NetApp

Running Stateful Applications in Containers with K8S Persistent Volumes and StatefulSets

OpenStack Summit, Vancouver

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Agenda

1) Stateful Apps and Persistent Data
2) K8S Persistent Data Concepts
3) Static vs Dynamic Provisioning
4) NetApp Trident
5) PostgreSQL Demo

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Stateful Apps and Persistent Data

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Stateful Apps

For Example

- SQL Databases
  - MySQL, PostgreSQL, SQL Server
- NoSQL Databases
  - MongoDB, ElasticSearch, Redis, Cassandra
- Pub Sub Systems
  - Kafka
- Time series Databases
  - InfluxDB, Graphite
- Big Data
  - Splunk

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Persistent Data

For Example

- Object
  - S3, Swift
- File
  - NFS, SMB, Manila, GlusterFS
- Block
  - iSCSI, FC, EBS, Cinder

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Kubernetes Volume Plugins

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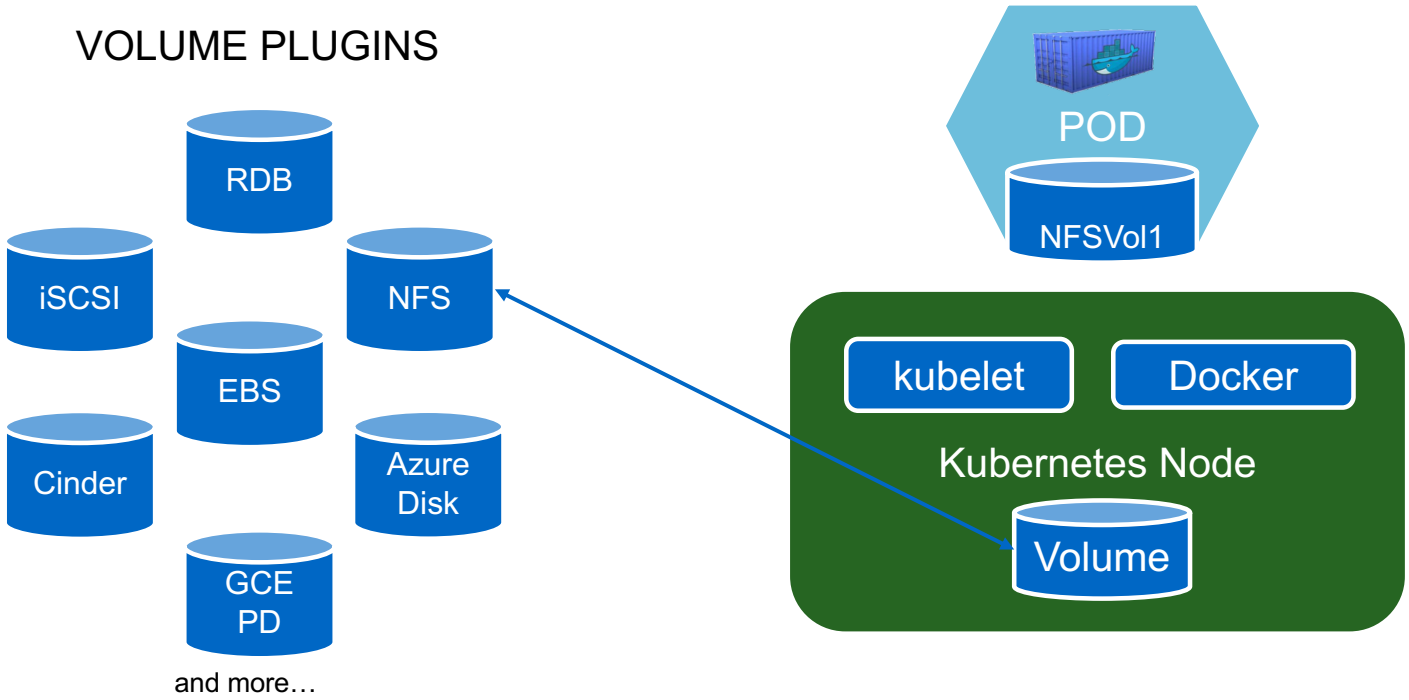
Kubernetes Volume Plugins

- Reference block device and mounted file system
- Accesible by all containers in a pod
- Lifetime of a volume is same as the pod (or longer)



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Kubernetes Volume Plugins

- Remote
  - GCEPersistentDisk
  - AWSElasticBlockStore
  - AzureFile, AzureDisk
  - iSCSI , FC
  - Flocker
  - NFS
  - RBD, CephFS, GlusterFS
  - Cinder
  - VsphereVolume, VMware Photon
  - Quobyte Volumes
  - Portworx Volumes
  - ScaleIO Volumes
  - StorageOS
- Ephemeral
  - Empty Dir
  - Secret
  - ConfigMap
- Local Persistent Volume (beta)
- Out-of-tree
  - CSI (beta)
- Other
  - Host path

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Example

- Cinder Volume in a Pod

```
1  apiVersion: v1
2  kind: Pod
3  metadata:
4    name: cinder-web
5  spec:
6    containers:
7      - name: web
8        image: nginx
9        ports:
10         - name: web
11           containerPort: 80
12           protocol: tcp
13       volumeMounts:
14         - name: html-volume
15           mountPath: "/usr/share/nginx/html"
16   volumes:
17     - name: html-volume
18       cinder:
19         # Enter the volume ID below
20         volumeID: volume_ID
21         fsType: ext4
```


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Example

- EBS Volume in a Pod

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: aws-web
spec:
  containers:
    - name: web
      image: nginx
      ports:
        - name: web
          containerPort: 80
          protocol: tcp
      volumeMounts:
        - name: html-volume
          mountPath: "/usr/share/nginx/html"
  volumes:
    - name: html-volume
      awsElasticBlockStore:
        # Enter the volume ID below
        volumeID: volume_ID
        fsType: ext4
```


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Example

- iSCSI volume in a Pod

```yaml
---
apiVersion: v1
kind: Pod
metadata:
  name: iscsipd
spec:
  containers:
  - name: iscsipd-ro
    image: kubernetes/pause
    volumeMounts:
    - mountPath: "/mnt/iscsipd"
      name: iscsivol
  volumes:
  - name: iscsivol
    iscsi:
      targetPortal: 127.0.0.1
      iqn: iqn.2015-02.example.com:test
      lun: 0
      fsType: ext4
      readOnly: true
      chapAuthDiscovery: true
      chapAuthSession: true
      secretRef:
         name: chap-secret
```


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PV and PVC Abstraction

Decouple storage implementation from consumption

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Administrator creates a PV

- PV: PersistentVolume API Object
- Configured for backing storage device
  - NFS, iSCSI, Cinder, AWS EBS, GCE, Azure
- Includes connection information for the storage volume
- Example: NFS PV

```
1  apiVersion: v1
2  kind: PersistentVolume
3  metadata:
4    name: pv-5gig
5  spec:
6    capacity:
7      storage: 5Gi
8    accessModes:
9      - ReadWriteOnce
10   persistentVolumeReclaimPolicy: Recycle
11   nfs:
12     server: 10.0.101.107
13     path: /path_to/5gig
```


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User Creates PVC

- PVC
  - PersistentVolumeClaim API Object
- Created by a user to request storage
- User provides:
  - Size
  - Access mode
  - Storage class (optional)
- Kubernetes assigns a PV to meet the requirements requested in the PVC
  - Does not require an exact match for capacity

```
1  apiVersion: v1
2  kind: PersistentVolumeClaim
3  metadata:
4    name: pvc-5gig
5  spec:
6    accessModes:
7      - ReadWriteOnce
8    resources:
9      requests:
10       storage: 5Gi
```


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User provides PVC name in the Pod/Deployment

- PVC claim name
- mount path

```
1  apiVersion: v1
2  kind: Pod
3  metadata:
4    name: pod-nginx
5  spec:
6    containers:
7      - image: nginx
8        name: nginx
9        ports:
10         - containerPort: 80
11           name: http
12       volumeMounts:
13         - name: my-vol
14           mountPath: /usr/share/nginx/html/
15   volumes:
16     - name: my-vol
17       persistentVolumeClaim:
18         claimName: pvc-5gig
```


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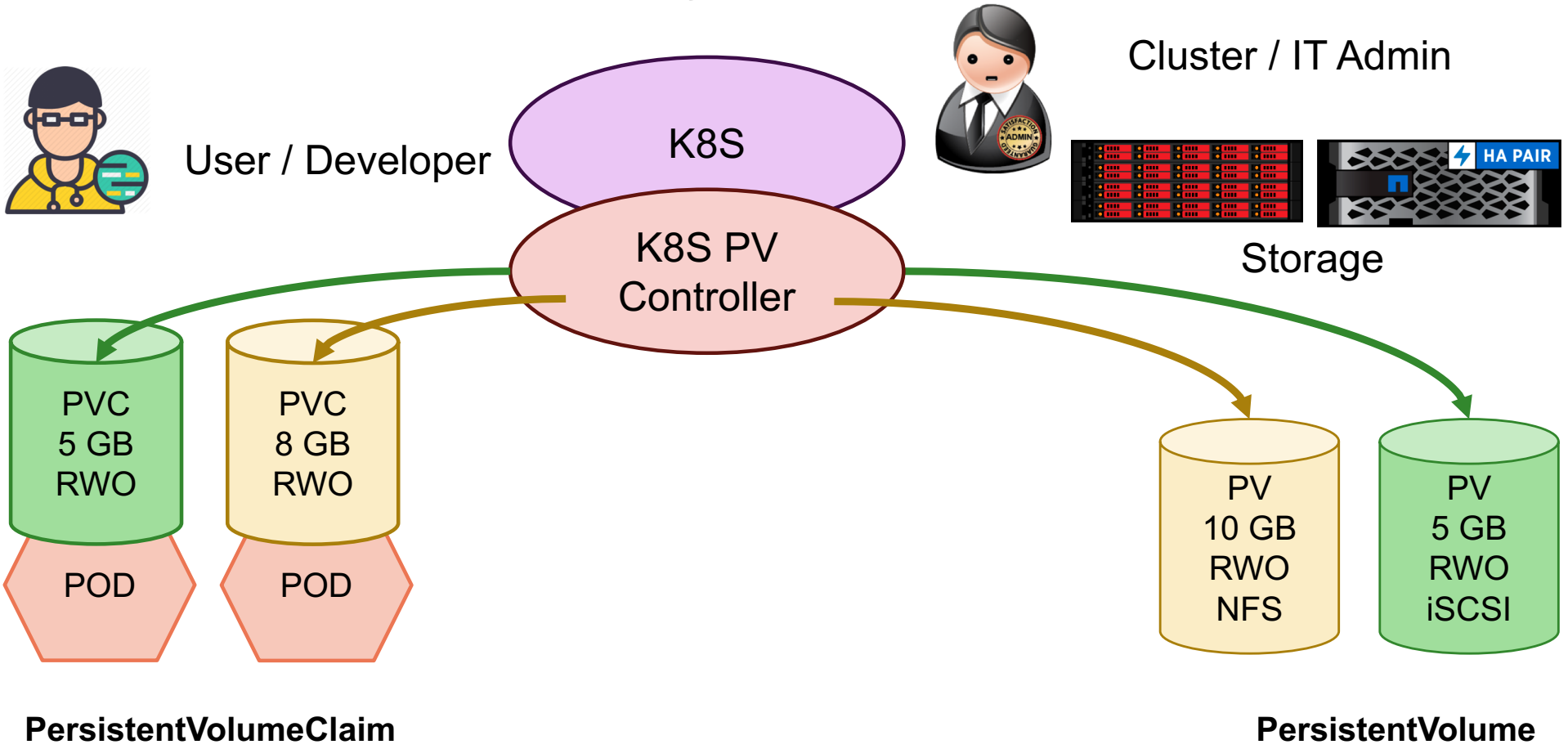
Kubernetes Static Provisioning



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Storage Classes and Dynamic Provisioning

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StorageClass

- Administrators can classify different storage types in the K8s environment using Storage classes
- Example
  - SSD/HDD
  - QoS
  - Dedupe/compression
  - Protocol: iSCSI/NFS
  - Etc.
- Abstract underlying storage
- E.g. Gold::Silver::Bronze

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SC Example

- Cinder

```
1  kind: StorageClass
2  apiVersion: storage.k8s.io/v1
3  metadata:
4    name: gold
5  provisioner: kubernetes.io/cinder
6  parameters:
7    type: fast
8    availability: nova
```


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SC Example

- NetApp ONTAP
  - NFS
  - SSD

```
1  apiVersion: storage.k8s.io/v1
2  kind: StorageClass
3  metadata:
4    name: ontap-gold
5  provisioner: netapp.io/trident
6  parameters:
7    backendType: "ontap-nas"
8    media: "ssd"
9    provisioningType: "thin"
10   snapshots: "true"
11
```


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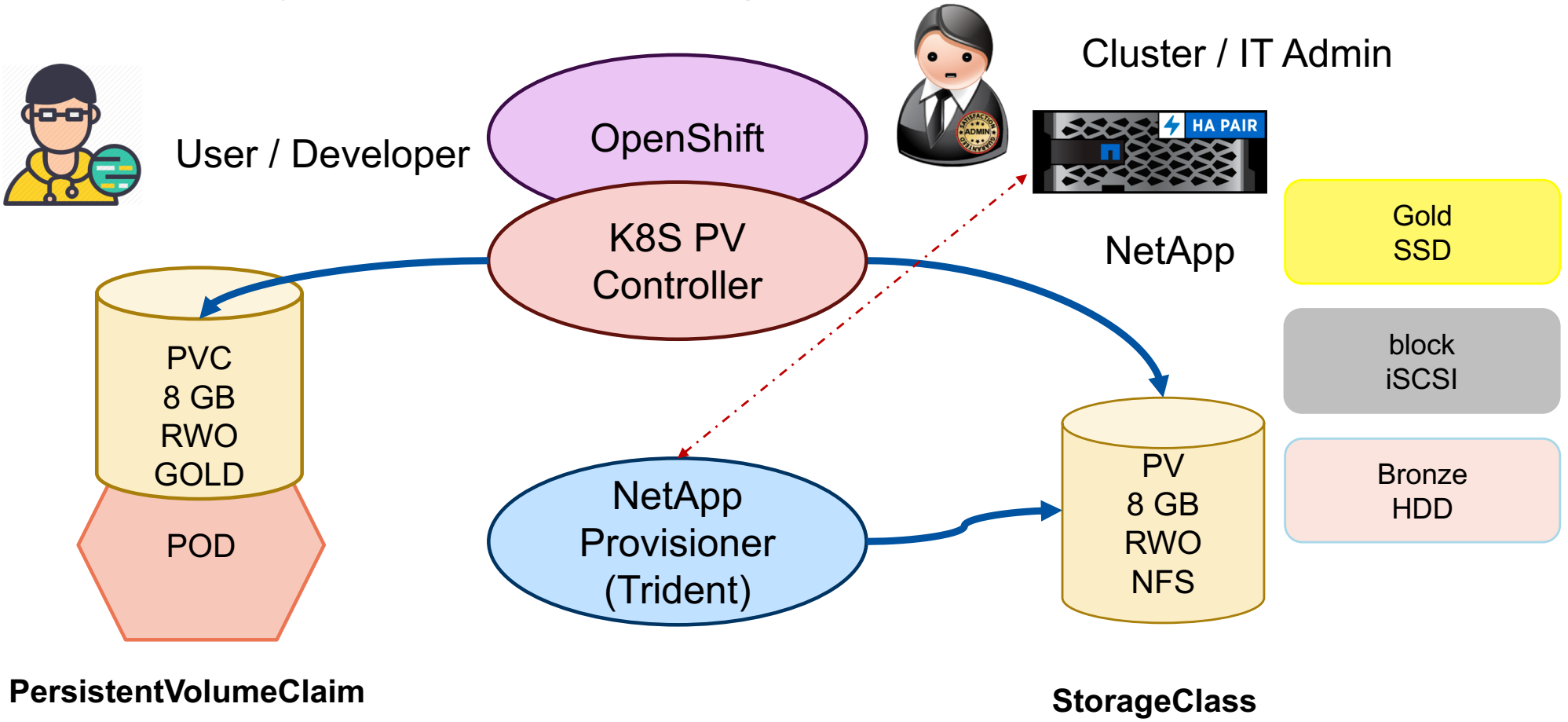
Kubernetes Dynamic Provisioining



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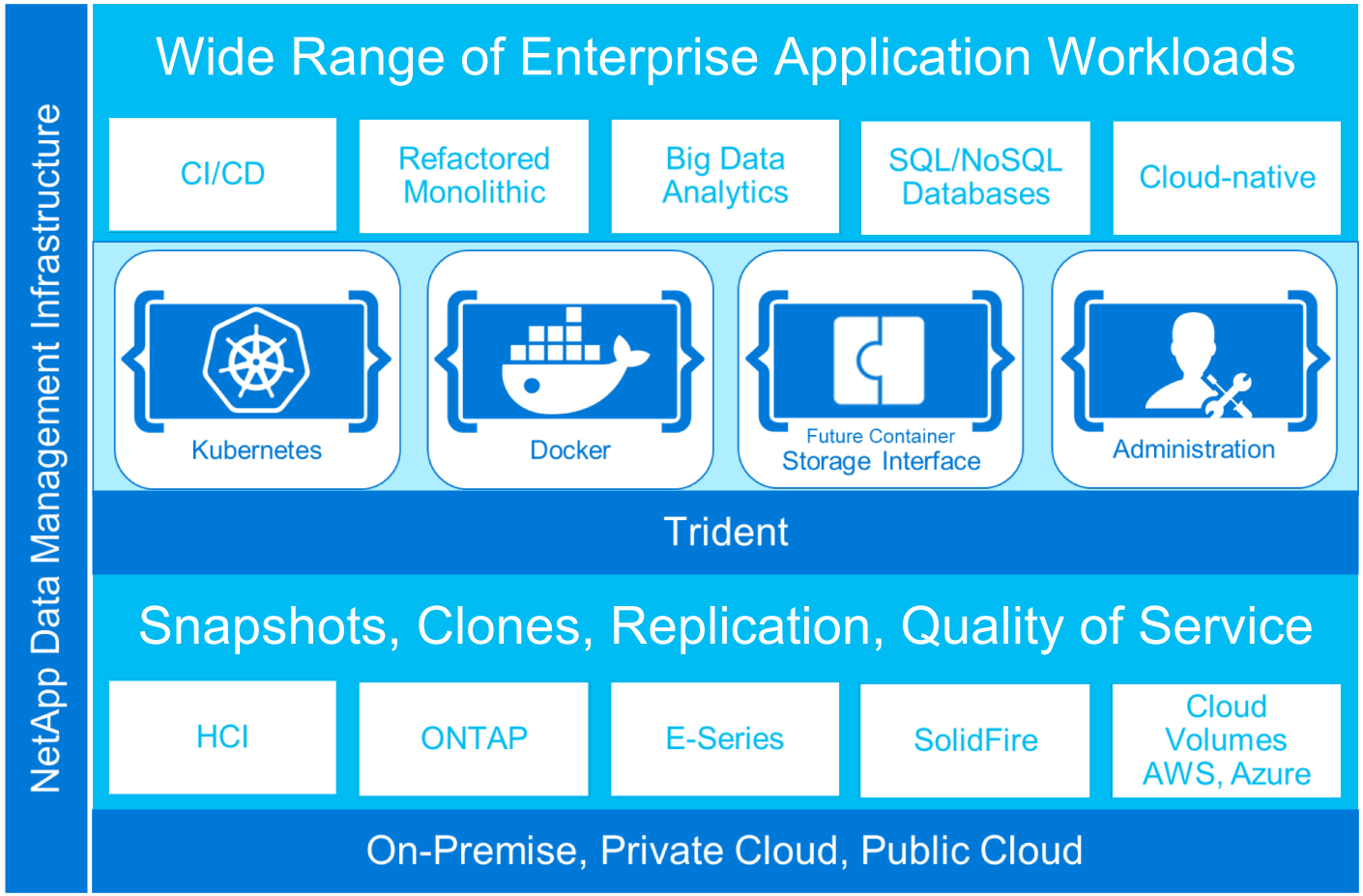
NetApp Trident



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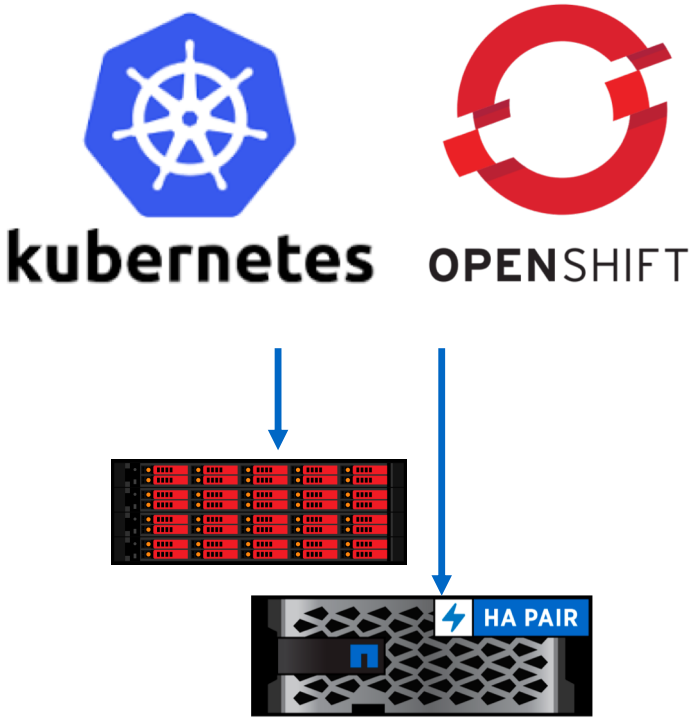
Trident for Kubernetes

- NetApp's Open source dynamic storage provisioner suppo
  - ONTAP
  - SolidFire
  - E-Series
- Automates Volume Creation and Mapping
- Compatible with:
  - Kubernetes
  - OpenShift Origin & RedHat OCP
- Snapshot and Cloning enabled
- Available on GitHub: https://github.com/NetApp/trident



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Resource Quotas

- Kubernetes Resource Quotas
  - https://kubernetes.io/docs/concepts/policy/resource-quotas/
- Blog
  - https://netapp.io/2017/06/09/self-provisioning-storage-kubernetes-without-worry/
- Set Limits on
  - requests.storage
  - value.storageclass.storage.k8s.io/requests.storage
  - persistentvolumeclaims
  - value.storageclass.storage.k8s.io/persistentvolumeclaims

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Future

- Container Storage Interface (CSI)
  - Moving towards an industry standard, orchestrator-agnostic basic storage abstraction
  - Standard API
- Now Beta!
- Spec
  - https://github.com/container-storage-interface/spec
- Blog
  - https://kubernetes.io/blog/2018/04/10/container-storage-interface-beta/

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Demo : PostgreSQL

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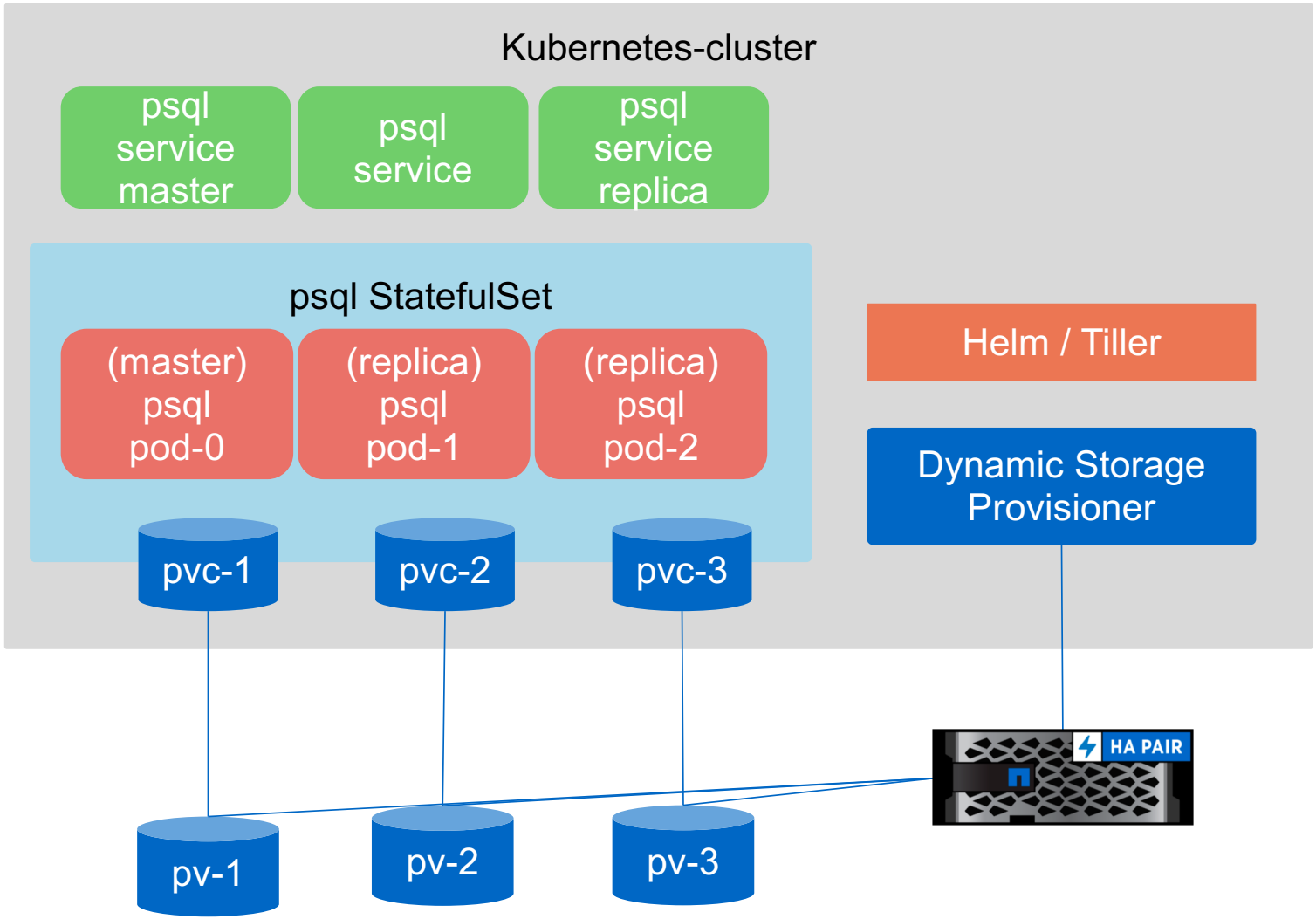

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Why use Helm?

- Standardized deployments
- Build a catalog for users
- Repeatable and predictable deployments
- Follow best practices

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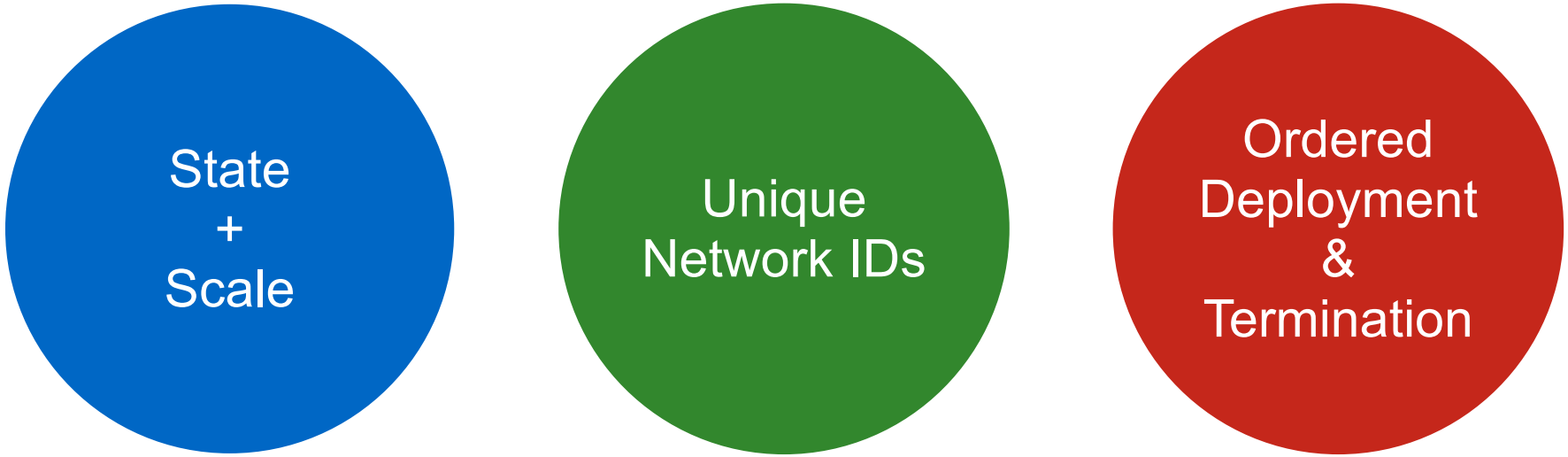
StatefulSets

When and Why?



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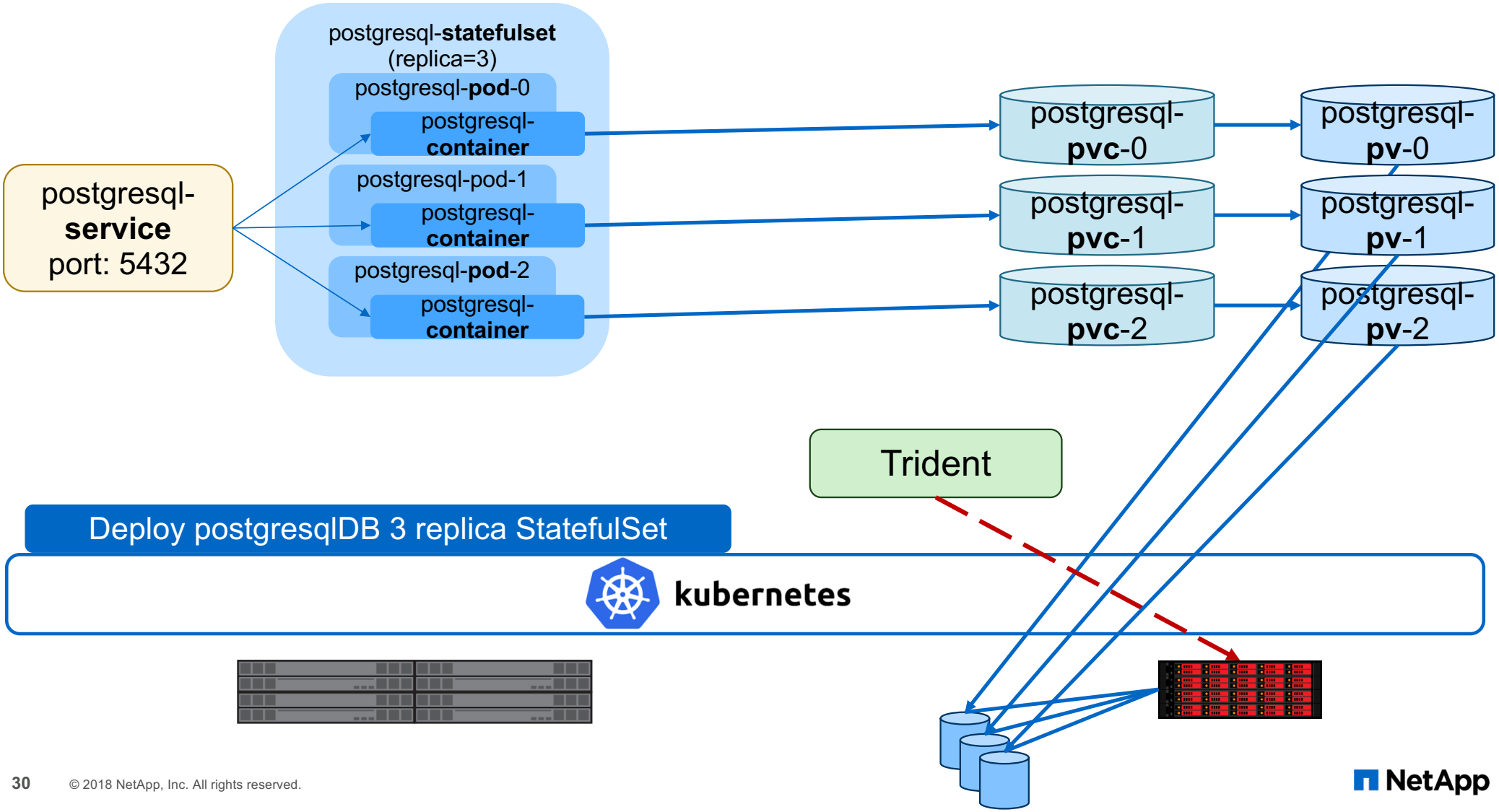

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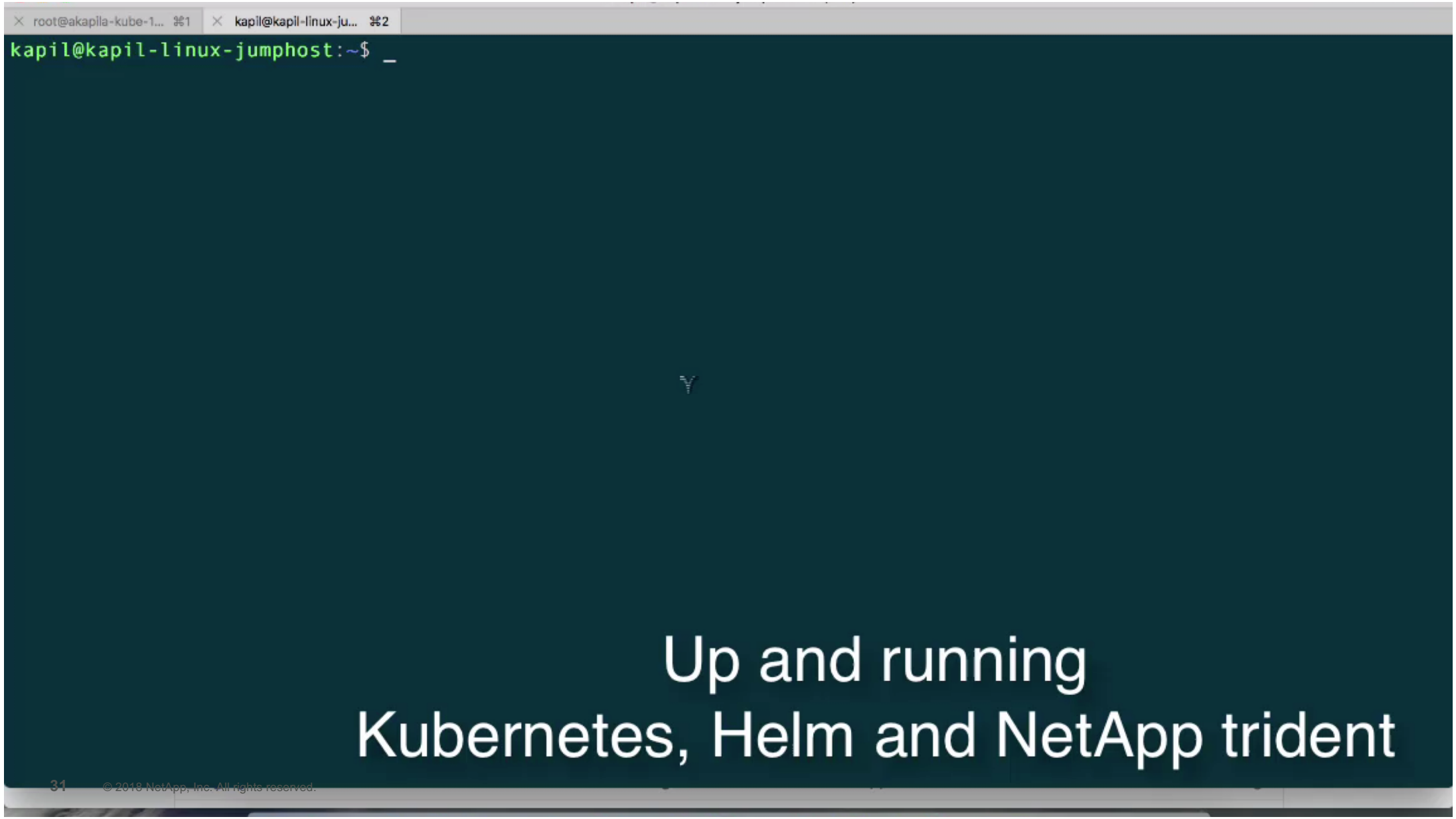

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Summary

- Stateful Apps run on Kubernetes
- PV, PVC and StorageClass
- Static vs Dynamic provisioning
- NetApp Trident
- CSI

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Resources

- Blog and Video
  - https://netapp.io/2018/03/21/deploy-postgresql-using-kubernetes-helm-trident/
- PostgreSQL sample Helm Chart
  - https://github.com/NetAppEMEA/kubernetes-netapp
- NetApp Trident
  - https://github.com/NetApp/trident

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NetApp website
nt-ap.com/2CneVeR

GitHub
github.com/NetApp/trident

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