59d69c6c69-2xcrp |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 1 | my-release-spinnaker-orca-7c8fd56d9-pmr7d |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-spinnaker-roscos-7759ffcc65-jsw66 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | my-release-upload-build-image-d4f9f |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 1 | nginx-77v62 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 1 | nginx-kkrnm8 |
| service-instance_db568933-c59d-409e-a488-a716641e55cd | 1 | nginx-mqr9x |
| service-instance_db568933-c59d-409e-a488-a716641e55cd | 1 | nginx-rbnlm |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 21 | wordpress-mysql-bcc89f687-vjfc |
+-----+-----+-----+
```

## View Pods by Running Time

To view the running pod count by cluster for each hour in the current day, run the following query:

```
select agent,timestampdiff(HOUR,min(collect_time), max(collect_time)) + 1 as
"hours today", pod_name from pkldata where collect_time > curdate() -1 group by pod_name;
```

For example:

```
MariaDB [telemetry]> select agent,hour(collect_time) as hour,count(distinct pod_name) from pksdata group by agent,hour;
+-----+-----+
| agent | hour | count(distinct pod_name) |
+-----+-----+
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 0 | 12 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 1 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 2 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 3 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 4 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 5 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 6 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 7 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 8 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 9 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 10 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 11 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 12 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 13 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 14 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 15 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 16 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 17 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 18 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 19 | 9 |
| service-instance_b43c891c-6a4d-42ef-8bcd-402c0433f89e | 20 | 11 |
| service-instance_db568933-c59d-409e-a488-a716641e55cd | 20 | 2 |
+-----+-----+
```

## Downloading Cluster Logs

To download cluster logs, perform the following steps:

1. Gather credential and IP address information for your BOSH Director, SSH into the Ops Manager VM, and use the BOSH CLI v2+ to log in to the BOSH Director from the Ops Manager VM. For more information, see [Advanced Troubleshooting with the BOSH CLI](#).
2. After logging in to the BOSH Director, identify the name of your PKS deployment. For example:

```
$ bosh -e pkcs deployments
```

Your PKS deployment name begins with `pivotal-container-service` and includes a BOSH-generated hash.

3. Identify the names of the VMs you want to retrieve logs from by listing all VMs in your deployment. For example:

```
$ bosh -e pkcs -d pivotal-container-service-aa1234567bc8de9f0a1c vms
```

4. Download the logs from the VM. For example:

```
$ bosh -e pkcs \
-d pivotal-container-service-aa1234567bc8de9f0a1c logs pkcs/0
```

See the [View Log Files](#) section of the *Diagnostic Tools* topic for information about using cluster logs to diagnose issues in your PKS deployment.

## Backing up and Restoring PKS

Page last updated:

This section describes how to back up and restore the Pivotal Container Service (PKS) control plane. PKS uses the Cloud Foundry [BOSH Backup and Restore](#) framework to back up and restore the PKS control plane.

The PKS control plane includes the following components:

- UAA MySQL database
- PKS API MySQL database

BOSH Backup and Restore (BBR) backs up the PKS control plane components. BBR does not back up cluster data or deployed applications.

BBR orchestrates triggering the backup or restore process on the PKS BOSH deployment, and transfers the backup artifacts to and from the PKS BOSH deployment.

For more information about installing and using BBR, see the following topics:

- [Installing BOSH Backup and Restore](#)
- [Backing up the PKS Control Plane](#)
- [Restoring the PKS Control Plane](#).
- For information about troubleshooting BBR, see [BBR Logging](#).

## Installing BOSH Backup and Restore

Page last updated:

This topic describes how to install BOSH Backup and Restore (BBR).

To install BBR, you copy the `bbr` executable to a jumpbox.

Once installed on your jumpbox, you can run `bbr` commands to back up and restore your PKS deployment.

For more information, see [Backing up the PKS Control Plane](#) and [Restoring the PKS Control Plane](#).

### Prerequisite

You must have a jumpbox before you can install BBR to the jumpbox. A jumpbox is a separate, hardened server on your network that provides a controlled means of access to the VMs other computers on your network.

See the [jumpbox-deployment](#) GitHub repository for an example jumpbox deployment.

### Step 1: Configure Your Jumpbox

Configure your jumpbox to meet the following requirements:

- Your jumpbox must be able to communicate with the network that contains your PKS deployment. You can use the Ops Manager VM as your jumpbox.
- Your jumpbox must have sufficient space for the backup.
- Your jumpbox must be in the same network as the deployed VMs because BBR connects to the VMs at their private IP addresses. BBR does not support SSH gateways.
- BBR copies the backed-up data from the VMs to the jumpbox, so you should have minimal network latency between the VMs and the jumpbox to reduce transfer times.

 Note: BBR uses SSH to orchestrate the backup of your PKS instances using port 22 by default.

### Step 2: Transfer BBR to Your Jumpbox

Perform the following steps to transfer the `bbr` binary to your jumpbox:

1. Download the latest [BOSH Backup and Restore release](#) from Pivotal Network.

2. To add executable permissions to the `bbr` binary file, run `chmod a+x bbr`:

```
$ chmod a+x bbr
```

3. To securely copy the `bbr` binary file to your jumpbox, run the following command:

```
scp LOCAL-PATH-TO-BBR/bbr JUMPBOX-USER/JUMPBOX-ADDRESS
```

If your jumpbox has access to the internet, you can instead SSH into your jumpbox and use `wget`:

```
$ ssh JUMPBOX-USER/JUMPBOX-ADDRESS -i YOUR-CERTIFICATE.pem  
$ wget BBR-RELEASE-URL  
$ chmod a+x bbr
```

## Backing up the PKS Control Plane

Page last updated:

This topic describes how to use BOSH Backup and Restore (BBR) to back up the PKS control plane.

To perform a restore, see [Restoring the PKS Control Plane](#).

### Prerequisites

If you want to use the result of the backup to restore to a destination environment, verify that the current environment and the destination environment are compatible. For more information, see the [Compatibility of Restore](#) section of *Restoring the PKS Control Plane*.

Before you begin backing up the PKS control plane, perform the following steps:

1. Download the root CA certificate for your PKS deployment as follows:
  - a. On the Ops Manager Installation Dashboard, in the top right corner, click your username.
  - b. Navigate to **Settings > Advanced**.
  - c. Click **Download Root CA Cert**.
2. Locate and record your PKS BOSH deployment name as follows:
  - a. On the Ops Manager Installation Dashboard, click the Director tile.
  - b. In the Director tile, click the **Credentials** tab.
  - c. Navigate to **Bosh Commandline Credentials** and click **Link to Credential**.
  - d. Copy the credential value.
  - e. On the command line, run the following command to retrieve your PKS BOSH deployment name. Replace `BOSH-CLI-CREDENTIALS` with the credential value you copied in the previous step:

```
BOSH-CLI-CREDENTIALS deployments | grep pivotal-container-service
```

 **Note:** Your PKS BOSH deployment name begins with “pivotal-container-service” and includes a unique identifier.

## Connect to Your Jumpbox

You can establish a connection to your jumpbox in one of the following ways.

- [Connect with SSH](#)
- [Connect with BOSH\\_ALL\\_PROXY](#)

For general information about the jumpbox, see [Installing BOSH Backup and Restore](#).

### Connect with SSH

SSH into your jumpbox. If you connect to your jumpbox with SSH, you must run the BBR commands in the following sections from within your jumpbox.

### Connect with BOSH\_ALL\_PROXY

Set and use `BOSH_ALL_PROXY`. Using `BOSH_ALL_PROXY` opens an SSH tunnel with SOCKS5 to the jumpbox. This tunnel allows you to forward requests to the BOSH Director through the jumpbox from your local machine.

Use one of the following methods to create the tunnel:

- **Tunnel created by BOSH CLI:** To provide the BOSH CLI with the SSH credentials it needs to create the tunnel, run the following command:

```
export BOSH_ALL_PROXY=ssh+socks5://jumpbox@jumpbox-ip:12345?private_key=jumpbox.key
```

- Tunnel established separately:

1. To establish the tunnel and make it available on a local port, run the following command:

```
ssh -4 -D 12345 -fNC jumpbox@jumpbox-ip -i jumpbox.key
```

2. To provide the BOSH CLI with access to the tunnel through use of the `BOSH_ALL_PROXY` environment variable, run the following command:

```
export BOSH_ALL_PROXY=socks5://localhost:12345
```

 **Note:** Using `BOSH_ALL_PROXY` can result in longer backup and restore times due to network performance degradation. Because all operations must pass through the proxy, moving backup artifacts can be significantly slower.

## Back up the PKS Control Plane

1. Run the BBR pre-backup check to confirm that your BOSH Director is reachable and has a deployment that can be backed up:

```
BOSH_CLIENT_SECRET=BOSH-CLIENT-SECRET \
bbr deployment \
--target BOSH-TARGET \
--username BOSH-CLIENT \
--deployment DEPLOYMENT-NAME \
--ca-cert PATH-TO-BOSH-SERVER-CERT \
pre-backup-check
```

Replace the placeholder text using the information in the following table.

Placeholder Text	Instructions
<code>BOSH-CLIENT-SECRET</code>	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT_SECRET</code> .
<code>BOSH-TARGET</code>	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_ENVIRONMENT</code> . You must be able to reach the target address from the workstation where you run <code>bbr</code> commands.
<code>BOSH-CLIENT</code>	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT</code> .
<code>DEPLOYMENT-NAME</code>	Use the PKS BOSH deployment name that you located in the <a href="#">Prerequisites</a> section.
<code>PATH-TO-BOSH-CA-CERT</code>	Use the path to the root CA certificate that you downloaded in the <a href="#">Prerequisites</a> section.

For example:

```
$ BOSH_CLIENT_SECRET=p455w0rd \
bbr deployment \
--target bosh.example.com \
--username admin \
--deployment cf-acceptance-0 \
--ca-cert bosh.ca.cert \
pre-backup-check
```

2. If the pre-backup check command fails, perform the following actions:

- Run the command again, adding the `--debug` flag to enable debug logs. For more information, see [BBR Logging](#).
- Make any correction suggested in the output and run the pre-backup check again. For example, the deployment that you selected might not have the correct backup scripts, or the connection to the BOSH Director failed.

3. If the pre-backup check succeeds, run the BBR backup command from your jumpbox to back up the PKS control plane:

```
BOSH_CLIENT_SECRET=BOSH-CLIENT-SECRET \
nohup bbr deployment \
--target BOSH-TARGET \
--username BOSH-CLIENT \
--deployment DEPLOYMENT-NAME \
--ca-cert PATH-TO-BOSH-SERVER-CERT \
backup
```

Replace the placeholder text using the information in the following table. These are the same values as shown in the previous table.

Placeholder Text	Instructions
BOSH-CLIENT-SECRET	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosch Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT_SECRET</code> .
BOSH-TARGET	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosch Commandline Credentials</b> . Record the value for <code>BOSH_ENVIRONMENT</code> . You must be able to reach the target address from the workstation where you run <code>bbr</code> commands.
BOSH-CLIENT	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosch Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT</code> .
DEPLOYMENT-NAME	Use the PKS BOSH deployment name that you located in the <a href="#">Prerequisites</a> section.
PATH-TO-BOSH-CA-CERT	Use the path to the root CA certificate that you downloaded in the <a href="#">Prerequisites</a> section.

 **Note:** If you want to include the manifest in the backup artifact, add the `--with-manifest` flag. However, be aware that the backup artifact then includes credentials that you must keep secret.

For example:

```
$ BOSH_CLIENT_SECRET=p455w0rd \
nohup bbr deployment \
--target bosh.example.com \
--username admin \
--deployment cf-acceptance-0 \
--ca-cert bosh.ca.cert \
backup
```

 **Note:** The BBR backup command can take a long time to complete. You can run it independently of the SSH session so that the process can continue running even if your connection to the jumpbox fails. The command above uses `nohup`, but you can run the command in a `screen` or `tmux` session instead.

4. If the command completes successfully, follow the steps in [Manage Your Backup Artifact](#) below.

5. If the backup command fails, perform the following actions:

- o Run the command again, adding the `--debug` flag to enable debug logs. For more information, see [BBR Logging](#).
- o Follow the steps in [Recover from a Failing Command](#).

## Recover from a Failing Command

If the backup fails, follow these steps:

1. Ensure that you set all the parameters in the backup command.
2. Ensure the BOSH Director credentials are valid.
3. Ensure the deployment that you specify in the BBR command exists.
4. Ensure that the jumpbox can reach the BOSH Director.
5. Consult [BBR Logging](#).
6. If you see the error message `Directory /var/vcap/store/bbr-backup already exists on instance`, run the appropriate cleanup command. See [Clean up After a Failed Backup](#) below.
7. If the backup artifact is corrupted, discard the failing artifacts and run the backup again.

## Cancel a Backup

Backups can take a long time. If you need to cancel a backup, for example if you realize that the backup is going to fail or that your developers need to push an app in a hurry, follow these steps:

1. Terminate the BBR process by pressing Ctrl-C and typing `yes` to confirm.

- Because stopping a backup can leave the system in an unusable state and prevent additional backups, follow the procedures in [Clean up After a Failed Backup](#) below.

## Clean up After a Failed Backup

If your backup process fails, it might leave the BBR backup folder on the instance, causing any subsequent attempts to backup to fail. In addition, BBR might not have run the post-backup scripts, leaving the instance in a locked state.

If the PKS control plane backup failed, run the following command to use the BBR cleanup script to clean up:

```
BOSH_CLIENT_SECRET=BOSH-CLIENT-SECRET \
bbr deployment \
--target BOSH-TARGET \
--username BOSH-CLIENT \
--deployment DEPLOYMENT-NAME \
--ca-cert PATH-TO-BOSH-CA-CERT \
backup-cleanup
```

Replace the placeholder text using the information in the following table. These are the same values as shown in the previous table.

Placeholder Text	Instructions
BOSH-CLIENT-SECRET	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT_SECRET</code> .
BOSH-TARGET	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_ENVIRONMENT</code> . You must be able to reach the target address from the workstation where you run <code>bbr</code> commands.
BOSH-CLIENT	In your BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT</code> .
DEPLOYMENT-NAME	Use the PKS BOSH deployment name that you located in the <a href="#">Prerequisites</a> section.
PATH-TO-BOSH-CA-CERT	Use the path to the root CA certificate that you downloaded in the <a href="#">Prerequisites</a> section.

**Note:** If you want to include the manifest in the backup artifact, add the `--with-manifest` flag. However, be aware that the backup artifact then includes credentials that you must keep secret.

For example:

```
$ BOSH_CLIENT_SECRET=p455w0rd \
bbr deployment \
--target bosh.example.com \
--username admin \
--deployment cf-acceptance-0 \
--ca-cert bosh.ca.crt \
backup-cleanup
```

## Manage Your Backup Artifact

Keep your backup artifact safe by following these steps:

- Move the backup artifact off the jumpbox to your storage space. BBR stores each backup in a subdirectory named `DEPLOYMENT-TIMESTAMP` within the current working directory. The backup created by BBR consists of a folder with the backup artifacts and metadata files.
- Compress and encrypt the backup artifacts when storing them.
- Make redundant copies of your backup and store them in multiple locations. This minimizes the risk of losing your backups in the event of a disaster.
- Each time you redeploy PKS, test your backup artifact by following the procedures in [Restoring the PKS Control Plane](#).

## Restoring the PKS Control Plane

Page last updated:

This topic describes how to use BOSH Backup and Restore (BBR) to restore the PKS control plane.

To back up the PKS control plane with BBR, see [Backing up the PKS Control Plane](#).

## Compatibility of Restore

This section describes the restrictions for a backup artifact to be restorable to another environment. This section is for guidance only, and Pivotal highly recommends that operators validate their backups by using the backup artifacts in a restore.

The restrictions for a backup artifact to be restorable are the following:

- **Topology:** BBR requires the BOSH topology of a deployment to be the same in the restore environment as it was in the backup environment.
- **Naming of instance groups and jobs:** For any deployment that implements the backup and restore scripts, the instance groups and jobs must have the same names.
- **Number of instance groups and jobs:** For instance groups and jobs that have backup and restore scripts, the same number of instances must exist..
- **Limited validation:** BBR puts the backed up data into the corresponding instance groups and jobs in the restored environment, but cannot validate the restore beyond that. For example, if the MySQL encryption key is different in the restore environment, the BBR restore might succeed although the restored MySQL database is unusable.

**Note:** A change in VM size or underlying hardware should not affect the ability for BBR restore data, as long as adequate storage space to restore the data exists.

## Step 1: Recreate VMs

Before restoring the PKS control plane, you must create the VMs that constitute the deployment.

In a disaster recovery scenario, you can re-create the control plane with your PKS deployment manifest. If you used the `--with-manifest` flag when you ran the BBR backup command, your backup artifact includes a copy of your manifest.

## Step 2: Transfer Artifacts to Jumpbox

Transfer your BBR backup artifact from your safe storage location to the jumpbox.

For example, you could run the following command to SCP the backup artifact to your jumpbox:

```
scp LOCAL-PATH-TO-BACKUP-ARTIFACT JUMPBOX-USER/JUMPBOX-ADDRESS
```

If this artifact is encrypted, you must decrypt it.

## Step 3: Restore

**Note:** The BBR restore command can take a long time to complete. You can run it independently of the SSH session so that the process can continue running even if your connection to the jumpbox fails. The command above uses `nohup`, but you run the command in a `screen` or `tmux` session instead.

Perform the following steps to restore the PKS control plane. You can use the optional `--debug` flag to enable debug logs. See the [BBR Logging](#) topic for more information.

1. Ensure the PKS deployment backup artifact is in the folder from which you run BBR.
2. Download the root CA certificate for your PKS deployment as follows:

- a. On the Ops Manager Installation Dashboard, in the top right corner, click your username.
- b. Navigate to **Settings > Advanced**.
- c. Click **Download Root CA Cert**.
  
3. Locate and record your PKS BOSH deployment name as follows:
  - a. On the Ops Manager Installation Dashboard, click the Director tile.
  - b. In the Director tile, click the **Credentials** tab.
  - c. Navigate to **Bosh Commandline Credentials** and click **Link to Credential**.
  - d. Copy the credential value.
  - e. On the command line, run the following command to retrieve your PKS BOSH deployment name. Replace **BOSH-CLI-CREDENTIALS** with the credential value you copied in the previous step:

```
BOSH-CLI-CREDENTIALS deployments | grep pivotal-container-service
```



**Note:** Your PKS BOSH deployment name begins with “pivotal-container-service” and includes a unique identifier.

4. Run the BBR restore command to restore the PKS control plane:

```
BOSH_CLIENT_SECRET=BOSH-CLIENT-SECRET \
nohup bbr deployment \
--target BOSH-TARGET \
--username BOSH-CLIENT \
--deployment DEPLOYMENT-NAME \
--ca-cert PATH-TO-BOSH-SERVER-CERT \
restore \
--artifact-path PATH-TO-DEPLOYMENT-BACKUP
```

Replace the placeholder values as follows:

Credential	Location
<b>BOSH-CLIENT-SECRET</b>	In the BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <b>BOSH_CLIENT_SECRET</b> .
<b>BOSH-TARGET</b>	In the BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <b>BOSH_ENVIRONMENT</b> . You must be able to reach the target address from the workstation where you run <b>bbr</b> commands.
<b>BOSH-CLIENT</b>	In the BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <b>BOSH_CLIENT</b> .
<b>DEPLOYMENT-NAME</b>	Use the PKS BOSH deployment name that you recorded in a previous step.
<b>PATH-TO-BOSH-CA-CERT</b>	Use the path to the root CA certificate that you downloaded in a previous step.
<b>PATH-TO-DEPLOYMENT-BACKUP</b>	Use the path to the PKS control plane backup that you want to restore.

For example:

```
$ BOSH_CLIENT_SECRET=p455w0rd \
nohup bbr deployment \
--target bosh.example.com \
--username admin \
--deployment cf-acceptance-0 \
--ca-cert bosh.ca.crt \
restore \
--artifact-path /home/cf-abcd1234abcd1234abcd-abcd1234abcd1234abcd1234
```

If the command fails, follow the steps in [Recover from a Failing Command](#).

## Recover from a Failing Command

1. Ensure that you set all the parameters in the command.
2. Ensure that the BOSH Director credentials are valid.
3. Ensure that the specified BOSH deployment exists.
4. Ensure that the jumpbox can reach the BOSH Director.

5. Ensure the source BOSH deployment is compatible with the target BOSH deployment.
6. If you see the error message `Directory /var/vcap/store/bbr-backup already exists on instance`, run the relevant commands from the [Clean up After Failed Restore](#) section of this topic.
7. See the [BBR Logging](#) topic.

## Cancel a Restore

If you must cancel a restore, perform the following steps:

1. Terminate the BBR process by pressing Ctrl-C and typing `yes` to confirm.
2. Perform the procedures in the [Clean up After Failed Restore](#) section to enable future restores. Stopping a restore can leave the system in an unusable state and prevent future restores.

## Clean up After Failed Restore

If your restore process fails, then the process may leave the BBR restore folder on the instance. As a result, any subsequent restore attempts may also fail. In addition, BBR may not have run the post-restore scripts, which can leave the instance in a locked state.

To resolve these issues, run the BBR cleanup script with the following command:

```
BOSH-CLIENT-SECRET=BOSH-CLIENT-SECRET \
bbr deployment \
--target BOSH-TARGET \
--username BOSH-CLIENT \
--deployment DEPLOYMENT-NAME \
--ca-cert PATH-TO-BOSH-CA-CERT \
restore-cleanup
```

Replace the placeholder values as follows:

Credential	Location
<code>BOSH-CLIENT-SECRET</code>	In the BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT_SECRET</code> .
<code>BOSH-TARGET</code>	In the BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_ENVIRONMENT</code> . You must be able to reach the target address from the workstation where you run <code>bbr</code> commands.
<code>BOSH-CLIENT</code>	In the BOSH Director tile, navigate to <b>Credentials &gt; Bosh Commandline Credentials</b> . Record the value for <code>BOSH_CLIENT</code> .
<code>DEPLOYMENT-NAME</code>	Use the PKS BOSH deployment name that you recorded in a previous step.
<code>PATH-TO-BOSH-CA-CERT</code>	Use the path to the root CA certificate that you downloaded in a previous step.

For example:

```
$ BOSH_CLIENT_SECRET=p455w0rd \
bbr deployment \
--target bosh.example.com \
--username admin \
--deployment cf-acceptance-0 \
--ca-cert bosh.ca.crt \
restore-cleanup
```

## BBR Logging

This topic provides information about BBR logging. Use this information when troubleshooting a failed backup or restore using BBR.

### Understand Logging

By default, BBR displays the following:

- The backup and restore scripts that it finds
- When it starts or finishes a stage, such as `pre-backup scripts` or `backup scripts`
- When the process is complete
- When any error occurs

BBR writes any errors associated with stack traces to a file in the form `bbr-TIMESTAMP.err.log` in the current directory.

If more logging is needed, use the optional `--debug` flag to print the following information:

- Logs about the API requests made to the BOSH server
- All commands executed on remote instances
- All commands executed on local environment
- Standard in and standard out streams for the backup and restore scripts when they are executed

## PKS Security

Page last updated:

This section includes security topics for Pivotal Container Service (PKS).

See the following topic:

- [PKS Security Disclosure and Release Process](#)

## PKS Security Disclosure and Release Process

Page last updated:

This topic describes the processes for disclosing security issues and releasing related fixes for Pivotal Container Service (PKS), Kubernetes, Cloud Foundry Container Runtime (CFCR), VMware NSX, and VMware Harbor.

### Security Issues in PKS

Pivotal and VMware provide security coverage for PKS. Please report any vulnerabilities directly to [Pivotal Application Security Team](#) or the [VMware Security Response Center](#).

Security fixes are provided in accordance with the [PCF Security Release Policy](#) and the [Pivotal Support Lifecycle Policy](#).

Where applicable, security issues may be coordinated with the responsible disclosure process for the open source security teams in Kubernetes and Cloud Foundry projects.

### Security Issues in Kubernetes

Pivotal and VMware follow the Kubernetes responsible disclosure process to work within the Kubernetes project to report and address suspected security issues with Kubernetes.

This process is discussed in [Kubernetes Security and Disclosure Information](#).

When the Kubernetes project releases security fixes, PKS releases fixes according to the [PCF Security Release Policy](#) and the [Pivotal Support Lifecycle Policy](#).

### Security Issues in CFCR

Pivotal and VMware follow the Cloud Foundry responsible disclosure process to work within the Cloud Foundry Foundation to report and address suspected security issues with CFCR.

This process is discussed in [Cloud Foundry Security](#).

When the Cloud Foundry Foundation releases security fixes, PKS releases fixes according to the [PCF Security Release Policy](#) and the [Pivotal Support Lifecycle Policy](#).

### Security Issues in VMware NSX

Security issues in VMware NSX are coordinated with the [VMware Security Response Center](#).

### Security Issues in VMware Harbor

Security issues in VMware Harbor are coordinated with the [VMware Security Response Center](#).

## Diagnosing and Troubleshooting PKS

This topic is intended to provide assistance when diagnosing and troubleshooting issues installing or using Pivotal Container Service (PKS).

See the following sections:

- [Diagnostic Tools](#)
- [Verifying Deployment Health](#)
- [Service Interruptions](#)
- [Troubleshooting](#)

## Diagnostic Tools

### Verify PKS CLI Version

The Pivotal Container Service (PKS) CLI interacts with your PKS deployment through the PKS API endpoint. You create, manage, and delete Kubernetes clusters on your PKS deployment by entering commands in the PKS CLI. The PKS CLI is under active development and commands may change between versions.

To determine the version of PKS CLI installed locally, run the following command:

```
pks --version
```

For example:

```
$ pks --version  
PKS CLI version: 1.0.0-build.3
```

### SSH into the PKS VM

To SSH into the PKS VM using BOSH, follow the steps below:

1. Gather credential and IP address information for your BOSH Director, SSH into the Ops Manager VM, and use BOSH CLI to log in to the BOSH Director from the Ops Manager VM. For more information, see [Advanced Troubleshooting with the BOSH CLI](#).
2. To identify your PKS deployment's name, run the following command:

```
bosh -e ENVIRONMENT deployments
```

Where `ENVIRONMENT` is the BOSH environment alias you set in [Set a BOSH Environment Alias](#).

For example:

```
$ bosh -e pks deployments
```

Your PKS deployment name begins with `pivotal-container-service` and includes a BOSH-generated hash.

3. To identify your PKS VM's name, run the following command:

```
bosh -e ENVIRONMENT -d DEPLOYMENT vms
```

Where:

- `ENVIRONMENT` is the BOSH environment alias.
- `DEPLOYMENT` is your PKS deployment name.

For example:

```
$ bosh -e pks -d pivotal-container-service/a1b2c333d444e5f66a77 vms
```

Your PKS VM name begins with `pivotal-container-service` and includes a BOSH-generated hash.

 **Note:** The PKS VM hash value is different from the hash in your PKS deployment name.

4. To SSH into the PKS VM, run the following command:

```
bosh -e ENVIRONMENT -d DEPLOYMENT ssh PKS-VM
```

Where:

- `ENVIRONMENT` is the BOSH environment alias.

- `DEPLOYMENT` is your PKS deployment name.
- `PKS-VM` is your PKS VM name.

For example:

```
$ bosh -e pkss \
-d pivotal-container-service/a1b2c333d444e5f66a77 \
ssh pivotal-container-service/000a111-222b-3333-4cc5-de66f7a8899b
```

## View Log Files

Log files contain error messages and other information you can use to diagnose issues with your PKS deployment. SSH into the PKS VM then follow the steps below to access PKS log files.

1. To act as super user on the PKS VM, run the following command:

```
sudo su
```

2. To navigate to the PKS VM's `/var/vcap/sys/log` log file directory, run the following command:

```
cd /var/vcap/sys/log
```

3. Examine the following files:

- On the PKS master VM, examine the `kube-apiserver` log file.
- On a PKS worker VM, examine the `kubelet` log file.

## Verifying Deployment Health

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This topic describes how to verify the health of your Pivotal Container Service (PKS) deployment.

For the BOSH CLI commands in this topic, replace the text as follows:

- `MY-ENV` : the alias you set for your BOSH Director. For more information, see [Managing PKS Deployments with BOSH](#).
- `MY-DEPLOYMENT` : the name of your PKS deployment. PKS deployment names begin with `pivotal-container-service` and include a unique BOSH-generated hash.
- `VM-NAME` : your Kubernetes master node VM name.
- `ID` : your Kubernetes master node VM ID. This is a unique BOSH-generated hash.

## Verify Kubernetes Health

Verify the health of your Kubernetes environment by following the steps below:

1. To verify that all nodes are in a ready state, run the following command for all Kubernetes contexts:

```
kubectl get nodes
```

2. To verify that all pods are running, run the following command for all Kubernetes contexts:

```
kubectl get pods --all-namespaces
```

3. To verify that all the processes are in a running state, run the following command for each deployment:

```
bosh -d MY-DEPLOYMENT instances --ps
```

For example:

```
$ bosh -d pivotal-container-service/a1b2c333d444e5f66a77 instances --ps
```

## Verify NCP Health (NSX-T Only)

NCP runs as a BOSH host process. Each Kubernetes master node VM has one NCP process running. If your cluster has multiple master nodes, one NCP process is active while the others are on standby. For more information, see [Architectural Changes](#).

Verify NCP health by following the steps below:

1. From the Ops Manager VM, run the following command:

```
bosh -e MY-ENV login
```

For example:

```
$ bosh -e pkcs login
```

2. To locate the Kubernetes master node VM name and ID, run the following command:

```
bosh -e MY-ENV -d MY-DEPLOYMENT vms
```

For example:

```
$ bosh -e pkcs -d pivotal-container-service/a1b2c333d444e5f66a77 vms
```

Your PKS API VM name begins with `pivotal-container-service` and includes a BOSH-generated hash. This value is different from the deployment hash.

3. To SSH into the Kubernetes master node VM, run the following command:

```
bosh -e MY-ENV -d MY-DEPLOYMENT ssh VM-NAME/ID
```

For example:

```
$ bosh -e pks \
-d pivotal-container-service/a1b2c333d444e5f66a77 \
ssh pivotal-container-service/000a111-222b-3333-4cc5-de66f7a8899b
```

4. From the master node VM, run the following command:

```
monit summary
```

Verify that you see `Process: 'ncp'` is `running`.

5. To check if the NCP process is active or on standby, run the following command:

```
/var/vcap/jobs/ncp/bin/nsxcli -c get ncp-master status
```

6. To restart the NCP process, run the following command:

```
monit restart ncp
```

7. To verify that the NCP process restarts successfully, run the following command:

```
monit summary
```

## Service Interruptions

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This topic describes events in the lifecycle of a Kubernetes cluster deployed by Pivotal Container Service (PKS) that can cause temporary service interruptions.

### Stemcell or Service Update

An operator updates the stemcell version or PKS version.

#### Impact

- **Workload:** If you run the recommended configuration, no workload downtime is expected since the VMs are upgraded one at a time. For more information, see [Maintaining Workload Uptime](#).
- **Kubernetes control plane:** The Kubernetes master VM is recreated during the upgrade, so `kubectl` and the Kubernetes control plane experience a short downtime.

#### Required Actions

None. If the update deploys successfully, the Kubernetes control plane recovers automatically.

### VM Process Failure on a Cluster Master

A process, such as the scheduler or the Kubernetes API server, crashes on the cluster master VM.

#### Impact

- **Workload:** If the scheduler crashes, workloads that are in the process of being rescheduled may experience up to 120 seconds of downtime.
- **Kubernetes control plane:** Depending on the process and what it was doing when it crashed, the Kubernetes control plane may experience 60-120 seconds of downtime. Until the process resumes, the following can occur:
  - Developers may be unable to deploy workloads
  - Metrics or logging may stop
  - Other features may be interrupted

#### Required Actions

None. BOSH brings the process back automatically using `monit`. If the process resumes cleanly and without manual intervention, the Kubernetes control plane recovers automatically.

### VM Process Failure on a Cluster Worker

A process, such as Docker or `kube-proxy`, crashes on a cluster worker VM.

#### Impact

- **Workload:** If the cluster and workloads follow the recommended configuration for the number of workers, replica sets, and pod anti-affinity rules, workloads should not experience downtime. The Kubernetes scheduler reschedules the affected pods on other workers. For more information, see [Maintaining Workload Uptime](#).

## Required Actions

None. BOSH brings the process back automatically using `monit`. If the process resumes cleanly and without manual intervention, the worker recovers automatically, and the scheduler resumes scheduling new pods on this worker.

## VM Process Failure on the Pivotal Container Service VM

A process, such as the PKS API server, crashes on the pivotal-container-service VM.

### Impact

- **PKS control plane:** Depending on the process and what it was doing, the PKS control plane may experience 60-120 seconds of downtime. Until the process resumes, the following can occur:
  - The PKS API or UAA may be inaccessible
  - Use of the PKS CLI is interrupted
  - Metrics or logging may stop
  - Other features may be interrupted

## Required Actions

None. BOSH brings the process back automatically using `monit`. If the process resumes cleanly, the PKS control plane recovers automatically and the PKS CLI resumes working.

## VM Failure

A PKS VM fails and goes offline due to either a virtualization problem or a host hardware problem.

### Impact

- If the BOSH Resurrector is enabled, BOSH detects the failure, recreates the VM, and reattaches the same persistent disk and IP address. Downtime depends on which VM goes offline, how quickly the BOSH Resurrector notices, and how long it takes the IaaS to create a replacement VM. The BOSH Resurrector usually notices an offline VM within one to two minutes. For more information about the BOSH Resurrector, see the [BOSH documentation](#).
- If the BOSH Resurrector is not enabled, some cloud providers, such as vSphere, have similar resurrection or high availability (HA) features. Depending on the VM, the impact can be similar to a key process on that VM going down as described in the previous sections, but the recovery time is longer while the replacement VM is created. See the sections for process failures on the [cluster worker](#), [cluster master](#), and [PKS VM](#) sections for more information.

## Required Actions

When the VM comes back online, no further action is required for the developer to continue operations.

## AZ Failure

An availability zone (AZ) goes offline entirely or loses connectivity to other AZs (net split).

### Impact

The control plane and clusters are inaccessible. The extent of the downtime is unknown.

## Required Actions

When the AZ comes back online, the control plane recovers in one of the following ways:

- **If BOSH is in a different AZ,** BOSH recreates the VMs with the last known persistent disks and IPs. If the persistent disks are gone, the disks can be restored from your last backup and reattached. Pivotal recommends manually checking the state of VMs and databases.
- **If BOSH is in the same AZ,** follow the directions for [region failure](#).

## Region Failure

An entire region fails, bringing all PKS components offline.

## Impact

The entire PKS deployment and all services are unavailable. The extent of the downtime is unknown.

## Required Actions

The PKS control plane can be restored using BOSH Backup and Restore (BBR). Each cluster may need to be restored manually from backups.

For more information, see [Restoring the PKS Control Plane](#).

## Troubleshooting

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### PKS API is Slow or Times Out

#### Symptom

When you run PKS CLI commands, the PKS API times out or is slow to respond.

#### Explanation

The PKS API control plane VM requires more resources.

#### Solution

1. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
  2. Select the **Pivotal Container Service** tile.
  3. Select the **Resource Config** page.
  4. For the **Pivotal Container Service** job, select a **VM Type** with greater CPU and memory resources.
  5. Click **Save**.
  6. Click the **Installation Dashboard** link to return to the Installation Dashboard.
  7. Click **Review Pending Changes**. Review the changes that you made. For more information, see [Reviewing Pending Product Changes](#).
- Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.
8. Click **Apply Changes**.

### Cluster Creation Fails

#### Symptom

When creating a cluster, you run `pkcs cluster CLUSTER-NAME` to monitor the cluster creation status. In the command output, the value for **Last Action State** is `error`.

#### Explanation

There was an error creating the cluster.

#### Diagnostics

1. Log in to the BOSH Director and run `bosh tasks`. The output from `bosh tasks` provides details about the tasks that the BOSH Director has run. See [Managing PKS Deployments with BOSH](#) for more information about logging in to the BOSH Director.
2. In the BOSH command output, locate the task that attempted to create the cluster.
3. To retrieve more information about the task, run the following command:

```
bosh -e MY-ENVIRONMENT task TASK-NUMBER
```

Where:

- o `MY-ENVIRONMENT` is the name of your BOSH environment.
- o `TASK-NUMBER` is the number of the task that attempted to create the cluster.

For example:

```
$ bosh -e pkstask 23
```

BOSH logs are used for error diagnostics but if the issue you see in the BOSH logs is related to using or managing Kubernetes, you should consult the [Kubernetes Documentation](#) for troubleshooting that issue.

For troubleshooting failed BOSH tasks, see the [BOSH documentation](#).

## Cannot Re-Create a Cluster that Failed to Deploy

### Symptom

After cluster creation fails, you cannot re-run `pkstask 23` to attempt creating the cluster again.

### Explanation

PKS does not automatically clean up the failed BOSH deployment. Running `pkstask 23` using the same cluster name creates a name clash error in BOSH.

### Solution

Perform the following steps to clean up the BOSH deployment:

1. Run the following command:

```
bosh -e MY-ENVIRONMENT delete-deployment -d DEPLOYMENT-NAME
```

Where:

- `MY-ENVIRONMENT` is the name of your BOSH environment.
- `DEPLOYMENT-NAME` is the name of your BOSH deployment.

 **Note:** If necessary, you can append the `--force` flag to delete the deployment.

2. Run the following command:

```
pkstask 23
```

Where `CLUSTER-NAME` is the name of your PKS cluster.

## Cannot Access Add-On Features or Functions

### Symptom

You cannot access a feature or function provided by a Kubernetes add-on.

Examples include the following:

- You cannot access the Kubernetes [Web UI \(Dashboard\)](#) in a browser or using the `kubectl` command-line tool.
- [Heapster](#) does not start.
- Pods cannot resolve DNS names, and error messages report the service `kube-dns` is invalid. If `kube-dns` is not deployed, the cluster typically fails to start.

### Explanation

The Kubernetes features and functions listed above are provided by the following PKS add-ons:

- **Kubernetes Dashboard**: `kubernetes-dashboard`
- **Heapster**: `heapster`
- **DNS Resolution**: `kube-dns`

To enable these add-ons, Ops Manager must run scripts after deploying PKS. You must configure Ops Manager to automatically run these post-deploy scripts.

## Solution

Perform the following steps to configure Ops Manager to run post-deploy scripts to deploy the missing add-ons to your cluster.

1. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
2. Click the Ops Manager v2.1 tile.
3. Select **Director Config**.
4. Select **Enable Post Deploy Scripts**.

 **Note:** This setting enables post-deploy scripts for all tiles in your Ops Manager installation.

5. Click **Save**.
6. Click the **Installation Dashboard** link to return to the Installation Dashboard.
7. Click **Review Pending Changes**. Review the changes that you made. For more information, see [Reviewing Pending Product Changes](#).

 **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.

8. Click **Apply Changes**.
9. After Ops Manager finishes applying changes, enter `pks delete-cluster` on the command line to delete the cluster. For more information, see [Deleting Clusters](#).
10. On the command line, enter `pks create-cluster` to recreate the cluster. For more information, see [Creating Clusters](#).

## Resurrecting VMs Causes Incorrect Permissions in vSphere HA

### Symptoms

Output resulting from the `bosh vms` command alternates between showing that the VMs are `failing` and showing that the VMs are `running`. The operator must run the `bosh vms` command multiple times to see this cycle.

### Explanation

The VMs' permissions are altered during the restarting of the VM so operators have to reset permissions every time the VM reboots or is redeployed.

VMs cannot be successfully resurrected if the resurrection state of your VM is set to `off` or if the vSphere HA restarts the VM before BOSH is aware that the VM is down. For more information about VM resurrection, see [Resurrection](#) in the Cloud Foundry BOSH documentation.

### Solution

Run the following command on all of your master and worker VMs:

```
bosh -environment BOSH-DIRECTOR-NAME -deployment DEPLOYMENT-NAME ssh INSTANCE-GROUP-NAME -c "sudo /var/vcap/jobs/kube-controller-manager/bin/pre-start; sudo /var/vcap/jobs/kube-apiserver/bin/post-start"
```

Where:

- `BOSH-DIRECTOR-NAME` is your BOSH Director name.
- `DEPLOYMENT-NAME` is the name of your BOSH deployment.
- `INSTANCE-GROUP-NAME` is the name of the BOSH instance group you are referencing.

The above command, when applied to each VM, gives your VMs the correct permissions.

## Worker Node Hangs Indefinitely

### Symptoms

After making your selection in the **Upgrade all clusters errand** section, the worker node might hang indefinitely. For more information on monitoring the **Upgrade all clusters errand** using the BOSH CLI, see [Upgrade the PKS Tile](#) in *Upgrading PKS*.

### Explanation

During the PKS tile upgrade process, worker nodes are cordoned and drained. This drain is dependent on Kubernetes being able to unschedule all pods. If Kubernetes is unable to unschedule a pod, then the drain hangs indefinitely. One reason why Kubernetes may be unable to unschedule the node is if the `PodDisruptionBudget` object has been configured in a way that allows 0 disruptions and only a single instance of the pod has been scheduled.

In your spec file, the `.spec.replicas` configuration sets the total amount of replicas that are available in your application. `PodDisruptionBudget` objects can specifies the amount of replicas, proportional to that total, that must be available in your application, regardless of downtime. Operators can configure `PodDisruptionBudget` objects for each application using their spec file.

Some apps deployed using Helm-Charts may have a default `PodDisruptionBudget` set. For more information on configuring `PodDisruptionBudget` objects using a spec file, see [Specifying a PodDisruptionBudget](#) in the Kubernetes documentation.

### Solution

Configure `.spec.replicas` to be greater than the `PodDisruptionBudget` object.

When the number of replicas configured in `.spec.replicas` is greater than the number of replicas set in the `PodDisruptionBudget` object, disruptions can occur.

For more information, see [How Disruption Budgets Work](#) in the Kubernetes documentation. For more information about workload capacity and uptime requirements in PKS, see [Prepare to Upgrade](#) in *Upgrading PKS*.

## Cannot Authenticate to an OpenID Connect-Enabled Cluster

### Symptom

When you authenticate to an OpenID Connect-enabled cluster using an existing kubeconfig file, you see an authentication or authorization error.

### Explanation

`users.user.auth-provider.config.id-token` and `users.user.auth-provider.config.refresh-token` contained in the kubeconfig file for the cluster may have expired.

### Solution

1. Upgrade the PKS CLI to v1.2.0 or later. To download the PKS CLI, navigate to [Pivotal Network](#). For more information, see [Installing the PKS CLI](#).
2. Obtain a kubeconfig file that contains the new tokens by running the following command:

```
pkcs get-credentials CLUSTER-NAME
```

Where `CLUSTER-NAME` is the name of your cluster.

3. Connect to the cluster using kubectl.

If you continue to see an authentication or authorization error, verify that you have sufficient access permissions for the cluster.

## Error: Failed Jobs

### Symptom

In stdout or log files, you see an error message referencing `post-start scripts failed` or `Failed Jobs`.

### Explanation

After deploying PKS, Ops Manager runs scripts to start a number of jobs. You must configure Ops Manager to automatically run these post-deploy scripts.

### Solution

Perform the following steps to configure Ops Manager to run post-deploy scripts.

1. Navigate to `https://YOUR-OPS-MANAGER-FQDN/` in a browser to log in to the Ops Manager Installation Dashboard.
2. Click the BOSH Director tile.
3. Select **Director Config**.
4. Select **Enable Post Deploy Scripts**.

 **Note:** This setting enables post-deploy scripts for all tiles in your Ops Manager installation.

5. Click **Save**.
  6. Click the **Installation Dashboard** link to return to the Installation Dashboard.
  7. Click **Review Pending Changes**. Review the changes that you made. For more information, see [Reviewing Pending Product Changes](#).
-  **Note:** In Ops Manager v2.2, the *Review Pending Changes* page is a Beta feature. If you deploy PKS to Ops Manager v2.2, you can skip this step.
8. Click **Apply Changes**.
  9. (Optional) If it is a new deployment of PKS, follow the steps below:
    - a. On the command line, enter `pks delete-cluster` to delete the cluster. For more information, see [Deleting Clusters](#).
    - b. Enter `pks create-cluster` to recreate the cluster. For more information, see [Creating Clusters](#).

## Error: No Such Host

### Symptom

In stdout or log files, you see an error message that includes `lookup vm-WORKER-NODE-GUID on IP-ADDRESS: no such host`.

### Explanation

This error occurs on GCP when the Ops Manager Director tile uses 8.8.8.8 as the DNS server. When this IP range is in use, the master node cannot locate the route to the worker nodes.

### Solution

Use the Google internal DNS range, 169.254.169.254, as the DNS server.

## Error: FailedMount

### Symptom

In Kubernetes log files, you see a `Warning` event from kubelet with `FailedMount` as the reason.

### Explanation

A persistent volume fails to connect to the Kubernetes cluster worker VM.

### Diagnostics

- In your cloud provider console, verify that volumes are being created and attached to nodes.
- From the Kubernetes cluster master node, check the controller manager logs for errors attaching persistent volumes.
- From the Kubernetes cluster worker node, check kubelet for errors attaching persistent volumes.

## PKS CLI

Page last updated:

This topic describes how to use the Pivotal Container Service Command Line Interface (PKS CLI) to interact with the PKS API.

The [PKS CLI](#) is used to create, manage, and delete Kubernetes clusters. To deploy workloads to a Kubernetes cluster created using the PKS CLI, use the Kubernetes CLI, [kubectl](#).

Current Version: 1.2.0-build.43

### pkcs cluster

View the details of the cluster

#### Synopsis

Run this command to see details of your cluster such as name, host, port, ID, number of worker nodes, last operation, etc.

```
pkcs cluster [flags]
```

#### Examples

```
pkcs cluster my-cluster
```

#### Options

```
-h, --help  help for cluster  
--json  Return the PKS-API output as json
```

### pkcs clusters

Show all clusters created with PKS

#### Synopsis

This command describes the clusters created via PKS, and the last action taken on the cluster

```
pkcs clusters [flags]
```

#### Examples

```
pkcs clusters
```

#### Options

```
-h, --help  help for clusters  
--json  Return the PKS-API output as json
```

## pks create-cluster

Creates a kubernetes cluster, requires cluster name, an external host name, and plan

### Synopsis

Create-cluster requires a cluster name, as well as an external hostname and plan. External hostname can be a loadbalancer, from which you access your kubernetes API (aka, your cluster control plane)

```
pks create-cluster <cluster-name> [flags]
```

### Examples

```
pks create-cluster my-cluster --external-hostname example.hostname --plan production
```

### Options

```
-e, --external-hostname string  Address from which to access Kubernetes API  
-h, --help          help for create-cluster  
--json           Return the PKS-API output as json  
--network-profile string  Optional, network profile name (NSX-T only)  
--non-interactive      Don't ask for user input  
-n, --num-nodes string    Number of worker nodes  
-p, --plan string        Preconfigured plans. Run pks plans for more details  
--wait            Wait for the operation to finish
```

## pks create-network-profile

Create a network profile

### Synopsis

Create network profile requires a path to the profile JSON file (Only applicable for NSX-T)

```
pks create-network-profile <network-profile-JSON-path> [flags]
```

### Examples

```
pks create-network-profile my-network-profile.json
```

### Options

```
-h, --help  help for create-network-profile
```

## pks delete-cluster

Deletes a kubernetes cluster, requires cluster name

### Synopsis

Delete-cluster requires a cluster name.

```
pks delete-cluster <cluster-name> [flags]
```

### Examples

```
pks delete-cluster my-cluster
```

### Options

-h, --help	help for delete-cluster
--non-interactive	Don't ask for user input
--wait	Wait for the operation to finish

## pks delete-network-profile

Delete a network profile

### Synopsis

Deletes network profile. Requires a network profile name (Only applicable for NSX-T). Cannot be deleted if in use

```
pks delete-network-profile PROFILE_NAME [flags]
```

### Examples

```
pks delete-network-profile my-network-profile
```

### Options

-h, --help	help for delete-network-profile
--non-interactive	Don't ask for user input

## pks get-credentials

Allows you to connect to a cluster and use kubectl

### Synopsis

Run this command in order to update a kubeconfig file so you can access the cluster through kubectl

```
pks get-credentials <cluster-name> [flags]
```

## Examples

```
pks get-credentials my-cluster
```

## Options

```
-h, --help help for get-credentials
```

# pks login

Log in to PKS

## Synopsis

The login command requires -a to target the IP of your PKS API, -u for username and -p for password

```
pks login [flags]
```

## Examples

```
pks login -a <API> -u <USERNAME> -p <PASSWORD> [--ca-cert <PATH TO CERT> | -k]  
pks login -a <API> --client-name <CLIENT NAME> --client-secret <CLIENT SECRET> [--ca-cert <PATH TO CERT> | -k]
```

## Options

```
-a, --api string      The PKS API server URI  
--ca-cert string     Path to CA Cert for PKS API  
--client-name string Client name  
--client-secret string Client secret  
-h, --help           help for login  
-p, --password string Password  
-k, --skip-ssl-validation Skip SSL Validation  
--skip-ssl-verification Skip SSL Verification (DEPRECATED: use --skip-ssl-validation)  
-u, --username string Username
```

# pks logout

Log out of PKS

## Synopsis

Log out of PKS. Does not remove kubeconfig credentials or kubectl access.

```
pks logout [flags]
```

## Examples

```
pks logout
```

## Options

```
-h, --help  help for logout
```

# pks network-profiles

Show all network profiles created with PKS

## Synopsis

Lists and describes network profiles

```
pks network-profiles [flags]
```

## Examples

```
pks network-profiles
```

## Options

```
-h, --help  help for network-profiles
--json  Return the PKS-API output as json
```

# pks plans

View the preconfigured plans available

## Synopsis

This command describes the preconfigured plans available

```
pks plans [flags]
```

## Examples

```
pks plans
```

## Options

```
-h, --help  help for plans
--json  Return the PKS-API output as json
```

## pks resize

Increases the number of worker nodes for a cluster

### Synopsis

Resize requires a cluster name, and the number of desired worker nodes. Users can only scale UP clusters, to a maximum of 50 worker nodes and not scale down

```
pks resize <cluster-name> [flags]
```

### Examples

```
pks resize my-cluster --num-nodes 5
```

### Options

```
-h, --help      help for resize
--json         Return the PKS-API output as json. Only applicable when used with --wait flag
--non-interactive  Don't ask for user input
-n, --num-nodes int32  Number of worker nodes (default 1)
--wait         Wait for the operation to finish
```