PKS Enterprise and Pure Storage Deployment Guide

Jon Owings
Principal Solutions Architect
Pure Storage

PARTNER READY
VMWARE PKS

Summary

Getting Started and Architectural Guide to using PKS Enterprise with Pure Storage. PKS provides an Enterprise Platform as a Service for deploying and managing Kubernetes Clusters at scale for Private and Public Cloud Solutions. This paper will walk through the configuration of PKS Enterprise on VMware vSphere using multiple Availability Zones and Highly Available Pure Storage FlashArray for Persistent Storage.

Introduction

Deploying Platform as a Service - PaaS enables developers to deliver applications to the business with consistency in the underlying Infrastructure and Platform. PKS Enterprise is delivering orchestration for containers using Kubernetes delivered with the familiar Enterprise PaaS tools used for Pivotal Cloud Foundry, allowing applications to now scale and be managed by Kubernetes. This enables them to run along side CF and enhance workflows and applications with Deployments, StateFul Sets, Daemon Sets and beyond. In most Enterprises, Pivotal will leverage VMware vSphere as the underlying Infrastructure as a Service - IaaS. In this reference guide, we will deploy Pivotal Ops Manager connected to VMware vCenter. There are other options to manage other Private and Public Clouds. Using Ops Manager we will deploy PKS Enterprise.

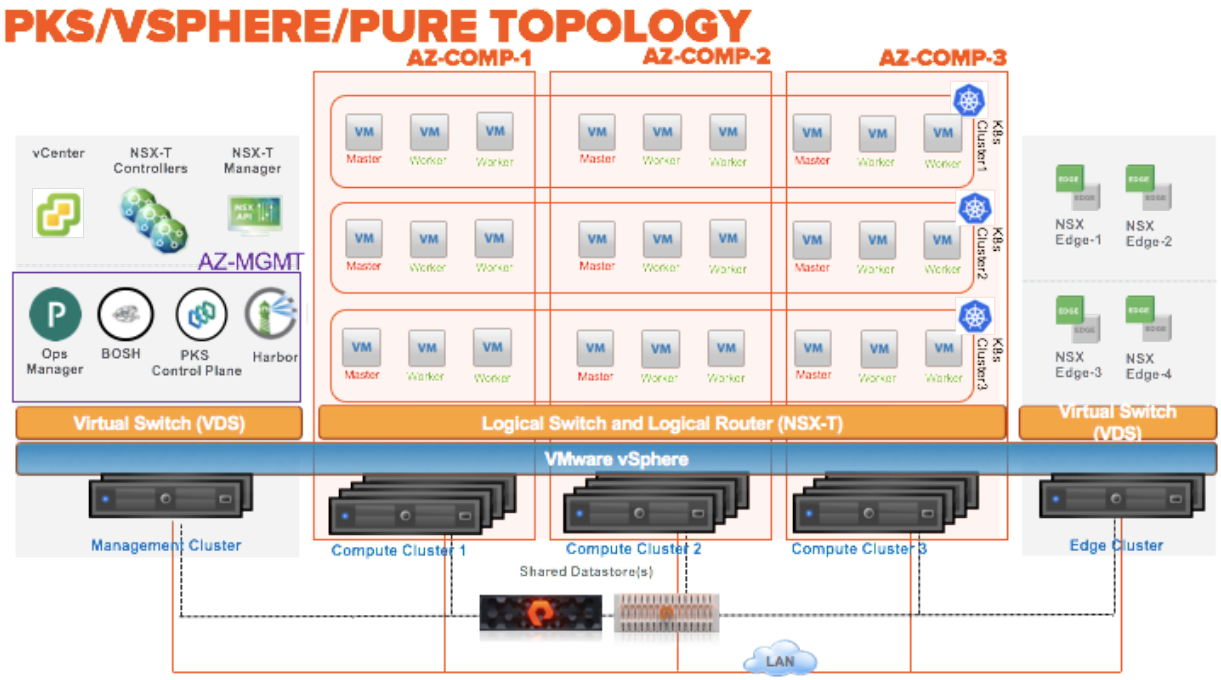
PKS Enterprise and Pure Storage

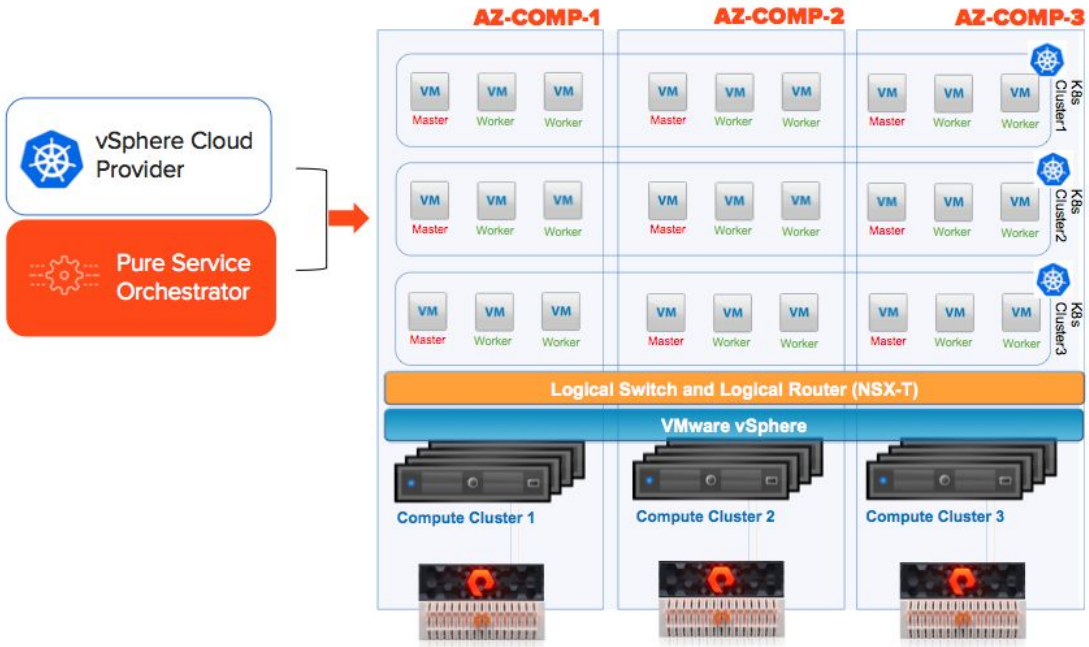
The benefit of running PKS and Pure Storage is customers can use existing vSphere environments or deploy a converged stack that is able to support both legacy VM workloads or new applications developed for the cloud to use PKS. Top reasons include:

1. Disaggregated Scale. Scale Compute, Network and Storage independently the same way modern Cloud and SaaS providers.
2. Better overall TCO. Stateless compute, storage and Applications allow that allow for a cloud consumption model that is never EOL, has zero tech refresh cycles. Highest levels of flexibility and the lowest operating costs.
3. Manage a single domain. Do not build siloed environments.

Pivotal Container Services (PKS)

High-Level Design





Software	Version
Ops Manager	2.6.9
VMware vSphere ESXi	6.7 (13006603)
VMware vSphere vCenter	6.7 (13639324)
Pivotal Container Services (PKS)	1.4.1-build.4*+
Purity//FA	5.1.10
Purity//FB	2.4.1
Pivotal Stemcell	Ubuntu-xenial 250.63
Bosh Director for vSphere	2.5.7-build.208*
VMware Harbor Registry	1.8.2-build.6
Pks cli	1.5.0-build.291
Bosh cli	6.0.0-5240e8aa-2019-08-05T22:16:39Z
NSX-T	2.4.2

VMware vSphere Configuration

The configuration of vSphere and NSX-T should follow the guidelines listed in the PKS Enterprise documentation.

Networking and NSX-T

NSX-T provides the virtual network constructs to allow PKS Enterprise to scale. The key benefits of PKS + NSX-T is the ability to provide customers a packaged turnkey solution that includes advanced container networking, micro-segmentation, ingress controller, load balancing, and security policy. Make sure it is configured by the instructions from Pivotal for your

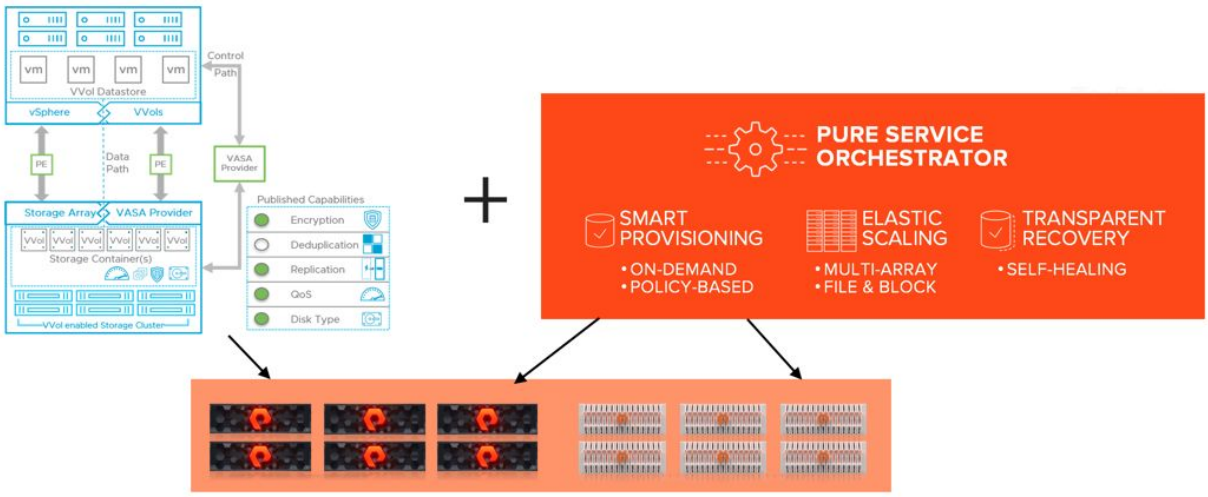
version of PKS. Make sure to enable networking pathing for iSCSI FlashArray and/or NFS for FlashBlade.
https://docs.pivotal.io/pks/1-4/vsphere-nsxt-requirements.html

Additionally, this blog from VMware covers the network topologies and their interaction from NSX-T and PKS.
https://blogs.vmware.com/networkvirtualization/2019/06/kubernetes-and-vmware-enterprise-pks-networking-security-operations-with-nsx-t-data-center.html/

DRS/HA Clusters
This architecture uses a single HA/DRS Cluster and Resource Pool for each Availability Zone.

Create a cluster in your vSphere environment. Configured according to the PKS Enterprise Documentation.
Create the PKS Management Plane
https://docs.pivotal.io/pks/1-4/nsxt-prepare-mgmt-plane.html
Create the PKS Compute Plane
https://docs.pivotal.io/pks/1-4/nsxt-prepare-compute-plane.html

Shared Storage
Shared storage using Storage Policy Based Management and Pure Service Orchestrator allows for workloads requiring Persistent Data to be accessible on all compute nodes in all availability zones.



A FlashArray and Flashblade will provide the resiliency and performance required for applications to scale for production workloads with no additional management trade-offs or overhead.
Using the vSphere Cloud Provider for Cloud Native Storage with Pure Storage FlashArray vVOls enables data mobility from Virtual Machines to Containers and to the Public Cloud. It allows for instant movement from 'other' container platforms and even cloning data between PKS Clusters. PKS clusters are no longer an island of persistent data enabling software developers to quickly and easily move applications from test environments to production and have consistent underlying persistent data.

Client Configuration

The management and configuration of PKS requires a few CLI tools. These tools are available for Linux, Mac OS and Windows.

Great article explaining all of the options. We will need the Bosh, Kubectl, UAAC Client, OM CLI and PKS CLI for this guide. The following website is a great collection and explanation of each.

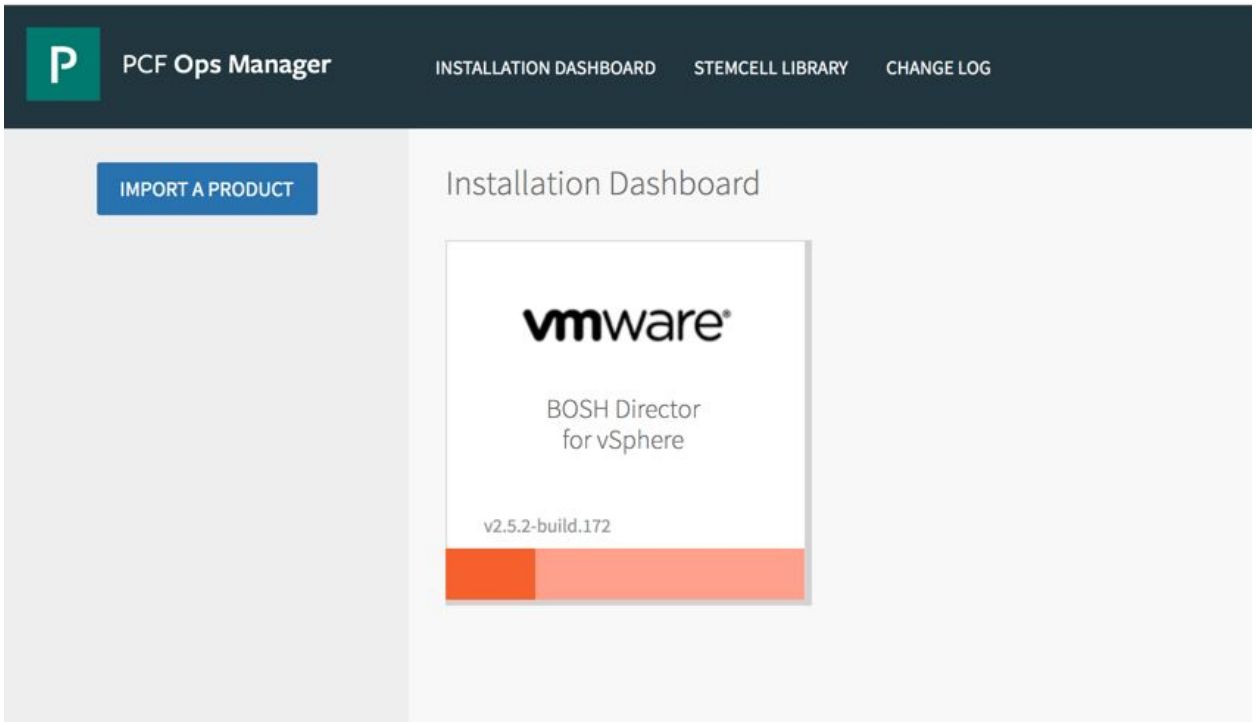
https://www.virtuallyghetto.com/2018/03/getting-started-with-vmware-pivotal-container-service-pks-part-2-pks-client.html

Configuration of OpsManager and BOSH Director

Deploy OVA for Ops Manager in MGT Cluster or Resource Pool. This requires importing the Operations Manager OVA downloaded from https://network.pivotal.io

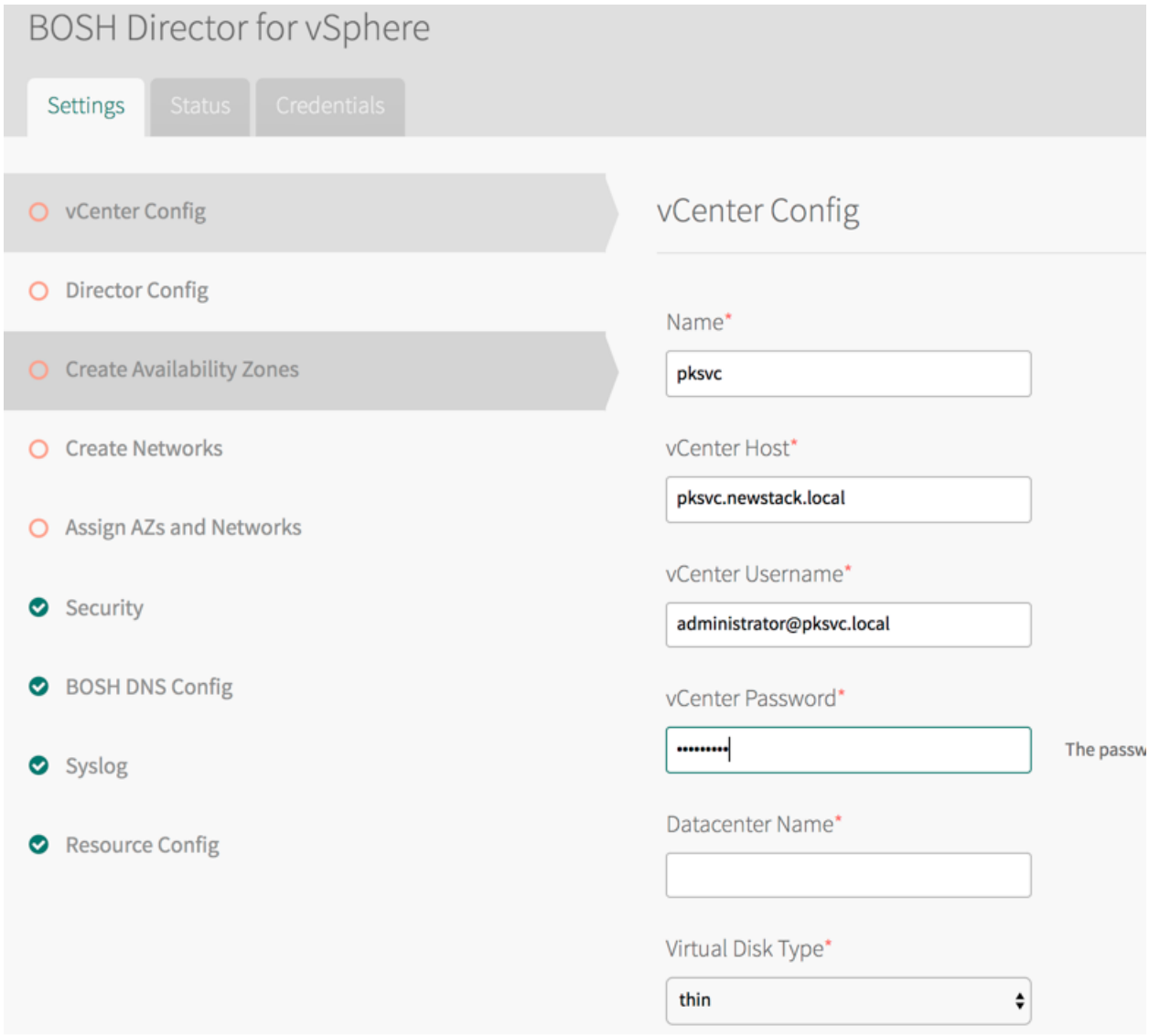
Choose your Auth method. Using Internal for Setup Guide as LDAP or OAUTH outside this scope.

Once logged into your Ops Manager Instance you should see the following screen.

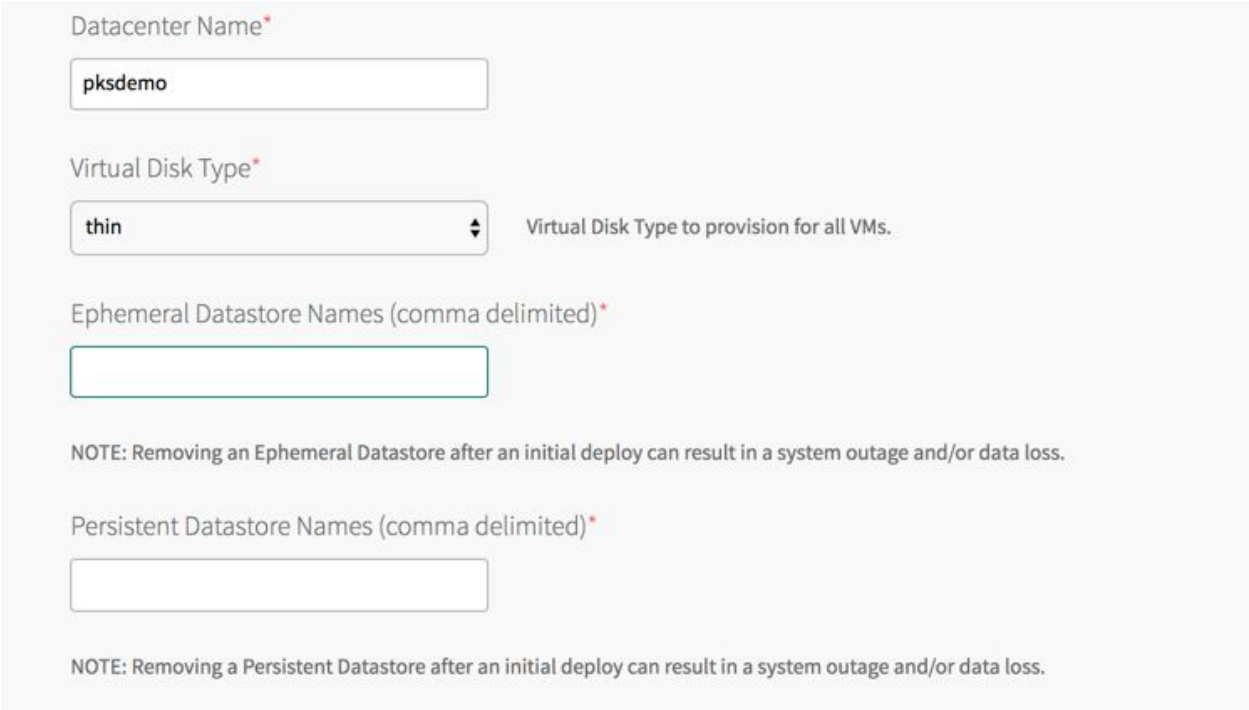

PCF Ops Manager
INSTALLATION DASHBOARD
STEMCELL LIBRARY
CHANGE LOG
IMPORT A PRODUCT
Installation Dashboard
vmware
BOSH Director
for vSphere
v2.5.2-build.172

Configure the BOSH director tile.

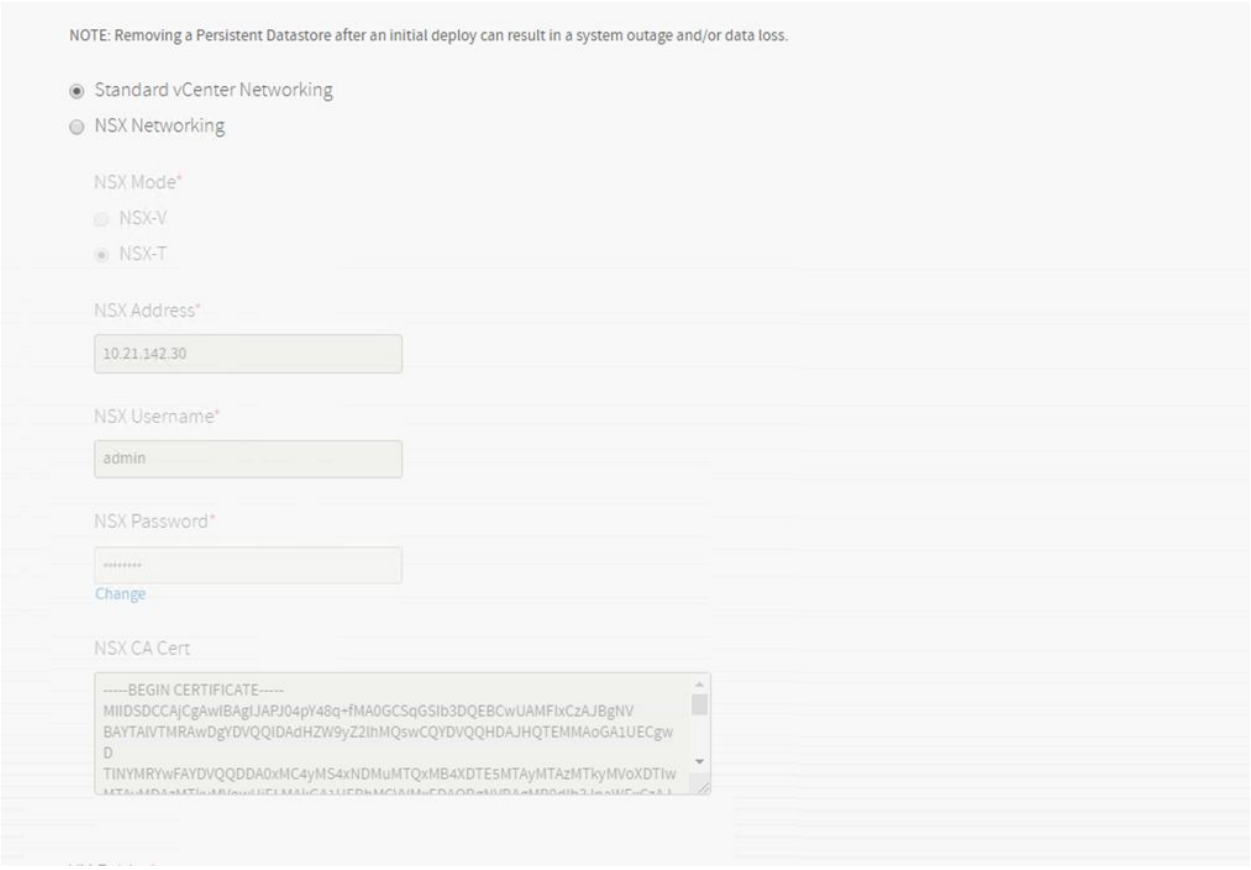
First setup the vCenter that Managers your PKS Enterprise Cluster. The Datacenter name is required and case sensitive.



Additionally, add a datastore for your Persistent and Ephemeral Data.

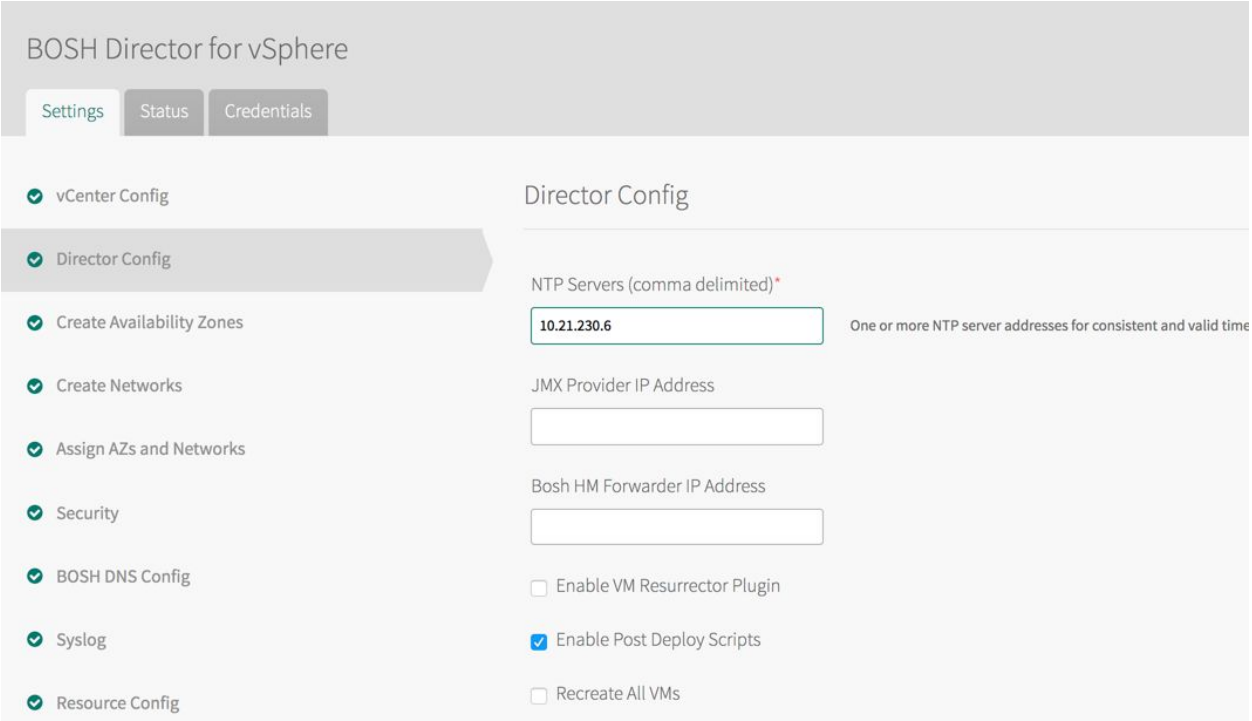


Last supply the details for your NSX environment. Be sure the networking and certificates are setup to match the PKS Enterprise for NSX-T documentation.



Set the NTP and other settings as needed. For PKS not much needs to be

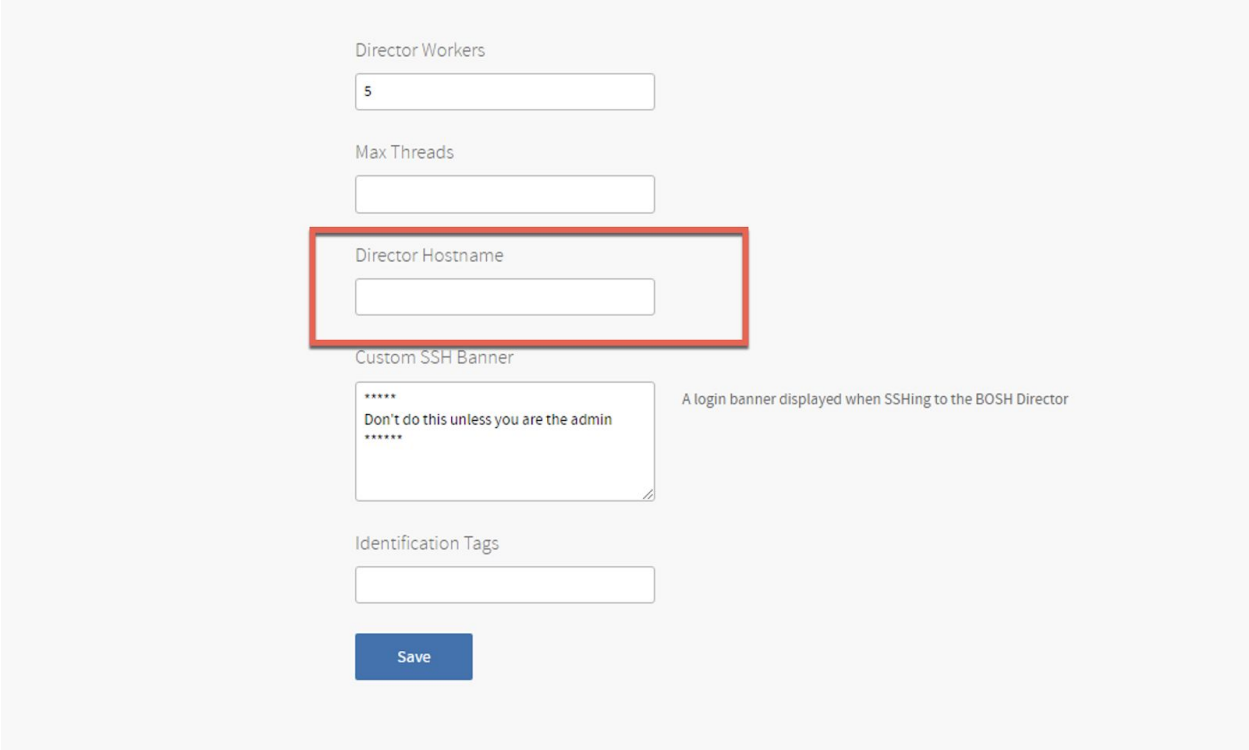
changed.



PKS requires clicking Enable Post Deploy Scripts. The PKS documentation also recommends enabling the VM Resurrector Plugin and Clicking the Recreate All VMs checkbox.

Note about the Director VM:

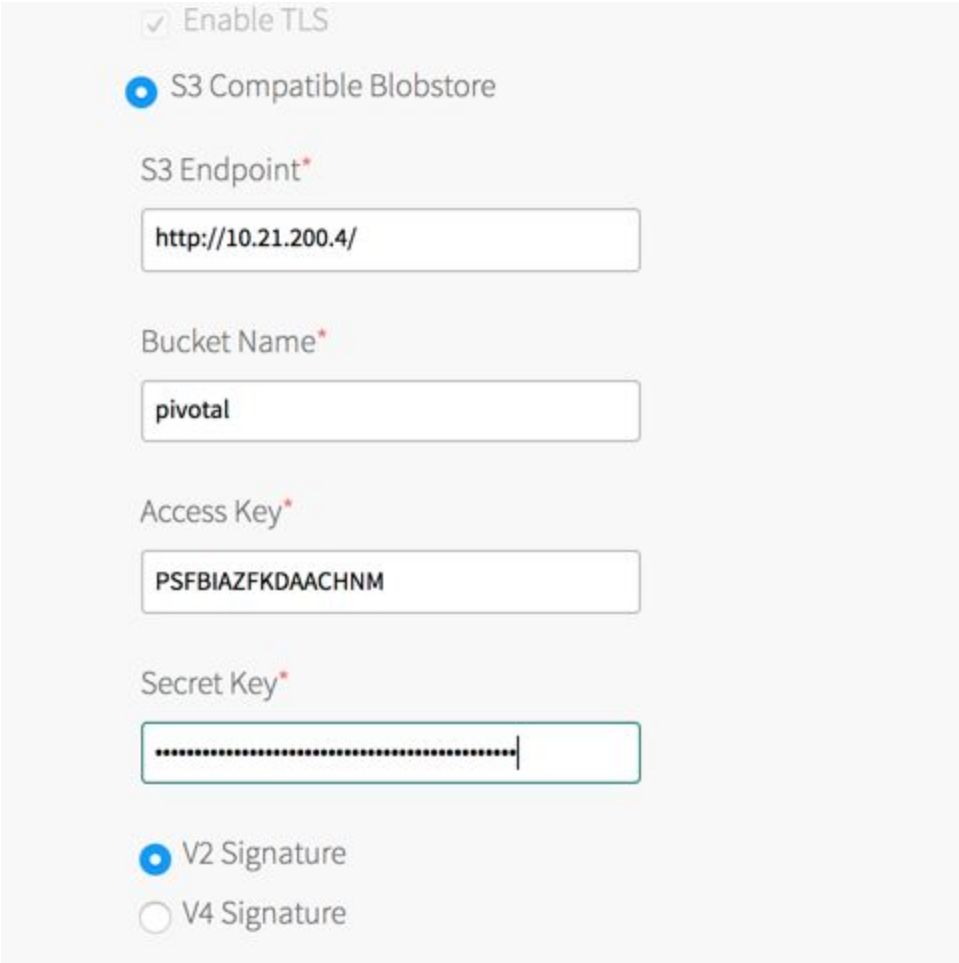
Additionally, If you are using NSX-T in NAT mode. You will most likely need to access the director VM via bosh for troubleshooting if anything ever goes wrong. You should set the Director Hostname to the DNS record for the NAT routable IP in your Network.



If you do not do this, the SSL certificate will be issued to the internal IP and connecting to the hostname on the outside network will fail.

Optional: Blob Store

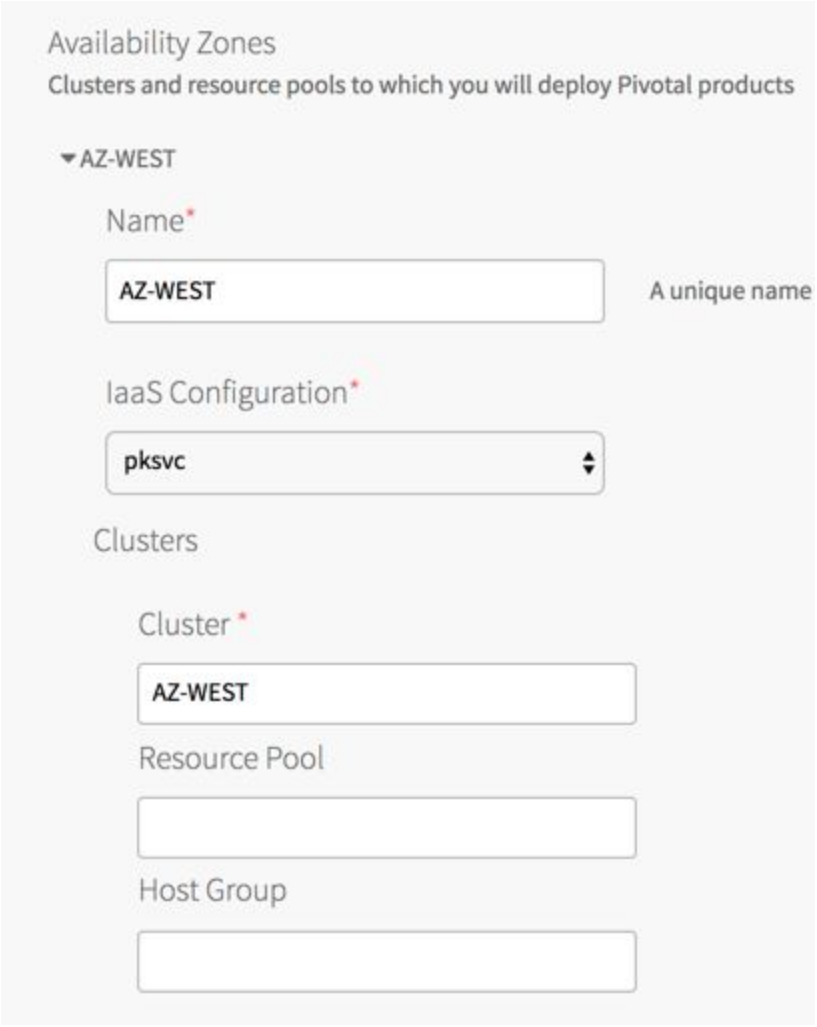
You are able to use an S3 bucket on FlashBlade to house the Bosh Blobstore. The endpoint, bucket name and keys are required to configure the blobstore.



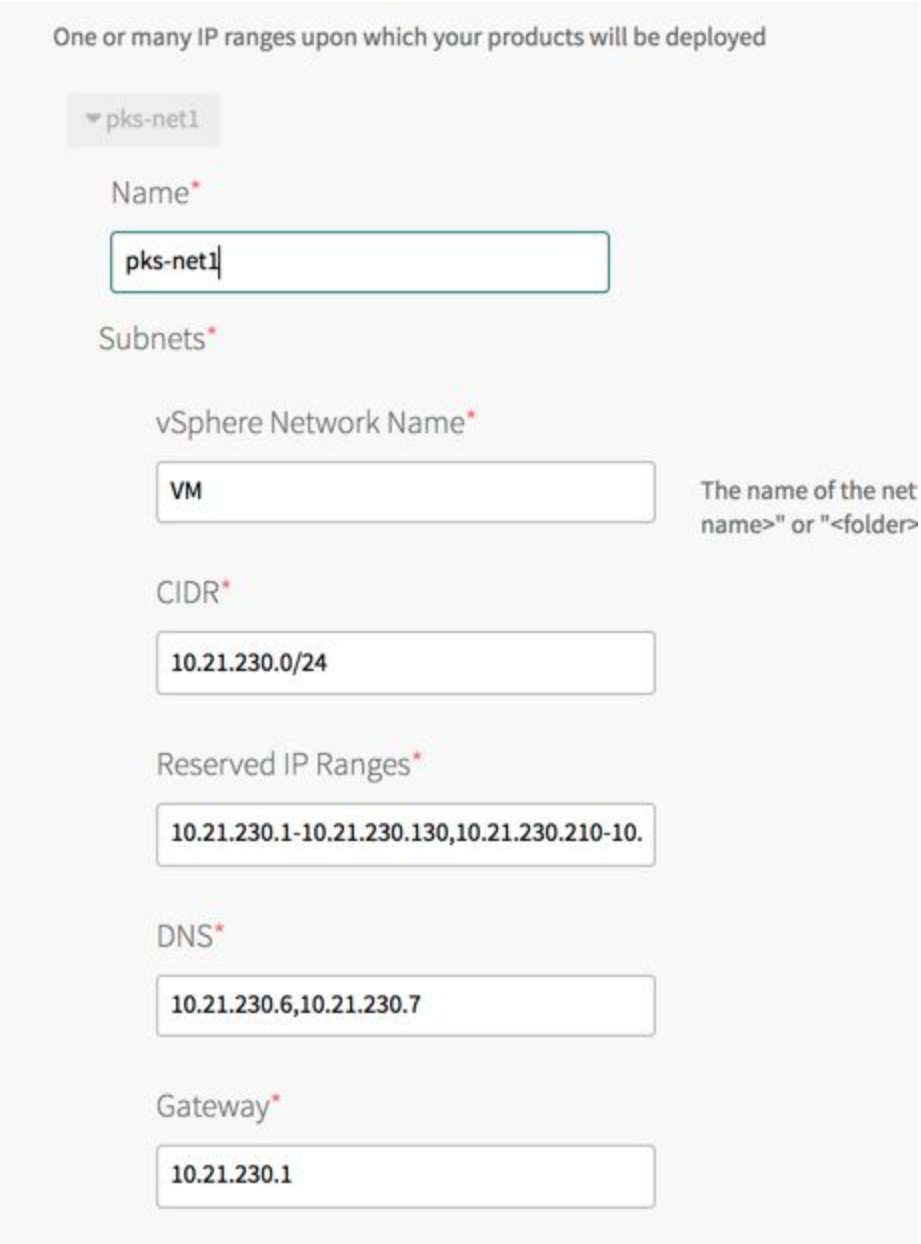
Create Availability Zones

Set the Availability Zones Create 1 for each vSphere Cluster or resource pool depending on your vSphere Setup.

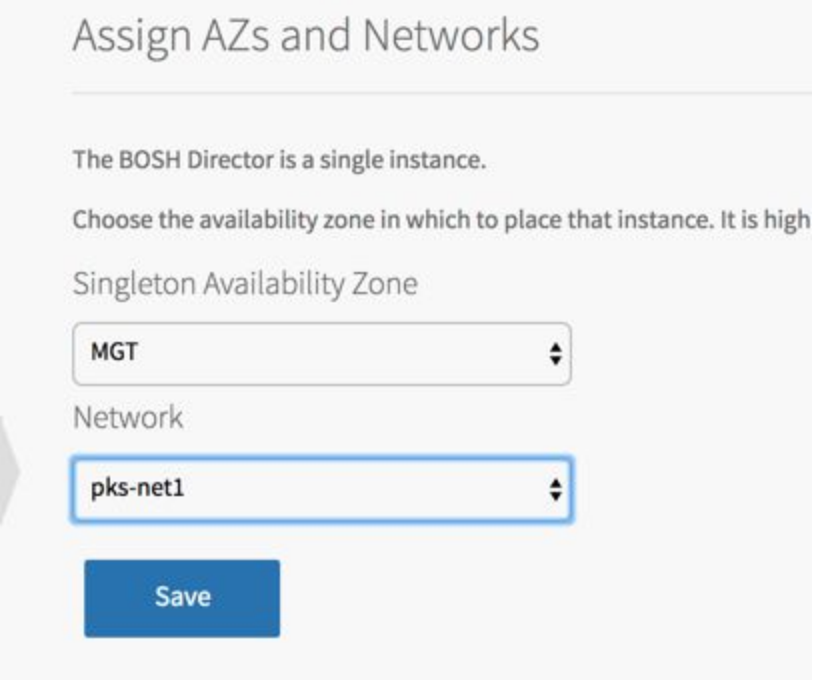
Our example uses 3 Compute zones and 1 Management Zone.



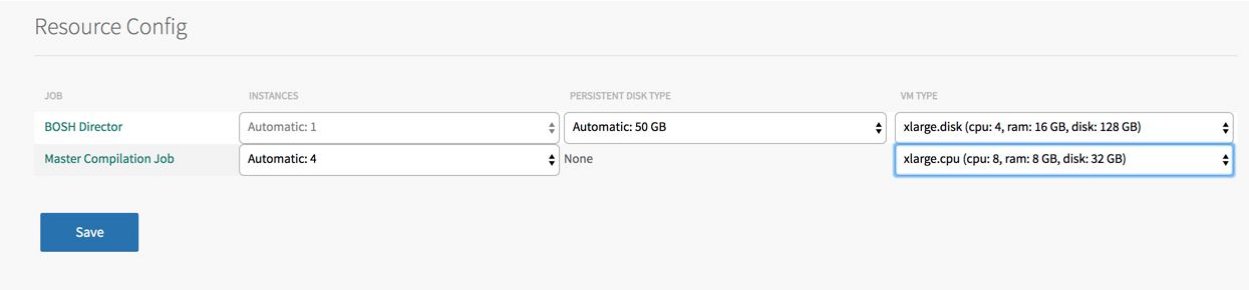
Setup your networks as necessary. Please visit Pivotal documentation for NSX-T setup .



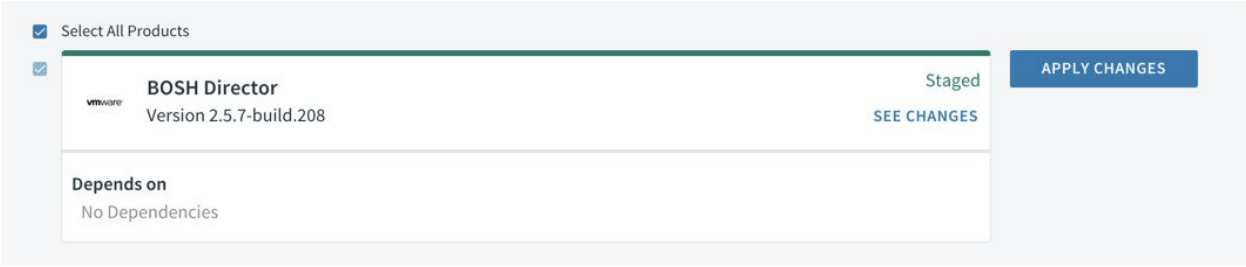
Assign where the Bosh Director will be deployed. In the Management zone.



Optional: Increase the VM size for the Bosh VM's as needed. My settings:



1. Initiate the setup of BOSH Director by going to:
    a. Click the **Installation Dashboard** link to return to the Installation Dashboard.
    b. Review Pending Changes



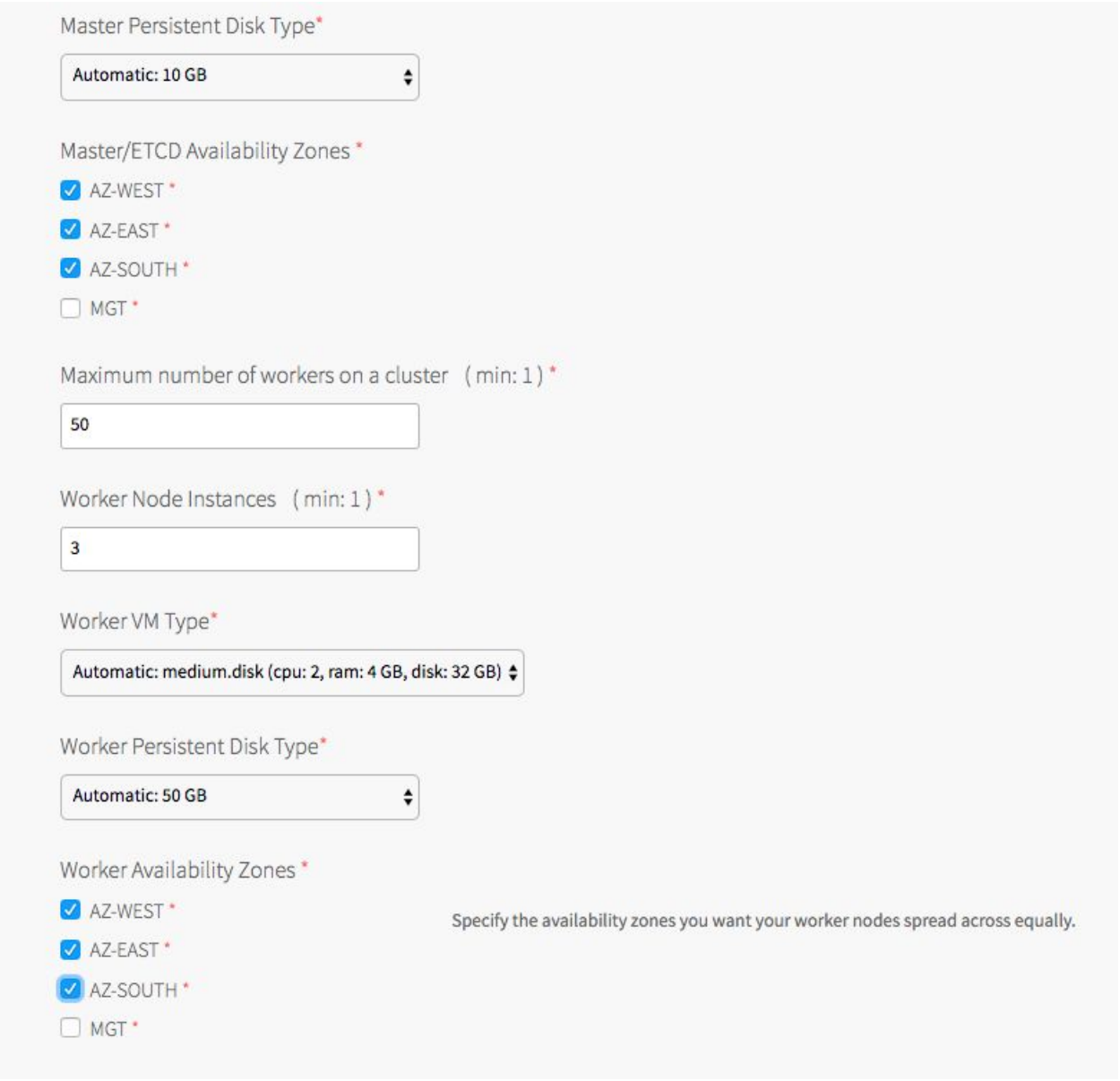
c. Apply Changes

Enterprise PKS Setup (PKS)

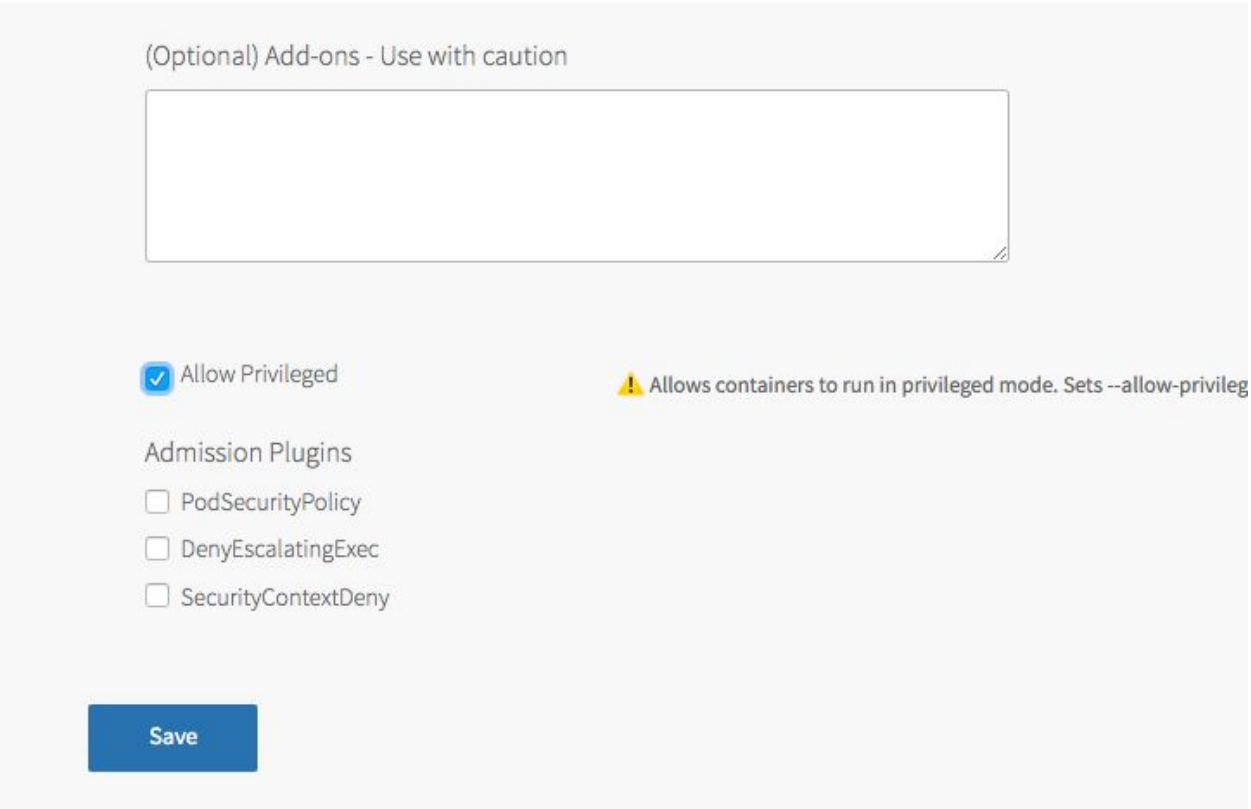
PKS Enterprise Configuration

Upload the PKS Package Downloaded from Pivotal and Install PKS

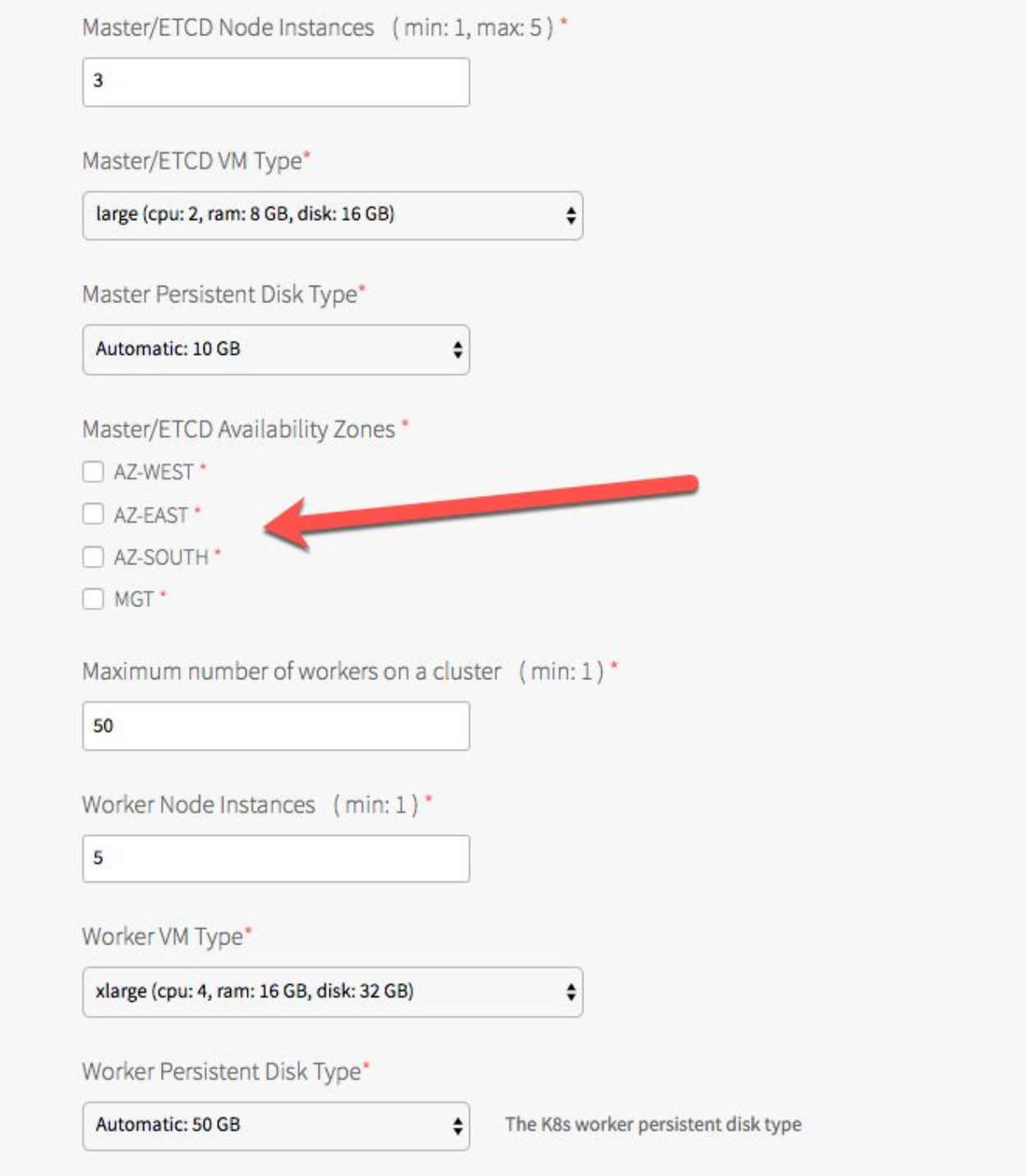
1. Import **Pivtoal-container-service-1.4.1-build.4.pivotal**
2. Import the stemcell - **Ubuntu-Xenial 250.63** (current version as of writing this, make sure you use the stem required by your PKS Enterprise version) **Update:** the required stem is now included in the PKS package from step 1. If you don't see the stemcell you can manually import one. This can be downloaded from Pivotal's download website.
3. API Endpoint.
    a. Click Generate Certificate then enter in your wildcard domain (*.newstack.local and *.app.newstack.local) hit Generate. For more on PKS and certificates please see the PKS Documentation. Use your Certificate Authority to sign the Certificate, this should be default practice for production.
    b. Enter the FQDN of you PKS API endpoint. (pks.app.newstack.local)
4. Plan 1-n.
    No matter how many plans you may require. We will spread the load across the Availability Zones we Created with our vSphere Clusters. Plan 1, maybe a lightweight dev cluster 1 master and 3 workers. Set the Worker and Master Type VM's to fit your requirements.



If you plan to use Helm and Pure Service Orchestrator with your cluster you will want to enable the "Allow Privileged" setting near the bottom and click save.



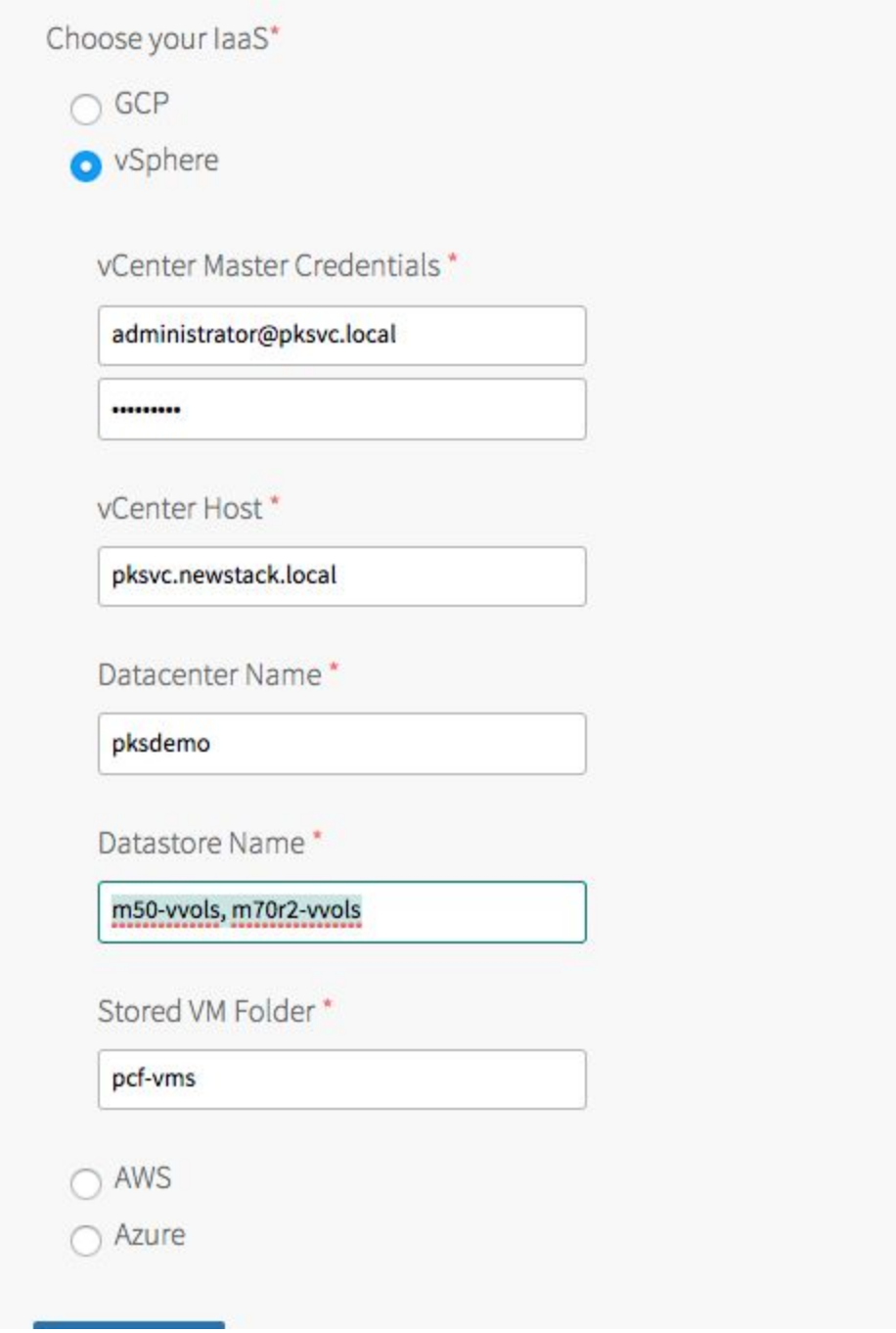
For a more prodcution or permanent cluster, Master nodes need to be HA and increase the Mem and CPU. Make sure to spread the master nodes across your AZ's and place Workers in different AZ's as necessary.



Don't forget to click "Allow Privileged" if you need it later.

a. Create as many plans as you need. I would suggest creating at least 3 for now.

5. Kubernetes Cloud Provider Configuration
   Fill in your vSphere information, The Stored VM Folder must match what you put into the Ops Manager Director earlier in the config. Additionally, Pure Storage recommends using vVOLS for the Persistent Datastore. This allows the use of Storage Policy Based Management (SPBM) and disaggregated scaling of Compute and Capacity to provide flexibility as you grow your Kubernetes footprint.



Click Save.

6. Under Monitoring Enable syslog and vRealize Log Insight Integration if you required.
7. Agree or Disagree with the Usage Data Portion.

8. Click “Installation Dashboard” Once you have green checks next to every config category. Click Review Pending Changes, then Apply Changes. This will take several minutes to complete.

DNS Configuration

After the BOSH setup is completed and successful. Make sure to enter in your DNS records for the pks api endpoint. In this configuration example pks.app.newstack.local must map to the IP given to the VM during the rollout of PKS Enterprise. Trying to access the PKS endpoint or cluster managers by IP will result in the request failing. The certificates generated are tied to the host names or endpoint names. So working DNS servers are required.

Select the Enterprise PKS tile in Ops Manager and Click the Status tab.

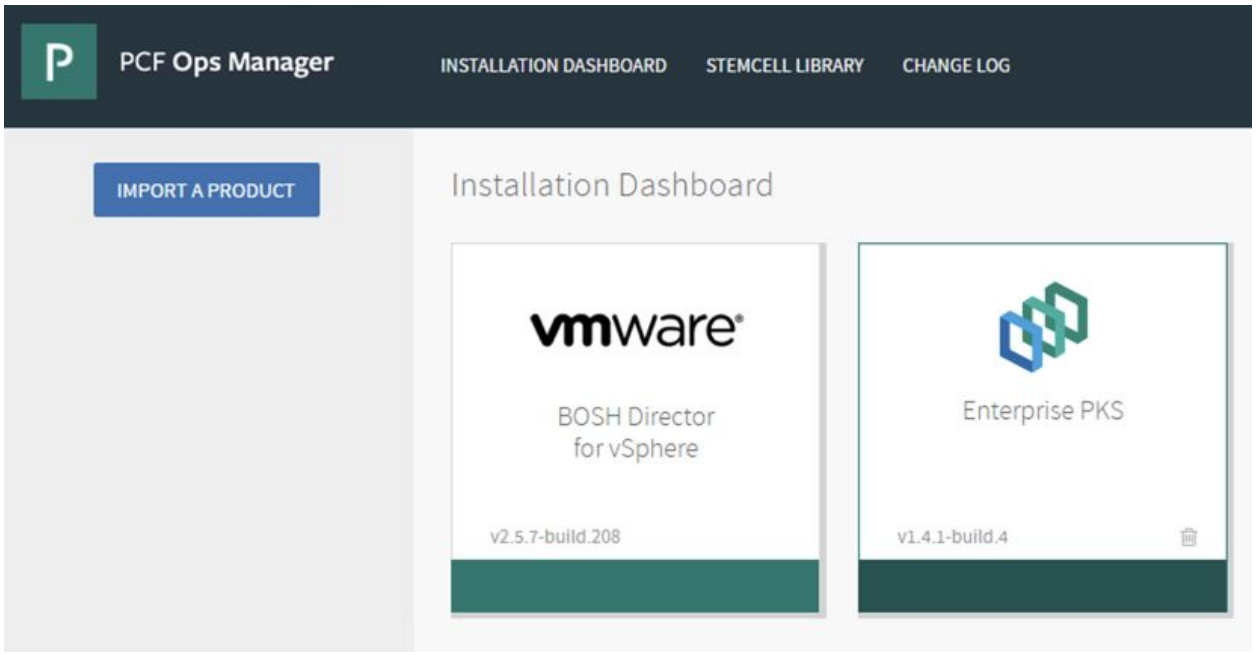
Setup Access to Ops Manager and PKS CLI

Create a PKS User

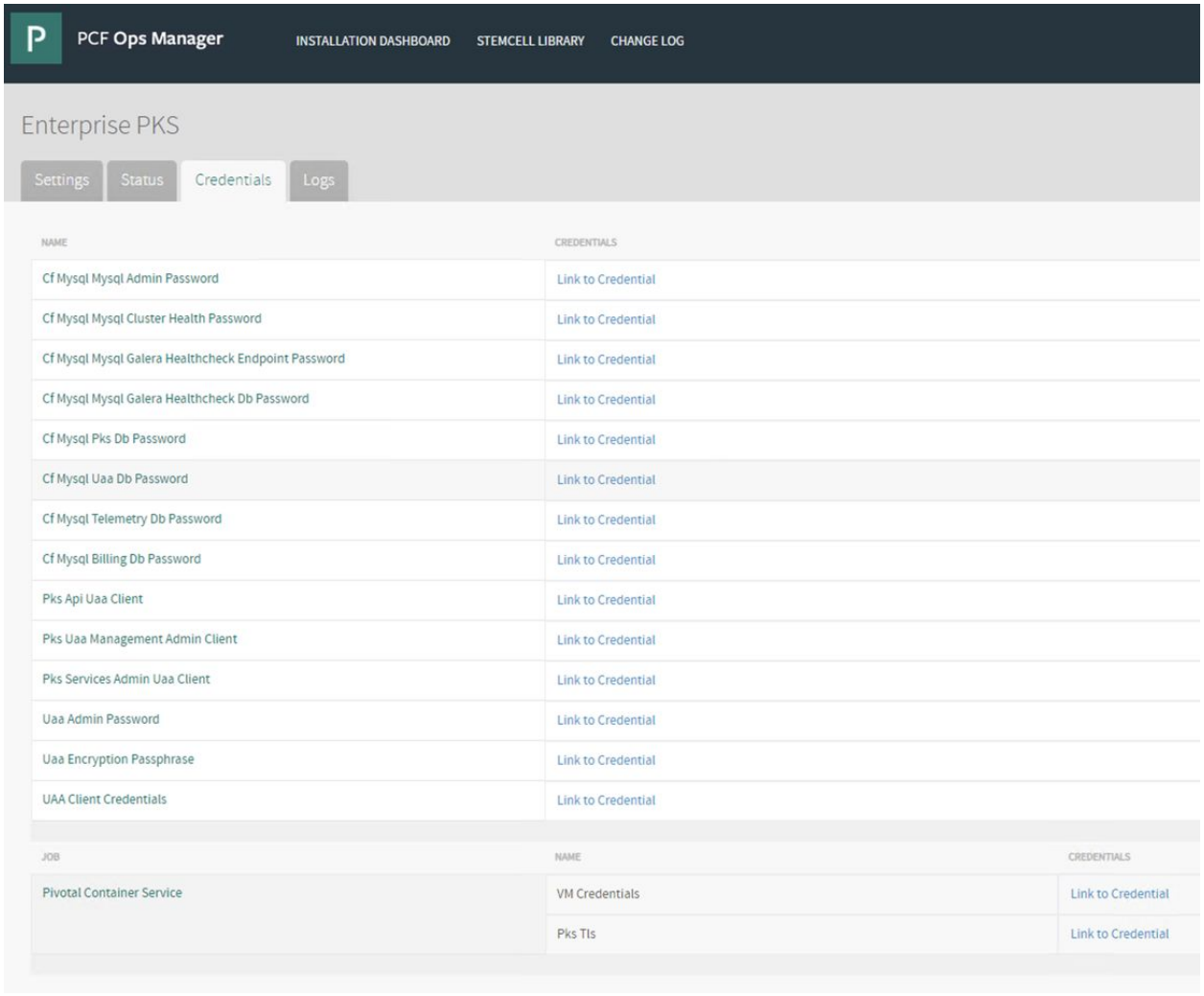
Set your UAAC target to the PKS API endpoint. (gem install cf-uaac). If you get an error installing on ubuntu make sure to install ruby.

```
uaac target https://pks.newstack.local:8443
--skip-ssl-validation
```

Go to the PKS Enterprise tile:



Go to Credentials Tab and get the **PKS Uaa Management Admin Client key** by clicking “Link to Credential. **Copy the key without the “ marks.**




```
uaac token client get admin -s <paste key here>
```

Create your PKS user

```
uaac user add jowings --emails jowings@newstack.local -p <create
a password>
```

Make your user cluster admin

```
uaac member add pks.clusters.admin jowings
```

Login to the PKS API server.

```
pks login -a pks.newstack.local -u jowings -k
```

Use the -k if your SSL is self-signed. Use your password created in the above step.

Test Cluster Creation

```
pks create-cluster testcluster --external-hostname test
--plan small
```

Use PKS Cli to Check your cluster status

```
pks cluster testcluster
```

When provisioning is finished output will look like this:

Now run:

```
pks get-credentials testcluster
```

Add a DNS record for the Master Host name to the IP.
With this example, we will create a host ‘test’ pointing to the IP 10.21.230.133

If you get a timeout or error the DNS record may not be ready. Make sure your client can resolve the IP.

Sequence to create and use a PKS Cluster

```
pks create-cluster <cluster name> --external-hostname <host
name> --plan <plan name>
pks cluster <cluster name>
pks get-credentials <cluster name>
```

Create DNS record match <host name> to the output IP from the successful cluster creation.

Creating the SPBM Storage Class for the vSphere Cloud Provider

The following page describes the SPBM options available to the VCP:
https://github.com/vmware/vsphere-storage-for-kubernetes/blob/master/documentation/storageclass.md

Right now this issue is blocking this from working:
https://github.com/kubernetes/kubernetes/issues/75040
Just tested (6/25/19) PKS Enterprise version 1.4.1-build.4 not working.

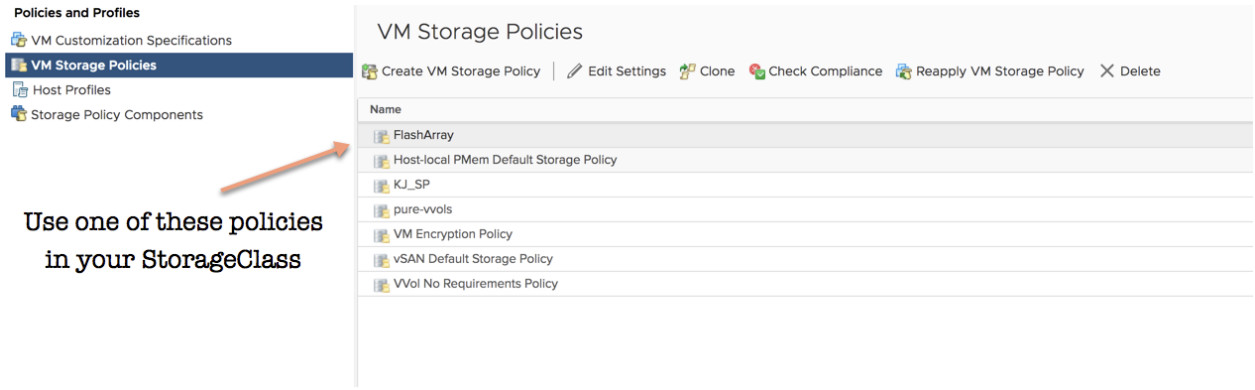
1. Create a StorageClass file. For example pure-vvols.yaml

```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: pure-vvols
provisioner: kubernetes.io/vsphere-volume
parameters:
    diskformat: zeroedthick
    storagePolicyName: FlashArray
```

Alternative is to create a Storage Class tied directly to the datastore
Example

```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: pure-ds
```

```
provisioner: kubernetes.io/vsphere-volume
parameters:
    datastore: m70-vvols-datastore
```



2. Apply the storage class
   Kubectl apply
3. Run a test application

More Information on configuring the vSphere Cloud Provider
https://vmware.github.io/vsphere-storage-for-kubernetes/documentation/overview.html

https://vmware.github.io/vsphere-storage-for-kubernetes/documentation/policy-based-mgmt.html

Setting Up Bosh

Bosh CLI will be needed to create releases and is also helpful when troubleshooting and other tasks in the PKS Clusters.
Note: you have to install the om tool first: https://github.com/pivotal-cf/om

1. Output the CA into a file to be used when connecting to your Bosh Director.
   om --target https://opsman.newstack.local -u admin -p **<Ops Manager PW you created at the very beginning>** -k curl -p /api/v0/certificate_authorities -s | jq -r '.certificate_authorities | select(map(.active == true))[0] | .cert_pem' > ~/opsmanager.pem
2. Output your credentials
   om --target https://opsman.newstack.local -u jowings -p **<Ops**

Manager PW you created at the very beginning> -k curl -p /api/v0/deployed/director/credentials/bosh2_commandline_credentials -s | jq -r '.credential'
Output from last command

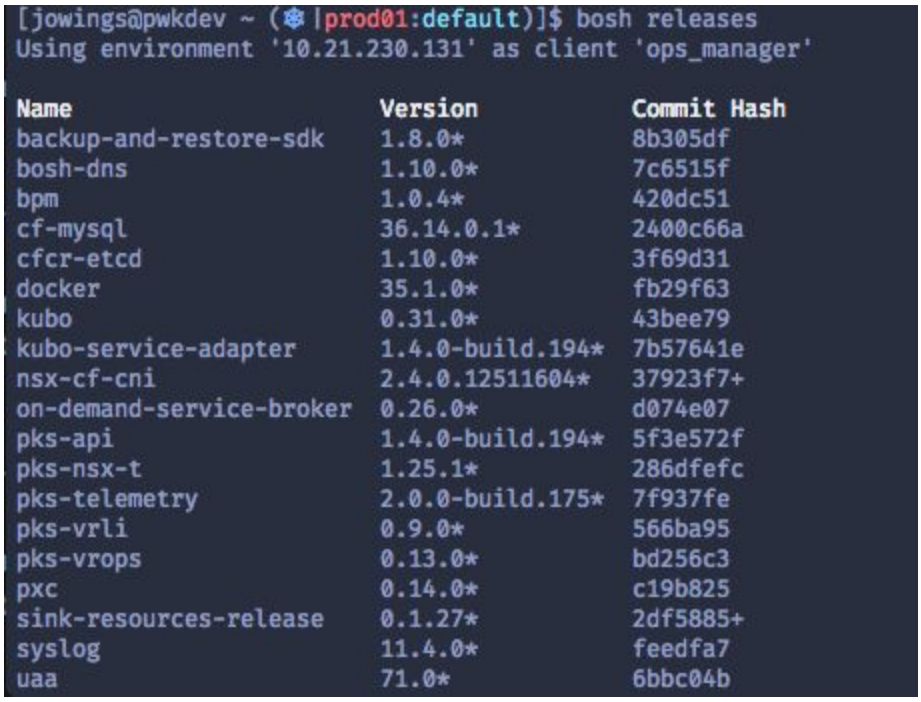
BOSH_CLIENT=ops_manager
BOSH_CLIENT_SECRET=anXl0m55LdLNNLAib1i_5HP-Je5jToYn
BOSH_CA_CERT=/var/tempest/workspaces/default/root_ca_certificate
BOSH_ENVIRONMENT=10.21.230.32 bosh

3. Format as follows for .bashrc notice just the IP for the BOSH_ENVIRONMENT and the CA_CERT it pointing to the file we dumped the cert into earlier.

   export BOSH_CLIENT=ops_manager
   export BOSH_CLIENT_SECRET=anXl0m55LdLNNLAib1i_5HP-Je5jToYn
   export BOSH_CA_CERT=~/opsmanager.pem
   export BOSH_ENVIRONMENT=10.21.230.32

4. Test BOSH from the CLI
   bosh releases

   Output should look like this:



Optional: Pure Service Orchestrator for ISCSI

Pure Service Orchestrator provides Container Storage-as-a-Service with Direct access to FlashArray or FlashBlade resources. PSO requires additional packages when using the FlashArray that are not currently included in the Ubuntu Xenial Stemcell used by PKS. The NFS Client Packages required by PSO when using the FlashBlade are used by other Pivotal use cases and are therefore included. **If you are using FlashBlade only you only need to follow the directions for installing Helm and Pure Service Orchestrator. For FlashBlade follow the section 'Runtime Config for PSO'.**

1. Install Helm using the Pivotal Docs below.
    a. https://docs.pivotal.io/runtimes/pks/1-4/helm.html
2. Setup the PSO Helm Repo
   helm repo add pure https://purestorage.github.io/helm-charts
   helm repo update
3. Create your values.yaml file
   Use the latest full file from the Pure Storage helm repo.
   https://raw.githubusercontent.com/purestorage/helm-charts/master/pure-k8s-plugin/values.yaml

   Example Changes

```
namespace:
c pure: pks
arrays:
 FlashBlades:
  - MgmtEndPoint: "<FlashBlade MGT IP>"
    NfsEndPoint: "<FlashBlade NFS IP>"
    APIToken: "T-9f276a18-50ab-446e-8a0c-666a3529a1b6"
```

4. Install PSO
   helm install -n pso pure/pure-k8s-plugin -f pksdemo-values.yaml

5. List the Storage Classes
   kubectl get sc

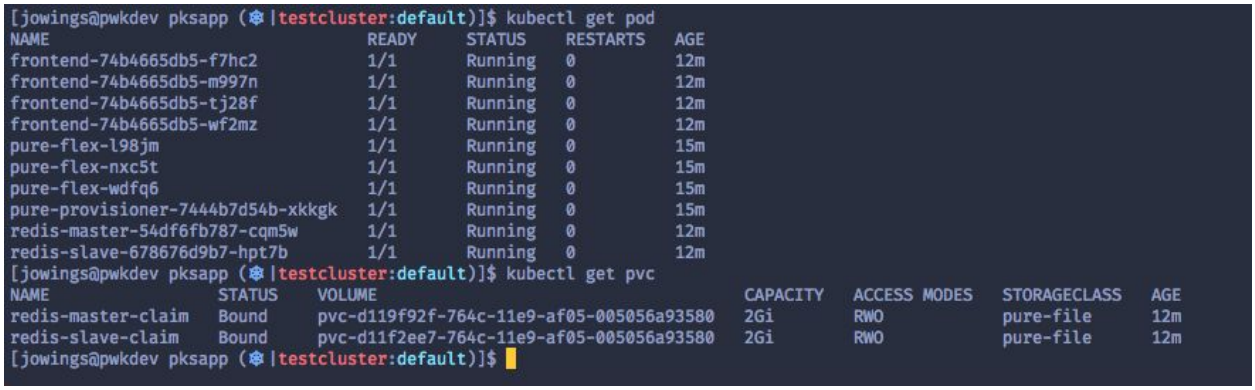
6. This example only used a single flashblade as we have not made runtime config changes needed for FlashArray.
7. Deploy an app using the pure-file StorageClass. https://github.com/2vcps/pksapp

```
git clone https://github.com/2vcps/pksapp.git
cd pksapp
kubectl apply -f .  #notice the . in the cli
```

8. Verify the demo app is running

```
Kubectl get pod
Kubectl get pvc
```

Output should look like this:



9.

Runtime Config for PSO

Create a custom Bosh Release to add the *open-iscsi* and *multipath-tools* packages to your PKS environment. Perform the steps below to create a runtime config that will install these two packages in the stemcell. This is an included and supported feature of Pivotal and is used by other 3rd party vendors for storage plugins and monitoring.

1. Go to the following git repo and clone to your client with the BOSH CLI tools. https://github.com/2vcps/pso_prereqs
2. Follow the README in the repo as it will have the most recent instructions for deployment.

Optional: Setup up Harbor

For Enterprise environments it is recommended to use an internal container repo. VMware provides Harbor with a tile to deply built into the Pivotal Platform.
https://docs.pivotal.io/pks/1-5/harbor.html

The deployment and use of Harbor requires the import CA Certificate from harbor to be used by your docker registry.

1. deploy tile following the documentation
2. download ca cert
3. copy ca.crt to /etc/docker/harbor.newstack.local/
4. You will have to login to push and pull from harbor

```
docker login harbor.newstack.local
jowings
password##
```

If you have images you need to push into the harbor repo you must tag them correctly prior to the docker push.

Mind the line wraping in the document

```
docker tag gcr.io/google-samples/gb-frontend:v4
harbor.newstack.local/library/gb-frontend:v4

docker tag gcr.io/google_samples/gb-redisslave:v1
harbor.newstack.local/library/gb-redisslave:v1
```

```
docker tag gcr.io/google_containers/redis:e2e
harbor.newstack.local/library/redis:e2e

docker push harbor.newstack.local/library/gb-frontend:v4
docker push harbor.newstack.local/library/redis:e2e
docker push harbor.newstack.local/library/gb-redisslave:v1
```

References:

Links I used to gather what I needed for install and configuration

https://docs.pivotal.io/runtimes/pks/1-4/installing.html

https://www.virtuallyghetto.com/2018/03/getting-started-with-vmware-pivotal-container-service-pks-part-1-overview.html

https://www.virtuallyghetto.com/2018/03/getting-started-with-vmware-pivotal-container-service-pks-part-2-pks-client.html

https://www.virtuallyghetto.com/2018/03/getting-started-with-vmware-pivotal-container-service-pks-part-3-nsx-t.html

https://www.virtuallyghetto.com/2018/03/getting-started-with-vmware-pivotal-container-service-pks-part-4-ops-manager-bosh.html

https://www.virtuallyghetto.com/2018/04/getting-started-with-vmware-pivotal-container-service-pks-part-5-pks-control-plane.html

https://www.virtuallyghetto.com/2018/04/getting-started-with-vmware-pivotal-container-service-pks-part-6-kubernetes-go.html

https://www.virtuallyghetto.com/2018/04/getting-started-with-vmware-pivotal-container-service-pks-part-7-harbor.html

Very Helpful
https://github.com/goharbor/harbor/blob/master/docs/use_notary.md