Kubernetes on Azure 201 Workshop

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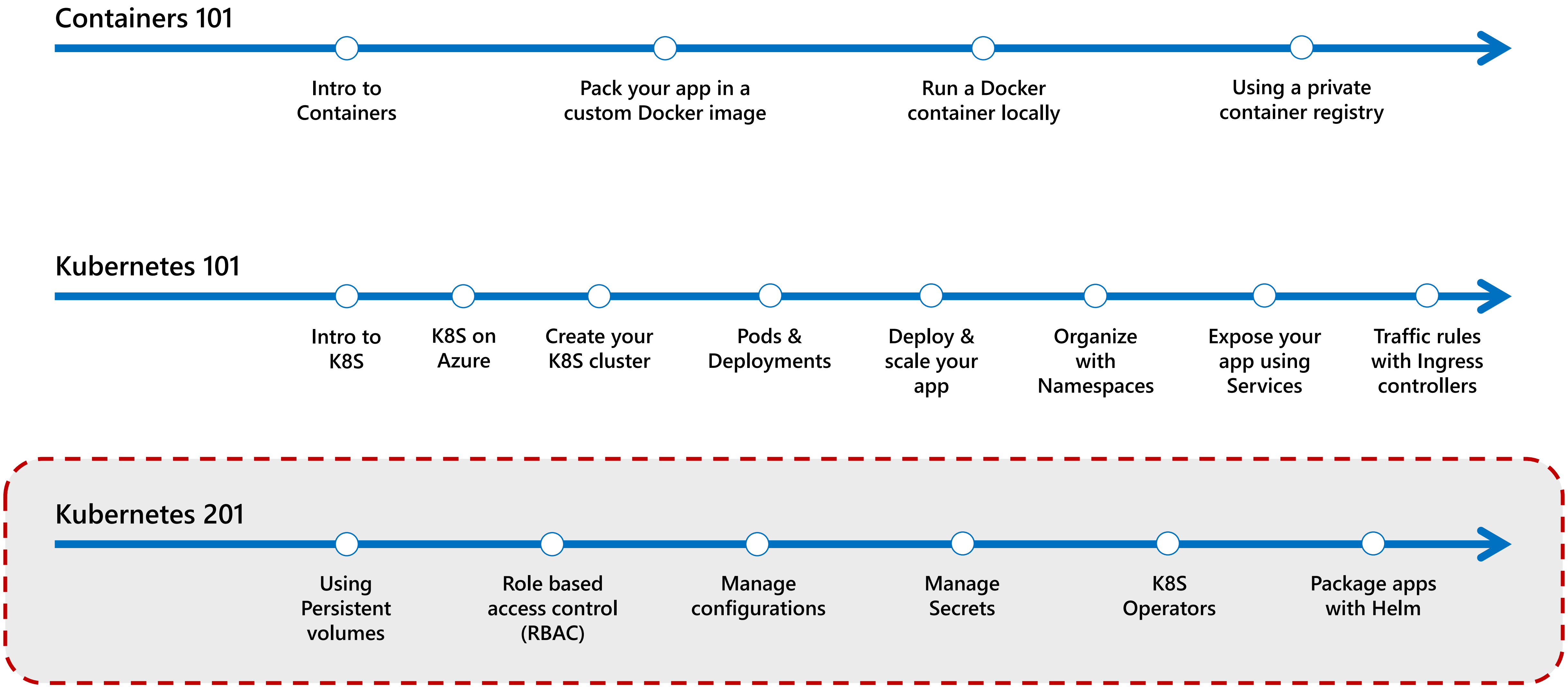
Containers & Kubernetes workshops



Containers 101

- Intro to Containers
- Pack your app in a custom Docker image
- Run a Docker container locally
- Using a private container registry

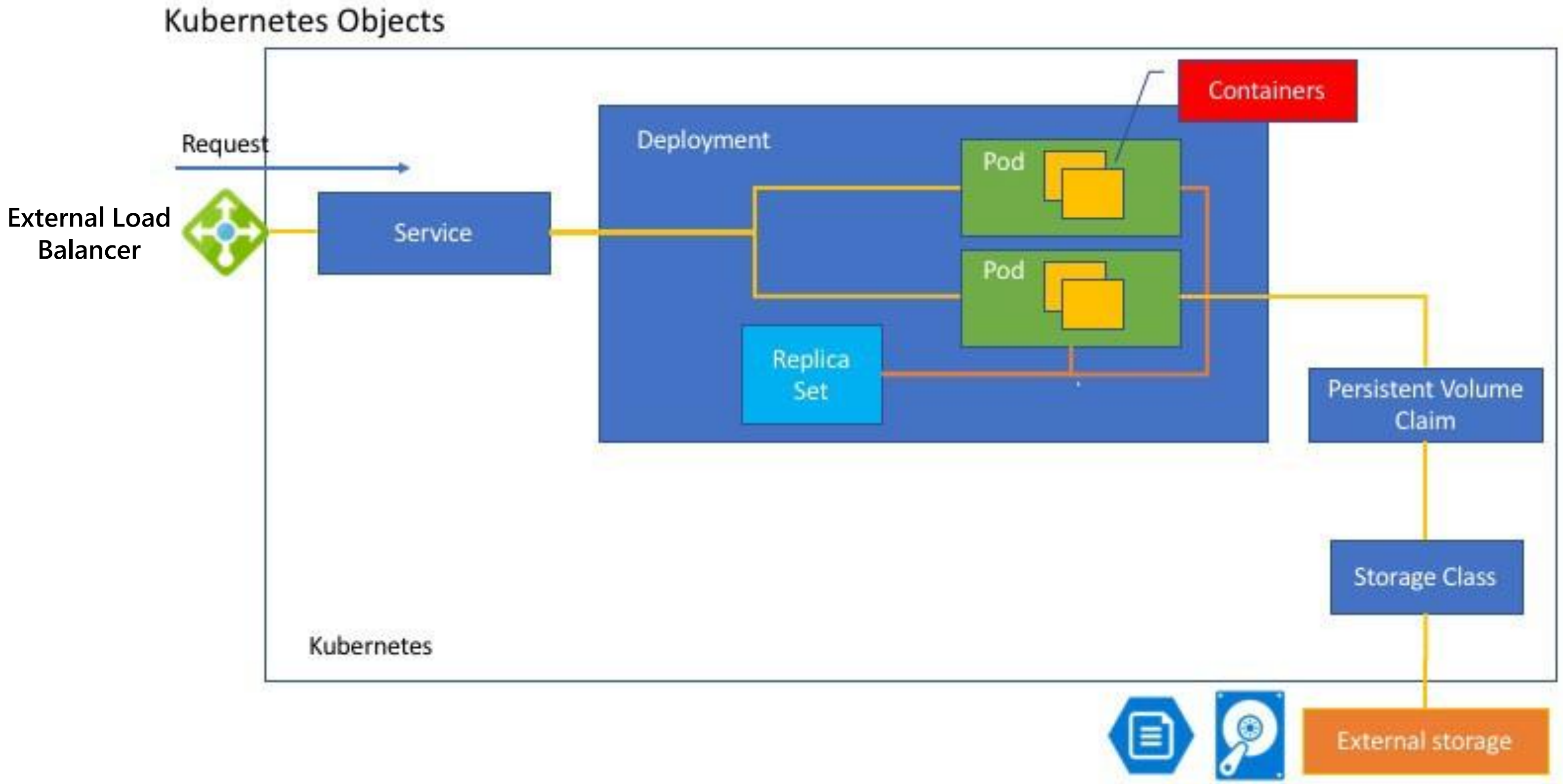
Kubernetes 101

- Intro to K8S
- K8S on Azure
- Create your K8S cluster
- Pods & Deployments
- Deploy & scale your app
- Organize with Namespaces
- Expose your app using Services
- Traffic rules with Ingress controllers

Kubernetes 201

- Using Persistent volumes
- Role based access control (RBAC)
- Manage configurations
- Manage Secrets
- K8S Operators
- Package apps with Helm

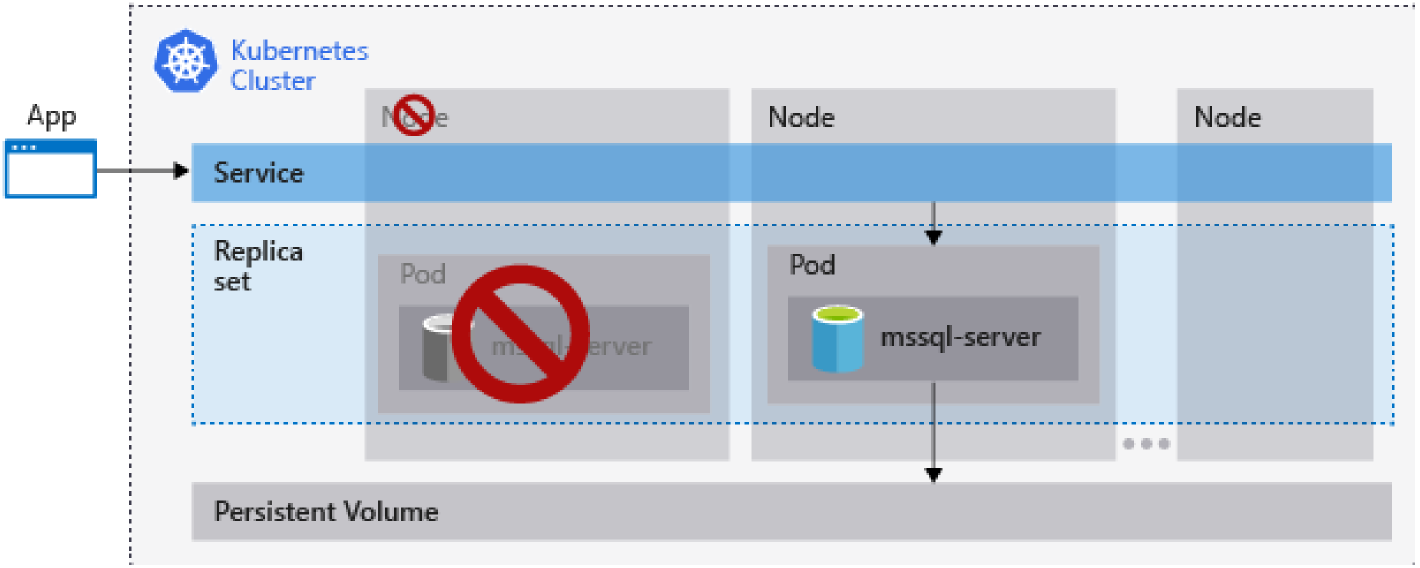
Kubernetes 101 recap



Using
Persistent volumes

Storage and persistence

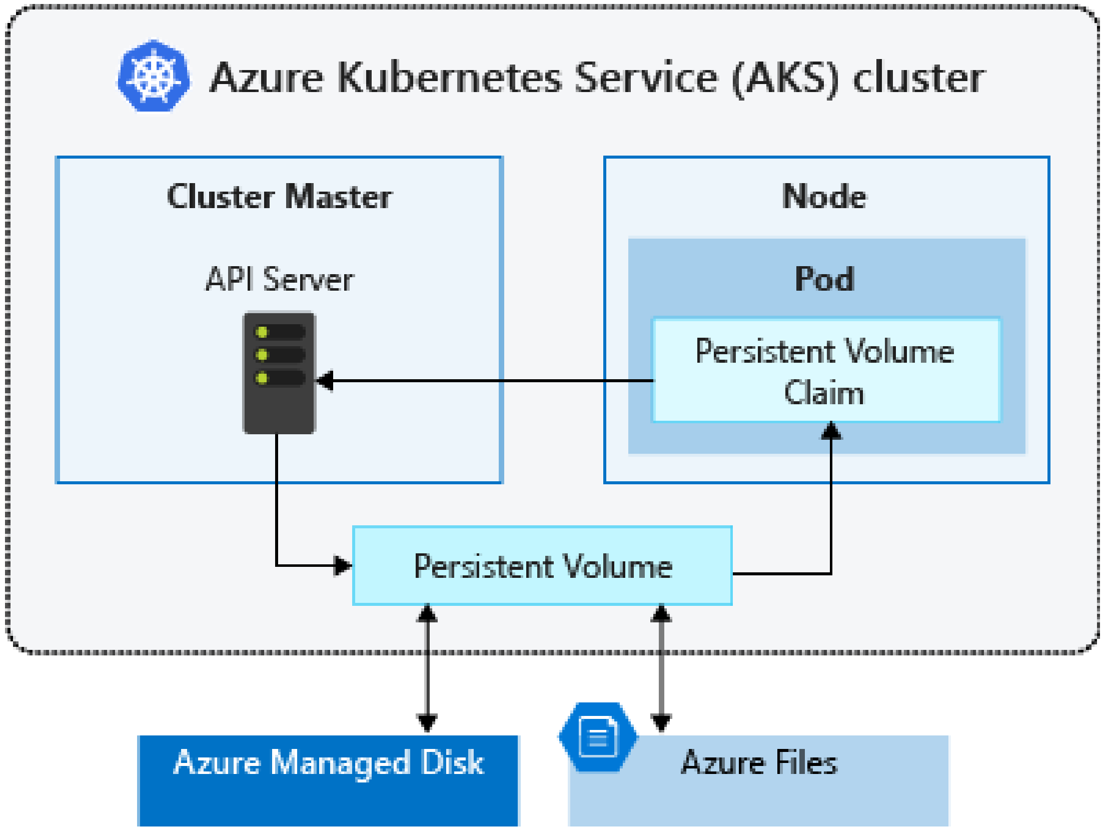
- Containers are volatile.
- In some cases, persistent storage is a need for sharing data between containers or to guarantee high availability where data must resist to container failures



Storage and persistence on AKS

- A PersistentVolume can be **statically** created by a cluster administrator.

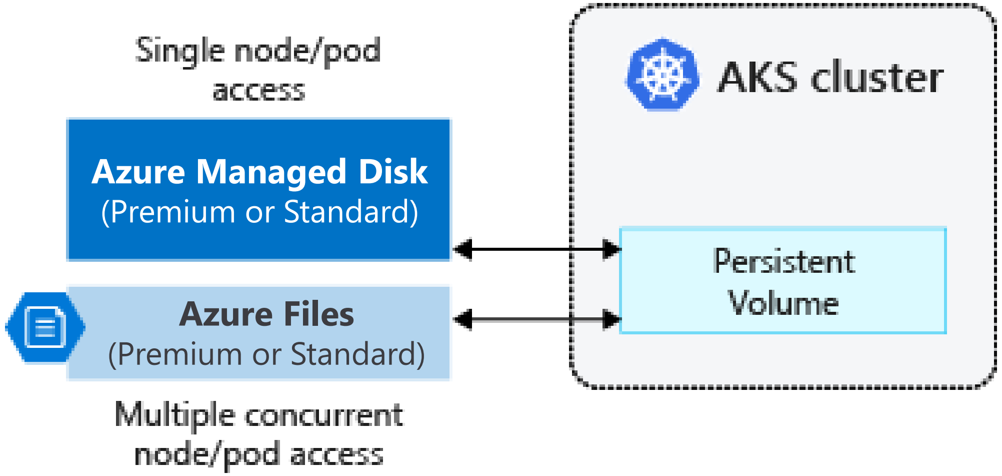
- Or **dynamically** created by the Kubernetes API server. If a pod is scheduled and requests storage that is not currently available, Kubernetes can create the underlying Azure Disk or Files storage and attach it to the pod. Dynamic provisioning uses a StorageClass to identify what type of Azure storage needs to be created.



Storage classes

- A storage class is used to define how a unit of storage is dynamically created with a persistent volume

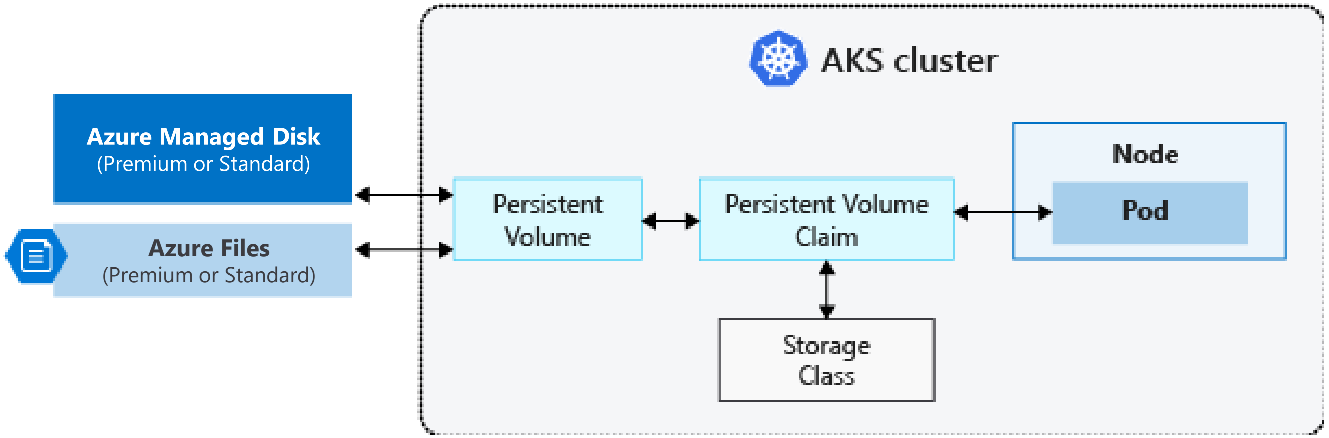
- Each AKS cluster includes 4 pre-created storage classes, both configured to work with Azure disks and files: Standard and Premium



```
kind: StorageClass
apiVersion: storage.k8s.io/v1beta1
metadata:
     name: azure-disk-standard
provisioner: kubernetes.io/azure-disk
parameters:
  storageaccounttype: Standard_LRS
  kind: Managed
```

Storage – Persistent volumes

- A persistent volume claim (PVC) is used to automatically provision storage based on a storage class



```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: my-data-pv-claim
  annotations:
    volume.beta.kubernetes.io/storage-class: default
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 2Gi
```

Storage – Using persistent volumes

- Using a persistent volume claim (PVC) in a Pod and mounting it in a mount point

```
kind: Pod
apiVersion: v1
metadata:
  name: task-pv-pod
spec:
  volumes:
    - name: task-pv-storage
      persistentVolumeClaim:
       claimName: my-data-pv-claim
  containers:
    - name: task-pv-container
      image: nginx
      ports:
        - containerPort: 80
          name: "http-server"
      volumeMounts:
        - mountPath: "/usr/share/nginx/html"
          name: task-pv-storage
```

Lab 1: Dynamic Persistent Volumes

Create and use new persistent volume

Task	With Azure

Check storage classes	`kubectl get storageclasses`
	`# create new storage class if needed`
	`kubectl create -f sample-storageclass.yaml`

Create persistent volume	`kubectl create -f sample-pvc.yaml`
	`# get persistent volumes`
	`kubectl get pv`
	`kubectl describe pv`

Use persistent volume	`kubectl apply -f test-persistent-volumes.yaml`
	`# get pods using persistent volume`
	`kubectl get pod task-pv-pod`
	`# access persistent volume (write something, destroy the pod and repeat the test again)`
	`kubectl exec -it task-pv-pod -- /bin/bash`

Static storage volumes not managed by AKS

- A PersistentVolume can be **statically** created by a cluster administrator.
- Create the Azure Disk or Azure File Share and collect the resource URI
- Configure it in a Pod

```
apiVersion: v1
kind: Pod
metadata:
  name: mypod-disk-tst
spec:
  containers:
  - image: nginx:1.15.5
    name: mypod
    volumeMounts:
      - name: azure
        mountPath: /mnt/azure
  volumes:
      - name: azure
        azureDisk:
          kind: Managed
          diskName: mydisk01
          diskURI: /subscriptions/2dd567af-d55f-4c2c-ba14-
4bd7699a59b3/resourceGroups/k8s-
volumes/providers/Microsoft.Compute/disks/mydisk01
```

Lab 2: Static Volumes

Use existing static volumes not managed by AKS

Task	With Azure

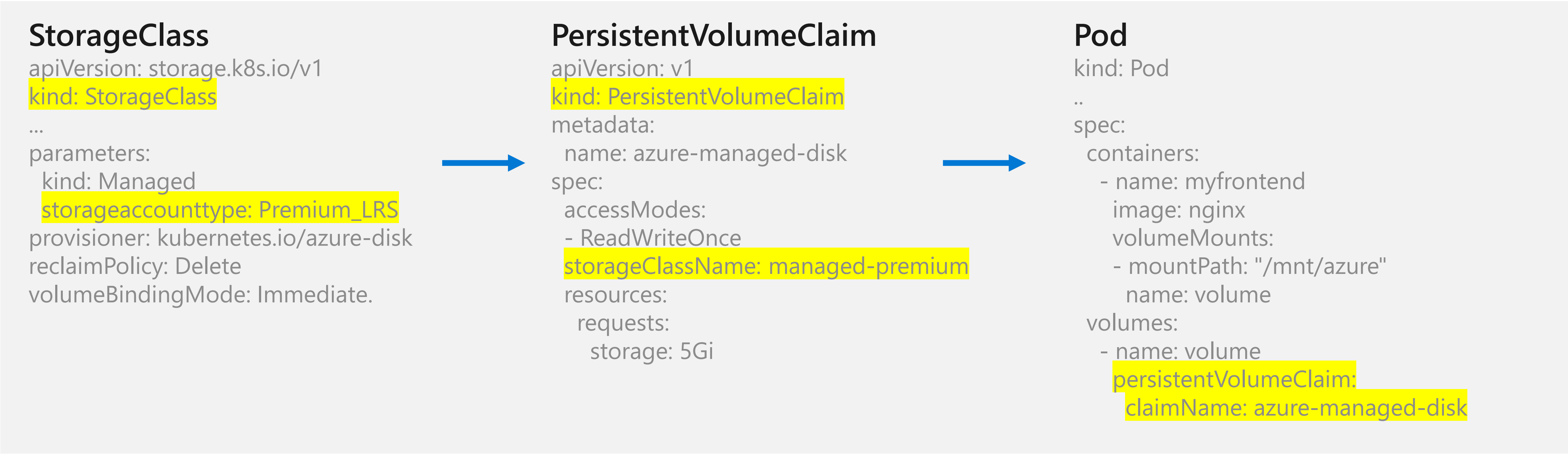
Create Azure Disk or Azure File Share and collect the Id	`# Sample Azure Disk Id`
	`/subscriptions/2dd567af-d55f-4c2c-ba14-4bd7699a59b3/resourceGroups/k8s-volumes/providers/Microsoft.Compute/disks/mydisk01`

Deploy Pod using the created disk	`kubectl apply -f azure-disk-pod.yaml`

Test and use the persistent volume inside the Pod	`# access persistent volume (write something, destroy the pod and repeat the test again)`
	`kubectl exec -it mypod-disk-tst -- /bin/bash`

Dynamic Provisioning

- Use Dynamic Provisioning whenever possible



StorageClass

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
...
parameters:
  kind: Managed
  storageaccounttype: Premium_LRS
provisioner: kubernetes.io/azure-disk
reclaimPolicy: Delete
volumeBindingMode: Immediate.
```

PersistentVolumeClaim

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: azure-managed-disk
spec:
  accessModes:
  - ReadWriteOnce
  storageClassName: managed-premium
  resources:
    requests:
      storage: 5Gi
```

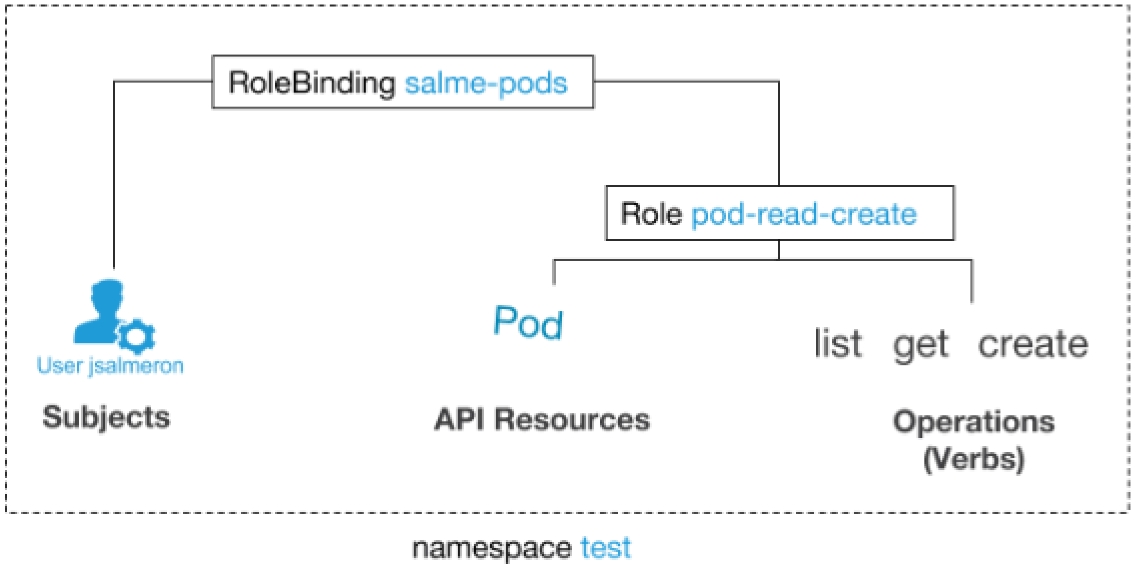
Pod

```
kind: Pod
..
spec:
  containers:
    - name: myfrontend
      image: nginx
      volumeMounts:
      - mountPath: "/mnt/azure"
        name: volume
  volumes:
    - name: volume
      persistentVolumeClaim:
        claimName: azure-managed-disk
```

Role based access control (RBAC)

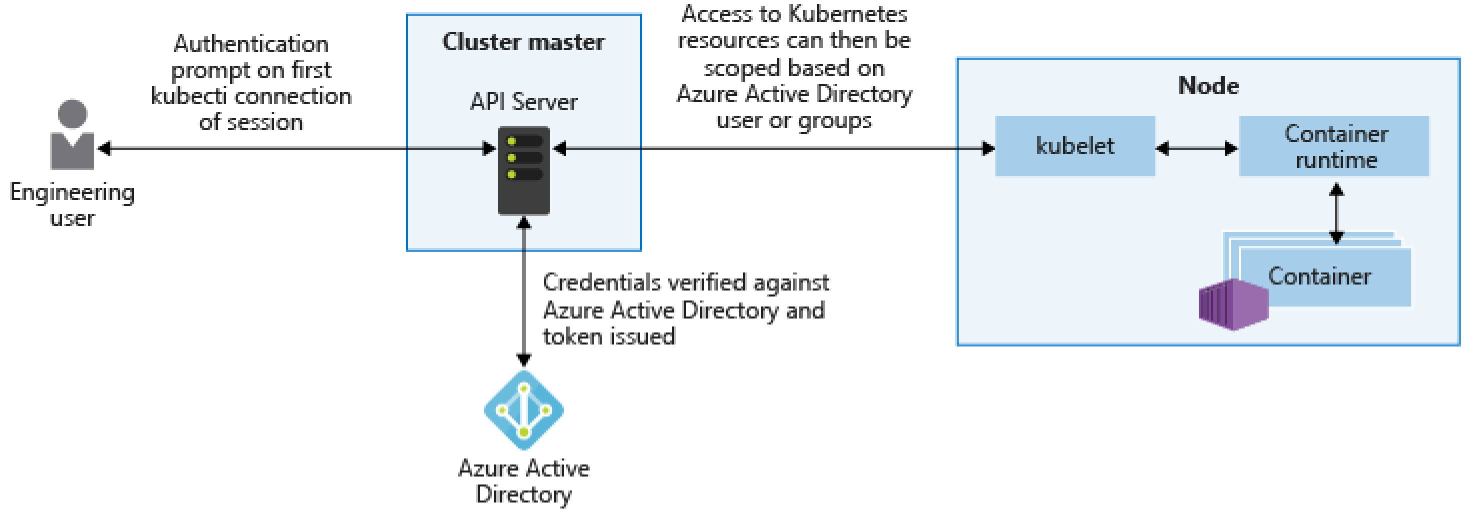
Role based access control (RBAC)

- Role grants permissions to Kubernetes objects, typically in a namespaces
- RoleBinding can be assigned to users or groups



AKS RBAC with Azure Active Directory

- AKS uses Azure Active Directory as an Identity Services for users and groups


Authentication prompt on first kubecti connection of session
Engineering user
Cluster master
API Server
Access to Kubernetes resources can then be scoped based on Azure Active Directory user or groups
Node
kubelet
Container runtime
Container
Credentials verified against Azure Active Directory and token issued
Azure Active Directory

RBAC Role

- Roles grants permissions to Kubernetes objects, typically namespaces

```
kind: Role
apiVersion: rbac.authorization.k8s.io/v1beta1
metadata:
  name: dev-user-full-access
  namespace: dev
rules:
- apiGroups: ["", "extensions", "apps"]
  resources: ["*"]
  verbs: ["*"]
- apiGroups: ["batch"]
  resources:
  - jobs
  - cronjobs
  verbs: ["*"]
```

RBAC RoleBinding

- RoleBinding can be assigned to users or groups and optionally to namespaces

```
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1beta1
metadata:
  name: dev-user-access
  namespace: dev
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: dev-user-full-access
subjects:
- kind: Group
  namespace: dev
  name: groupObjectId
```

RBAC ClusterRoleBinding

- The are cluster roles that can be assigned to users and grouos

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: contoso-cluster-admins
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: cluster-admin
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: User
  name: "user@contoso.com"
```

Lab 3a: RBAC

Protect namespaces with RBAC

Task | **With Azure**

Create AKS with RBAC support

```
# This assumes that you have an AKS created with RBAC support
https://docs.microsoft.com/en-us/azure/aks/azure-ad-integration-cli

# Get resource ID of the AKS in the Azure Active Direcotry
AKS_ID=$(az aks show --resource-group myResourceGroup --name myAKSCluster --query id -o tsv)
```

Create users and groups in Azure Active Directory

```
# Create group for Application developers: appdev group.
APPDEV_ID=$(az ad group create --display-name appdev --mail-nickname appdev --query objectId -o tsv)

# Assign it as a user of the AKS
az role assignment create --assignee $APPDEV_ID --role "Azure Kubernetes Service Cluster User Role" \
  --scope $AKS_ID

# Create and Application developer user named aksdev that is part of the appdev group.
AKSDEV_ID=$(az ad user create --display-name "AKS Dev" --user-principal-name aksdev@contoso.com \
  --password P@ssw0rd1 --query objectId -o tsv)

# Assign it as a member of the appdev group
az ad group member add --group appdev --member-id $AKSDEV_ID
```

Lab 3b: RBAC

Protect namespaces with RBAC

Task	With Azure
Get admin credentials for AKs	`az aks get-credentials --resource-group myResourceGroup --name myAKSCluster –admin`
Create a new namespace	`kubectl create namespace dev`
Create a role for namespace dev	`kubectl apply -f role-dev-namespace.yaml`
Get the resource ID for the appdev group in the Azure Active Directory	`az ad group show --group appdev --query objectId -o tsv`

Create a RoleBinding for the appdev group and the previously created Role	`# On the last line of file rolebinding-dev-namespace.yaml, replace groupObjectId with the group object ID output from the previous command`
	`kubectl apply -f rolebinding-dev-namespace.yaml`

Test it with a user	`az aks get-credentials --resource-group myResourceGroup --name myAKSCluster --overwrite-existing`

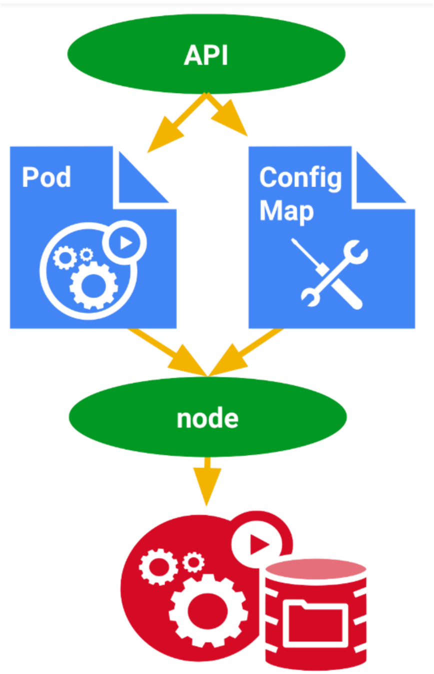
Manage configurations

ConfigMaps

- ConfigMaps are useful for storing and sharing non-sensitive, unencrypted configuration information.

- ConfigMaps bind configuration files, command-line arguments, environment variables, port numbers, and other configuration artifacts to your Pods' containers and system components at runtime

- Allow you to separate your configurations from your Pods and components, preventing hardcoding configuration data to Pod specifications



```yaml
apiVersion: v1
kind: ConfigMap
metadata:
  name: my-special-config
  namespace: default
data:
  log_level: INFO
  special.type: xpto
```

ConfigMaps data usage

- ConfigMaps data can be consumed in pods in a variety of ways
- Populate the values of environment variables
- Set command-line arguments in a container
- Populate config files in a volume

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: busybox
      command: [ "/bin/sh", "-c", "env" ]
      env:
        - name: SPECIAL_TYPE_KEY
          valueFrom:
            configMapKeyRef:
              name: my-special-config
              key: special.type
restartPolicy: Never
```

Lab 4: ConfigMap

Create and use ConfigMap from Pod

Task	With Azure

Create ConfigMap	`# Create config map from poreperties files`
	`kubectl create configmap myconfigmap --from-file xpto.properties`
	
	`# Or create it form yaml`
	`kubectl create –f myconfigmap.yaml`

Get and test ConfigMap	`# Get config map value`
	`kubectl get configmap my-special-config -o yaml`

Use the ConfigMap from Pod	`kubectl create –f pod-using-configmap.yaml`

Manage secrets

Secrets

- Secrets are useful for storing and sharing sensitive, encrypted configuration information.
- Allow you to separate your sensitive secrets (e.g., passwords, connection strings, etc.) from your Pods, preventing hardcoding

```
apiVersion: v1
kind: Secret
metadata:
  name: mysecret
type: Opaque
data:
  username: YWRtaW4=
  password: MWYyZDFlMmU2N2Rm
```

Secrets usage

- Secrets, like ConfigMaps data can be consumed in pods in a variety of ways
- Populate the values of environment variables
- Set command-line arguments in a container
- Populate secret files in a volume

```
apiVersion: v1
kind: Pod
metadata:
  name: secret-env-pod
spec:
  containers:
  - name: mycontainer
    image: redis
    env:
      - name: SECRET_USERNAME
        valueFrom:
          secretKeyRef:
            name: mysecret
            key: username
      - name: SECRET_PASSWORD
        valueFrom:
          secretKeyRef:
            name: mysecret
            key: password
  restartPolicy: Never
```

Lab 5: Secret

Create and use Secret from Pod

Task	With Azure

Create sample secrets	`echo -n 'admin' | base64`
	`YWRtaW4=`
	
	`echo -n '1f2d1e2e67df' | base64`
	`MWYyZDFlMmU2N2Rm`

Create Secret	`kubectl create –f secret.yaml`

Get and test Secret	`# Get secret value`
	`kubectl get secret mysecret -o yaml`
	
	`# Decode secret value`
	`echo 'MWYyZDFlMmU2N2Rm' | base64 –decode`

Use the Secret from Pod	`kubectl create –f pod-using-secret.yaml`

Kubernetes Operators

Custom Resources - Definition

- Kubernetes is highly extensible
- We can define Custom Resources on top of the out-of-the-box objects/resource types/APIs that come with k8s
- Defines a new API in K8S
- Seamless integration with existing APIs
- We can use kubectl

```
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata:
  name: tomcats.tomcat.apache.org
spec:
  group: tomcat.apache.org
  names:
    kind: Tomcat
    listKind: TomcatList
    plural: tomcats
    singular: tomcat
  scope: Namespaced
  subresources:
    status: {}
  validation:
    openAPIV3Schema:
      ...
```

Custom Resources – Object/Instance

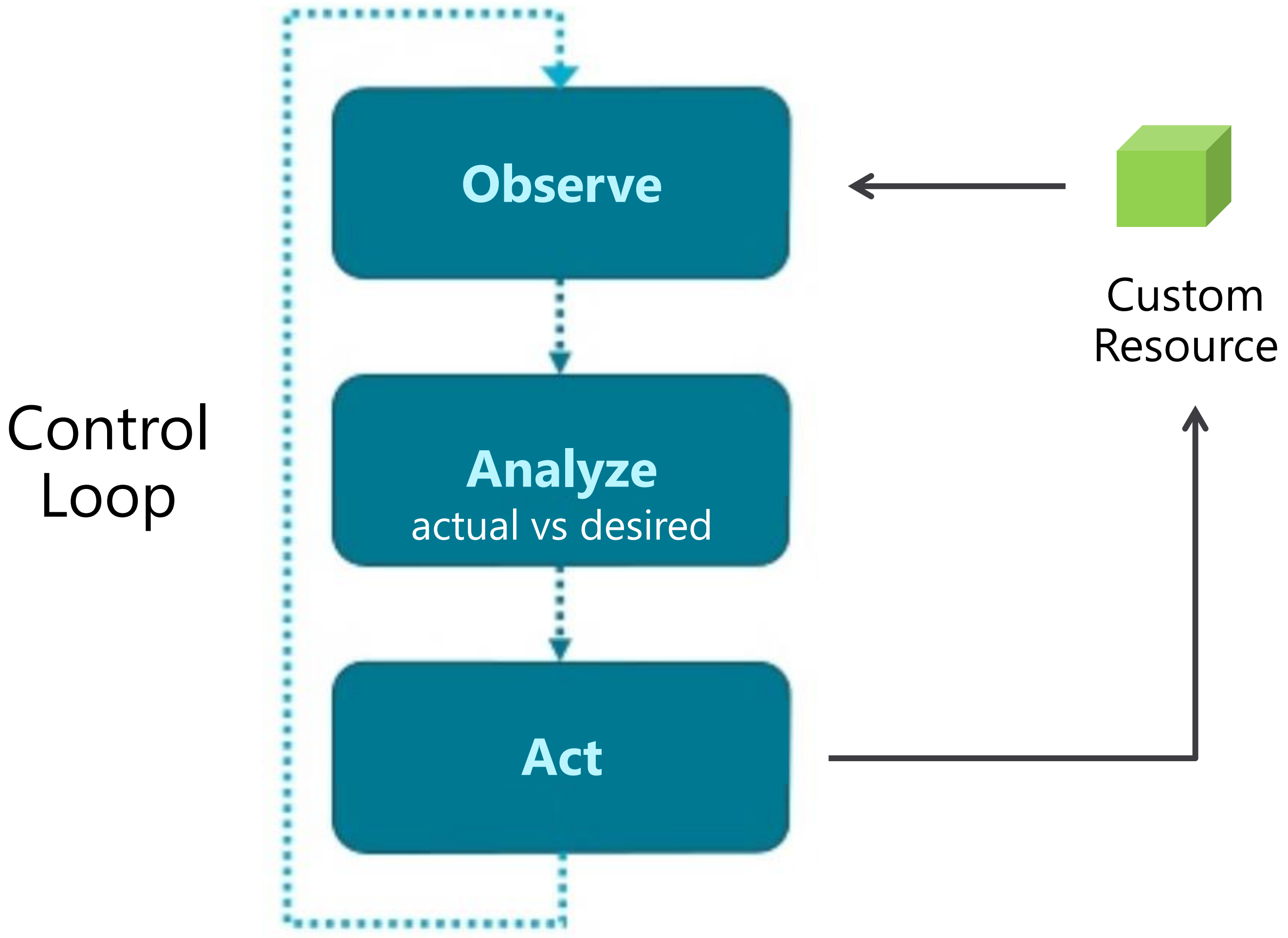
- We can define and configure K8S objects out of the custom resource definitions, just like any other Kubernetes object

- Using YAML and kubectl …

```yaml
apiVersion: tomcat.apache.org/v1alpha1
kind: Tomcat
metadata:
  name: tomcat
spec:
  replicas: 2
  image: tomcat:latest
  imagePullPolicy: IfNotPresent
  webArchiveImage: ananwaresystems/webarchive:1.0
  deployDirectory: /usr/local/tomcat/webapps
```

Custom Resources & Operators

- Remember that K8S uses the concept of desired state configuration
- We can automate the control of these custom resources using Operators
- Operator Watch CR objects
- Analyze differences between Actual and Desired State
- Act on changes
- An operator is itself a Deployment/Pod
- You can create your own operators



Operators, operators, operators

- An operator is itself a Deployment/Pod
- You can create your own operators
- A lot of operators exist today to automate the management of stateful or more complex resources like a database or big application
- Extend and automate the native K8S automation capabilities, targeting specific scenarios and workloads

Good examples

```
https://github.com/coreos/etcd-operator
https://github.com/operator-framework/awesome-operators
```

Welcome to OperatorHub.io

OperatorHub.io is a new home for the Kubernetes community to share Operators. Find an existing Operator or list your own today.

https://operatorhub.io/

Lab 6: Operators

Create a custom resource and deploy an operator to manage it

Task	With Azure
Create a custom resource	`kubectl apply -f lab06-operator/tomcat-crd-definition.yaml`

Create an operator for the custom resource	`# operator runs with a service account and a specific role`
	`kubectl apply -f lab06-operator/service_account.yaml`
	`kubectl apply -f lab06-operator/role.yaml`
	`kubectl apply -f lab06-operator/role_binding.yaml`
	`# deploy the operator`
	`kubectl apply -f lab06-operator/operator.yaml`

Create an instance of the custom resource type	`# Create a Tomcat cluster`
	`kubectl apply -f lab06-operator/tomcat-cr-instance.yaml`

Check what is deployed and running	`kubectl get tomcat`
	`kubectl get pod`
	`kubectl get svc`

Package apps with Helm

Helm

- Package manager for Kubernetes
- Helm helps you manage Kubernetes applications
- Avoiding K8S ymal templates copy & paste all the time
- Helm Charts help you define, install, and upgrade even the most complex Kubernetes application
- Charts are easy to create, version, share, and publish — so start using Helm and stop the copy-and-paste.

https://github.com/helm/charts

Lab 7: Helm

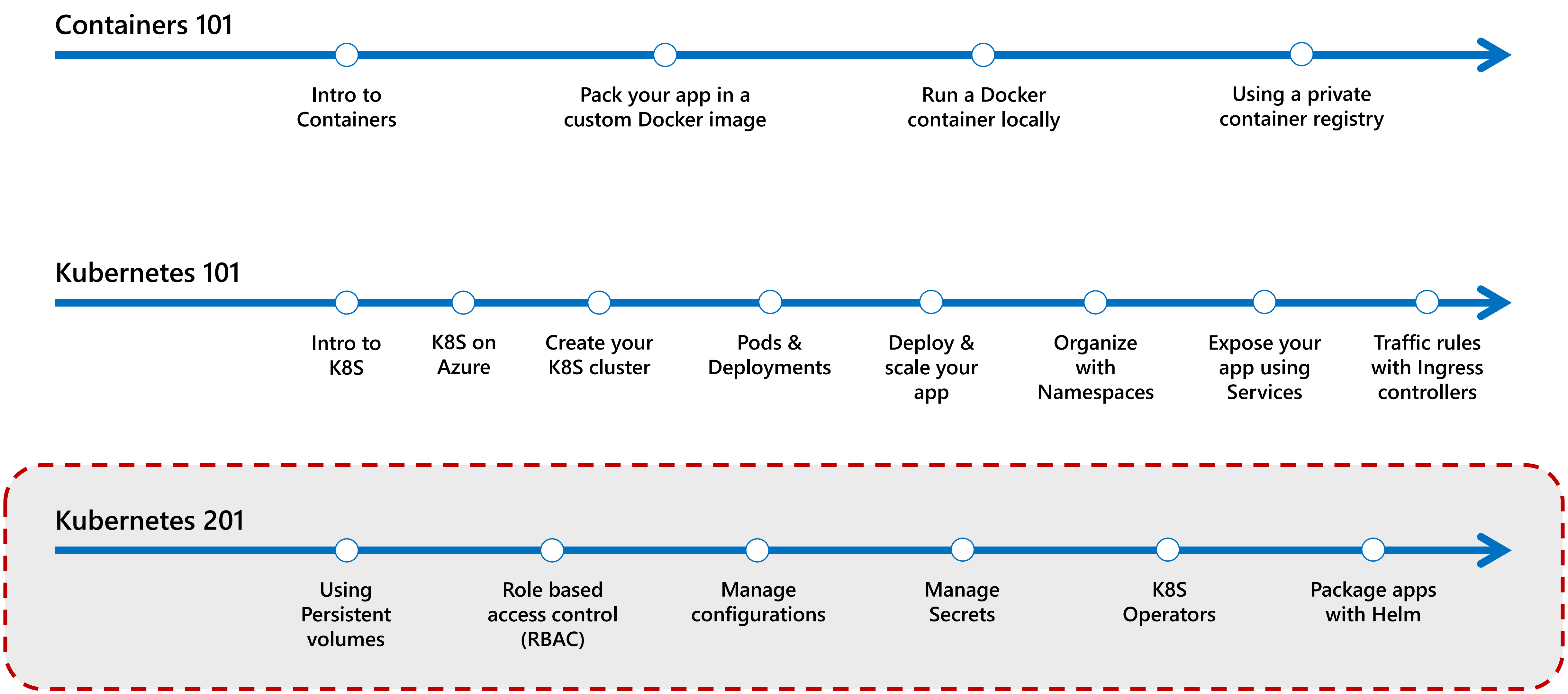
Create and use a new Helm chart

Task	With Azure
Create a new Helm chart/package	`helm create webfrontend`
Create Secret	`kubectl create –f secret.yaml`

Get and test Secret	`# Get secret value`
	`kubectl get secret mysecret -o yaml`
	
	`# Decode secret value`
	`echo 'MWYyZDFlMmU2N2Rm' | base64 –decode`

Use the Secret from Pod	`kubectl create –f pod-using-secret.yaml`

Containers & Kubernetes workshops



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Thank you