Operationalizing Multi-tenancy Support with Kubernetes

(It's Not Just About Security)

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Open FInTech Forum 2018

Your Presenters

Paul Sitowitz

Manager, Software Engineering

Paul is a Software engineer with Capital One who specializes in container technologies and Kubernetes and is a Certified Kubernetes Administrator and a Certified Kubernetes Application Developer. He is currently supporting a Kubernetes-based fraud decisioning platform.

Keith Gasser

Lead Software Engineer

Keith is a Software Engineer specializing in DevOps and Application Security at Capital One currently working on a team which has built a Kubernetes-based streaming and decisioning pipeline for Capital One Bank.

Case Study: Supporting Fast Decisioning Applications With Kubernetes

- Learn more about our Fraud Decisioning Platform at:

https://kubernetes.io/case-studies/capital-one

"a provisioning platform for Capital One applications deployed on AWS that use streaming, big-data decisioning, and machine learning. One of these applications handles millions of transactions a day; some deal with critical functions like fraud detection and credit decisioning. The key considerations: resilience and speed—as well as full rehydration of the cluster from base AMIs"

Agenda

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1. Introduction
   About what we will be presenting
2. Assumptions
   About our participants
3. Some Definitions
   Workload
   Containerized Workload
   Controllers
   Multi-tenancy
4. Pathway to Multi-tenancy in K8S
   Key Building Blocks
   Self-Healing
   Namespace Isolation
   Resource Limitation
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5. Cloud Provider Hosted K8s
   EKS, GKE, AKS
6. Kubernetes Feature Roadmap
   Upcoming features that will help with multi-tenancy
7. Summary
   Recap and take a ways
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Heartache and Pain Points of Multi-tenant Kubernetes

- Coordinated deployments
- Cluster version baseline (up through the addon stack)
- Resource starvation & contention
- “Thundering Herd”
- Cascading failures
- Node lockout
- APIServer Status: Node Unknown (kubelet death)
- Administrative blindness due to log forwarder saturation

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- Building large distributed software is not easy especially when:
  - you must support multiple tenants and each have their own workloads to run and SLAs to meet
  - compute and storage resources are limited and need to be shared
- Careful thought must be given to ensure that resource isolation is obtained to help to address resource contention and avoid starvation
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Introduction (continued)

- Unfortunately, there is no such thing as a self tuning / self-administering K8S cluster ☹
- These K8S features will be the key ingredients in our recipe for operating a well managed, multi-tenant, Kubernetes cluster
  - Namespaces
  - Taints / Tolerations
  - Affinity / Anti-affinity
  - Liveness / Readiness probes
  - Role Based Access Control
  - Security contexts
  - Pod Resource Requests/Limits
  - Node Selectors
  - Pod Security Policies
  - Secrets
  - Autoscaling
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Pros and Cons of Multi-tenancy in K8S

Pros	Cons

Pros

- Usually more cost effective
- Easier to share common components
- Easier to manage
  - when a single cluster is shared

Cons

- Resource contention / starvation
- Component sharing can degrade performance
- Hard to get right

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Our Assumptions about You (the Participant)

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- You are familiar with **Docker** or other container runtimes

Our Assumptions About you (the Participant)

You are familiar with **Kubernetes (K8S)**

Our Assumptions About you (the Participant)

- You will silence your **phones/pagers** during our presentation

Our Assumptions About you (the Participant)

- You will hold off on **questions** until the end

Thank You in advance!!

☺

Some Definitions

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Workload	Containerized Workload	Controllers/ Workload Mangers	Multi-tenancy

Workload

- An application that performs some work or processing and requires CPU & Memory resources
  - Server / daemon
  - Batch / scheduled jobs

Containerized Workload

- A workload that is packaged as an image and deployed inside of a container
  - *Docker / Containerd / RKT*
- **A Pod is the smallest unit for deploying a workload in K8S**
  - *Hosts 1 or more containers*

Controllers/ Workload Mangers

- Higher level components used to manage pods
  - Maintains the desired count of available replicas
  - Stateless
    - Deployment
    - Jobs
    - DaemonSets
  - Stateful
    - StatefulSets

Multi-tenancy

- Disparate workloads hosted on the same cluster
- Issues exacerbated by varied workload owners
  - Shared resources
  - Contention concerns

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Pathway to Multi-tenancy in Kubernetes

Pathway To Multi-tenancy

Key Building Blocks

- Robust & tested container images
- Controllers / Workload Managers

Self-healing

- Liveness Probes
- Readiness Probes
- Autoscaling

Namespace Isolation & Resource Request & Limitation

- Separate namespace per tenant
- Pod resource requests/limits
- Limit Ranges
- Resource Quotas

Worker Node Isolation

- Taints
- Node Selectors
- Node Affinity
- Pod Affinity/Anti-Affinity

Security Limitation

- Security Contexts
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Network Policy Isolation

- Control network ingress/egress communication between pods

Well-managed Multi-tenant Kubernetes cluster

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Pathway To Multi-tenancy

- It's mostly about well-managed and isolated workloads

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- Let's take a closer look at each of these in more detail

Key Building Blocks

Robust & Tested Container Images

- The pathway to multi-tenancy starts with the **container image**!
- Your images should be tested for **performance** and **quality**
  - Identify ideal workload resource **requests** & **limits**
  - Use **automation** for **repeatable** and **consistent** ongoing **testing**
- **Artifacts** needed to build images should be **version controlled**
- **NEVER** deploy an image with tag **latest**
- Always use a secure image **registry**
- Limit your **image size** when possible

Use Controllers / Workload Managers

You should NEVER, EVER deploy a single K8S Pod to Production!!!!!

- Un-managed Pods are **NOT** resilient

- You should instead use controllers/managers like:
  - Deployments, DaemonSets (stateless)
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- Sooner or later, software applications will fail! ☹

- **Self-healing** software can identify that it is not operating correctly and, without human intervention, can take action to restore itself to normal operation ☺

- K8S Pods need help to enable self-healing through the use of **Liveness** and **Readiness** probes

- **Autoscaling** can help to keep:
  - the system responsive and appear healthy under heavy loads
  - operational costs down when system load decreases

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Types of Probes Available For Liveness & Readiness

Command

- Executes a specified command inside the Container
- The diagnostic is considered **successful if the command exits with a status code of 0**.

TCP

- Performs a TCP check against the Container's IP address on a specified port.
- The diagnostic is considered **successful if the port is open**.

HTTP

- Performs an HTTP Get request against the Container's IP address on a specified port and path
- The diagnostic is considered **successful if 200 ≤ httpCode ≤ 400**.

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Liveness Probes

- Enable Pod containers to recover from a broken state by being restarted

- Define periodic checks to determine if a Pod container is “alive” and if not, then it is killed and re-started

Without Liveness probes, K8S is truly blind and unaware that our workloads may have silently failed or stopped working

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```yaml
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: liveness
  name: liveness-exec
spec:
    containers:
    - name: liveness
      image: k8s.gcr.io/busybox
      args:
      - /bin/sh
      - -c
      - touch /tmp/healthy; sleep 30; rm -rf /tmp/healthy; sleep 600
      livenessProbe:
        exec:
          command:
          - cat
          - /tmp/healthy
        initialDelaySeconds: 5
        periodSeconds: 5
```

https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-probes

Liveness Probe Example

Readiness Probes

- Allow containers to indicate that they are “not ready” and therefore should temporarily not receive traffic
- Define periodic checks to determine if a Pod container is “ready” and if not, then it will stop receiving traffic until it safely can
- Enforced by removing endpoint IPs for Pods automatically so that they will not receive traffic for services that they support

Readiness Probes

- Allow containers to indicate that they are “not ready” and therefore should temporarily not receive traffic
- Define periodic checks to determine if a Pod container is “ready” and if not, then it will stop receiving traffic until it safely can
- Enforced by removing endpoint IPs for Pods automatically so that they will not receive traffic for services that they support

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Readiness Probes (continued)

- When a Pod transitions back to “readiness”, it will automatically resume receiving traffic without any intervention

Without Readiness probes, K8S will send traffic to unready Pods and this can cause failures and unexpected results!

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Without Readiness probes, K8S will send traffic to unready Pods and this can cause failures and unexpected results!

Readiness Probe Example

```yaml
apiVersion: v1
kind: Pod
metadata:
  labels:
    app: goproxy
  name: goproxy
spec:
  containers:
  - name: goproxy
    image: k8s.gcr.io/goproxy:0.1
    ports:
    - containerPort: 8080
    readinessProbe:
      tcpSocket:
        port: 8080
      initialDelaySeconds: 5
      periodSeconds: 10
    livenessProbe:
      tcpSocket:
        port: 8080
      initialDelaySeconds: 25
      periodSeconds: 20
```

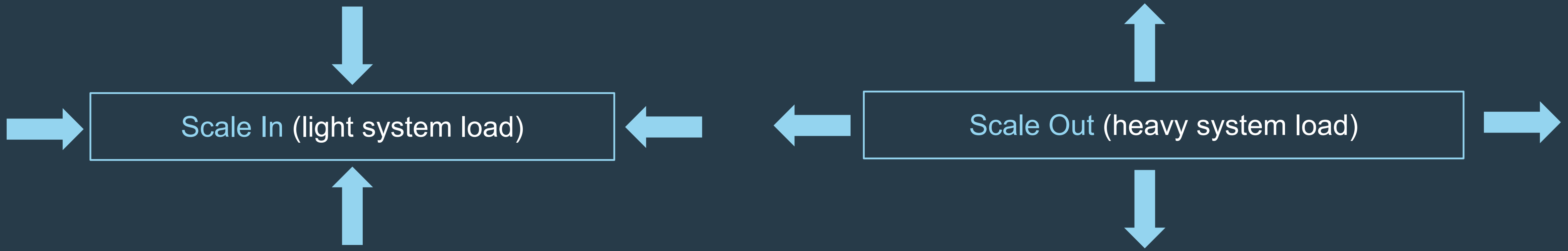
https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-probes

When using Probes

- If your workload requires time to properly startup / initialize

Then include an appropriate value for **`initialDelaySeconds`** `or else it may never be ready and may always restart`

Autoscaling



Horizontal

- increase/decrease in the number of replicas
  - Pods - Horizontal Pod Autoscaler (**HPA**)
  - Nodes - Cluster Autoscaler (**CA**)

Vertical

- increase/decrease in resource usage for a Pod
  - Pod resources – Vertical Pod Autoscaler (**VPA**)
    - Requires a Pod restart for changes to resources to take effect
- increase/decrease in persistent storage resources used by a Pod

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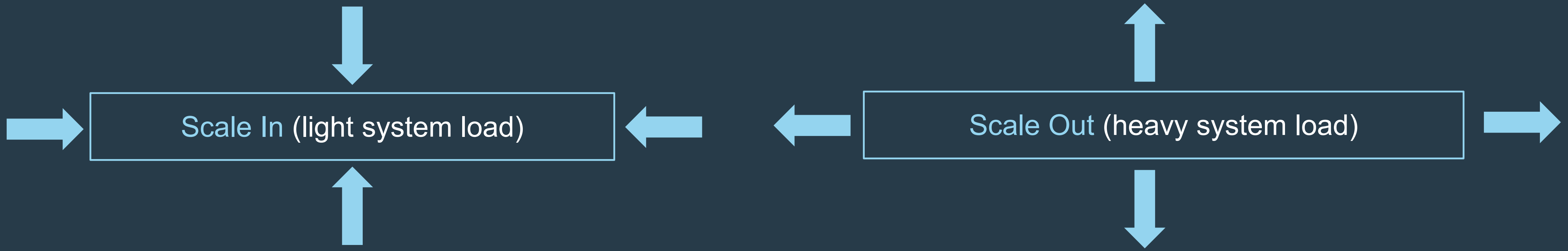

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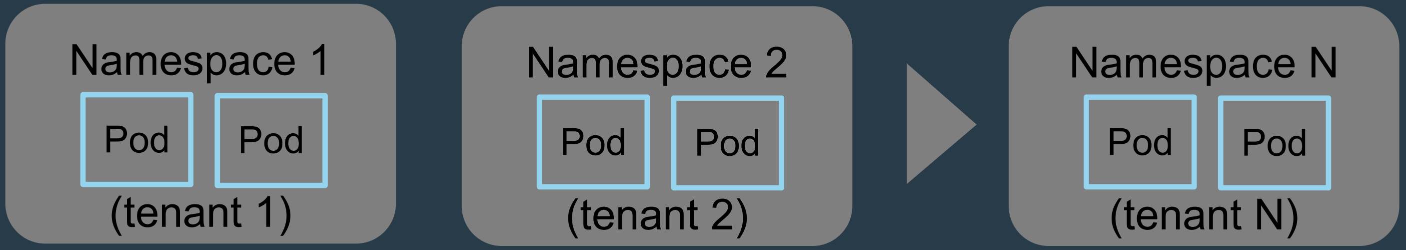
Namespace Isolation
&
Resource Limitation

Namespace Isolation

- Namespaces scope resource names and can specify constraints for resource consumption to prevent Pods from running with unbounded CPU and memory requests/limits (**which they will do by default**)

- By default, all resources in Kubernetes are created in a default namespace

- Resources created in one namespace are hidden from other namespaces



<u>Put tenant resources in corresponding & separate namespaces</u>

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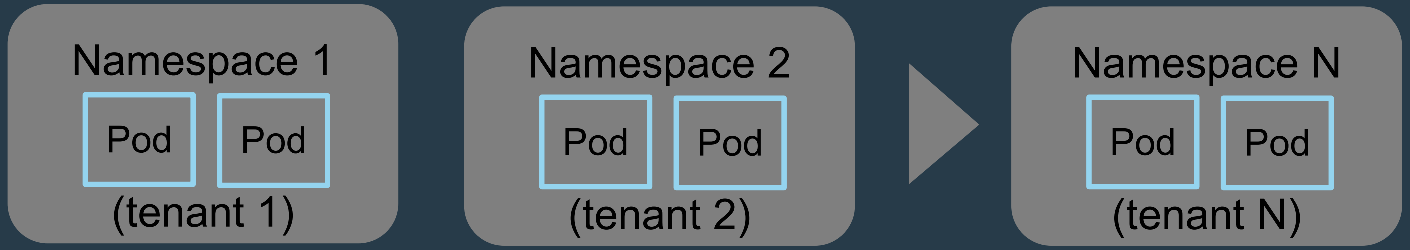

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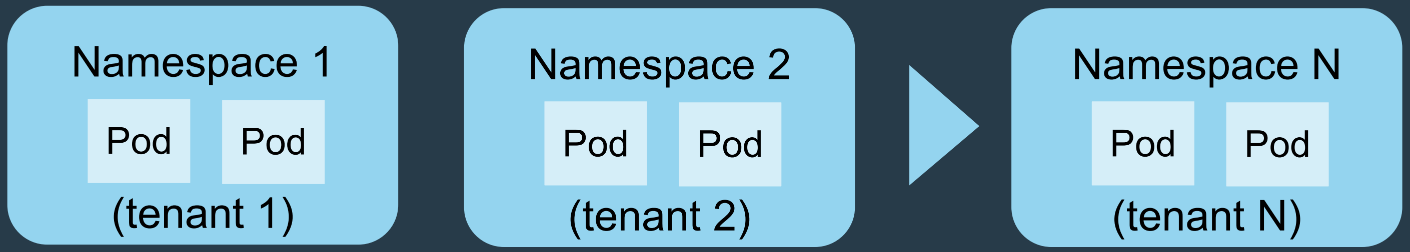

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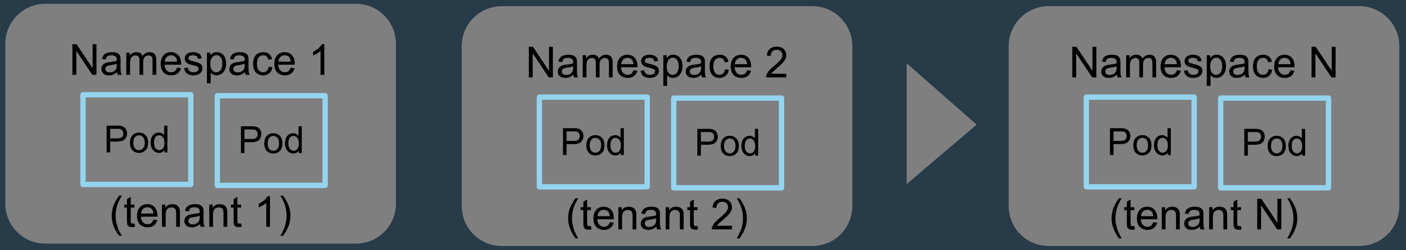

Put tenant resources in corresponding & separate namespaces

```yaml
kind: Namespace
apiVersion: v1
metadata:
  name: fintech
  labels:
    tenant: fintech
```

Always Label Namespaces

Resource Limitation & Request

Pod Resource Requests & Limits

- Specified for each container in a Pod (inside a Pod specification)
- NOTE: Pod resource requests and limits are the sum of all resource requests/limits for each container

Limit Ranges

- Supports configuring default memory and/or CPU requests and limits for all K8S resources created in a namespace
- The combined resource usage for K8S resources in a namespace can not exceed the defined limit

Resource Quotas

- Supports configuring limits for the number of types of K8S resources that can be created within a namespace
- Can even be used to disallow the usage of a given resource within a namespace by setting the number of allowed resources for a type to **0**

Resource Limitation & Request (continued)

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Pod Resource Request/Limit Examples

Memory

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: memory-demo
  namespace: mem-example
spec:
  containers:
  - name: memory-demo-ctr
    image: polinux/stress
    resources:
      limits:
        memory: "200Mi"
      requests:
        memory: "100Mi"
    command: ["stress"]
    args: ["--vm", "1", "--vm-bytes", "150M", "--vm-hang", "1"]
```

https://kubernetes.io/docs/tasks/configure-pod-container/assign-memory-resource/

CPU

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: cpu-demo
  namespace: cpu-example
spec:
  containers:
  - name: cpu-demo-ctr
    image: vish/stress
    resources:
      limits:
        cpu: "1"
      requests:
        cpu: ”0.5"
    args:
    - -cpus
    - “2”
```

https://kubernetes.io/docs/tasks/configure-pod-container/assign-cpu-resource/

Why are Resource Requests Important?

- **They ensure that the minimum required resources are available**

- **The scheduler bases its decisions only on allocable resource amounts**

Why are Resource Limits Important?

- They define the maximum allowed value for a resource
- **Without limits, a Pod can consume as much resources as it likes and can potentially starve other workloads!**
- Exceeding memory limits may cause a Pod to be OOM killed
- Exceeding CPU limits may cause a Pod to be throttled

Quality Of Service Classes (QoS)

- Used to determine the priority order for which workloads will be killed first when the system needs to reclaim memory for higher priority workloads

    - Guaranteed (highest)
    - Burstable (lower)
    - BestEffort (lowest)

- **Guaranteed**:

    resource limits = resource requests

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- **Guaranteed**:

  Set resource limits = resource requests (for all containers in a pod)

LimitRange Example(s)

Memory

```
apiVersion: v1
kind: LimitRange
metadata:
  name: mem-min-max-demo
spec:
  limits:
  - type: Container:
    max:
      memory: 1Gi
    min:
      memory: 500Mi
    default:
      memory: 1Gi
    defaultRequest:
      memory: 1Gi
 - type: Pod:
    max:
      memory: 1Gi
    min:
      memory: 500Mi
```

https://kubernetes.io/docs/tasks/administer-cluster/manage-resources/memory-constraint-namespace/

CPU

```
apiVersion: v1
kind: LimitRange
metadata:
  name: cpu-min-max-demo
spec:
  limits:
  - type: Container:
    max:
      cpu: “800m”
    min:
      cpu: “200m”
    default:
      cpu: “800m”
    defaultRequest:
      cpu: “800m”
```

https://kubernetes.io/docs/tasks/administer-cluster/manage-resources/cpu-constraint-namespace/

ResourceQuota Example

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: object-quota-demo
spec:
  hard:
    persistentvolumeclaims: "1"
    services.nodeports: "0"
    services.loadbalancers: "0"
    services: "5"
    pods: "5"
    secrets: "2"
    configmaps: "2"
    requests.cpu: 400m
    requests.memory: 200Mi
    limits.cpu: 600m
    limits.memory: 500Mi
```

https://kubernetes.io/docs/tasks/administer-cluster/quota-api-object/

When using Resource Quotas

- If resource **requests** and **limits** are specified, then each pod that the quota applies to **MUST** also define resource **requests and limits**

- You can always define default requests and limits via a **LimitRange**!

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Worker Node Isolation

Worker Node Isolation

- Workloads are scheduled to run on worker nodes (also referred to as ”minions”) in a K8S cluster

By default, multi-tenant workloads can and will be scheduled to run on the same worker nodes and forced to share resources

- unless you explicitly prevent them from doing so

- Let’s take a closer look at this in more detail

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Taints & Tolerations

Taints

- Have a key, value, and an effect to prevent scheduling or execution of a Pod on a Node unless it **Tolerates the Taint**
- A flexible way to keep pods away from nodes or evict those that shouldn't be running

```
kubectl taint nodes node1 key1=value1:NoSchedule
kubectl taint nodes node1 key1=value1:NoExecute
kubectl taint nodes node1 key2=value2:NoSchedule
```

Tolerations

- Also has a key, value, and an effect
- "matches" a taint if the keys are the same and the effects are the same
- Allows a Pod to be scheduled and/or executed on a Tainted node

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```
tolerations:
- key: "key1"
  operator: "Equal"
  value: "value1"
  effect: "NoSchedule"
- key: "key1"
  operator: "Equal"
  value: "value1"
  effect: "NoExecute"
```

Taints & Tolerations (continued)

- The Node controller will automatically taint nodes when certain conditions are true:

node.kubernetes.io/not-ready:	Node is not ready. This corresponds to the NodeCondition Ready being "False".
node.kubernetes.io/unreachable:	Node is unreachable from the node controller. This corresponds to the NodeCondition Ready being "Unknown".
node.kubernetes.io/out-of-disk:	Node becomes out of disk.
node.kubernetes.io/memory-pressure:	Node has memory pressure.
node.kubernetes.io/disk-pressure:	Node has disk pressure.
node.kubernetes.io/network-unavailable:	Node's network is unavailable.
node.kubernetes.io/unschedulable:	Node is unschedulable.
node.cloudprovider.kubernetes.io/uninitialized:	When the kubelet is started with "external" cloud provider, this taint is set on a node to mark it as unusable. After a controller from the cloud-controller-manager initializes this node, the kubelet removes this taint.

https://kubernetes.io/docs/concepts/configuration/taint-and-toleration/

Taints & Tolerations (continued)

```
node.kubernetes.io/not-ready:                    Node is not ready. This corresponds to the NodeCondition Ready
being “False”.
node.kubernetes.io/unreachable:                  Node is unreachable from the node controller. This corresponds
to the NodeCondition Ready being “Unknown”.

node.kubernetes.io/out-of-disk:                  Node becomes out of disk.

node.kubernetes.io/memory-pressure:              Node has memory pressure.

node.kubernetes.io/disk-pressure:                Node has disk pressure.

node.kubrnetes.io/network-unavailable:  Node’s network is unavailable.

node.kubernetes.io/unschedulable:                Node is unschedulable.

node.cloudprovider.kubernetes.io/uninitialized:  When the kubelet is started with “external” cloud provider,
this taint is set on a node to mark it as unusable. After a controller from the cloud-controller-manager
initializes this node, the kubelet removes this taint.
```

https://kubernetes.io/docs/concepts/configuration/taint-and-toleration/

Did you know that…

- For kubeadm installs, master nodes are tainted so that only internal K8S resources can run on them
  - These internal components define a matching toleration in their Pod specifications

Node Labels & Selectors

Node Labels

- Key-Value pairs added to a Node for labelling purposes

```
kubectl label nodes node1 disktype=ssd
```

Node Selectors

- Defined in a Pod specification to force it to be scheduled only to a Node with a matching label(s)
- Supports equality operators and set-based operators
- Less flexible than Node Affinity

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- Less flexible than Node Affinity

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    layer: web
spec:
  containers:
  - name: nginx
    image: nginx
    imagePullPolicy: Always
  nodeSelector:
    diskType: ssd
```

Node Affinity

- Similar to node selectors though much more flexible
- Allows you to constrain which nodes your pod is eligible to be scheduled on, based on labels on the node. There are two types:

requiredDuringSchedulingIgnoredDuringExecution

- **“hard” rule that must be met for a Pod to be scheduled to a Node and ran there**
- A guarantee that the scheduler will enforce

preferredDuringSchedulingIgnoredDuringExecution

- **“soft” rule that may be met for a Pod to be scheduled to a Node**
- Supports a **weight** field (1-100)
  - A greater value means “more preferred”
- Not a guarantee that the scheduler will enforce

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- Supports a **weight** field (1-100)
  - A greater value means "more preferred"
- Not a guarantee that the scheduler will enforce

Node Affinity (continued)

- Built In Node Labels (Cloud Provider specific)

```
kubernetes.io/hostname
failure-domain.beta.kubernetes.io/zone
failure-domain.beta.kubernetes.io/region
beta.kubernetes.io/instance-type
beta.kubernetes.io/os
beta.kubernetes.io/arch
```

https://kubernetes.io/docs/concepts/configuration/assign-pod-node/#affinity-and-anti-affinity

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: with-node-affinity
spec:
  affinity:
    nodeAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        nodeSelectorTerms:
        - matchExpressions:
          - key: kubernetes.io/e2e-az-name
            operator: In
            values:
            - e2e-az1
            - e2e-az2
      preferredDuringSchedulingIgnoredDuringExecution:
      - weight: 1
        preference:
          matchExpressions:
          - key: another-node-label-key
            operator: In
            values:
            - another-node-label-value
  containers:
  - name: with-node-affinity
    image: k8s.gcr.io/pause:2.0
```

https://kubernetes.io/docs/concepts/configuration/assign-pod-node/#affinity-and-anti-affinity

Node Affinity Example

Pod Affinity / Anti-Affinity

- allow you to constrain which nodes your pod is eligible to be scheduled *based on labels on pods that are already running on the node* rather than based on labels on the node
- Supports a **topologyKey** which can also match a node label

Affinity

- Allows a Pod to run on a node if the node is already running one or more specified Pods

Anti-Affinity

- Prevents a Pod from running on a node if the node is already running one or more specified Pods

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Pod Affinity / Anti-Affinity Example

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: with-pod-affinity
spec:
  affinity:
    podAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
      - labelSelector:
          matchExpressions:
          - key: security
            operator: In
            values:
            - S1
        topologyKey: failure-domain.beta.kubernetes.io/zone
    podAntiAffinity:
      preferredDuringSchedulingIgnoredDuringExecution:
      - weight: 100
        podAffinityTerm:
          labelSelector:
            matchExpressions:
            - key: security
              operator: In
              values:
              - S2
          topologyKey: kubernetes.io/hostname
  containers:
  - name: with-pod-affinity
    image: k8s.gcr.io/pause:2.0
```

https://kubernetes.io/docs/concepts/configuration/assign-pod-node/#affinity-and-anti-affinity

Security Limitation

Security Limitation

- While multi-tenant isolation is not only about security, **security certainly plays a big role!**

- Container security can be used to secure the container file system and enable/disable privileged actions and access to host machine Kernel features
  - **Security Contexts** and **Pod Security Policies** are the K8s features available for this

- Network security can be used to control ingress/egress connectivity between Pods
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- Network security can be used to control ingress/egress connectivity between Pods
  - **Network Policies** are the K8s features available for this

Capital One

Security Limitation (continued)

- Role Based Access Control is an approach to restricting system access to authorized users
  - **RBAC** is the K8s feature available for this

- Let’s take a closer look at each of these in more detail 🔍

Security Contexts

- Defines privilege and access control settings for a Pod or Container

- Can be defined within a Pod specification and/or within each container running inside of a Pod

  Defining at the container layer will override one defined at the Pod layer

This can be overwritten at a higher level by security context rules inside of a Pod Security Policy

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Security Context Example

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: security-context-demo-2
spec:
  securityContext:
    runAsUser: 1000
  containers:
  - name: sec-ctx-demo-2
    image: gcr.io/google-samples/node-hello:1.0
    securityContext:
      runAsUser: 2000
      allowPrivilegeEscalation: false
```

container Layer

Pod Layer

https://kubernetes.io/docs/tasks/configure-pod-container/security-context/

Pod Security Policy

- A cluster-level resource that controls security sensitive aspects of the pod specification
- Defines a set of conditions that a pod must run with in order to be accepted into the system

Can override security settings configured by a Pod's SecurityContext

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- Defines a set of conditions that a pod must run with in order to be accepted into the system

Can override security settings configured by a Pod's SecurityContext

Privileged Pod Security Policy Example

```yaml
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: privileged
  annotations:
    seccomp.security.alpha.kubernetes.io/allowedProfileNames: '*'
spec:
  privileged: true
  allowPrivilegeEscalation: true
  allowedCapabilities:
  - '*'
  volumes:
  - '*'
  hostNetwork: true
  hostPorts:
  - min: 0
    max: 65535
  hostIPC: true
  hostPID: true
  runAsUser:
    rule: 'RunAsAny'
  seLinux:
    rule: 'RunAsAny'
  supplementalGroups:
    rule: 'RunAsAny'
  fsGroup:
    rule: 'RunAsAny'
```

https://kubernetes.io/docs/concepts/policy/pod-security-policy

Restricted Pod Security Policy Example

```yaml
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: restricted
  annotations:
    seccomp.security.alpha.kubernetes.io/allowedProfileNames: 'docker/default'
    apparmor.security.beta.kubernetes.io/allowedProfileNames: 'runtime/default'
    seccomp.security.alpha.kubernetes.io/defaultProfileName:  'docker/default'
    apparmor.security.beta.kubernetes.io/defaultProfileName:  'runtime/default'
spec:
  privileged: false
  # Required to prevent escalations to root.
  allowPrivilegeEscalation: false
  # This is redundant with non-root + disallow privilege escalation,
  # but we can provide it for defense in depth.
  requiredDropCapabilities:
    - ALL
  # Allow core volume types.
  volumes:
    - 'configMap'
    - 'emptyDir'
    - 'projected'
    - 'secret'
    - 'downwardAPI'
    # Assume that persistentVolumes set up by the cluster admin are safe to use.
    - 'persistentVolumeClaim'
  hostNetwork: false
  hostIPC: false
  hostPID: false
  runAsUser:
    # Require the container to run without root privileges.
    rule: 'MustRunAsNonRoot'
  seLinux:
    # This policy assumes the nodes are using AppArmor rather than SELinux.
    rule: 'RunAsAny'
  supplementalGroups:
    rule: 'MustRunAs'
    ranges:
      # Forbid adding the root group.
      - min: 1
        max: 65535
  fsGroup:
    rule: 'MustRunAs'
    ranges:
      # Forbid adding the root group.
      - min: 1
        max: 65535
  readOnlyRootFilesystem: false
```

https://kubernetes.io/docs/concepts/policy/pod-security-policy

Secrets

- Objects intended to hold sensitive data
    - Passwords
    - Tokens
    - Keys

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Secrets Example

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

---

apiVersion: v1
kind: Pod
metadata:
  name: mypod
spec:
  containers:
  - name: mypod
    image: redis
    volumeMounts:
    - name: foo
      mountPath: "/etc/foo"
      readOnly: true
  volumes:
  - name: foo
    secret:
      secretName: mysecret
```

Definition

Reference

https://kubernetes.io/docs/concepts/configuration/secret/

Role Based Access Control (RBAC)

- a method of regulating access to computer or network resources based on the roles of individual users

- Uses Roles and ClusterRoles to represent permissions

- Uses RoleBindings and ClusterRoleBindings to grant role permissions to users

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RBAC Example 1

```
kind: Role
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  namespace: default
  name: pod-reader
rules:
- apiGroups: [""] # "" indicates the core API group
  resources: ["pods"]
  verbs: ["get", "watch", "list"]

---

# This role binding allows "jane" to read pods in the "default" namespace.
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: read-pods
  namespace: default
subjects:
- kind: User
  name: jane # Name is case sensitive
  apiGroup: rbac.authorization.k8s.io
roleRef:
  kind: Role            # this must be Role or ClusterRole
  name: pod-reader      # this must match the name of the Role or ClusterRole you wish to
bind to
  apiGroup: rbac.authorization.k8s.io
```

https://kubernetes.io/docs/reference/access-authn-authz/rbac/

Capital One

RBAC Example 2

```
kind: ClusterRole
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  # "namespace" omitted since ClusterRoles are not namespaced
  name: secret-reader
rules:
- apiGroups: [""]
  resources: ["secrets"]
  verbs: ["get", "watch", "list"]

---

# This cluster role binding allows anyone in the "manager" group to read secrets in
any namespace.
kind: ClusterRoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: read-secrets-global
subjects:
- kind: Group
  name: manager # Name is case sensitive
  apiGroup: rbac.authorization.k8s.io
roleRef:
  kind: ClusterRole
  name: secret-reader
  apiGroup: rbac.authorization.k8s.io
```

https://kubernetes.io/docs/reference/access-authn-authz/rbac/

Network Policy Isolation

Network Policy Isolation

- Requires that a Network plugin which implements network policies (Calico, Weavenet, etc.) is installed and running on all nodes
- Enables Pod isolation by explicitly rejecting or allowing connections to/from other Pods and/or other network endpoints
- Network policies are defined for namespaces

Without network policies, Pods will accept traffic from any source!

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Network Policy Isolation (continued)

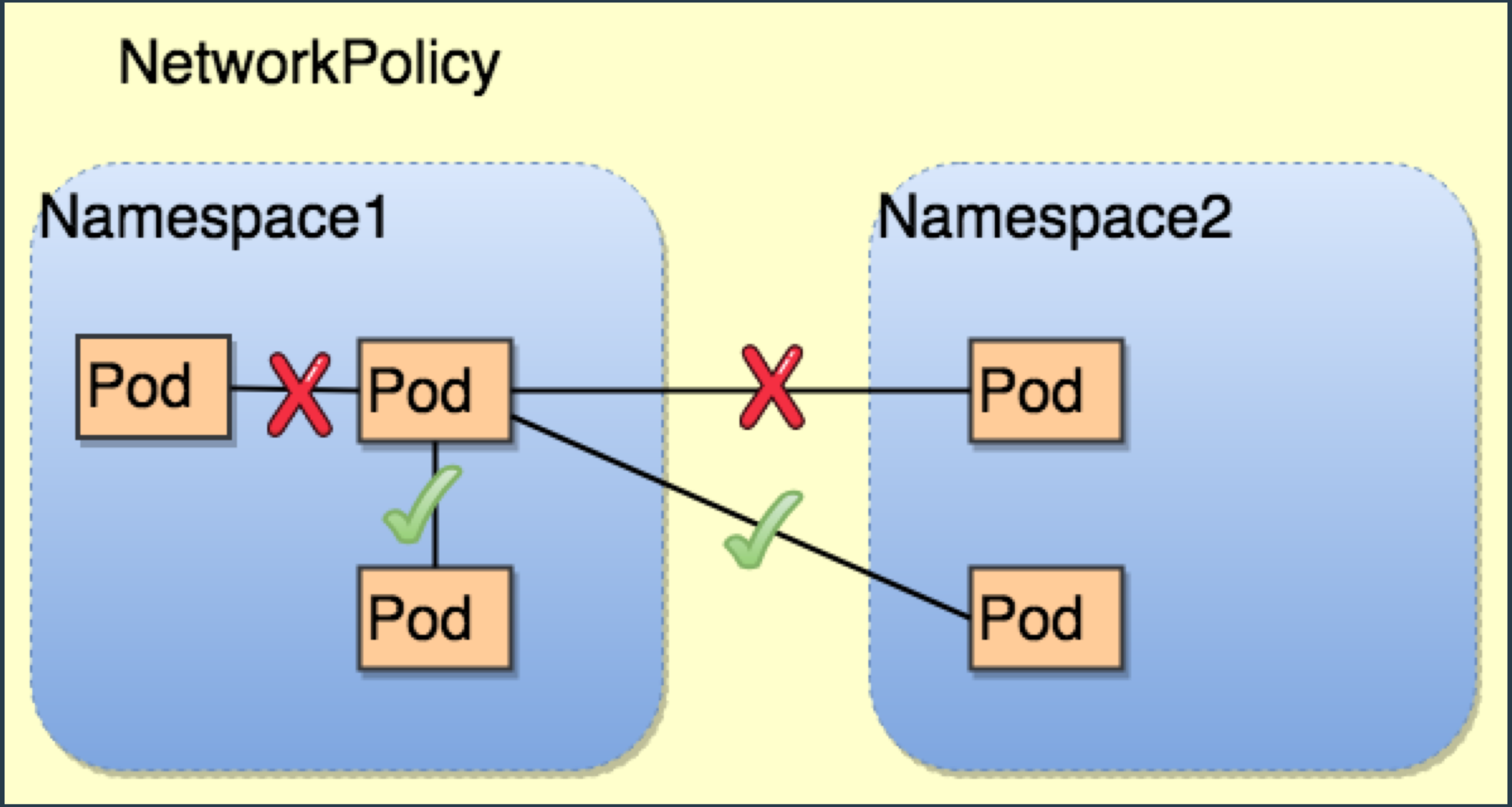

Diagram created by **Mike Knapp, Capital One**

```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: test-network-policy
  namespace: default
spec:
  podSelector:
    matchLabels:
      role: db
  policyTypes:
  - Ingress
  - Egress
  ingress:
  - from:
    - ipBlock:
        cidr: 172.17.0.0/16
        except:
        - 172.17.1.0/24
    - namespaceSelector:
        matchLabels:
          tenant: fintech
    - podSelector:
        matchLabels:
          role: frontend
    ports:
    - protocol: TCP
      port: 6379
  egress:
  - to:
    - ipBlock:
        cidr: 10.0.0.0/24
    ports:
    - protocol: TCP
      port: 5978
```

https://kubernetes.io/docs/concepts/services-networking/network-policies/

Network Policy Isolation Example

Network Policy Isolation Deny/Allow Ingress Traffic Examples

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: default-deny
spec:
  podSelector: {}
  policyTypes:
  - Ingress

---

apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: allow-all
spec:
  podSelector: {}
  ingress:
  - {}
```

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- Provision and manage K8S clusters on your behalf
- Can provide additional multi-tenancy related features

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- Add support for HPA and VPA to work on the same pods
- Add support for VPA to adjust resource limits without requiring a Pod restart
- Affinity
  - **requiredDuringSchedulingRequiredDuringExecution**
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More Talks About Our Platform

More Talks Regarding Our Fraud Decisioning Platform

- "**Implementing SAAS on Kubernetes**"
    - When:
        - Thursday, Oct. 11th @ 1:40pm (1st session after lunch)
    - Presenters:
        - **Mike Knapp & Andrew Gao**

More Talks Regarding Our Fraud Decisioning Platform (continued)

- "**Will HAL Open the Pod Bay Doors? An (Enterprise FI) Decisioning Platform Leveraging Machine Learning**"
  - When:
    - Thursday, Oct. 11th @ 2:50pm (3rd session after lunch)
  - Presenters:
    - **Sumit Daryani & Niraj Tank**

More Talks Regarding Our Fraud Decisioning Platform (continued)

- "**Panel Discussion: Real-World Kubernetes Use Cases in Financial Services: Lessons Learned from Capital One, BlackRock and Bloomberg**"
  - When:
    - Thursday, Oct. 11th @ 4:25pm
  - Capital One Panel Member:
    - **Jeffrey Odom**

THE END