Seamlessly deploying & managing Kubernetes across multi-cloud with VMware Technologies

Table of Contents*:*

Multi-Cloud Challenges and VMware Cloud Capabilities

The impact of cloud continues to be undeniable to both business and IT. Cloud has redefined the relationship between business and IT, reshaping business models, accelerating delivery of new business services, created new models for customer engagement and improved the efficiency and effectiveness of employees.

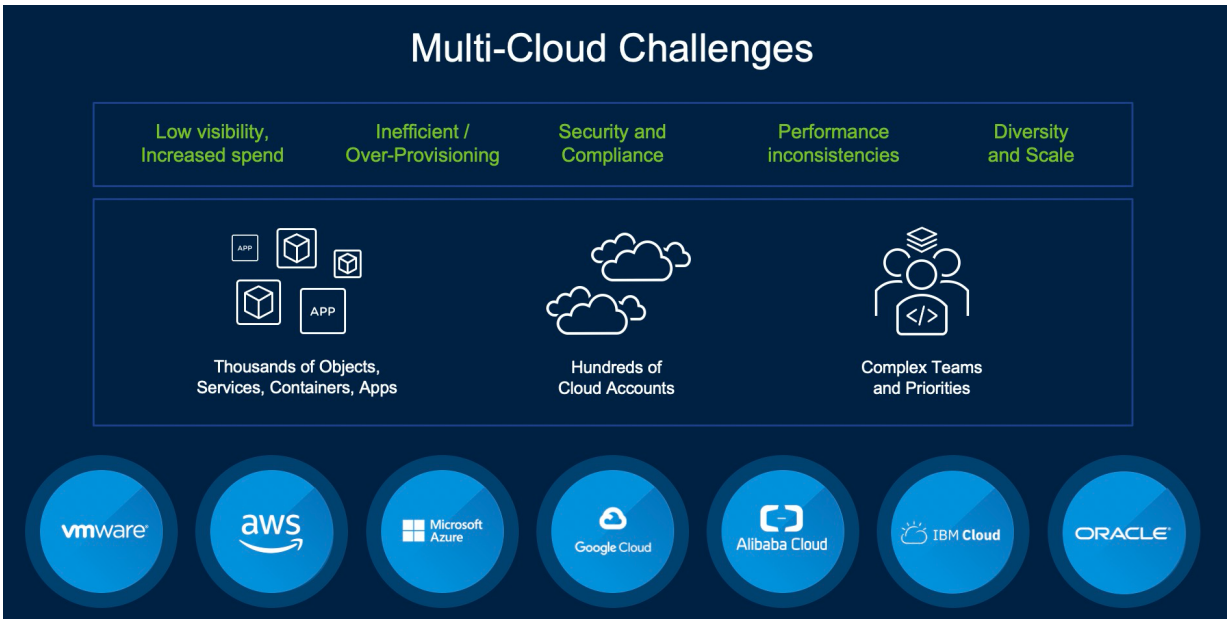


Figure 1: Challenges with Multi-Cloud

But the cloud market is at an inflection point. Organizations have hundreds or thousands of applications - both existing monoliths and new cloud microservices. They are all different. But they are also critical to their business. Longstanding app architectures are giving way to new cloud native models. The worlds of datacenter, cloud and edge are converging. And the diversity of multi-cloud, once viewed as chaotic and complex, is emerging as the most powerful source of innovation.

What Defines the Ideal Cloud Environment?

- Freedom to build and run applications for ANY environment
- With development and operations teams collaborating freely
- Ability to manage diverse environments CONSISTENTLY
- With applications and data that are secure and protected EVERYWHERE
- And the freedom to change my mind in the future without PENALTY

Figure 2: The VMware Multi-Cloud Strategy

Only VMware can drive the next generation of cloud, supporting ambitious multi-cloud strategies, for all application initiatives to deliver unprecedented business value. VMware App Modernization delivers the technology to build, run, and manage all these applications across any cloud, and the team to guide any organization's application modernization effort.

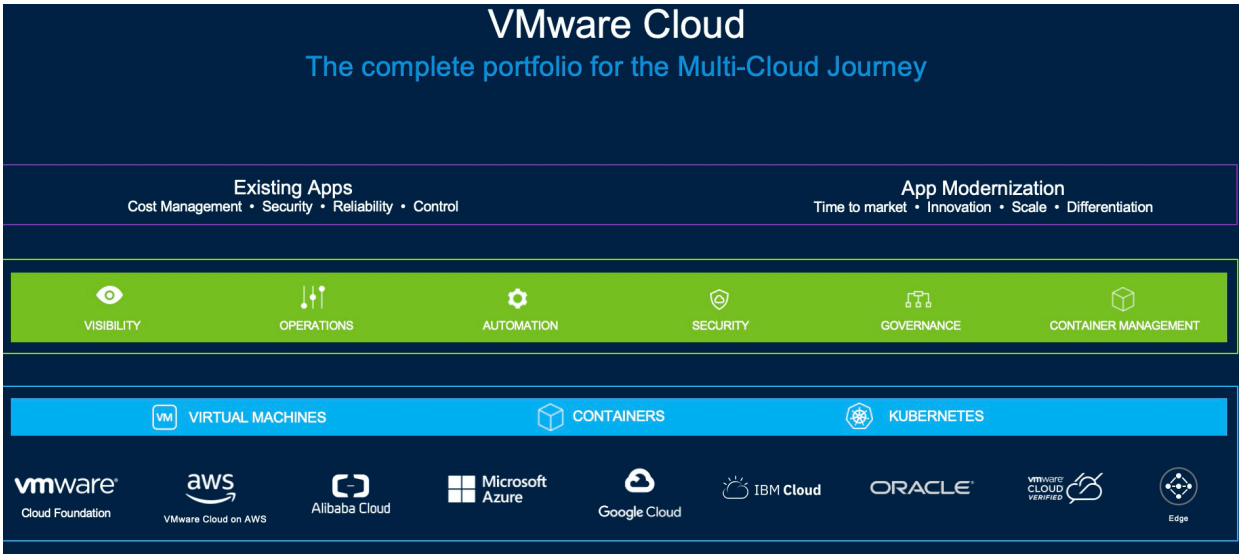


Figure 3: Portfolio of a multi-cloud journey

VMware offers the complete portfolio for the multi-cloud journey for any enterprise on any cloud. It provides a platform where both legacy and modern apps can co-exist and ubiquitously run across different cloud without re-platforming.

Kubernetes provides an ideal platform for Multi and Hybrid Cloud

Kubernetes provides the capability for container orchestration, while also facilitating an easy way to encapsulate applications. The Kubernetes management system provides a standardized mechanism for application delivery that is decoupled from the underlying infrastructure and can run in any cloud. All public & private cloud providers have adopted cloud-native technology and make it possible for running

applications in a standardized manner across a multi-cloud infrastructure. Modern developers can now leverage Kubernetes APIs in multi-cloud environments anywhere in the world to deploy their applications. Kubernetes has energized the software industry's need for productivity, efficiency, by leveraging cloud-native technology available anywhere across public and private clouds.

Tanzu Kubernetes Grid (TKG)

Things get complex while running tens of thousands of containers across your enterprise at scale in production. Automation is mandatory for the deployment and management of all those containers on clusters of virtual or physical machines. Kubernetes, the industry-standard for container management, can streamline container orchestration to avoid the complexities of interdependent system architectures. However, there's still considerable heavy lifting that an operations team must do to stand-up and manage a Kubernetes runtime consistently, while running in multiple data centers and clouds. They must also have the in-house expertise to design, deploy and integrate all the necessary components.

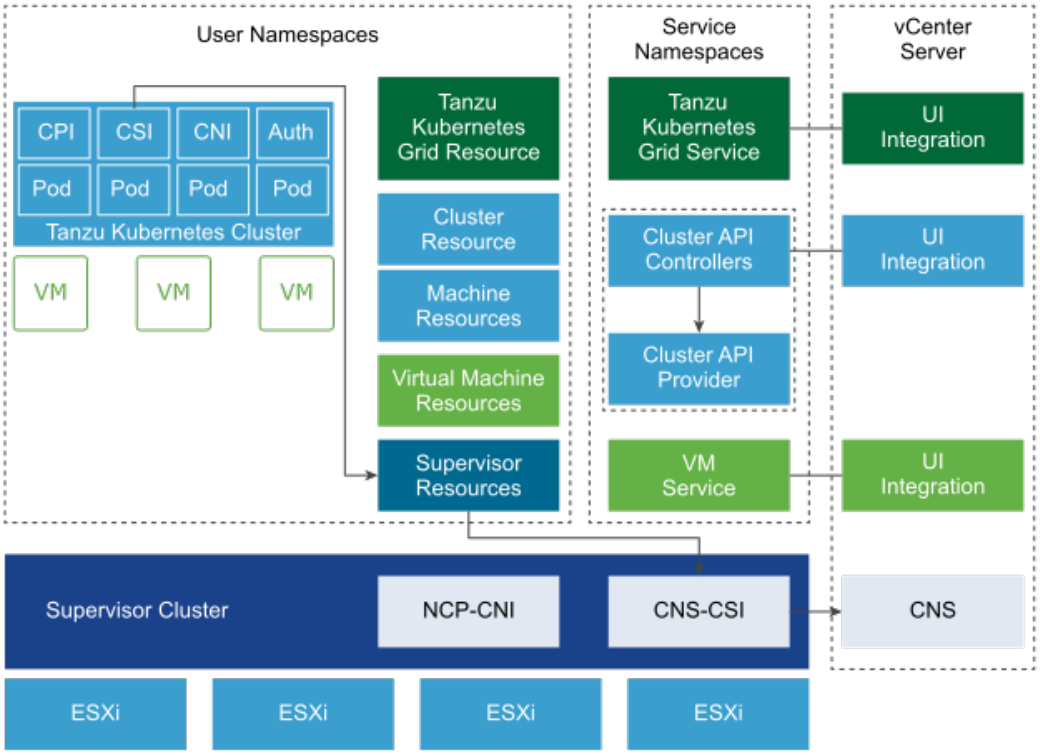


Figure 4: Tanzu Kubernetes Grid logical schematic

Tanzu Kubernetes Grid is engineered to simplify installation and Day 2 operations of Kubernetes across enterprises. It is tightly integrated with vSphere and can be extended to run with consistency across public cloud and edge environments. Tanzu Kubernetes Grid delivers multiple benefits to unlock the full potential of upstream Kubernetes and its burgeoning ecosystem of open-source cloud native technology through:

Simplified Installation

Tanzu Kubernetes Grid is engineered to include the tools and open-source technologies needed to deploy and consistently operate a scalable Kubernetes environment across VMware private cloud, i public cloud, edge, or encompassing multiple clouds.

Automated multi-cluster operations

With declarative, multi-cluster lifecycle management, a CLI tool, and streamlined upgrades and patching, Tanzu Kubernetes Grid helps enterprises easily manage large- scale, multi-cluster Kubernetes deployments and automate manual tasks to reduce business risk and focus on more strategic work.

Integrated Platform Services

Tanzu Kubernetes Grid streamlines the deployment of local and in-cluster services to simplify the configuration of container image registry policies, monitoring, logging, ingress, networking & storage, and enables the Kubernetes environment for production workloads.

Open-Source Alignment

Containerized applications can be run on an upstream-aligned Kubernetes distribution and key open-source technologies like Cluster API, Fluentbit, and Contour, enabling portability and the support and innovation of the global Kubernetes community.

Where does Tanzu Kubernetes Grid run?

Figure 5: Private Cloud Datacenter

Private cloud

With Tanzu Kubernetes Grid Service integrated with vSphere, existing data center tooling and workflows can be leveraged to give developers on-demand access to conformant Kubernetes clusters in the private cloud and managing cluster lifecycle through automated, API-driven workflows.

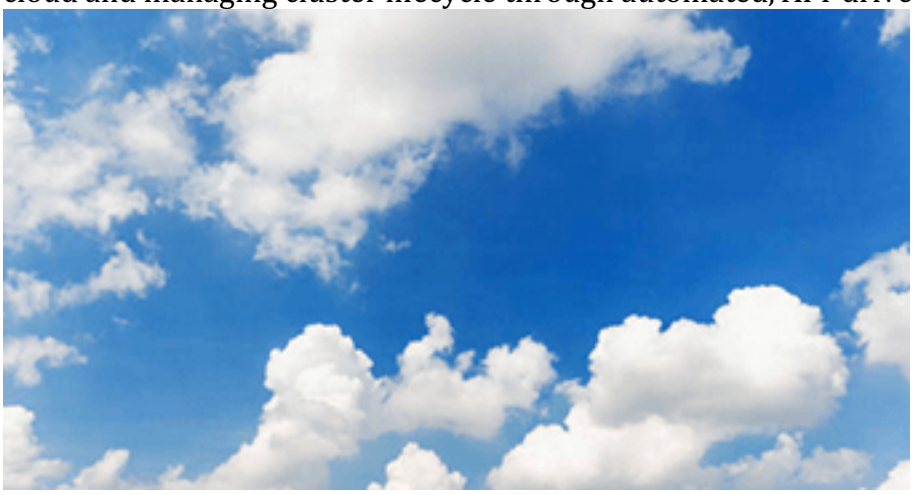


Figure 6: Public Cloud Infrastructure

Public cloud

Tanzu Mission Control can be used to enable development teams to quickly spin up managed Kubernetes clusters in their public cloud accounts, while operations maintain access to the control plane for security and customization.

Figure 7: Edge Computing Infrastructure

Edge

Tanzu Kubernetes Grid's open architecture enables lightweight deployments and streamlined multicluster operations in highly distributed edge environments, like retail remote site locations.

Tanzu Service Mesh

Tanzu Service Mesh provides consistent connectivity and security for microservices across all Kubernetes clusters and clouds in the most demanding multi-cluster and multi-cloud environments. Tanzu Service Mesh can be installed in Tanzu Kubernetes Grid (TKG) clusters and third-party Kubernetes-conformant clusters. It can be used with clusters managed by Tanzu Mission Control (i.e., Tanzu-managed clusters) or clusters managed by other Kubernetes platforms and managed services.

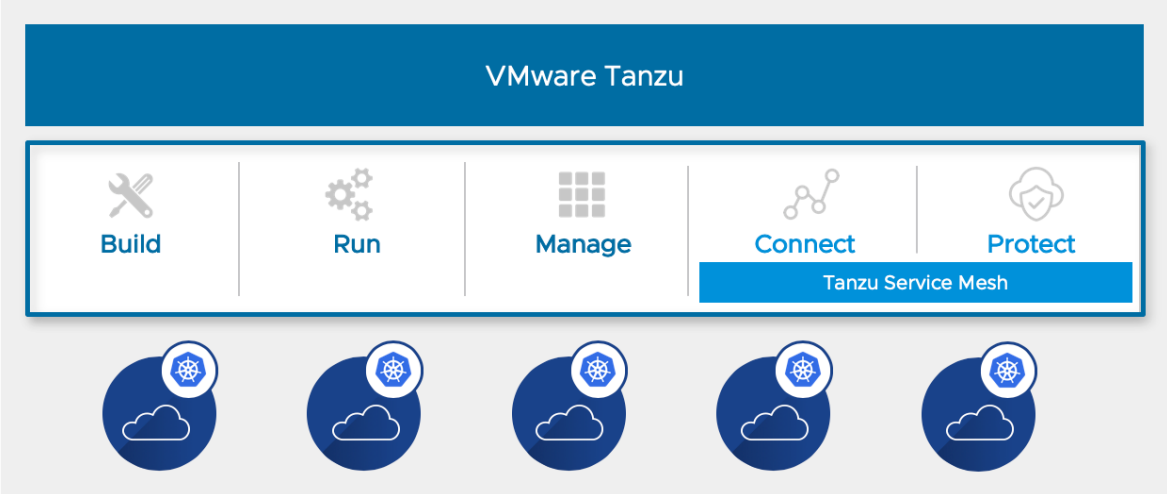


Figure 8: Tanzu Service Mesh provides security across multi-cloud Kubernetes

What Makes Tanzu Service Mesh Different?

Beyond its multi-cloud focus, one of the other differentiating characteristics of Tanzu Service Mesh is its ability to support cross-cluster and cross-cloud use cases via Global Namespaces (GNS). A GNS abstracts an application from the underlying Kubernetes cluster namespaces and networking, allowing you to transcend infrastructure limitations and boundaries, and securely stretch applications across clusters and clouds. Global Namespaces allow you to have consistent traffic routing, application resiliency, and security policies for your applications across cloud siloes, regardless of where the applications are running.

By enabling and delivering true multi-cloud capabilities, GNS can offer improved agility, business continuity, visibility, and better security for your modern applications.

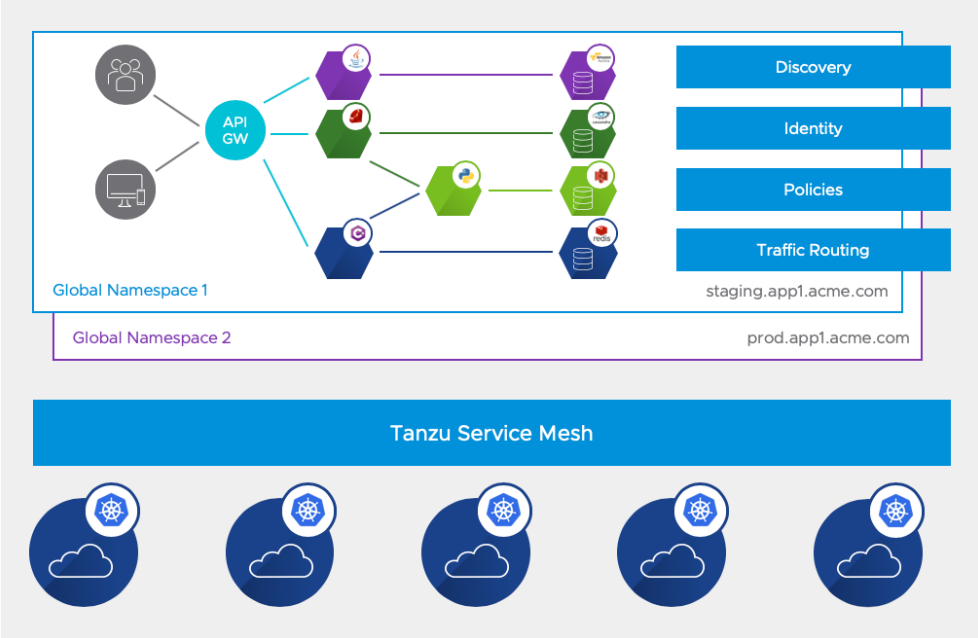


Figure 9: Tanzu Service Mesh & Global Namespaces

In addition to providing an abstraction for applications, GNS also provides strong isolation that can be used for multi-tenancy model for application teams and business units. Each of these groups can have as many GNSs as they need for their application. More about GNS can be found at "Using Global Namespaces to secure multi-cloud applications".

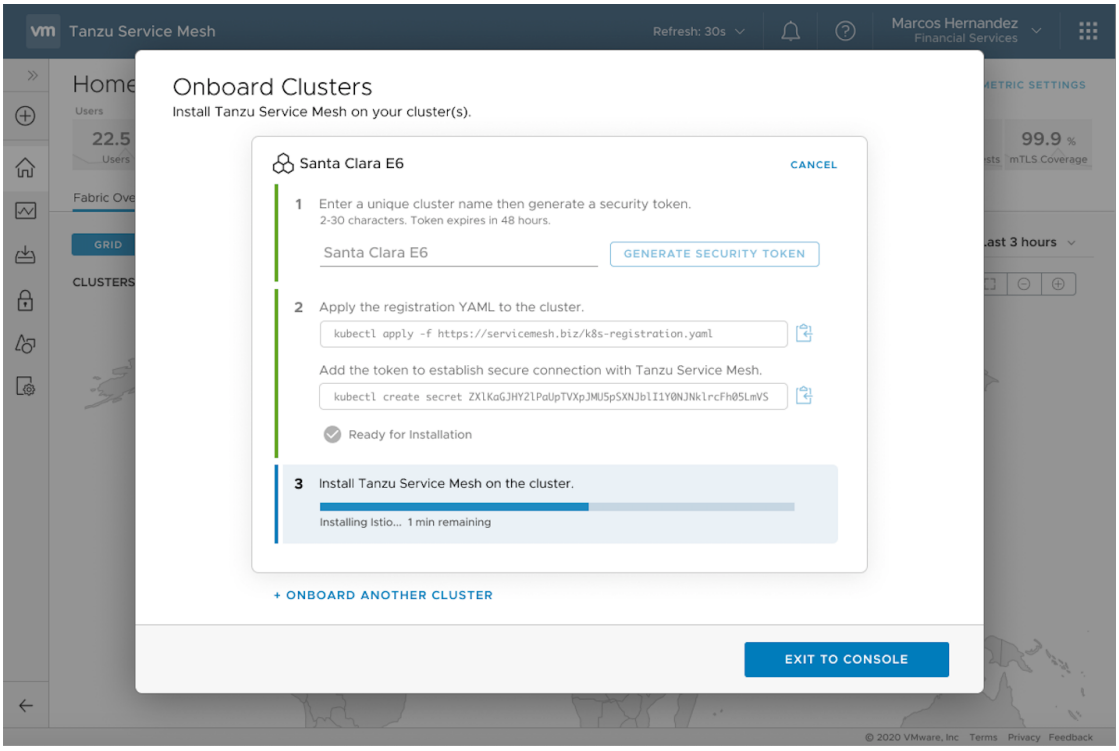


Figure 10: Onboarding Clusters on Tanzu Service Mesh

Tanzu Service Mesh can also automate and simplify the installation and lifecycle management of the service mesh bits running inside your Kubernetes clusters, while maintaining intended configuration values. One can also "move" application services without having to change anything in the application itself, which brings the idea of multi-cloud or hybrid-cloud workloads to life. This cross-domain/cross-cloud communication requires additional security considerations, so GNS encrypts the traffic, end to end, between the services across clusters and clouds.

Tanzu Mission Control:

Tanzu Mission Control, now available through VMware Cloud Partner Navigator, is a centralized management platform for consistently operating and securing your Kubernetes infrastructure and modern applications across multiple teams and clouds. Tanzu Mission Control provides operators with a single control point to give developers the independence they need to drive business forward, while enabling consistent management and operations across environments for increased security and governance.

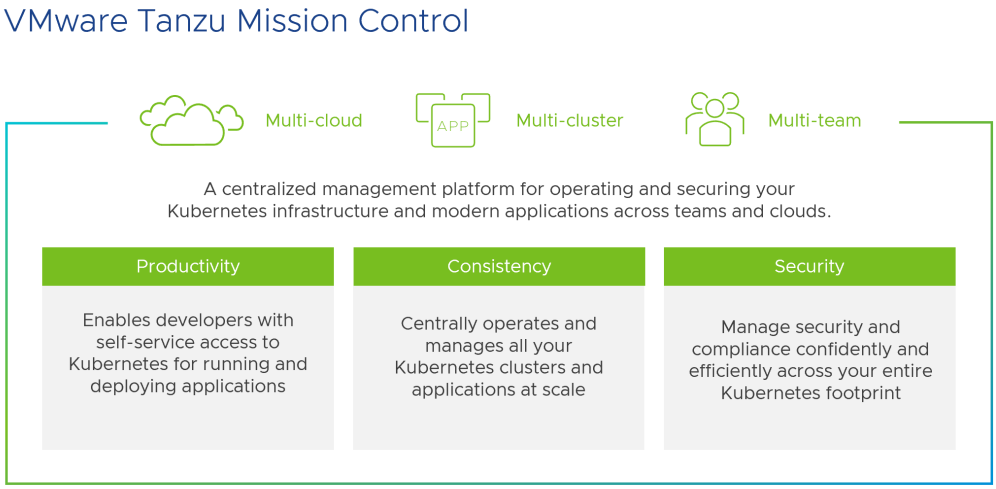
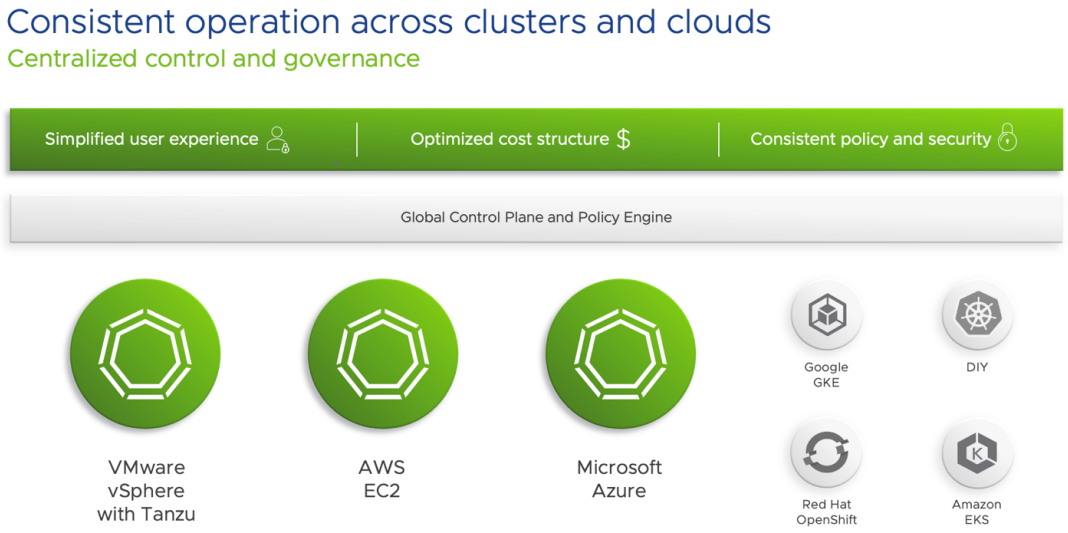


Figure 11: VMware Tanzu Mission Control offers a centralized Kubernetes management platform

The infrastructure and platform teams use Tanzu Mission Control to enable developers with self-service access to Kubernetes. It also allows them to centrally operate and manage the Kubernetes clusters and modern apps running on them with efficiency, consistency, and security. Application teams use Tanzu Mission Control to better manage and maintain applications by easily deploying services and workloads across clusters, better understanding the health of their applications and quickly troubleshooting issues.

Provider and Customer Challenges

There are a variety of Kubernetes distributions out there. Managing access, policy, security and cost across isolated distributions can be a challenge. Tanzu Mission Control provides a centralized management platform, giving managed service providers and their users the independence, they need to drive business forward, while enabling consistent management and operations across environments at scale.



- Multi-Cluster Management
- Manage Kubernetes on vSphere 7
- Kubernetes Deployment at the Edge

Figure 12: Tanzu Mission provides consistent operations across clouds

The Problem

It is hard to consistently connect, control, monitor, and remediate cloud native apps. Moderns App are running in multiple platforms and clouds. There are multiple endpoints to monitor, scale, and make them resilient. Operational and remediation policies differ across clouds. Security, auditing and compliance are disoriented

Solution Components

TKG allows use of existing data center tools and workflows to give developers secure, self-serve access to conformant Kubernetes clusters in their VMware private cloud and extend the same consistent Kubernetes runtime across their public cloud and edge environments. TKG can enable consistent Kubernetes everywhere with automated multi-cluster operations, validated integrated services and enterprise-wide management.

VMware Tanzu Mission Control gives teams self service capabilities to spin up their own Kubernetes clusters, while keeping track of all their services using workspaces. Workspaces work across clusters provides teams the flexibility they need to run their services, while conforming to organizational policies.

Workspaces also allows operations teams to assign policy in a hierarchical way at the global, cluster, and workspace level.

Tanzu Service mesh provides the ability to run applications across multi-cloud environments. It ensures application high availability and resiliency to deliver on application SLAs and ensure a positive experience for application users, while protecting sensitive data and ensuring compliance. It enables operational Control to deliver consistent and intelligent operations across cloud environments.

This solution seeks to combine the capabilities of TKG, Tanzu Mission Control and Tanzu Service Mesh to host an end to end secure and optimized multi-cloud application. Kubernetes is deployed distinct multi-cloud locations that include VMC on AWS and VMC on Dell EMC.

The Solution

This solution show cases a multi-cloud deployment of a distributed application leveraging Tanzu Kubernetes Grid. The multi cloud TKG solution is deployed in a distributed fashion across two different cloud environments that includes a VMC on AWS SDDC in Oregon and VMC on Dell EMC SDDC in Santa Clara. Tanzu Mission Control and Tanzu service mesh described below are used to operationalize, secure and manage the environment.

Solution Architecture

The logical schematic of the solution is shown. TKG is deployed independently in two distinct multicloud locations that include a VMC on AWS SDDC and a VMC on Dell EMC Edge location. Tanzu Mission Control is used to manage these TKG clusters in a centralized manner as shown. Tanzu Service mesh is used to create a global namespace and provides for monitoring, automation, policy management and secure communications across the multi-cloud infrastructure. An example e-commerce application was deployed across the multicloud environment to showcase the capabilities of the solution.

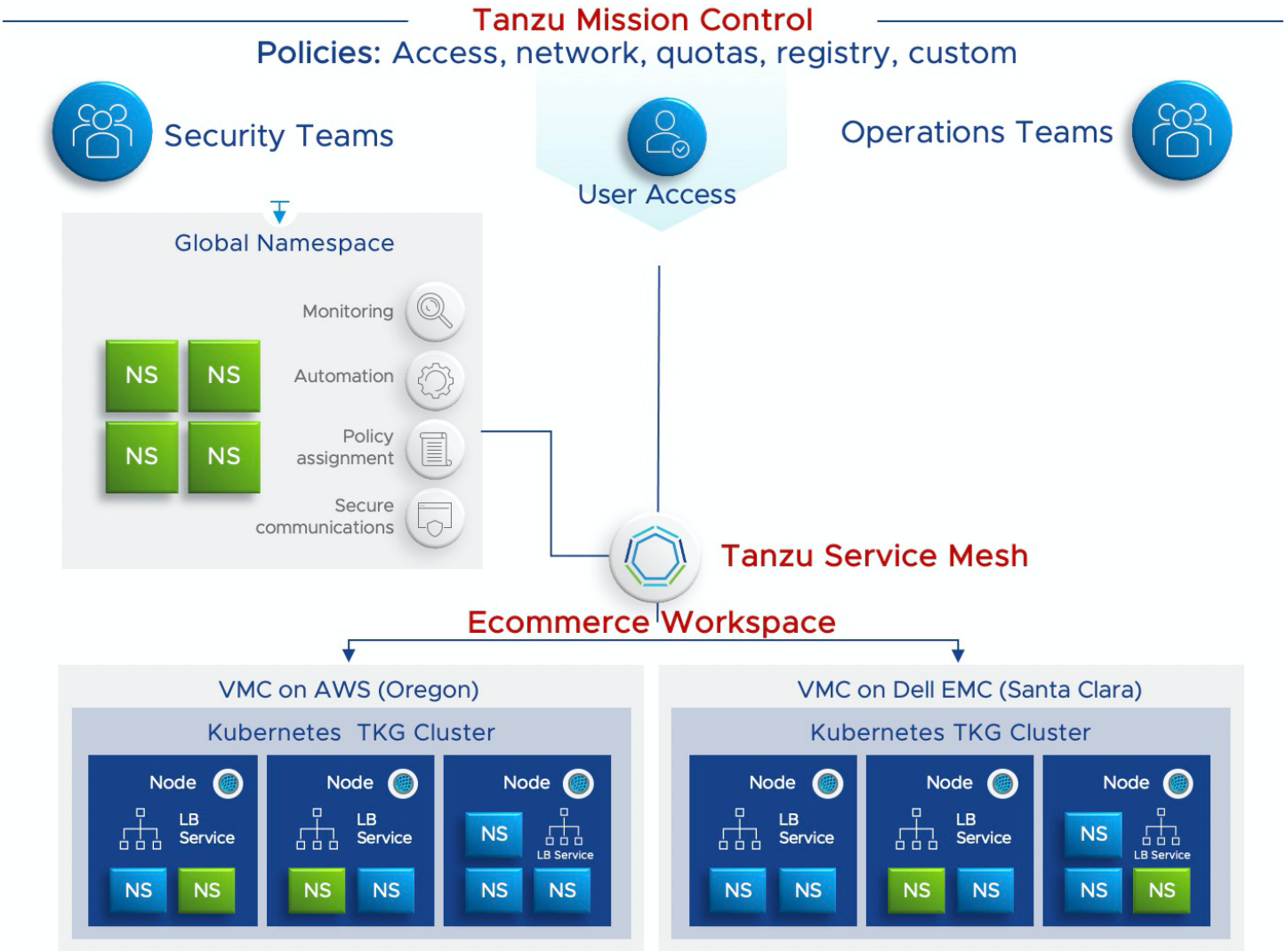


Figure 13: Logical schematic of solution showing all components

Solution Configuration

VMware Tanzu Mission Control (TMC) is used to centrally manage Kubernetes clusters. The two Kubernetes clusters, one running in VMC on AWS and the other in VMC in Dell EMC are shown in the TMC console.

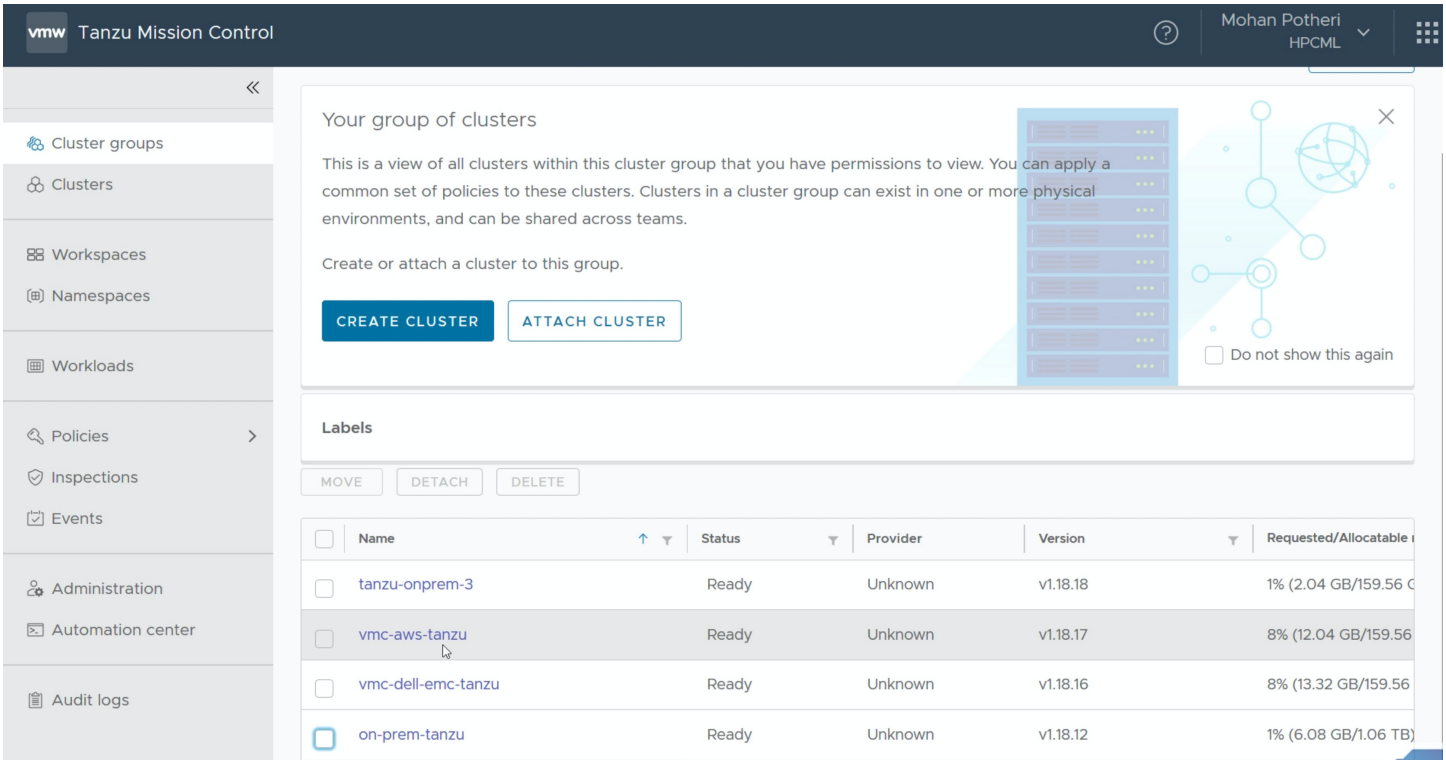


Figure 14: Tanzu Mission Control console showing the two managed clusters in the solution

VMware Tanzu Mission Control provides insight into all aspects of the Kubernetes clusters it manages. It provides a graphical view of all the health metrics, the nodes, namespaces and workloads.

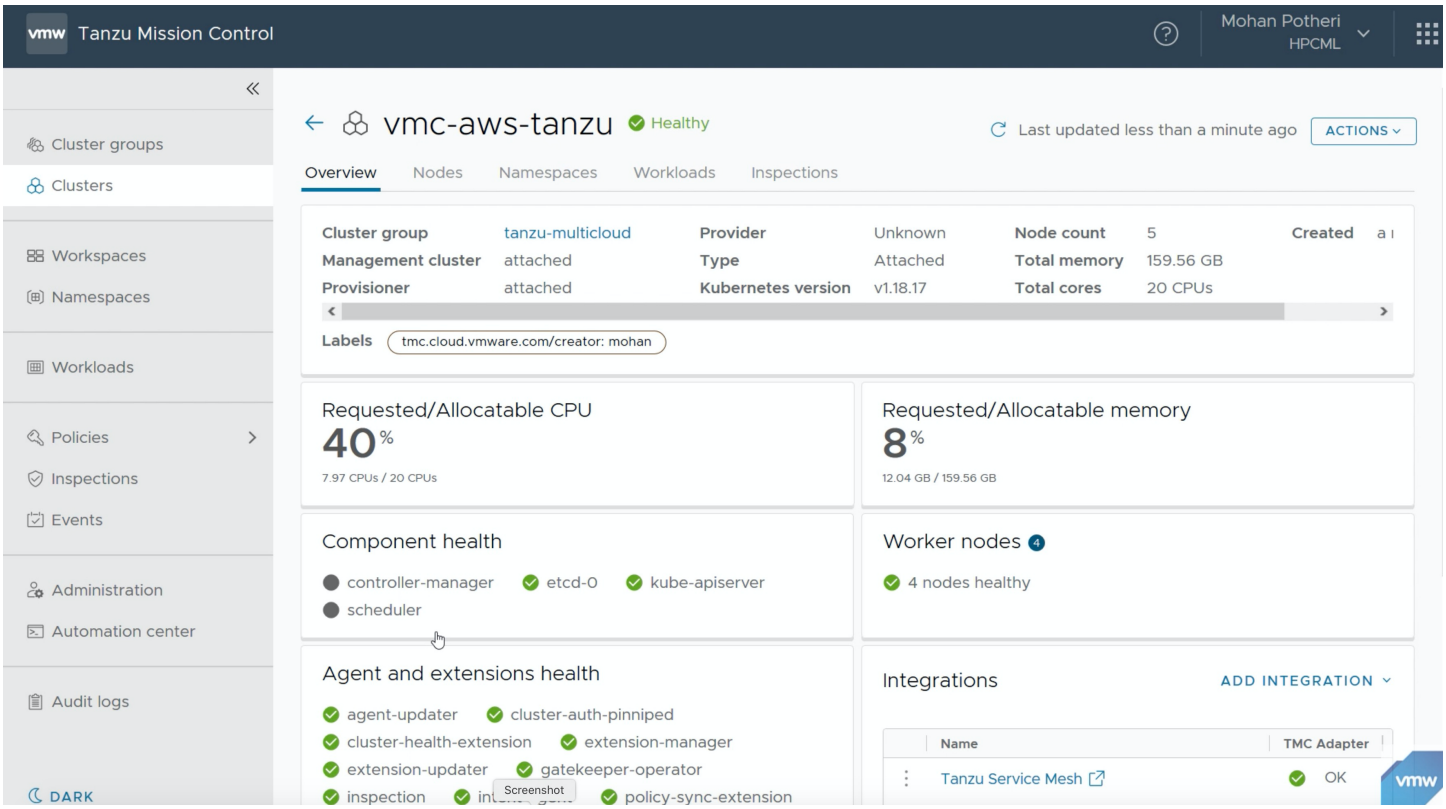


Figure 15: VMC on AWS TKG Cluster overview in TMC

The VMC on Dell EMC Kubernetes cluster is shown below. The master node is identified as the control plane and the four worker nodes are shown below that.

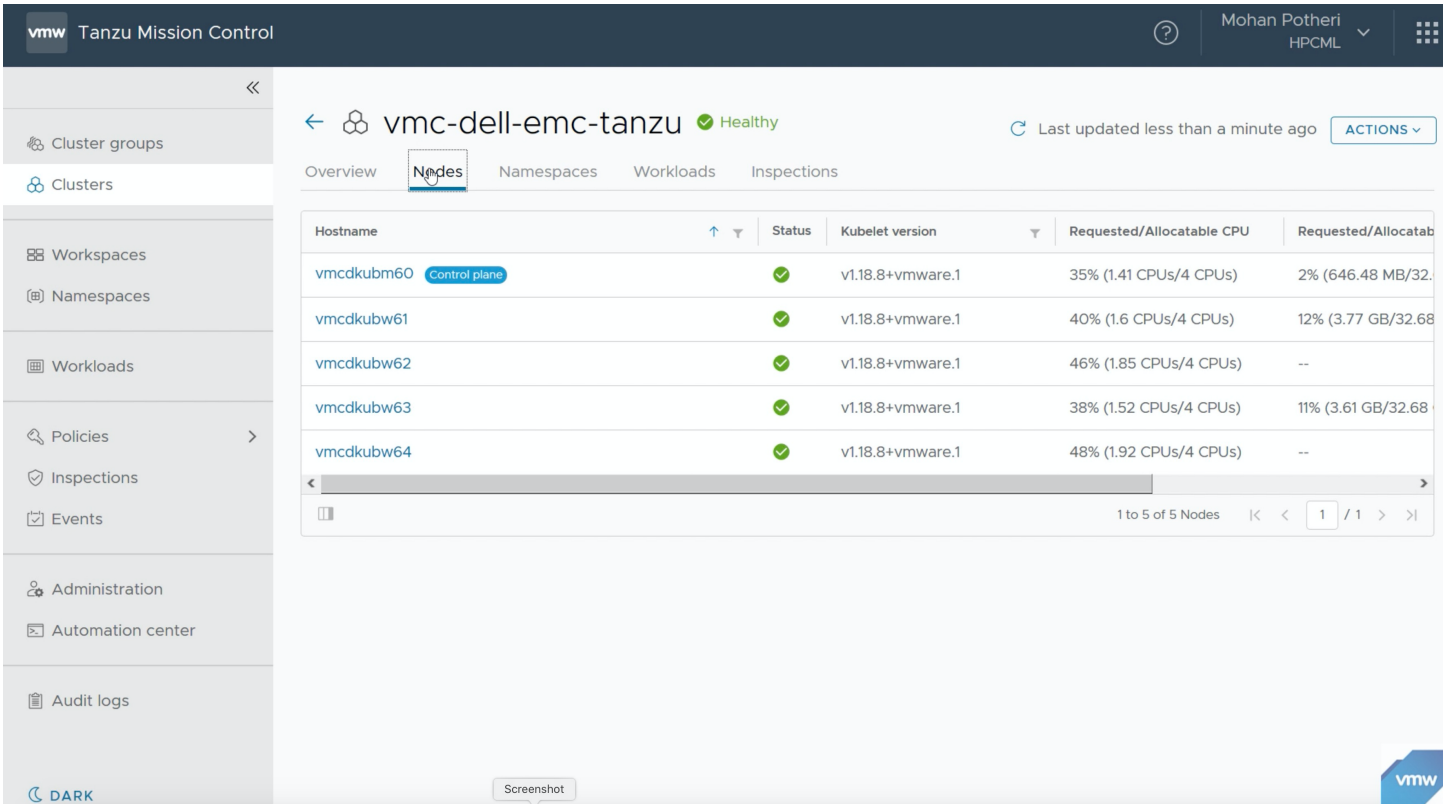


Figure 16: VMC on Dell EMC TKG Cluster nodes as seen in TMC

Tanzu Service Mesh (TSM) console is shown with all its components. The sample global namespace used by the multi-cloud web application is shown.

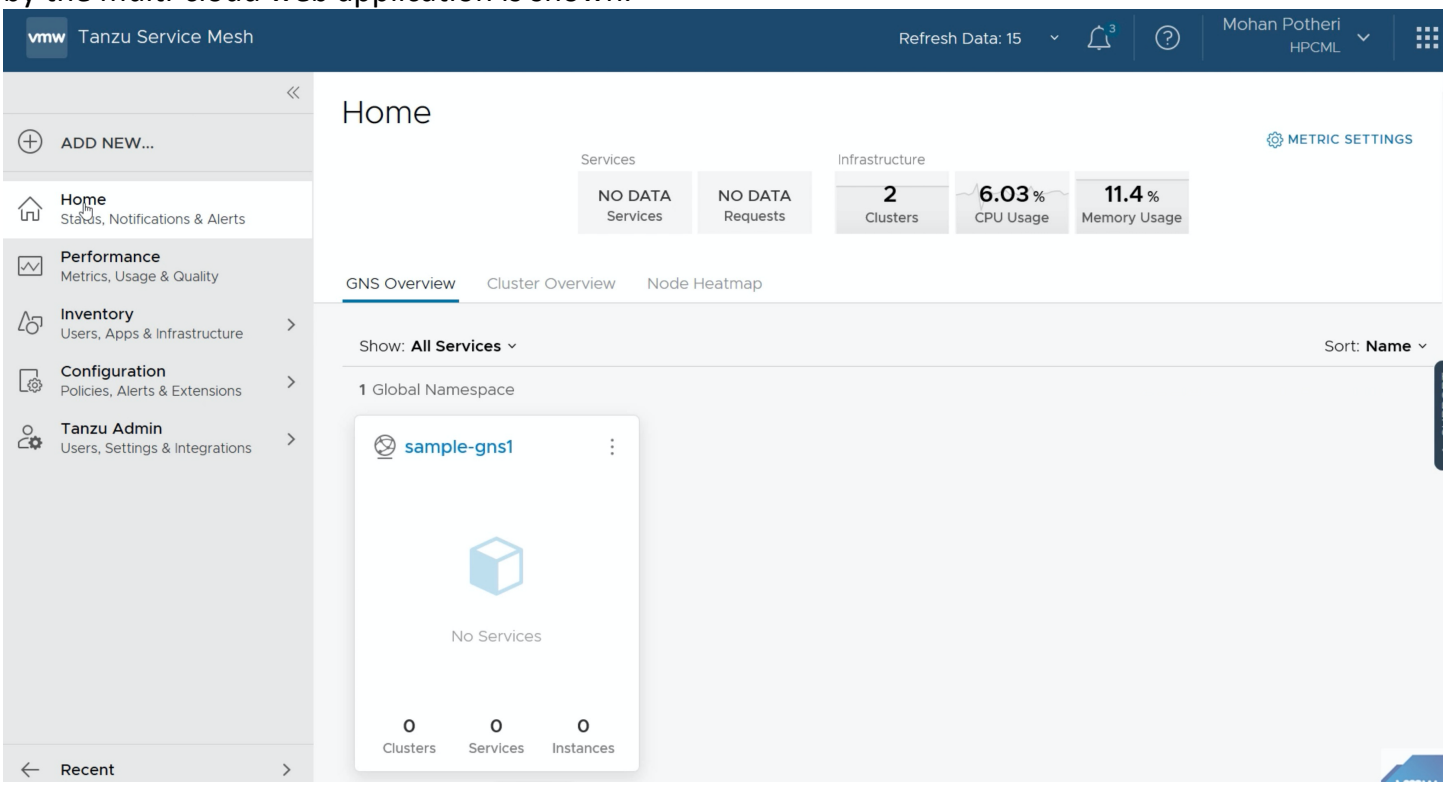


Figure 17: Global Namespace for solution in Tanzu Service Mesh

The two clusters are combined into a global namespace as shown below with Tanzu Service Mesh. TSM secures and manages the communication across the clusters and the namespace.

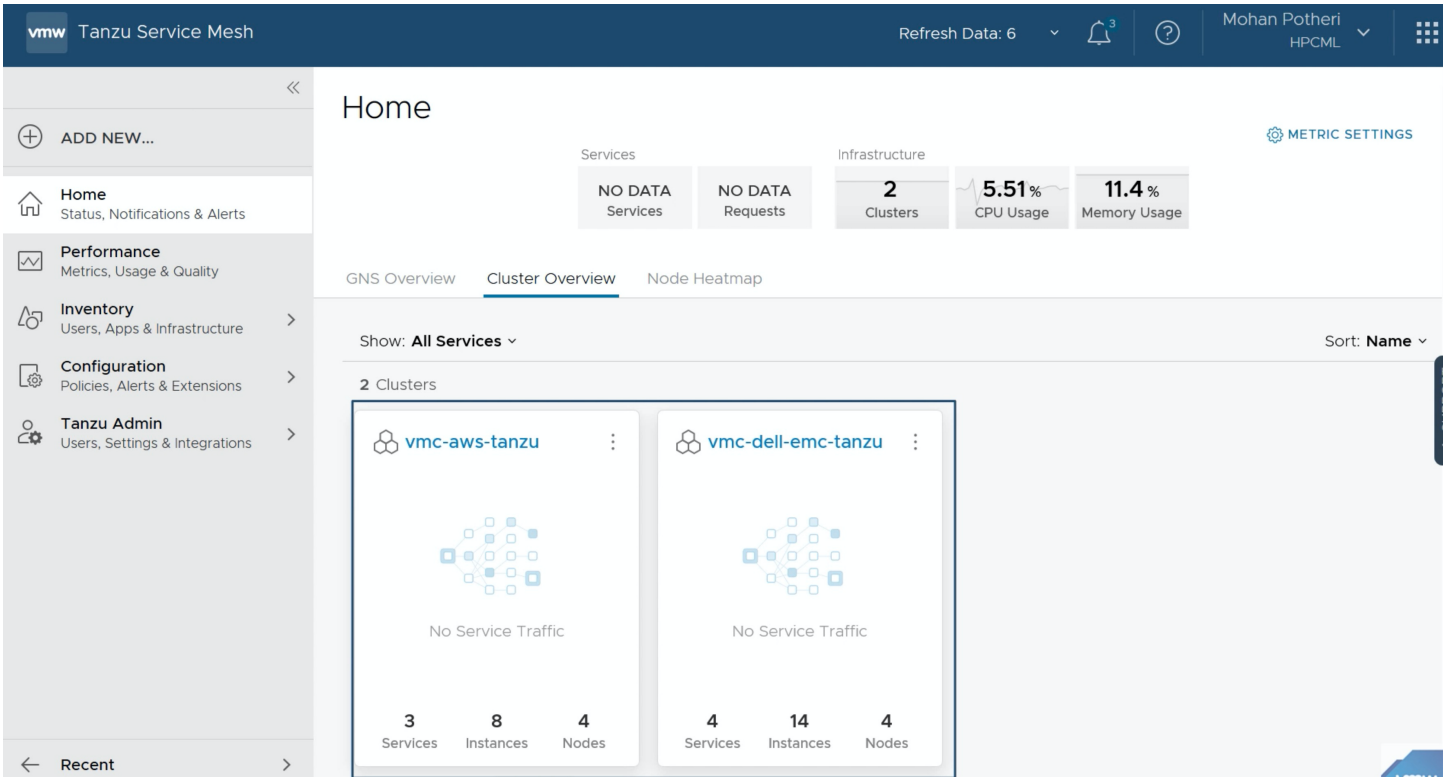


Figure 18: VMC on AWS TKG Cluster overview in TMC

Details about the sample service “sample.acme.com” and its details in TSM are shown. Details about the application security and certificates are shown.

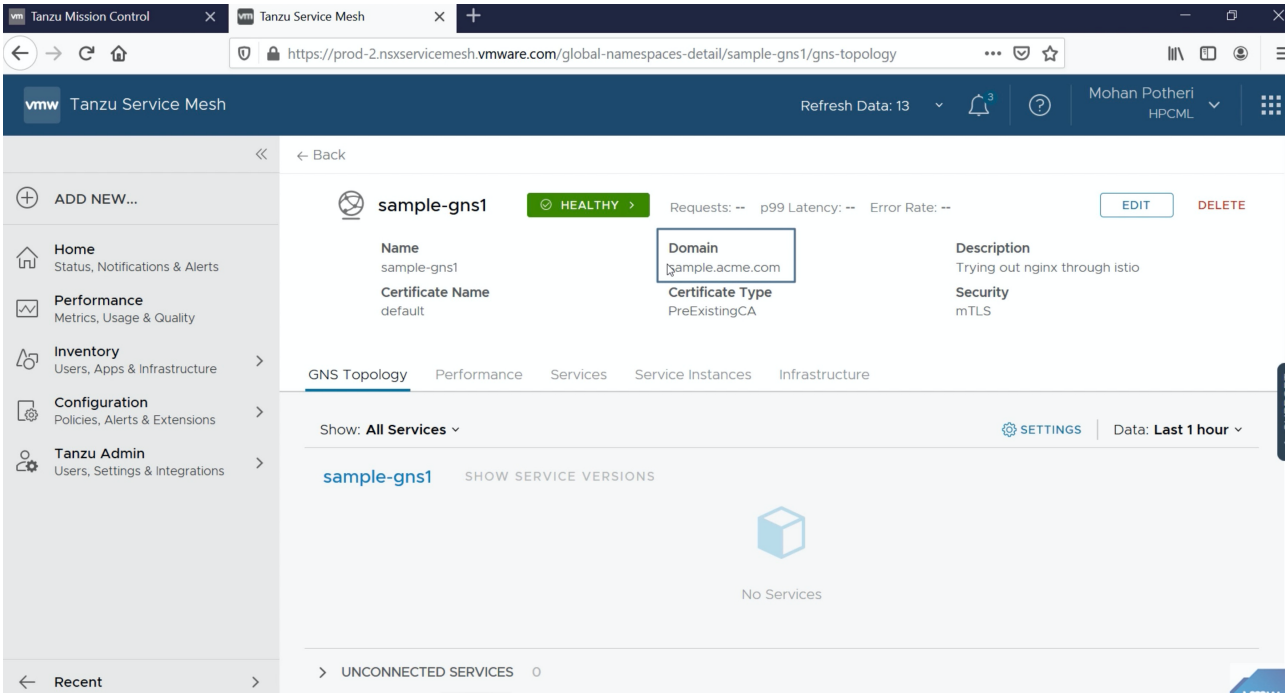


Figure 19: Details of the Global Namespace and associated application service

A snippet from the yaml file from acme fitness service is shown with details of the shopping application. Full version of the YAML file can be seen in Appendix A.

acme_fitness_cluster1.yaml | secrets.yaml | gateway.yaml | acme_fitness_clu

```
  template:
    metadata:
      labels:
        app: shopping
        service: shopping
    spec:
      containers:
      - image: gcr.io/vmwarecloudadvocacy/acmeshop-front-end:rel1
        name: shopping
        imagePullPolicy: IfNotPresent
        env:
        - name: FRONTEND_PORT
          value: '3000'
        - name: USERS_HOST
          value: 'users.sample.acme.com'
        - name: CATALOG_HOST
          #value: 'catalog.acme.com'
          value: 'catalog.sample.acme.com'
        - name: ORDER_HOST
          value: 'order.sample.acme.com'
        - name: CART_HOST
          value: 'cart.sample.acme.com'
        - name: USERS_PORT
```

Figure 20: Snippet of the ACME Fitness Application YAML file

Shown is a listing of some of the commands that were run for the the creation of a mongo dB database and other components of the acme fitness application.

```
root@vmckubm70:acme-cluster-2# ls
acme_fitness_cluster2.yaml  secrets.yaml
root@vmckubm70:acme-cluster-2# kc secrets.yaml
secret/redis-pass created
secret/catalog-mongo-pass created
secret/order-mongo-pass created
secret/users-mongo-pass created
root@vmckubm70:acme-cluster-2# kc acme_fitness_cluster2.yaml
configmap/catalog-initdb-config created
service/catalog-mongo created
deployment.apps/catalog-mongo created
service/catalog created
deployment.apps/catalog created
root@vmckubm70:acme-cluster-2#
```

Figure 21: Commands showing creation of ACME fitness App service

Components of the acme application in the VMC on Dell EMC Kubernetes is shown in a flow chart format. TSM shows compelling views of the applications it manages and their relationship.

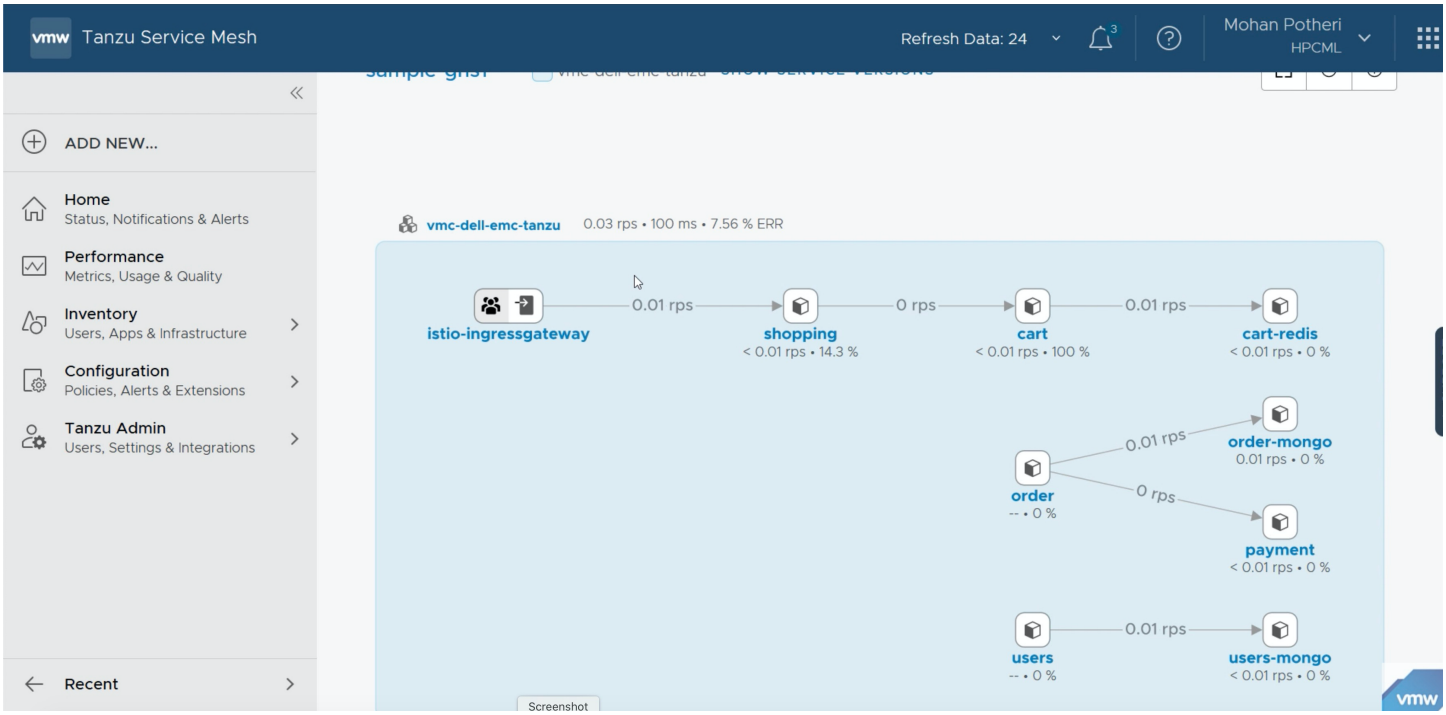


Figure 22: Components of the ACME app and their relationships as seen in TSM

The web interface of the multi-tiered application is shown here. The application components are deployed across two different Kubernetes clusters across a multi-cloud environment.

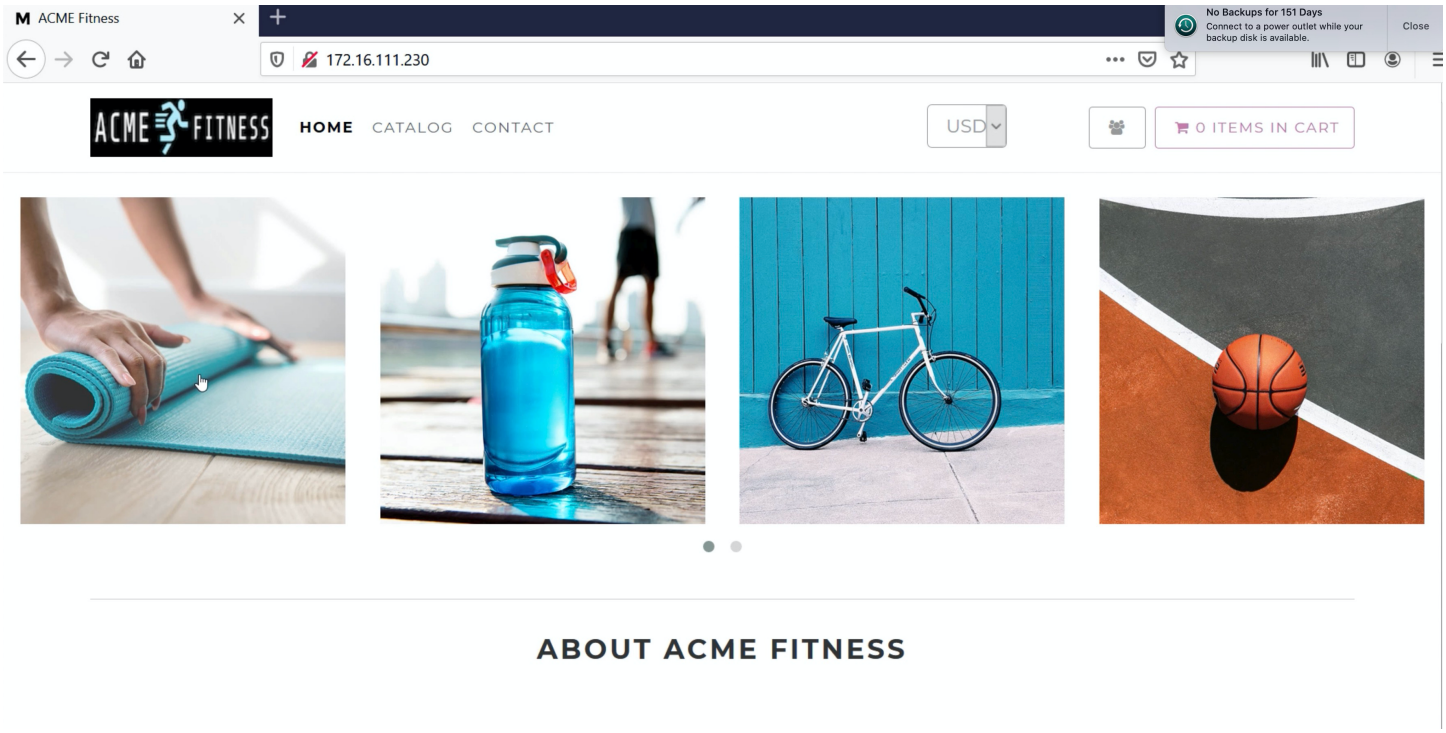


Figure 23: Web Interface of the ACME multi-tiered application

The catalog service is hosted in the VMC on AWS Kubernetes cluster while the other aspects of the solution and the mongo DB are hosted in the Kubernetes cluster running on the VMC on Dell EMC SDDC. The Tanzu Service Mesh makes it seamless for the application components to communicate with each other securely across clouds while showing a unified front to the users.

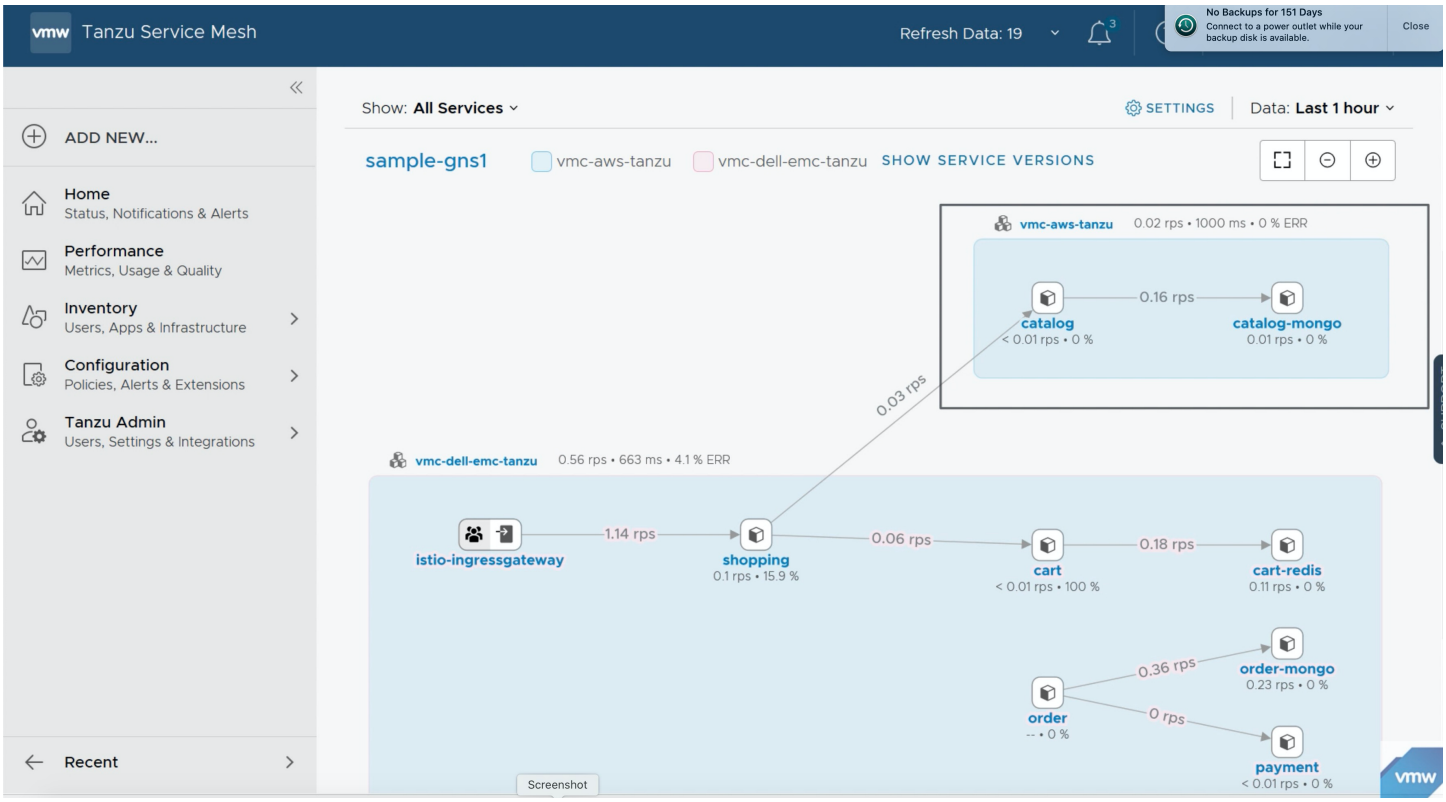


Figure 24: Global Namespace showing the application components dispersed across multi-cloud

The Kubernetes dashboard for each individual cluster helps monitor and maintain the different pods that make up the distributed web application.

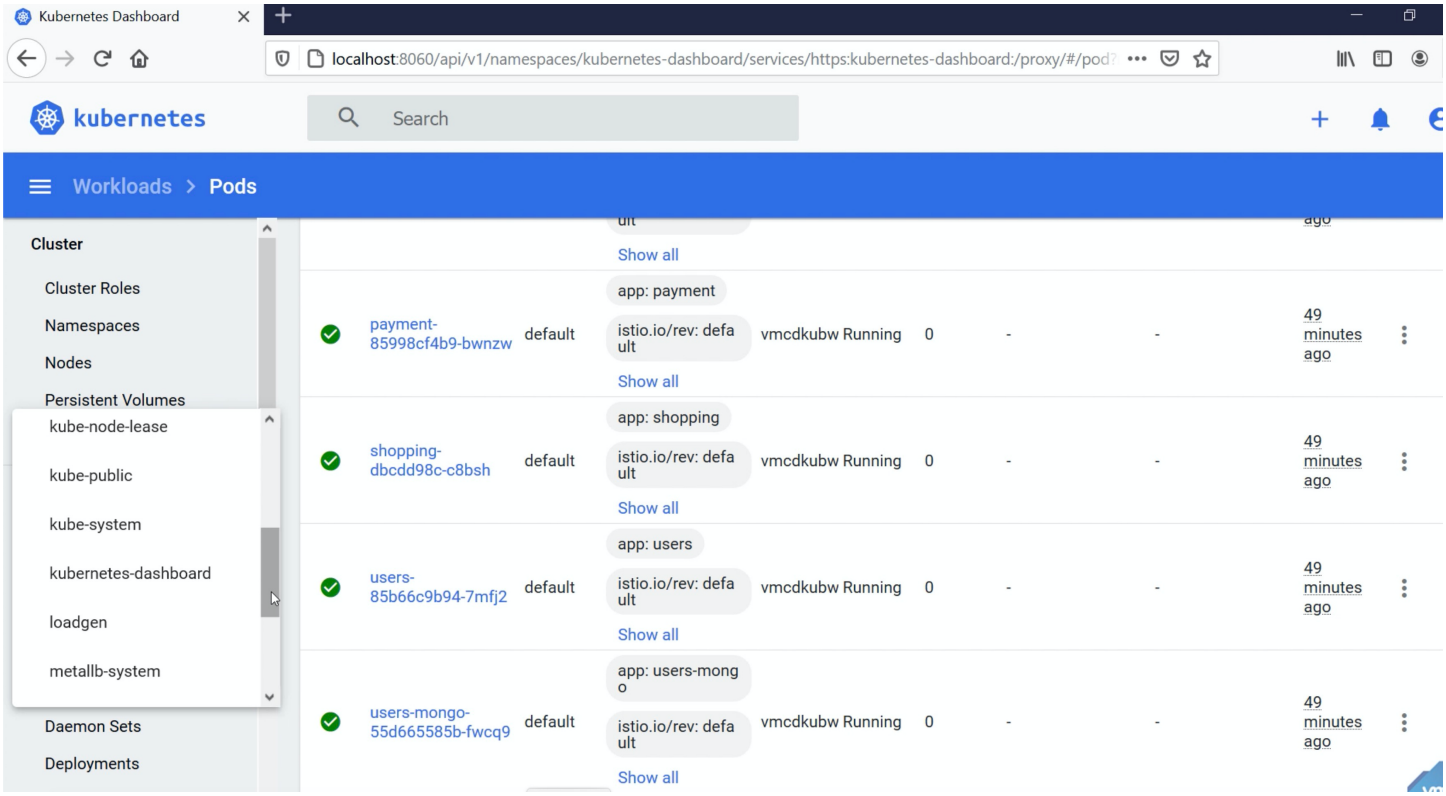


Figure 25: Kubernetes Dashboard to monitor and manage individual Kubernetes cluster

Conclusion:

In summary we have shown that this solution can leverage TKG clusters deployed across a multi-cloud environment. Tanzu mission control provides visibility and operational capabilities to manage these Kubernetes clusters with a single pane of glass. Tanzu service mesh provides the ability to combine multi-cloud applications with global namespaces and secures the application effectively across cloud boundaries. All the components showcased in this multi-cloud solution are part of the VMware Tanzu Advanced Edition. VMware Tanzu can be effectively leveraged by enterprises to deploy and manage Kubernetes application across a multi-cloud Kubernetes based environment.

Appendix A: Fitness_Cluster.yaml

```
--
apiVersion: v1
kind: Service
metadata:
name: cart-redis
labels:
app: cart-redis
service: cart-redis
spec:
ports:
- port: 6379
name: tcp-redis-cart
selector:
app: cart-redis
service: cart-redis
---
apiVersion: apps/v1
kind: Deployment
metadata:
name: cart-redis
labels:
app: cart-redis
service: cart-redis
spec:
selector:
matchLabels:
app: cart-redis  # has to match .spec.template.metadata.labels
service: cart-redis
replicas: 1
template:
metadata:
labels:
app: cart-redis  # has to match .spec.selector.matchLabels
service: cart-redis
spec:
containers:
- name: cart-redis
image: redis:5.0.3-alpine
command:
- "redis-server"
imagePullPolicy: Always
resources:
requests:
cpu: "100m"
memory: "100Mi"
ports:
- name: tcp-redis
containerPort: 6379
protocol: "TCP"
env:
- name: REDIS-HOST
value: 'cart-redis'
- name: REDIS_PASS
valueFrom:
secretKeyRef:
name: redis-pass
key: password
volumeMounts:
- mountPath: /var/lib/redis
name: redis-data
#          - mountPath: /etc/redis
#            name: redis-config
volumes:
- name: redis-data
emptyDir: {}
#       - name: redis-config
#         configMap:
#           name: redis-config
#           items:
#             - key: redis-config
#               path: redis.conf
---
apiVersion: v1
kind: Service
metadata:
name: cart
labels:
app: cart
service: cart
spec:
ports:
- name: http-cart
protocol: TCP
port: 5000
selector:
app: cart
service: cart
---
apiVersion: apps/v1
kind: Deployment
metadata:
name: cart
labels:
app: cart
service: cart
spec:
selector:
matchLabels:
app: cart
service: cart
strategy:
type: Recreate
replicas: 1
template:
metadata:
labels:
app: cart
service: cart
spec:
volumes:
- name: cart-data
emptyDir: {}
containers:
- image: gcr.io/vmwarecloudadvocacy/acmeshop-cart:1.0.0
name: cart
env:
- name: REDIS_HOST
value: 'cart-redis'
- name: REDIS_PASS
valueFrom:
secretKeyRef:
name: redis-pass
key: password
- name: REDIS_PORT
value: '6379'
- name: CART_PORT
value: '5000'
ports:
- containerPort: 5000
name: http-cart
volumeMounts:
- mountPath: "/data"
name: "cart-data"
resources:
requests:
memory: "64Mi"
cpu: "100m"
limits:
memory: "256Mi"
cpu: "500m"
---
apiVersion: v1
kind: Service
metadata:
name: shopping
labels:
app: shopping
```

```
service: shopping
spec:
ports:
- name: http-shopping
protocol: TCP
port: 3000
selector:
app: shopping
service: shopping
---
apiVersion: apps/v1 # for versions before 1.8.0 use apps/v1beta1
kind: Deployment
metadata:
name: shopping
labels:
app: shopping
service: shopping
spec:
selector:
matchLabels:
app: shopping
service: shopping
strategy:
type: Recreate
replicas: 1
template:
metadata:
labels:
app: shopping
service: shopping
spec:
containers:
- image: gcr.io/vmwarecloudadvocacy/acmeshop-front-end:rel1
name: shopping
env:
- name: FRONTEND_PORT
value: '3000'
- name: USERS_HOST
value: 'users'
- name: CATALOG_HOST
value: 'catalog.acme.com'
- name: ORDER_HOST
value: 'order'
- name: CART_HOST
value: 'cart'
- name: USERS_PORT
value: '8081'
- name: CATALOG_PORT
value: '8082'
- name: CART_PORT
value: '5000'
- name: ORDER_PORT
value: '6000'
ports:
- containerPort: 3000
name: http-shopping
---
apiVersion: v1
kind: Service
metadata:
name: order-mongo
labels:
app: order-mongo
service: order-mongo
spec:
ports:
- port: 27017
name: mongo-order
protocol: TCP
selector:
app: order-mongo
service: order-mongo
---
apiVersion: apps/v1
kind: Deployment
metadata:
name: order-mongo
labels:
app: order-mongo
service: order-mongo
spec:
selector:
matchLabels:
app: order-mongo  # has to match .spec.template.metadata.labels
service: order-mongo
replicas: 1
template:
metadata:
labels:
app: order-mongo  # has to match .spec.selector.matchLabels
service: order-mongo
spec:
containers:
- name: order-mongo
image: mongo:4
resources:
{}
ports:
- name: mongo-order
containerPort: 27017
protocol: "TCP"
env:
- name: MONGO_INITDB_ROOT_USERNAME
value: 'mongoadmin'
- name: MONGO_INITDB_ROOT_PASSWORD
valueFrom:
secretKeyRef:
name: order-mongo-pass
key: password
volumeMounts:
- mountPath: /data/db
name: mongodata
volumes:
- name: mongodata
emptyDir: {}
#       - name: mongodata
#         persistentVolumeClaim:
#           claimName: mongodata
---
apiVersion: v1
kind: Service
metadata:
name: order
labels:
app: order
service: order
spec:
ports:
- name: http-order
protocol: TCP
port: 6000
selector:
app: order
service: order
---
apiVersion: apps/v1 # for versions before 1.8.0 use apps/v1beta1
kind: Deployment
metadata:
name: order
labels:
app: order
service: order
spec:
selector:
matchLabels:
app: order
service: order
strategy:
type: Recreate
replicas: 1
template:
metadata:
```

```
labels:
app: order
service: order
spec:
volumes:
- name: order-data
emptyDir: {}
containers:
- image: gcr.io/vmwarecloudadvocacy/acmeshop-order:1.0.1
name: order
env:
- name: ORDER_DB_HOST
value: 'order-mongo'
- name: ORDER_DB_PASSWORD
valueFrom:
secretKeyRef:
name: order-mongo-pass
key: password
- name: ORDER_DB_PORT
value: '27017'
- name: ORDER_DB_USERNAME
value: 'mongoadmin'
- name: ORDER_PORT
value: '6000'
- name: PAYMENT_PORT
value: '9000'
- name: PAYMENT_HOST
value: 'payment'
ports:
- containerPort: 6000
name: http-order
volumeMounts:
- mountPath: "/data"
name: "order-data"
resources:
requests:
memory: "64Mi"
cpu: "100m"
limits:
memory: "256Mi"
cpu: "500m"
---
apiVersion: v1
kind: Service
metadata:
name: payment
labels:
app: payment
service: payment
spec:
ports:
- name: http-payment
protocol: TCP
port: 9000
selector:
app: payment
service: payment
---
apiVersion: apps/v1
kind: Deployment
metadata:
name: payment
labels:
app: payment
service: payment
spec:
selector:
matchLabels:
app: payment
service: payment
strategy:
type: Recreate
replicas: 1
template:
metadata:
labels:
app: payment
service: payment
spec:
containers:
- image: gcr.io/vmwarecloudadvocacy/acmeshop-payment:1.0.0
name: payment
env:
- name: PAYMENT_PORT
value: '9000'
ports:
- containerPort: 9000
name: http-payment
---
apiVersion: v1
kind: ConfigMap
metadata:
name: users-initdb-config
data:
seed.js: |
db.users.insertMany([
{"firstname":"Walter","lastname":"White","email":"walter@acmefitness.co
m","username":"walter","password":"6837ea9b06409112a824d113927ad7
4fabc5c76e","salt":""}
,{"firstname":"Dwight","lastname":"Schrute","email":"dwight@acmefitness.
com","username":"dwight","password":"6837ea9b06409112a824d113927a
d74fabc5c76e","salt":""}
,{"firstname":"Eric","lastname":"Cartman","email":"eric@acmefitness.com",
"username":"eric","password":"6837ea9b06409112a824d113927ad74fabc
5c76e","salt":""}
,{"firstname":"Han","lastname":"Solo","email":"han@acmefitness.com","use
rname":"han","password":"6837ea9b06409112a824d113927ad74fabc5c76
e","salt":""}
,{"firstname":"Phoebe","lastname":"Buffay","email":"phoebe@acmefitness.c
om","username":"phoebe","password":"6837ea9b06409112a824d113927a
d74fabc5c76e","salt":""}
,{"firstname":"Elaine","lastname":"Benes","email":"elaine@acmefitness.com
","username":"elaine","password":"6837ea9b06409112a824d113927ad74f
abc5c76e","salt":""}
]);
---
apiVersion: v1
kind: Service
metadata:
name: users-mongo
labels:
app: users-mongo
service: users-mongo
spec:
ports:
- port: 27017
name: mongo-users
protocol: TCP
selector:
app: users-mongo
service: users-mongo
---
apiVersion: apps/v1
kind: Deployment
metadata:
name: users-mongo
labels:
app: users-mongo
service: users-db
spec:
selector:
matchLabels:
app: users-mongo  # has to match .spec.template.metadata.labels
service: users-mongo
replicas: 1
template:
metadata:
labels:
app: users-mongo  # has to match .spec.selector.matchLabels
service: users-mongo
spec:
containers:
```

```
- name: users-mongo
image: mongo:4
resources:
{}
ports:
- name: mongo-users
containerPort: 27017
protocol: "TCP"
env:
- name: MONGO_INITDB_ROOT_USERNAME
value: 'mongoadmin'
- name: MONGO_INITDB_DATABASE
value: 'acmefit'
- name: MONGO_INITDB_ROOT_PASSWORD
valueFrom:
secretKeyRef:
name: users-mongo-pass
key: password
volumeMounts:
- mountPath: /data/db
name: mongodata
- mountPath: /docker-entrypoint-initdb.d
name: mongo-initdb
volumes:
- name: mongodata
emptyDir: {}
- name: mongo-initdb
configMap:
name: users-initdb-config
#       - name: mongodata
#         persistentVolumeClaim:
#           claimName: mongodata
---
apiVersion: v1
kind: Service
metadata:
name: users
labels:
app: users
service: users
spec:
ports:
- name: http-users
protocol: TCP
port: 8081
selector:
app: users
service: users
---
apiVersion: apps/v1
kind: Deployment
metadata:
name: users
labels:
app: users
service: users
spec:
selector:
matchLabels:
app: users
service: users
strategy:
type: Recreate
replicas: 1
template:
metadata:
labels:
app: users
service: users
spec:
volumes:
- name: users-data
emptyDir: {}
containers:
- image: gcr.io/vmwarecloudadvocacy/acmeshop-user:1.0.0
name: users
env:
- name: USERS_DB_HOST
value: 'users-mongo'
- name: USERS_DB_PASSWORD
valueFrom:
secretKeyRef:
name: users-mongo-pass
key: password
- name: USERS_DB_PORT
value: '27017'
- name: USERS_DB_USERNAME
value: 'mongoadmin'
- name: USERS_PORT
value: '8081'
ports:
- containerPort: 8081
name: http-users
volumeMounts:
- mountPath: "/data"
name: "users-data"
resources:
requests:
memory: "64Mi"
cpu: "100m"
limits:
memory: "256Mi"
cpu: "500m"
---
```

Appendix B: Catalog YAML file:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: catalog-initdb-config-v2
data:
  seed.js: |
    db.catalog.insertMany([
     {"name":"Super Yoga Mat","shortdescription":"Super Magic Yoga
Matv2!","description":"Our Yoga Mat is magic. You will twist into a human
pretzel with the greatest of ease. Never done Yoga before? This mat will
turn you into an instant professional with barely any work. It's the
American way!.
Namaste!","imageurl1":"/static/images/yogamat_square.jpg","imageurl2":
"/static/images/yogamat_thumb2.jpg","imageurl3":"/static/images/yoga
mat_thumb3.jpg","price":700.0,"tags":["mat"]}
     ,{"name":"Super Water Bottle","shortdescription":"The last Water Bottle
you'll ever buy!","description":"Our Water Bottle only has to be filled once!
That's right. ONCE. Unlimited water, for the rest of your life. Doesn't that
$34.99 seem a lot more reasonable now? Stop buying all those other water
bottles that you have to keep refilling like a sucker. Get the ACME bottle
today!","imageurl1":"/static/images/bottle_square.jpg","imageurl2":"/stati
c/images/bottle_thumb2.jpg","imageurl3":"/static/images/bottle_thumb3.j
pg","price":3400.9900016784668,"tags":["bottle"]}
     ,{"name":"Super Fit Bike","shortdescription":"Get Light on our Fit Bike!",
"description":"Ride like the wind on your very own ACME Fit Bike. Have you
ever wanted to travel as fast as a MotoGP racer on a bicycle with tiny tires?!
Me too! Get the Fit Bike, and you'll vroom your way into fitness in 30
seconds
flat!","imageurl1":"/static/images/bicycle_square.jpg","imageurl2":"/static
/images/bicycle_thumb2.jpg","imageurl3":"/static/images/bicycle_thumb3
.jpg", "price":4990.99,"tags":["bicycle"]}
     ,{"name":"Super Basket Ball","shortdescription":"World's Roundest
Basketball!","description":"That's right. You heard me correctly. The worlds
ROUNDEST basketball. Are you tired of your current basketball simply not
being round enough. Then it's time to step up to the ACME Basketball. Get
your round
on!","imageurl1":"/static/images/basketball_square.jpg","imageurl2":"/sta
tic/images/basketball_thumb2.jpg","imageurl3":"/static/images/basketbal
l_thumb3.jpg","price":1100.75,"tags":["basketball"]}
     ,{"name":"Super Smart Watch","shortdescription":"The watch that
makes you smarter!","description":"Do you have trouble remembering
things? Can you not remember what day it is? Do you need a robot with a
cute women's voice to tell you when to stand up and walk around? Then boy
do we have the watch for you! Get the ACME Smart Watch, and never have
to remember anything ever
again!","imageurl1":"/static/images/smartwatch_square.jpg","imageurl2":
"/static/images/smartwatch_thumb2.jpg","imageurl3":"/static/images/sm
artwatch_thumb3.jpg","price":3999.5899963378906,"tags":["watch"]}
     ,{"name":"Super Red Pants","shortdescription":"Because who doesn't
need red pants??", "description":"Have you found yourself walking around
tech conferences in the same old jeans and vendor t-shirt? Do you need to
up your pants game? ACME Red Pants are 100% GUARANTEED to take you
to a whole new level. Women will want to meet you. Men will want to be
you. You are... Fancy Pants. What are you waiting
for??","imageurl1":"/static/images/redpants_square.jpg","imageurl2":"/sta
tic/images/redpants_thumb2.jpg","imageurl3":"/static/images/redpants_t
humb3.jpg", "price":990.0,"tags":["clothing"]}
     ,{"name":"Super Running shoes","shortdescription":"Mama says they
was magic shoes!", "description":"And she was right! Are you slow? Out of
shape? But still ready to take on Usain Bolt in the 100? Then strap up your
ACME Running Shoes and Run Forest, Run! These shoes will make you run
the 100 in 2.5
flat!","imageurl1":"/static/images/shoes_square.jpg","imageurl2":"/static/i
mages/shoes_thumb2.jpg","imageurl3":"/static/images/shoes_thumb3.jpg"
, "price":1200.00,"tags":["running"]}
     ,{"name":"Super Weights","shortdescription":"Get ripped without
breaking a sweat!","description":"Are you ready to get Pumped Up with
Hanz and Franz? Or get swole like Arnold? It's time to hit the Add to Cart
button on the ACME Weights. Just 45 seconds a day, 3 days a week, and
you'll be showing those Muscle Beach clowns how it's done in no
time!","imageurl1":"/static/images/weights_square.jpg","imageurl2":"/stat
ic/images/weights_thumb2.jpg","imageurl3":"/static/images/weights_thu
mb3.jpg", "price":300.99,"tags":["weight"]} ]);
---
apiVersion: v1
kind: Service
metadata:
  name: catalog-mongo-v2
  labels:
    app: catalog-db-v2
    service: catalog-db-v2
spec:
  ports:
    - port: 27017
      name: mongo-catalog
      protocol: TCP
  selector:
    app: catalog-db-v2
    service: catalog-db-v2
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: catalog-mongo-v2
  labels:
    app: catalog-db-v2
    service: catalog-db-v2
spec:
  selector:
    matchLabels:
      app: catalog-db-v2  # has to match .spec.template.metadata.labels
      service: catalog-db-v2
  replicas: 1
  template:
    metadata:
      labels:
        app: catalog-db-v2  # has to match .spec.selector.matchLabels
        service: catalog-db-v2
    spec:
      containers:
        - name: catalog-mongo
          image: mongo:4
          resources:
            {}
          ports:
            - name: mongo-catalog
              containerPort: 27017
              protocol: "TCP"
          env:
          - name: MONGO_INITDB_ROOT_USERNAME
            value: 'mongoadmin'
          - name: MONGO_INITDB_DATABASE
            value: 'acmefit'
          - name: MONGO_INITDB_ROOT_PASSWORD
            valueFrom:
              secretKeyRef:
                name: catalog-mongo-pass
                key: password
          volumeMounts:
            - mountPath: /data/db
              name: mongodata
            - mountPath: /docker-entrypoint-initdb.d
              name: mongo-initdb
      volumes:
        - name: mongodata
          emptyDir: {}
        - name: mongo-initdb
          configMap:
            name: catalog-initdb-config-v2
#       - name: mongodata
#         persistentVolumeClaim:
#           claimName: mongodata
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: catalog-v2
  labels:
    app: catalog
```

```
    service: catalog
    version: v2
spec:
  selector:
    matchLabels:
      app: catalog
      service: catalog
      version: v2
  strategy:
    type: Recreate
  replicas: 1
  template:
    metadata:
      labels:
        app: catalog
        service: catalog
        version: v2
    spec:
      volumes:
      - name: catalog-data
        emptyDir: {}
      containers:
      - image: gcr.io/vmwarecloudadvocacy/acmeshop-catalog:1.0.0
        name: catalog
        env:
        - name: CATALOG_DB_HOST
          value: 'catalog-mongo-v2'
        - name: CATALOG_DB_PASSWORD
          valueFrom:
            secretKeyRef:
              name: catalog-mongo-pass
              key: password
        - name: CATALOG_DB_PORT
          value: '27017'
        - name: CATALOG_DB_USERNAME
          value: 'mongoadmin'
        - name: CATALOG_PORT
          value: '8082'
        ports:
        - containerPort: 8082
          name: http-catalog
        volumeMounts:
        - mountPath: "/data"
          name: "catalog-data"
        resources:
          requests:
            memory: "64Mi"
            cpu: "100m"
          limits:
            memory: "256Mi"
            cpu: "500m"
```

Appendix C: Load Generator

```
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: acme-locust
  namespace: loadgen
spec:
  selector:
    matchLabels:
      app: acme-locust
  replicas: 4
  template:
    metadata:
      labels:
        app: acme-locust
    spec:
      terminationGracePeriodSeconds: 5
      restartPolicy: Always
      volumes:
      - name: acme-locustfile
        configMap:
          name: acme-locustfile
      containers:
      - name: main
        image: harbor.tanzuworld.com/apps/locust:1.4.1
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 8089
        env:
        command:
        - locust
        args: ["-f","/mnt/locust/locustfile.py","--headless","--host=http://istio-
ingressgateway.istio-system"]
        resources:
          requests:
            cpu: 300m
            memory: 256Mi
          limits:
            cpu: 1
            memory: 512Mi
        volumeMounts:
        - name: acme-locustfile
          mountPath: /mnt/locust
---
apiVersion: v1
kind: ConfigMap
metadata:
  name: acme-locustfile
  namespace: loadgen
data:
  locustfile.py: |
    # This program will generate traffic for ACME Fitness Shop App. It
simulates both Authenticated and Guest user scenarios. You can run this
program either from Command line or from
    # the web based UI. Refer to the "locust" documentation for further
information.
    from locust import HttpUser, TaskSet, task, SequentialTaskSet, Locust,
LoadTestShape, between
    import random
    import math
    # List of users (pre-loaded into ACME Fitness shop)
    users = ["eric", "phoebe", "dwight", "han"]
    # List of products within the catalog
    products = []
    import logging
    # GuestUserBrowsing simulates traffic for a Guest User (Not logged in)
    class GuestUserBrowsing(SequentialTaskSet):
        def on_start(self):
            self.getProducts()
        def listCatalogItems(self):
            items = self.client.get("/products").json()["data"]
            for item in items:
                products.append(item["id"])
            return products
        @task
        def getProducts(self):
            logging.info("Guest User - Get Products")
            self.client.get("/products")
        @task
        def getProduct(self):
            logging.info("Guest User - Get a product")
            products = self.listCatalogItems()
            id = random.choice(products)
            product = self.client.get("/products/"+ id).json()
            logging.info("Product info - " +  str(product))
            products.clear()
    # AuthUserBrowsing simulates traffic for Authenticated Users (Logged
in)
    class AuthUserBrowsing(SequentialTaskSet):
        def on_start(self):
            self.login()
        @task
        def login(self):
            user = random.choice(users)
            logging.info("Auth User - Login user " + user)
            body = self.client.post("/login/", json={"username": user,
"password":"vmware1!"}).json()
            self.user.userid = body["token"]
        @task
        def getProducts(self):
            logging.info("Auth User - Get Catalog")
            self.client.get("/products")
        @task(2)
        def getProduct(self):
            logging.info("Auth User - Get a product")
            products = self.listCatalogItems()
            id = random.choice(products)
            product = self.client.get("/products/"+ id).json()
            logging.info("Product info - " +  str(product))
            products.clear()
        @task(2)
        def addToCart(self):
            self.listCatalogItems()
            productid = random.choice(products)
            logging.info("Add to Cart for user " + self.user.userid)
            cart = self.client.post("/cart/item/add/" + self.user.userid, json={
                    "name": productid,
                    "price": "100",
                    "shortDescription": "Test add to cart",
                    "quantity": random.randint(1,2),
                    "itemid": productid
                  })
            products.clear()
        @task
        def checkout(self):
            userCart = self.client.get("/cart/items/" + self.user.userid).json()
            order = self.client.post("/order/add/"+ self.user.userid, json={
"userid":"8888",
                    "firstname":"Eric",
                    "lastname": "Cartman",
                    "address":{
                      "street":"20 Riding Lane Av",
                      "city":"San Francisco",
                      "zip":"10201",
                      "state": "CA",
                      "country":"USA"},
                    "email":"jblaze@marvel.com",
                    "delivery":"UPS/FEDEX",
                    "card":{
                      "type":"amex/visa/mastercard/bahubali",
                      "number":"349834797981",
                      "expMonth":"12",
                      "expYear": "2022",
                      "ccv":"123"
                    },
                    "cart":[
                      {"id":"1234", "description":"redpants", "quantity":"1",
"price":"4"},
```

```
                {"id":"5678", "description":"bluepants", "quantity":"1",
"price":"4"}
              ],
              "total":"100"})
    def listCatalogItems(self):
      items = self.client.get("/products").json()["data"]
      for item in items:
        products.append(item["id"])
      return products
    @task(2)
    def index(self):
      self.client.get("/")
  class UserBehavior(SequentialTaskSet):
    tasks = [AuthUserBrowsing, GuestUserBrowsing]
  class WebSiteUser(HttpUser):
    tasks = [UserBehavior]
    userid = ""
    #min_wait = 2000
    #max_wait = 10000
    wait_time = between(0.5, 3)
  class StagesShape(LoadTestShape):
    """
    A simply load test shape class that has different user and spawn_rate at
    different stages.
    Keyword arguments:
      stages -- A list of dicts, each representing a stage with the following
keys:
        duration -- When this many seconds pass the test is advanced to the
next stage
        users -- Total user count
        spawn_rate -- Number of users to start/stop per second
        stop -- A boolean that can stop that test at a specific stage
      stop_at_end -- Can be set to stop once all stages have run.
    """
    total_runtime = 1200
    stages = [
      {"duration": 300, "users": 100, "spawn_rate": 5},
      {"duration": 450, "users": 150, "spawn_rate": 5},
      {"duration": 600, "users": 600, "spawn_rate": 50},
      {"duration": 750, "users": 400, "spawn_rate": 5},
      {"duration": 900, "users": 300, "spawn_rate": 1},
      {"duration": 1050, "users": 100, "spawn_rate": 5},
      {"duration": 1200, "users": 50, "spawn_rate": 1},
    ]

    def tick(self):
      run_time = self.get_run_time() % self.total_runtime

      for stage in self.stages:
        if run_time < stage["duration"]:
          tick_data = (stage["users"], stage["spawn_rate"])
          return tick_data

      return None
```