



# Using NetApp Trident with Cloud Volumes ONTAP for Provisioning Kubernetes Persistent Volumes

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**Oded Berman**

Product Marketing

[Oded.Berman@netapp.com](mailto:Oded.Berman@netapp.com)

**Michael Shaul**

Enterprise Solutions Engineer

[MShaul@netapp.com](mailto:MShaul@netapp.com)



# House Keeping

Before we get started...

## Recording & Slides

- Yes! The session is being recorded
- A copy of the recording and slides will be sent to you and will be available on our web site

## Q & A

- Questions can be sent through the Go-To-Webinar questions section at any time
- We'll address them during or at the end of the session



# Agenda

- 1) Containers
- 2) Kubernetes
- 3) Persistent Volumes
- 4) NetApp Cloud Volumes ONTAP
- 5) NetApp Trident
- 6) Demo
- 7) Q & A



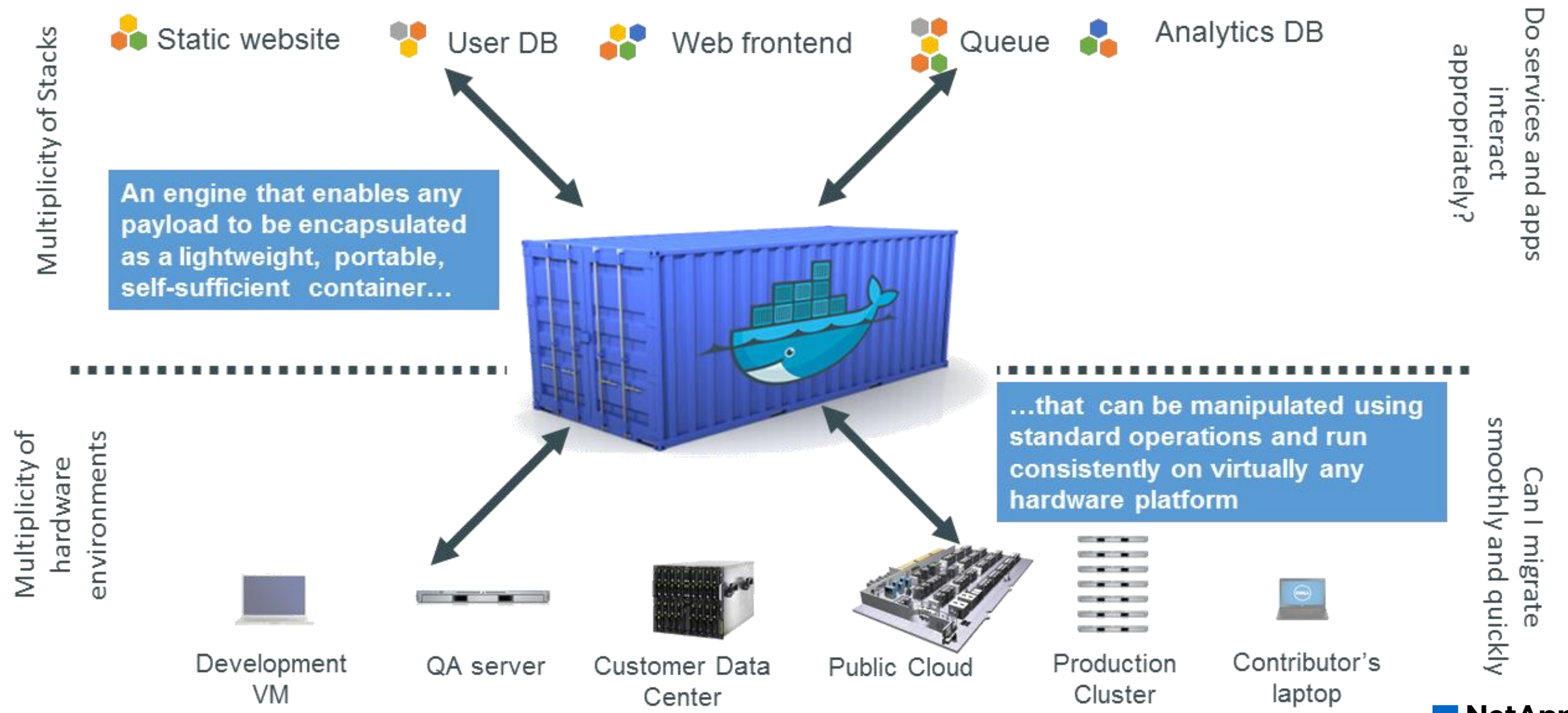
# Containers

Build, Ship and Run Any App Anywhere

# Intermodal Shipping Container



# Shipping Container for Code

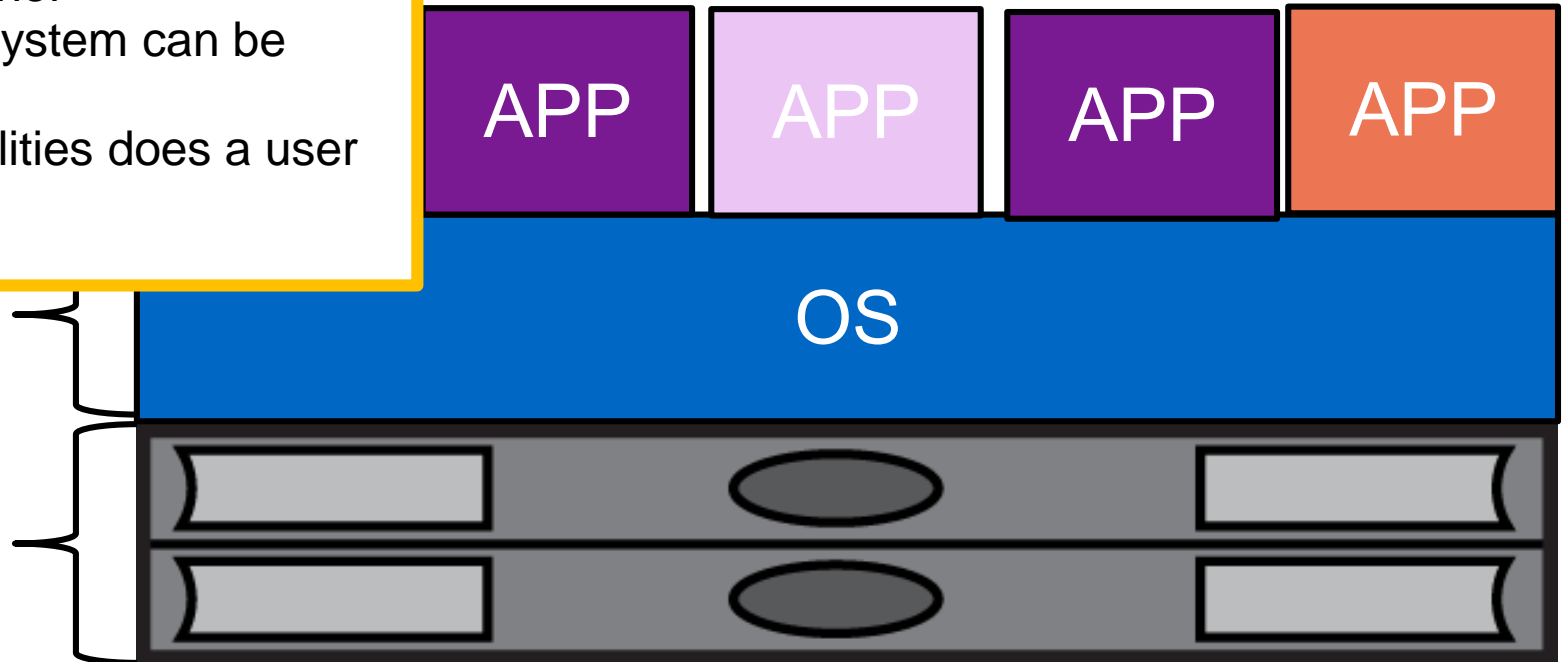


# Applications on Namespaces

- **Process namespace** - which application processes are allowed so see each other within a container
- **Network namespace** - what network interfaces can be accessed within a container
- **Mount namespace** - which filesystem can be accessed within a container
- **User namespace** - what capabilities does a user have within a container

Operating System

Physical Server





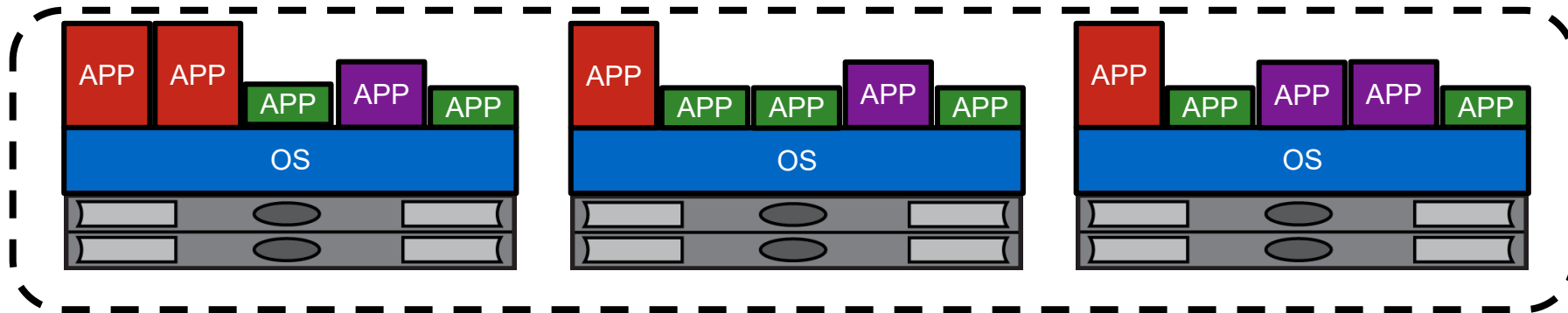
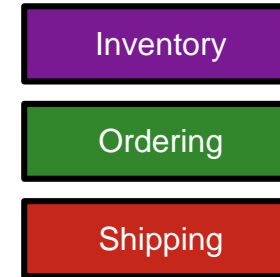
# Kubernetes

## Container Orchestration



# What is container orchestration?

- What do we need?
  - Platform that will run our services and will allow elastic scale out
  - That will handle resources allocation a distribution like CPU, memory, storage and network.
  - Keep services up and running and endure resource failures
  - Allow deployment of new versions without downtime
  - Provide global resource management of services



# Enter Kubernetes (K8s)



Source: <https://www.youtube.com/watch?v=Q4W8Z-D-gcQ>

# Containerized Stateful Applications

Companies are adopting the containerization strategy for all workloads

## The top 12 application components running in containers

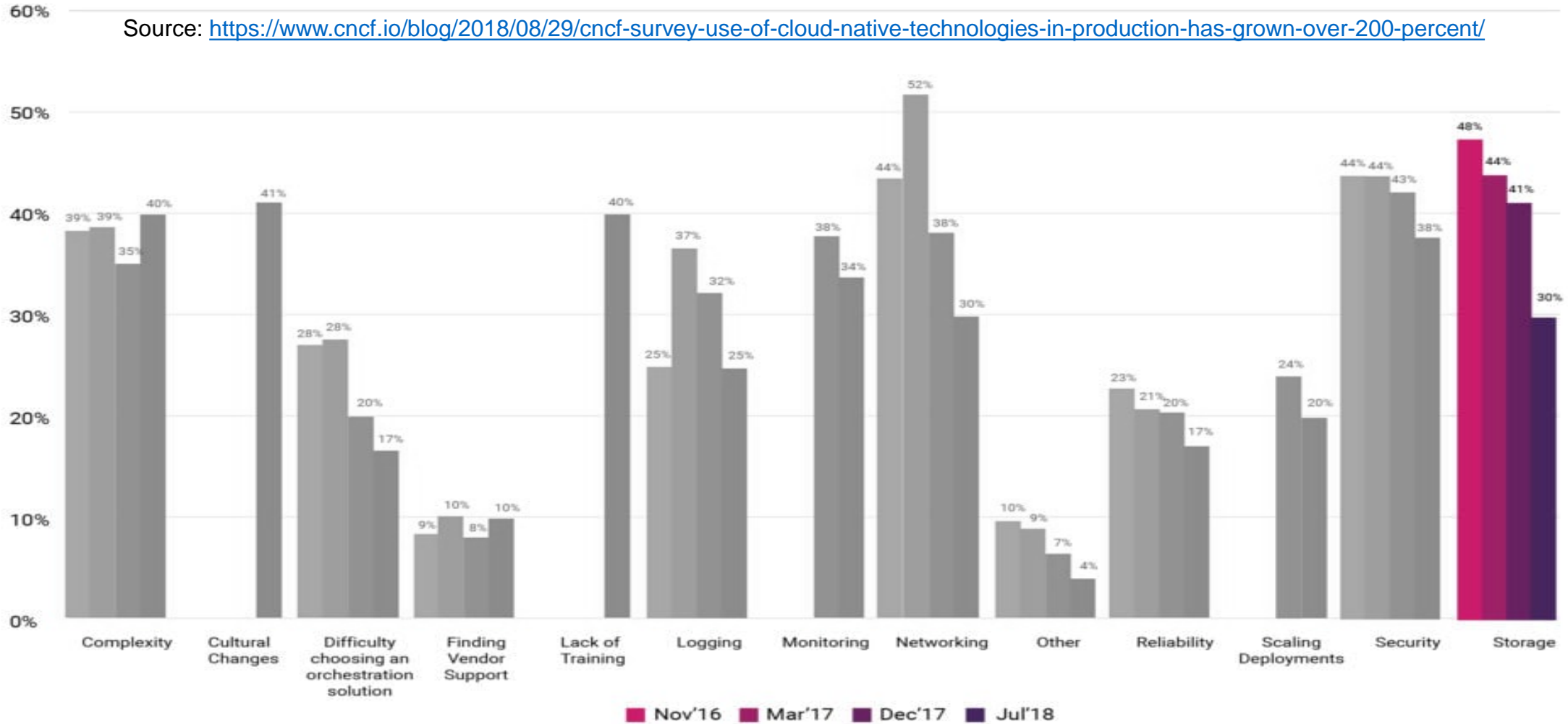
*Key Assessment: The old merges with the new*



Source: <https://sysdig.com/blog/2018-docker-usage-report/>

# Challenges with Containers

Storage for containers has been a challenge





# Persistent Volumes

Pod Independent Storage

# Persistent Volumes

- Storage which has been introduced to Kubernetes by an administrator
- Configured for backing storage device
  - NFS, iSCSI, Cinder, AWS EBS, GCE, Azure
- Abstracts the physical storage volume into an allocatable unit for applications
- Includes connection information for the storage volume

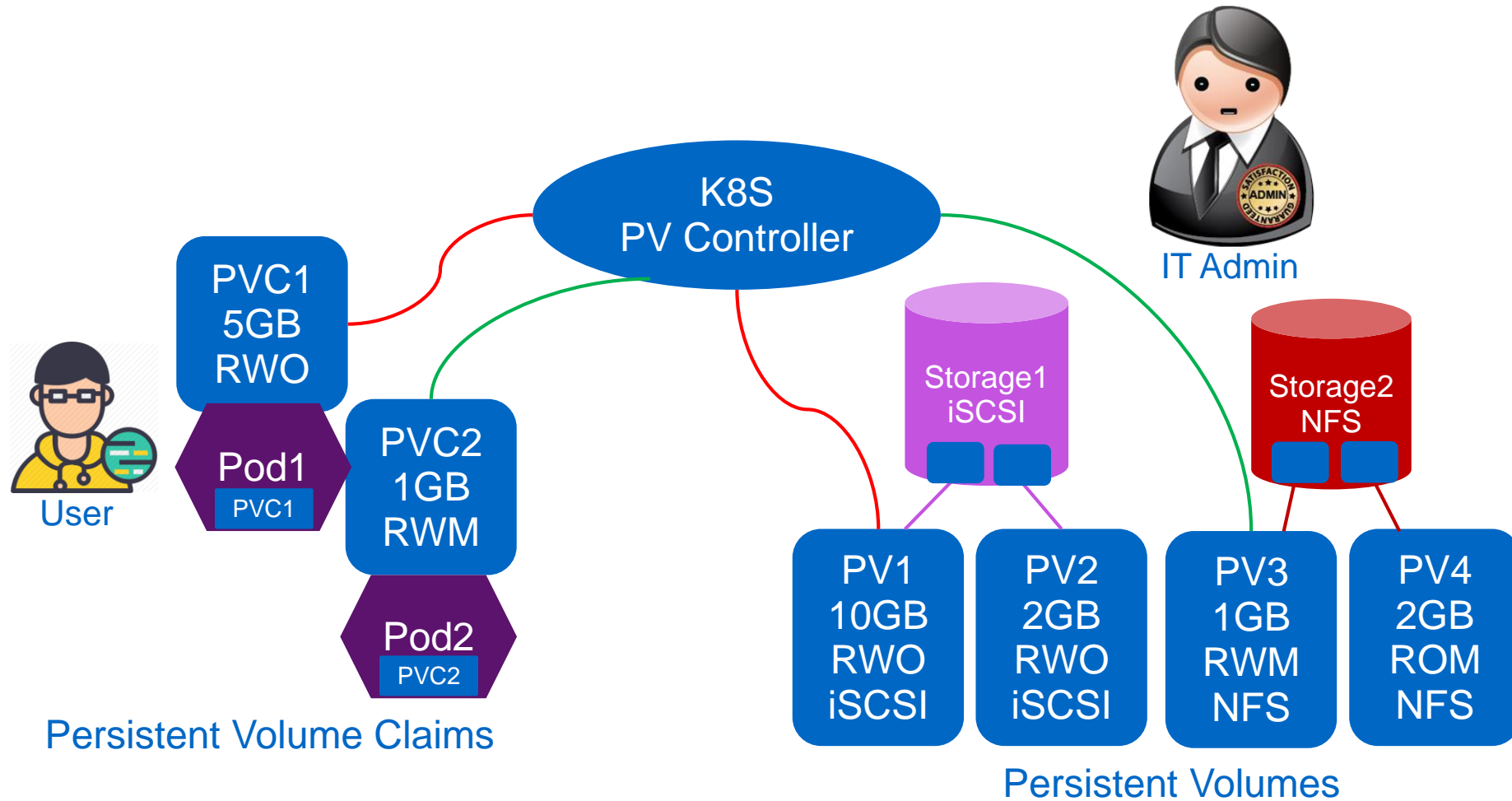
```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: pv0003
spec:
  capacity:
    storage: 5Gi
  accessModes:
    - ReadWriteMany
nfs:
  path: /tmp
  server: 172.17.0.2
```

# Persistent Volume Claims

- Created by a user to request storage
- Specifies desired capacity and access mode, along with labels to aid with selection
- Kubernetes assigns a PV to meet the requirements requested in the PVC
  - Does not require an exact match for capacity

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: thepub
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 5Gi
```

# Persistent Volume Framework





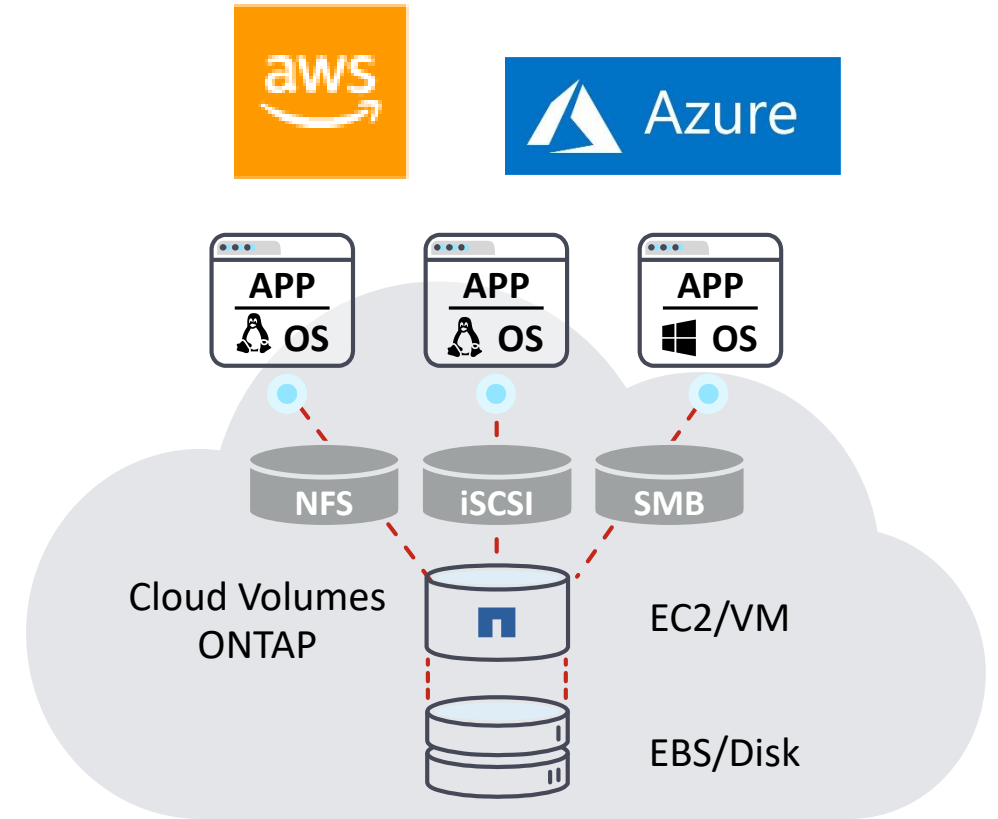


# NetApp Cloud Volumes ONTAP

A Great Fit for Kubernetes Persistent Volumes in the Cloud

# Cloud Volumes ONTAP® Overview

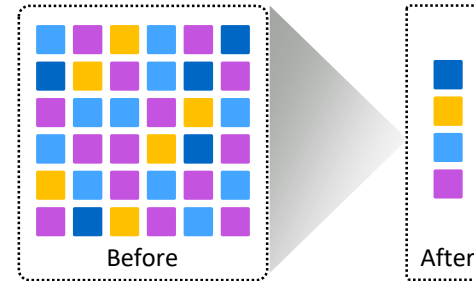
- A fully-fledged version of ONTAP running natively in the cloud
- Consumes native cloud storage
- Same ONTAP tools and processes
- Mature, proven technology
- Implemented with hundreds of customers
- Consumed by the hour (pay-go) or up front (BYOL)



# Storage Efficiencies

**Thin Provisioning** –  
grow as you go, and  
don't over allocate  
up front

**Deduplication** –



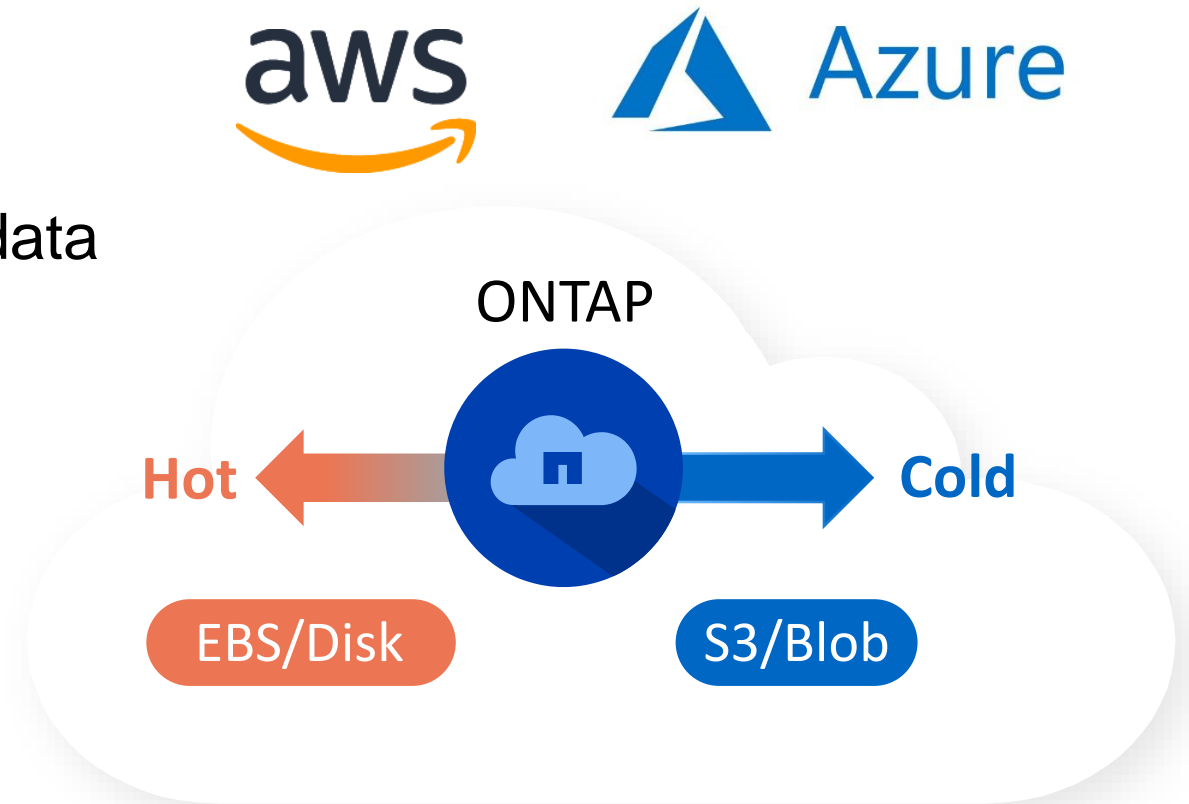
**Compression** –  
shrinking data to  
reduce overall capacity  
requirements

**Compaction** –  
fit more data into  
every 4KB blocks  
before it's written

# Data Tiering to Object Storage

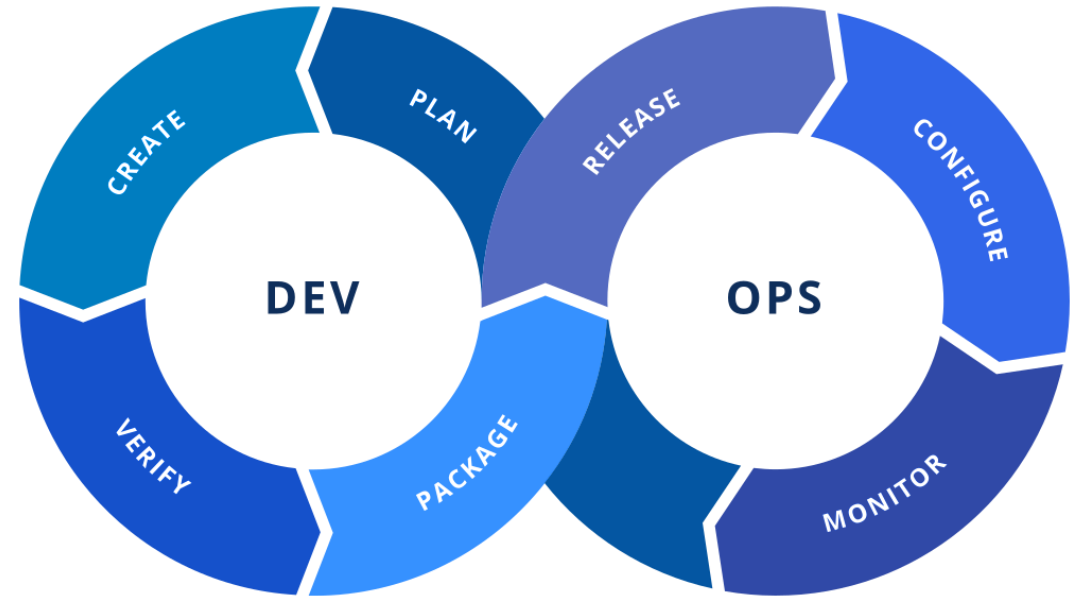
- Automated data tiering to low-cost object storage
- EBS/Disk - performance tier for “hot” data
- S3/Blob - capacity tier for “cold” data
- Reduce EBS/Disk footprint
- Suitable for data that is not accessed frequently

- ✓ **Huge cost saving!**
- ✓ **As low as 1¢ per GB per month**



# Data Cloning with FlexClone®

- Writeable copy
- Zero capacity penalty
- Created instantly
- No performance penalty
- Speed up DevOps and cut costs in automate testing processes
- Simplify DR testing



# Data Protection for your Critical Production Workloads



Snapshots for instant point-in-time recovery



SnapMirror® replication and sync technology



Disaster Recovery & Backup



High Availability

- Data loss prevention (RPO=0)
- Quick failover (RTO < 60 secs)

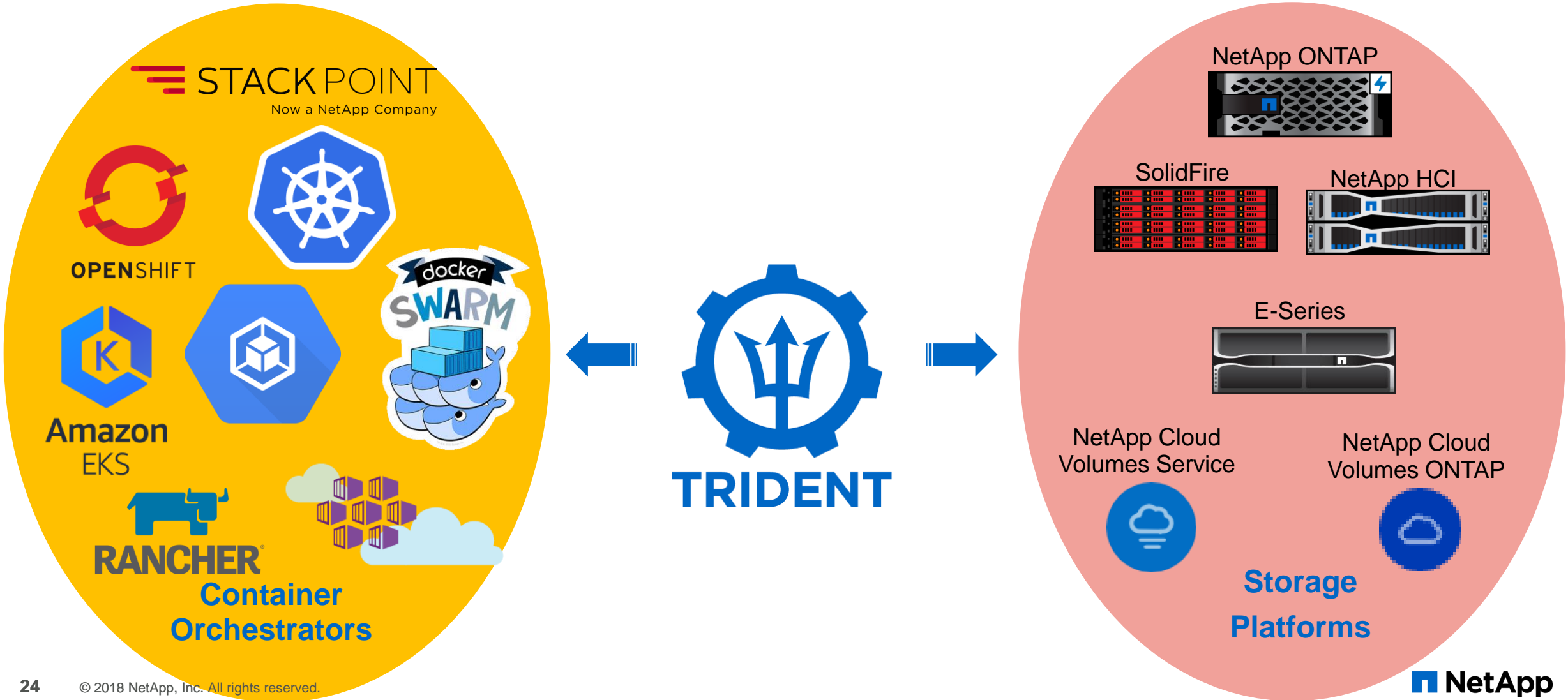


# NetApp Trident

NetApp's Dynamic Persistent Volume Provisioner for Kubernetes.

# Trident

NetApp's storage orchestrator for containerized workloads





# Trident Overview

NetApp's storage orchestrator for containerized workloads

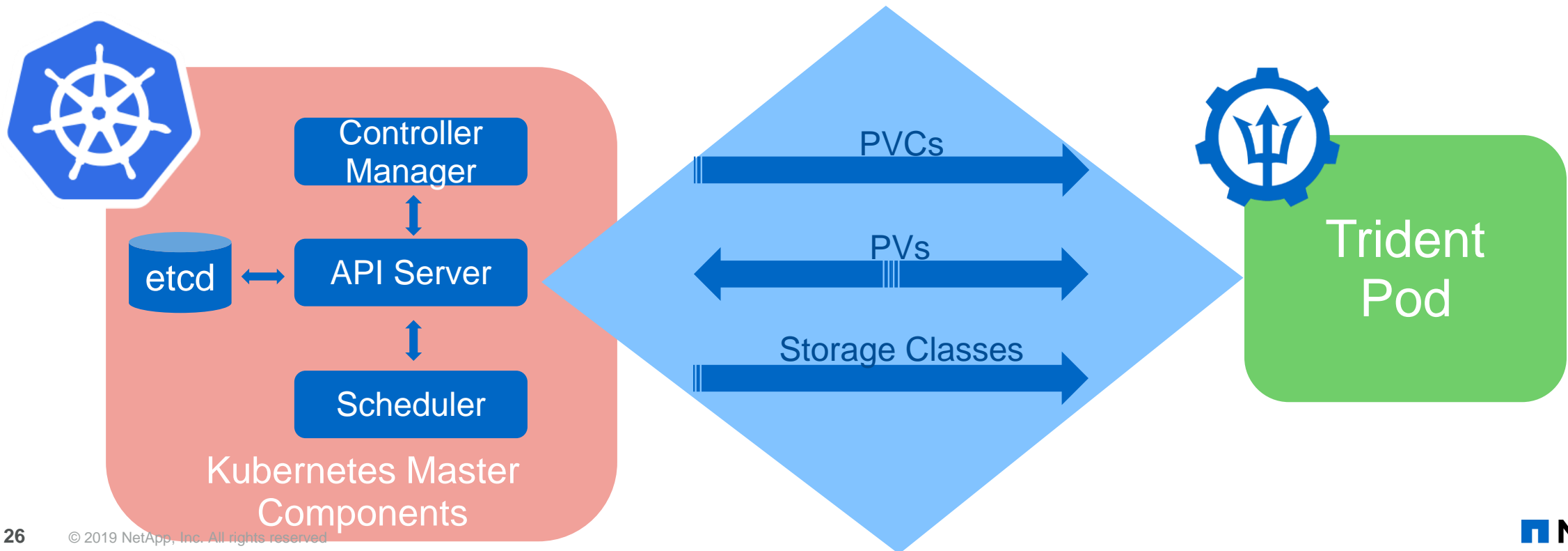
- Released as an open source project in December 2016
  - <https://github.com/NetApp/trident/>
  - Quarterly released and officially supported by NetApp
- Started as an external provisioner for Kubernetes and OpenShift
- Since v18.01, Trident works as a Docker Volume Plugin
- Since v18.07, Trident works as a Container Storage Interface (CSI) Plugin
- Supports a broad set of platforms and services across the NetApp portfolio
- Supports all major container orchestrators



# Trident as a Kubernetes Storage Orchestrator

NetApp's storage orchestrator for Kubernetes, Kubernetes distributions, and hosted Kubernetes services

- Known as “Trident for Kubernetes”
- An external controller that makes provisioning, deprovisioning, and resizing volumes self-service



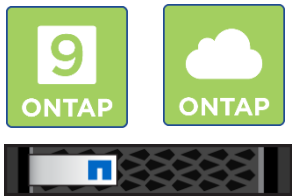
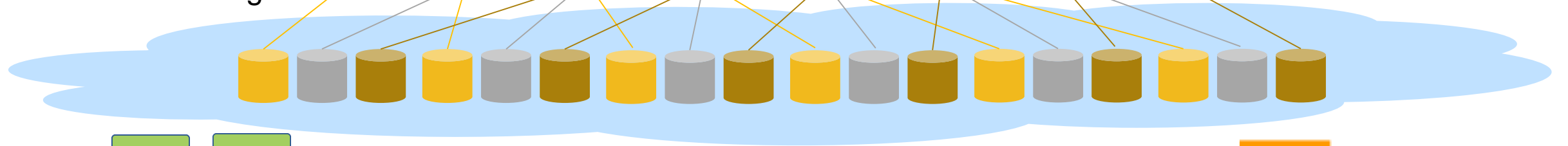
# Orchestration across Heterogeneous Backends

Mapping Kubernetes storage classes to Trident storage pools

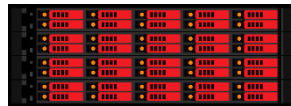
## Kubernetes Storage Classes



## Trident Storage Pools



ONTAP



Element OS



SANtricity



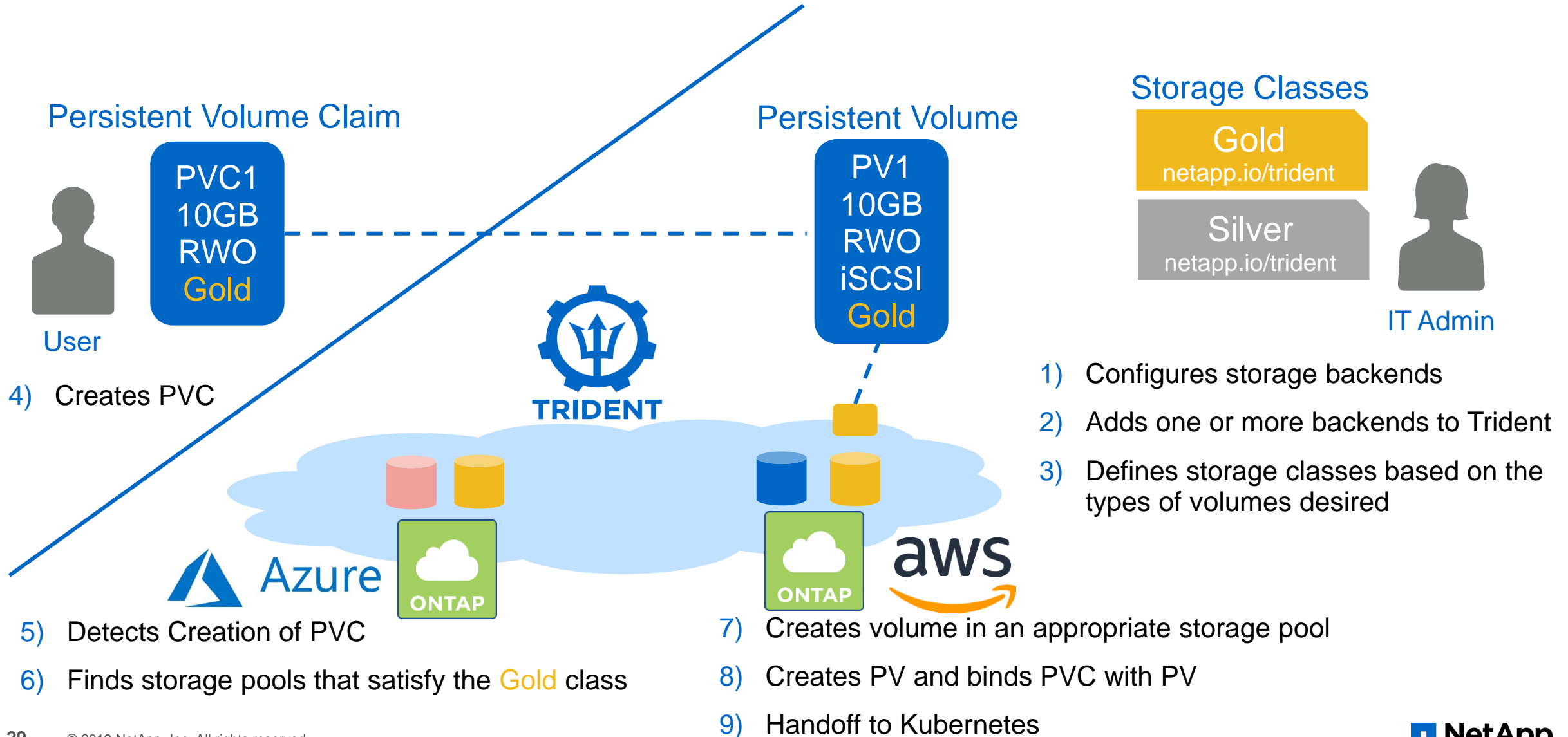
Cloud Volumes

# Storage Classes

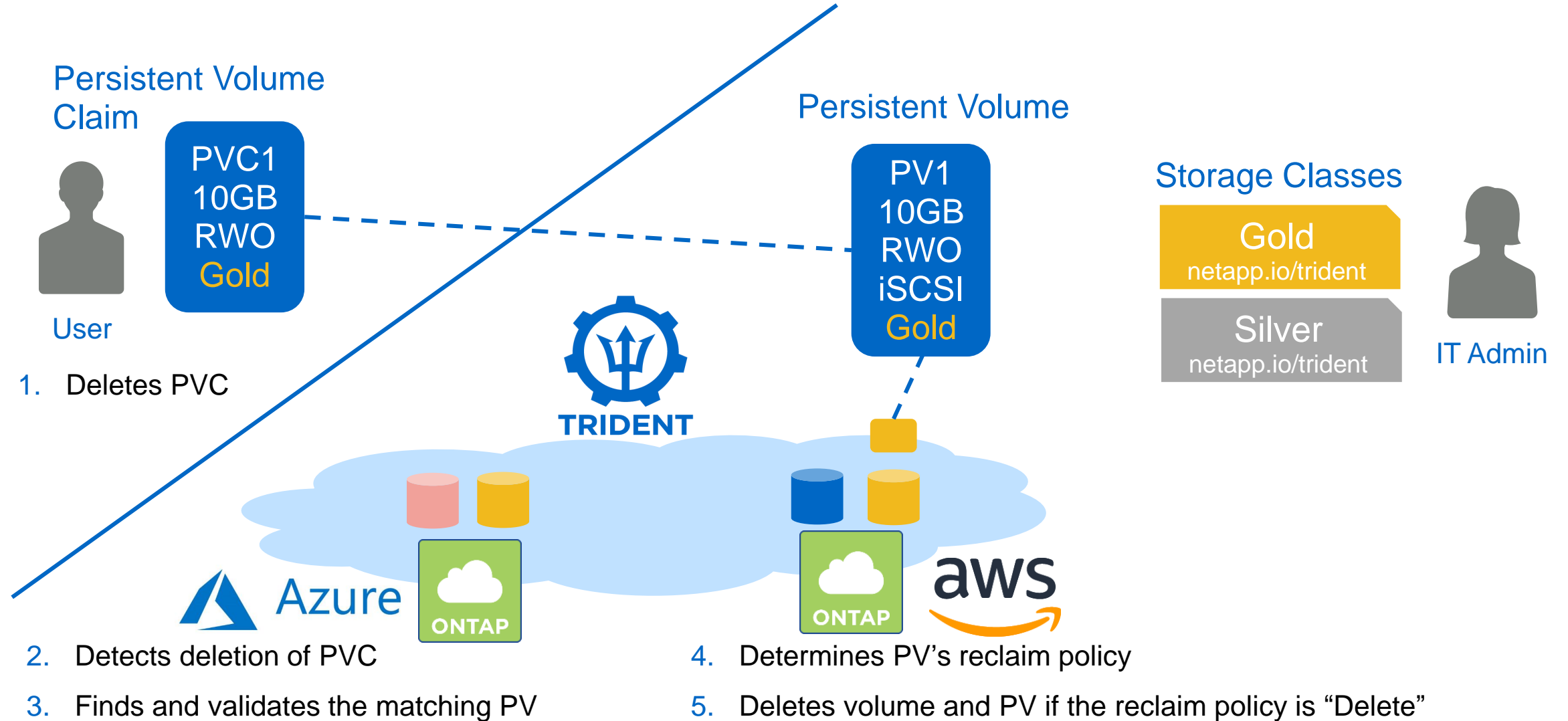
- Describes a storage offering and associates a provisioner
- Parameters are used to provide additional information to the provisioner
- Parameters are opaque to Kubernetes
- Storage classes can be used by statically provisioned PVs
- Used by PVCs to inform Kubernetes that the PV should belong

```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: bronze
provisioner: netapp.io/trident
parameters:
  backendType: "ontap-nas"
  mediaType: "hdd"
```

# Storage Provisioning Workflow in Kubernetes



# Storage Deprovisioning Workflow



# PVC - Persistent Volume Claim Clones

- In this case, we've simply extended the **PersistentVolumeClaim** object with a custom annotation named `trident.netapp.io/cloneFromPVC` that you use like this:

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: prod-clone
  annotations:
    trident.netapp.io/cloneFromPVC: prod
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: gold
```



# Demo



### Working Environments

+ Add Working Environment

Visual View Tabular View

### 2 Working Environments

2 Cloud Volumes ONTAP  
< 0.01 TB Allocated Capacity

**AWS** WebinarCVO2  
US-EAST-2B  
< 0.01 TB  
Allocated Capacity

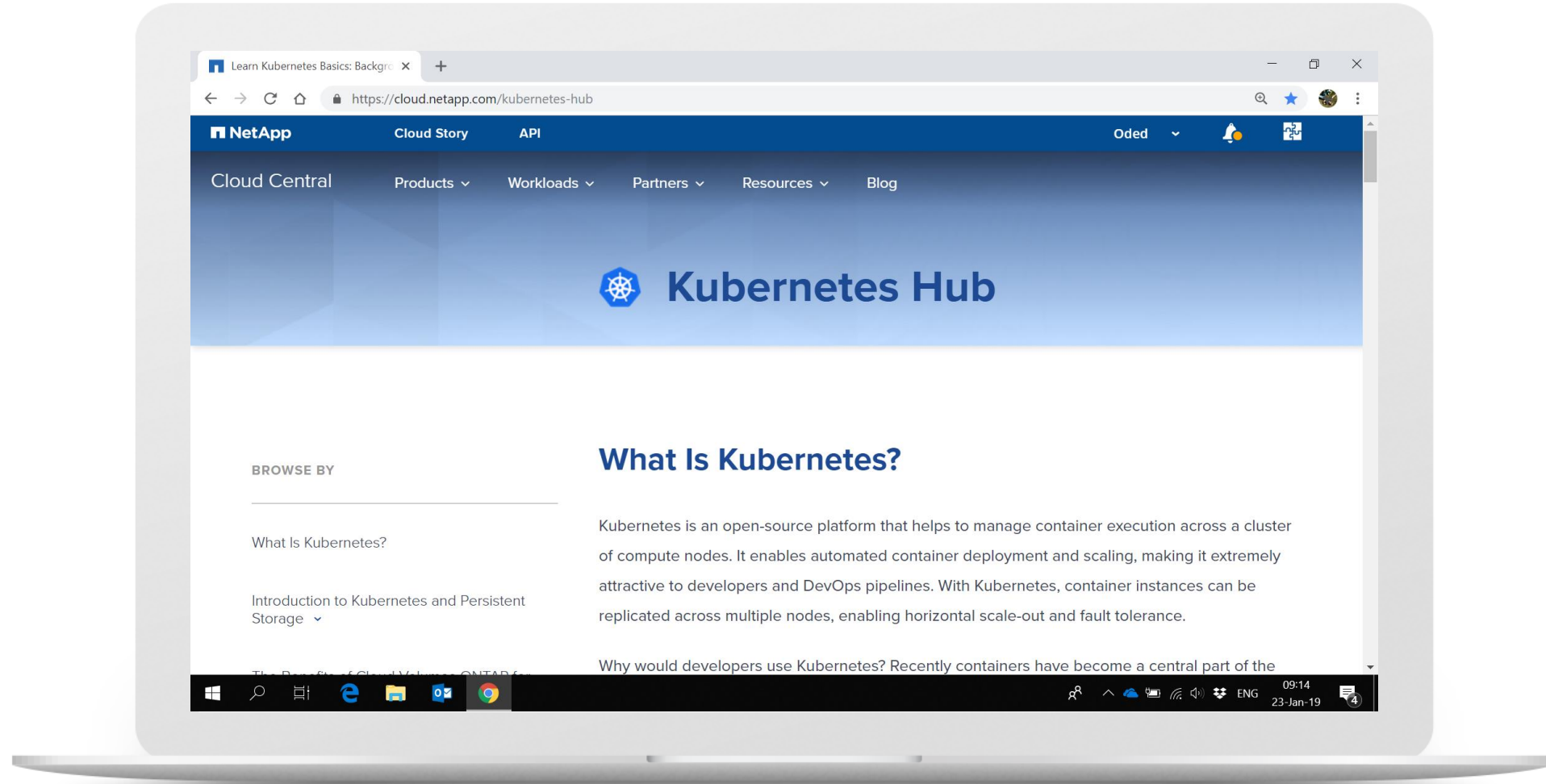
**AWS** WebinarCVO  
US-EAST-2B  
< 0.01 TB  
Allocated Capacity



# Key Takeaways

- Kubernetes is today's most widely-used platform for containers and microservices orchestration
- Managing storage in a Kubernetes cluster with a dynamic storage provisioner massively reduces the manual administration required for allocating cloud storage to pods and containers
- Using NetApp Trident, Kubernetes storage requests are dynamically fulfilled by Cloud Volumes ONTAP
- Cloud Volumes ONTAP is a powerful, cost-effective data management solution for your cloud workloads

# Visit Our [Kubernetes Hub](https://cloud.netapp.com/kubernetes-hub) on Cloud Central



<https://cloud.netapp.com/kubernetes-hub>

# TRY Cloud Volumes ONTAP NOW



## Start a 30-days free trial

- Cloud Central
- AWS/Azure Marketplace



## Set up an environment in less than an hour

- Launch NetApp Cloud Manager
- Create a new Cloud Volumes ONTAP instance
- Deploy NetApp Trident on Kubernetes cluster
- Start provisioning persistent volumes



## Support

- E-mail to: [ng-cloud-manager-architects@netapp.com](mailto:ng-cloud-manager-architects@netapp.com)



# Q & A



Thank You