KubeCon | CloudNativeCon

Europe 2018

Enabling Multi-Cloud with Istio

Stretching an Istio service mesh between Public & Private Clouds

John Joyce Cisco Principal Engineer

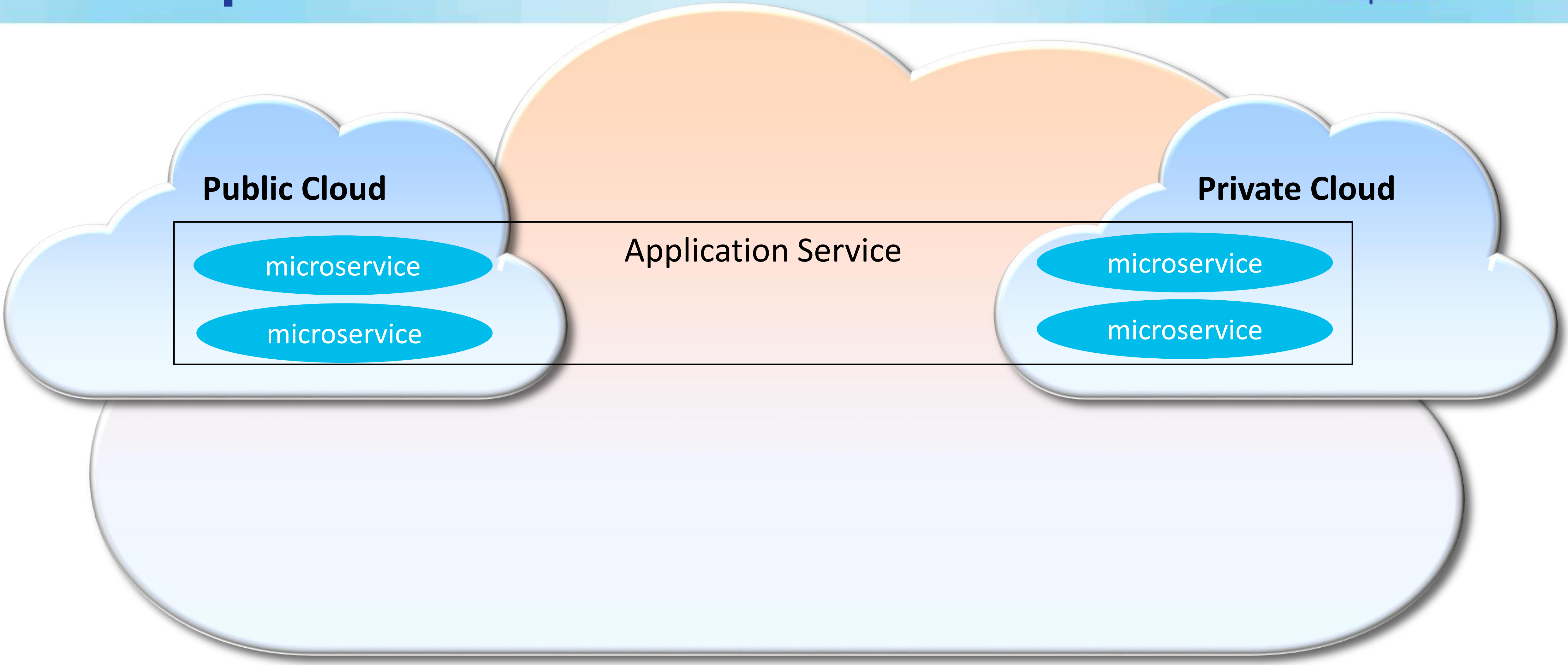
Robert Li Cisco Software Engineer

Agenda

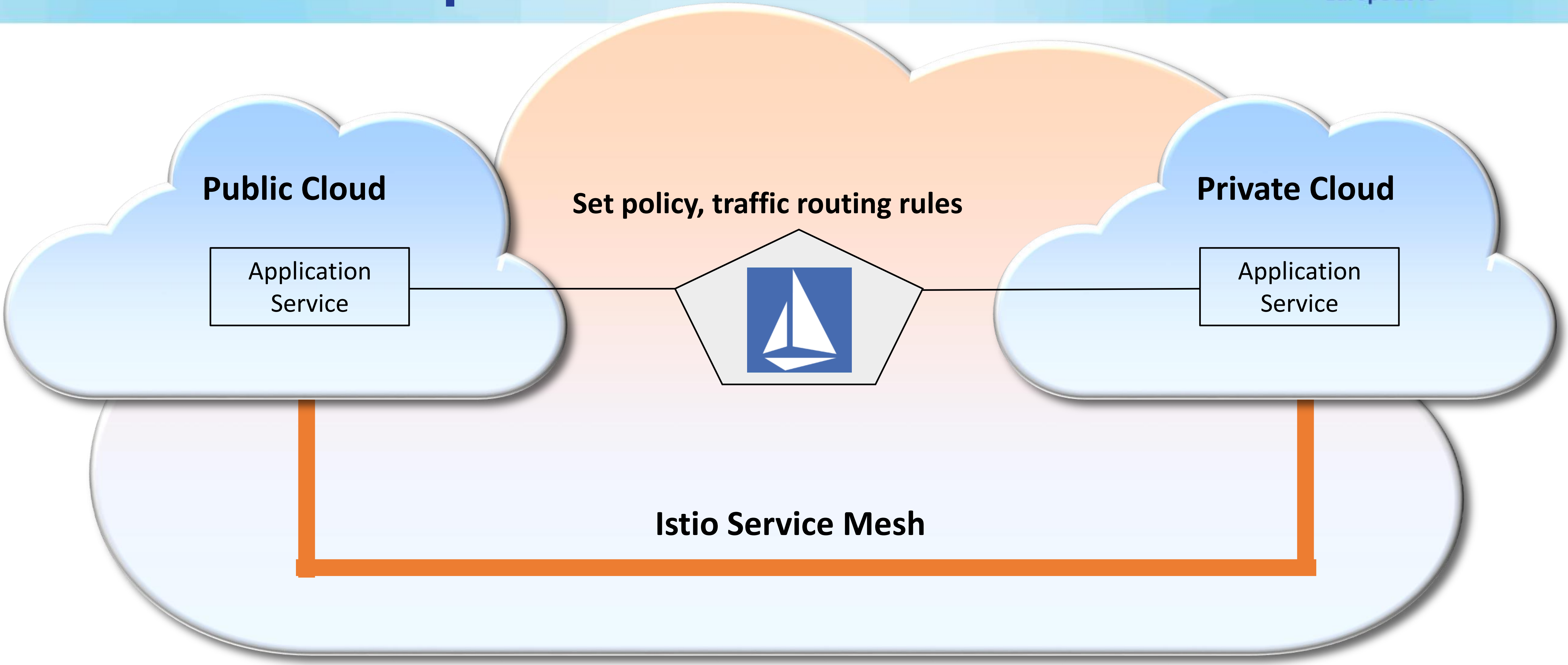
- Introduction
- Multicluster Architecture
- Deployment Details
- Deployment in Action
- Mesh Routing Demo
- Future Improvements
- References
- Q&A

Introduction

Extending an Application across Multiple Clouds



Stretching Istio's Service Mesh Across Multiple Clouds



Public Cloud

Application Service

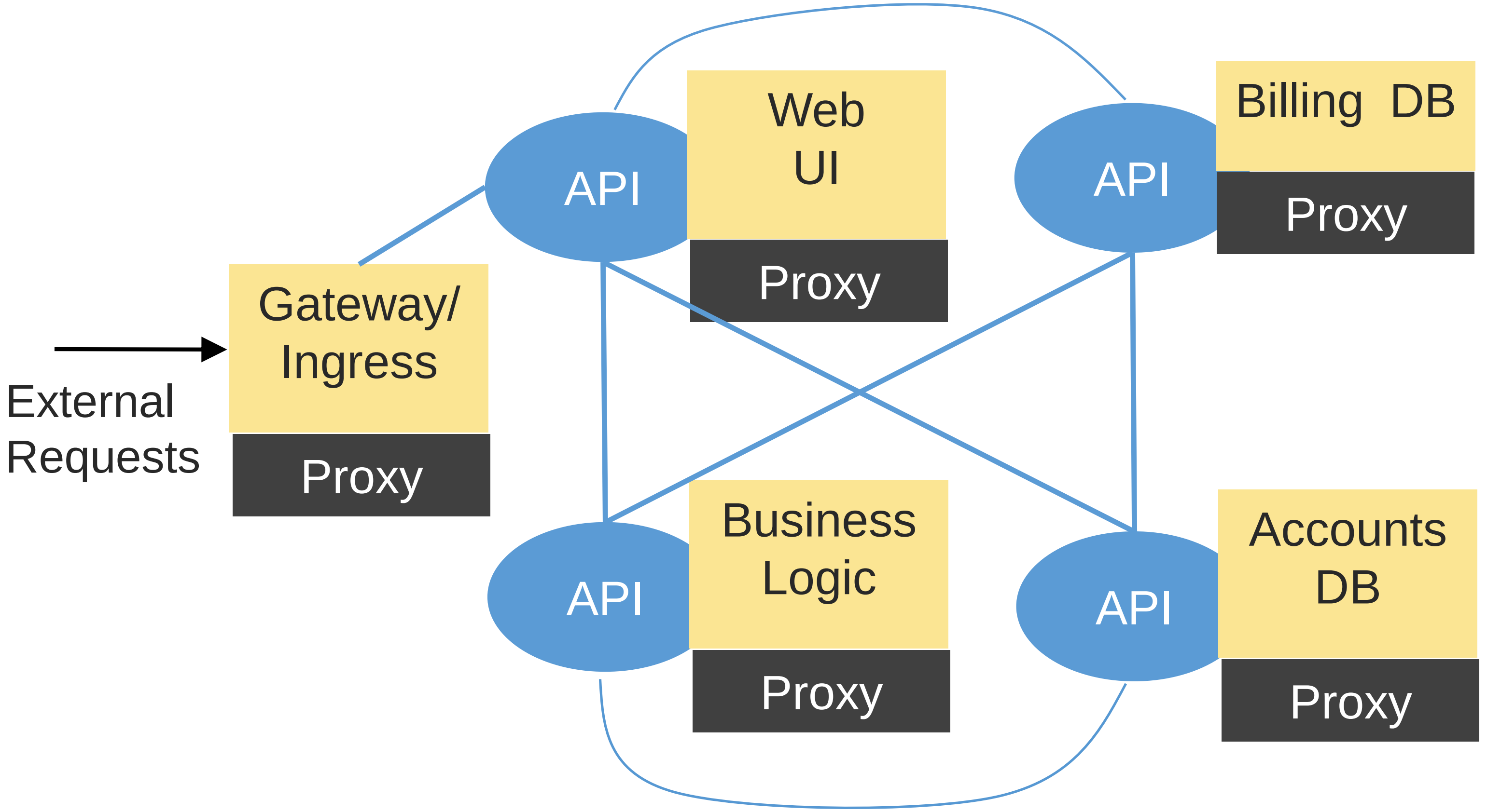
Set policy, traffic routing rules

Private Cloud

Application Service

Istio Service Mesh

What is a Service Mesh

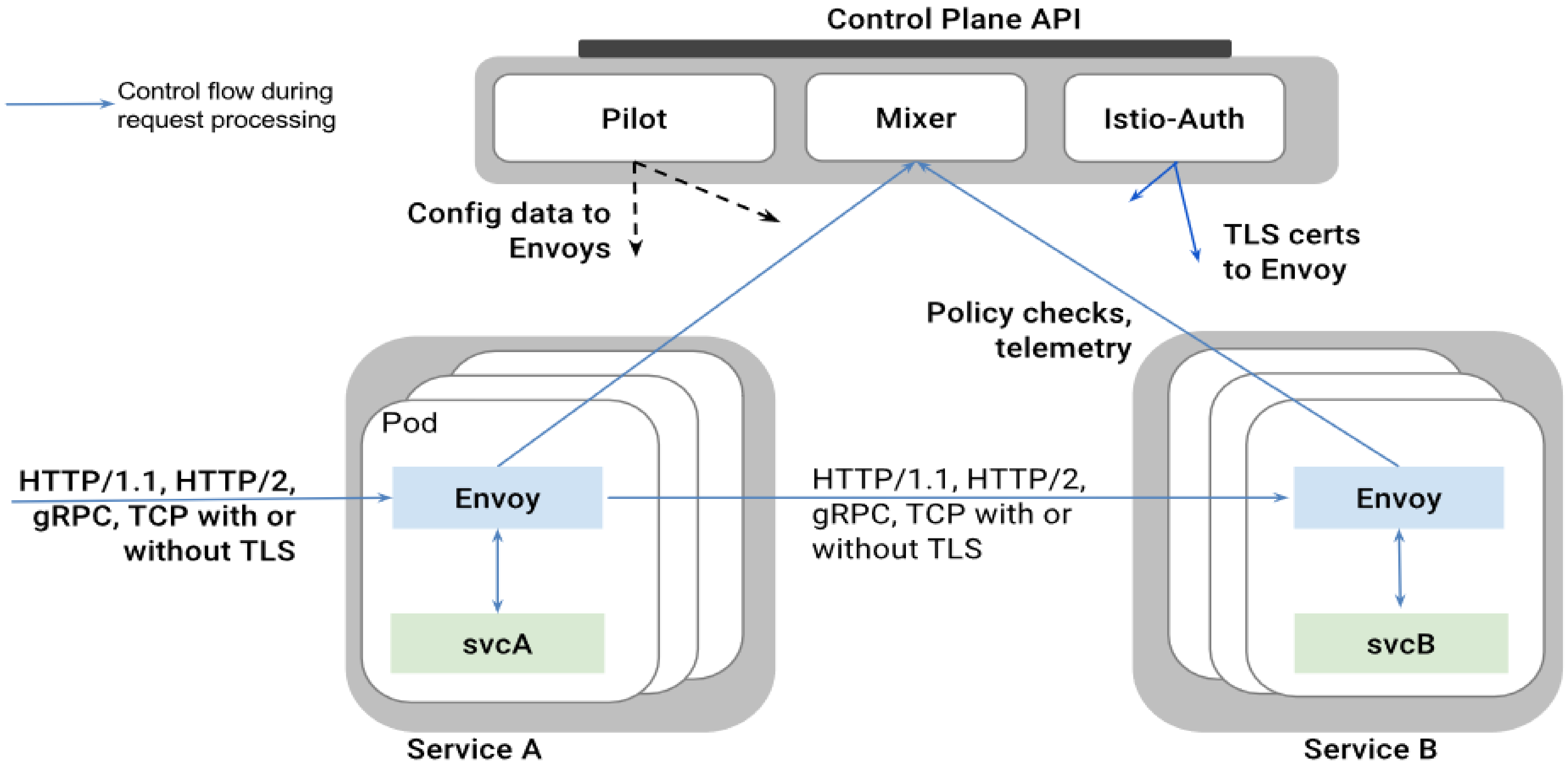


Istio’s Multicluster enhancement allows cloud boundaries anywhere in above mesh

- Infrastructure layer for service-to-service communication
- A mesh of proxies
- Proxies injected as sidecars
- Supports numerous protocols (HTTP 1/2, gRPC, TCP, UDP)
- Can inspect API transactions at Layer 7 or layer 3/4.
- Intelligent routing rules can be applied between endpoints

Istio Architecture

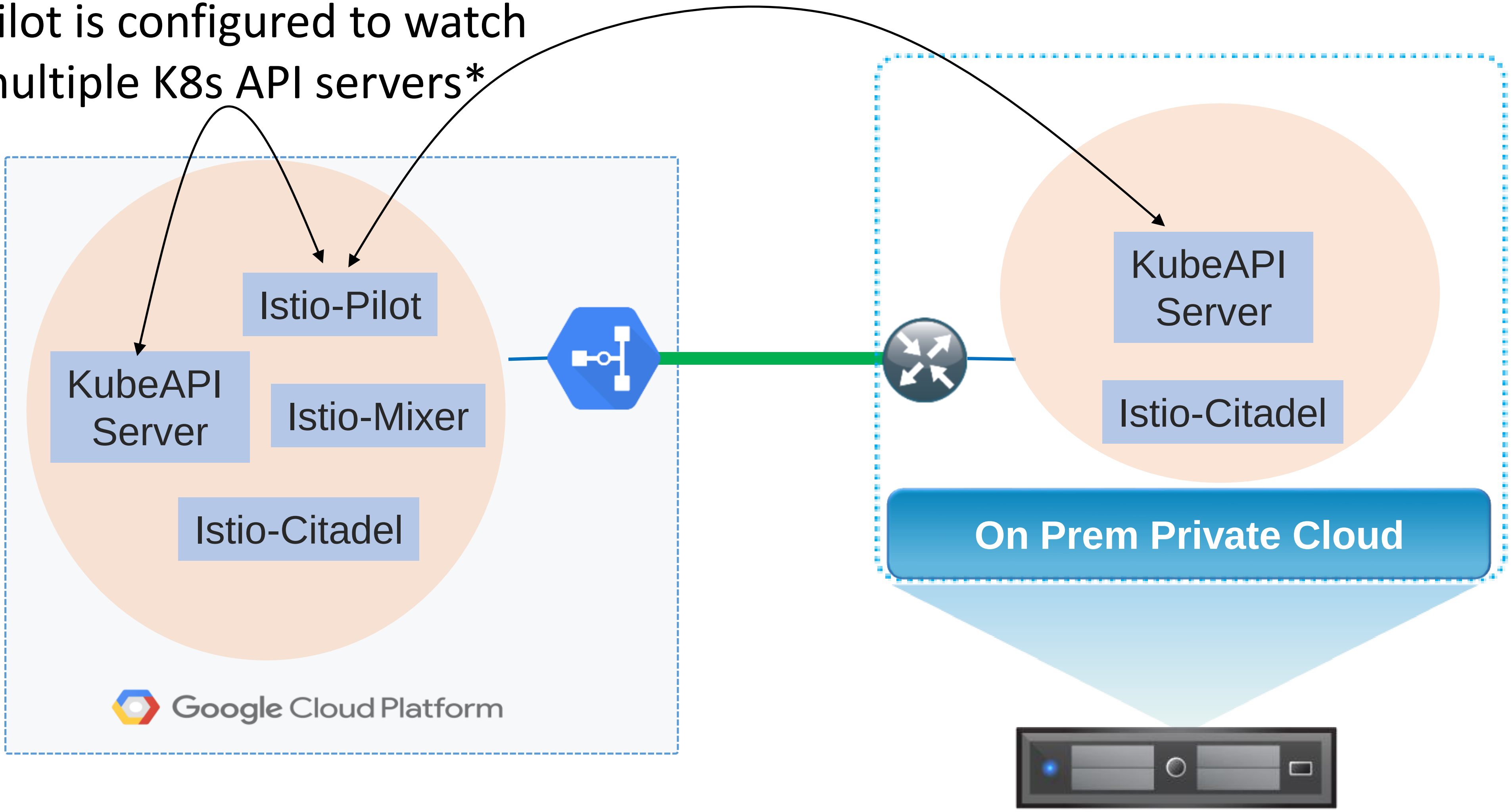
Source: https://istio.io/docs/concepts/what-is-istio/overview.html



Multicluster Architecture

Service and Endpoint Discovery

Pilot is configured to watch multiple K8s API servers*



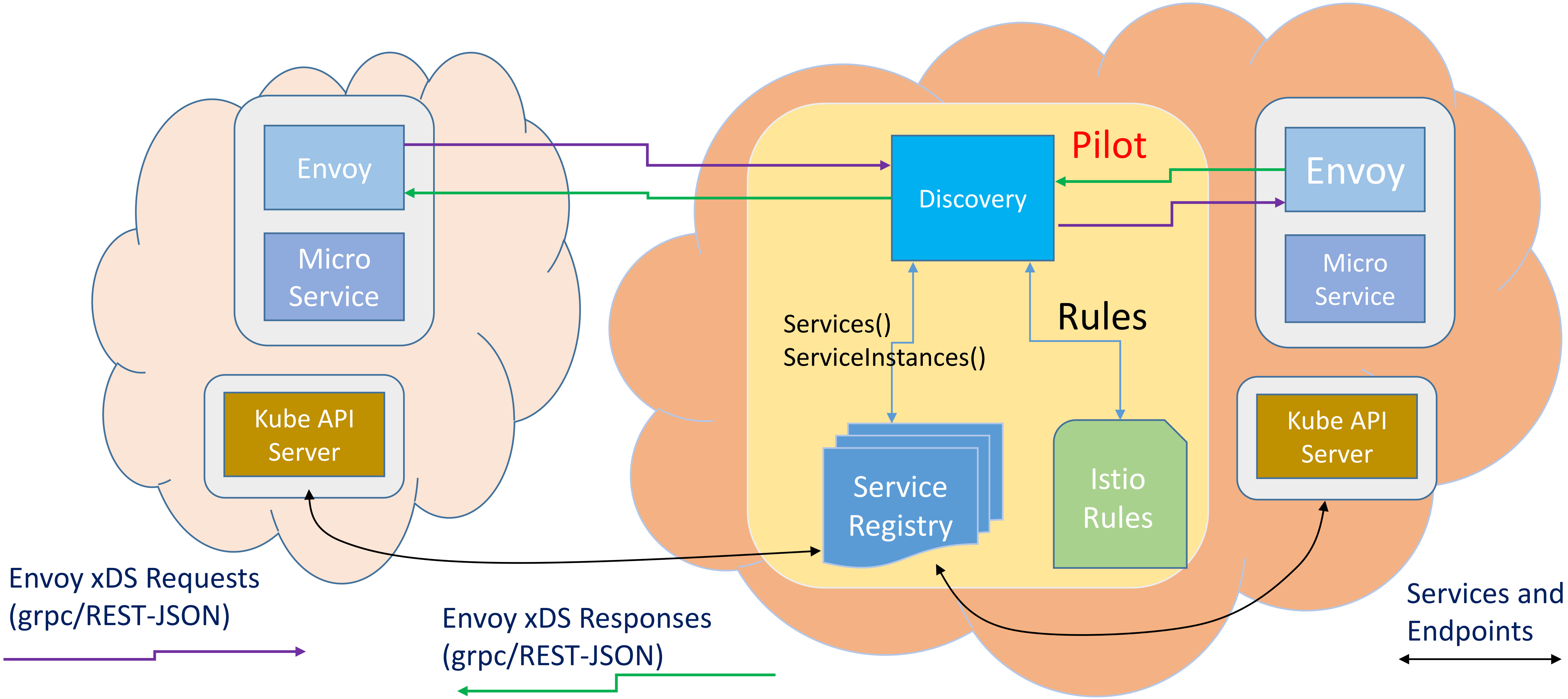
K8s Clusters

⟷

Controller created in Pilot for each cluster which gathers all service & endpoint data

* Configuration via file based clusterregistry format

Envoy xDS propagation

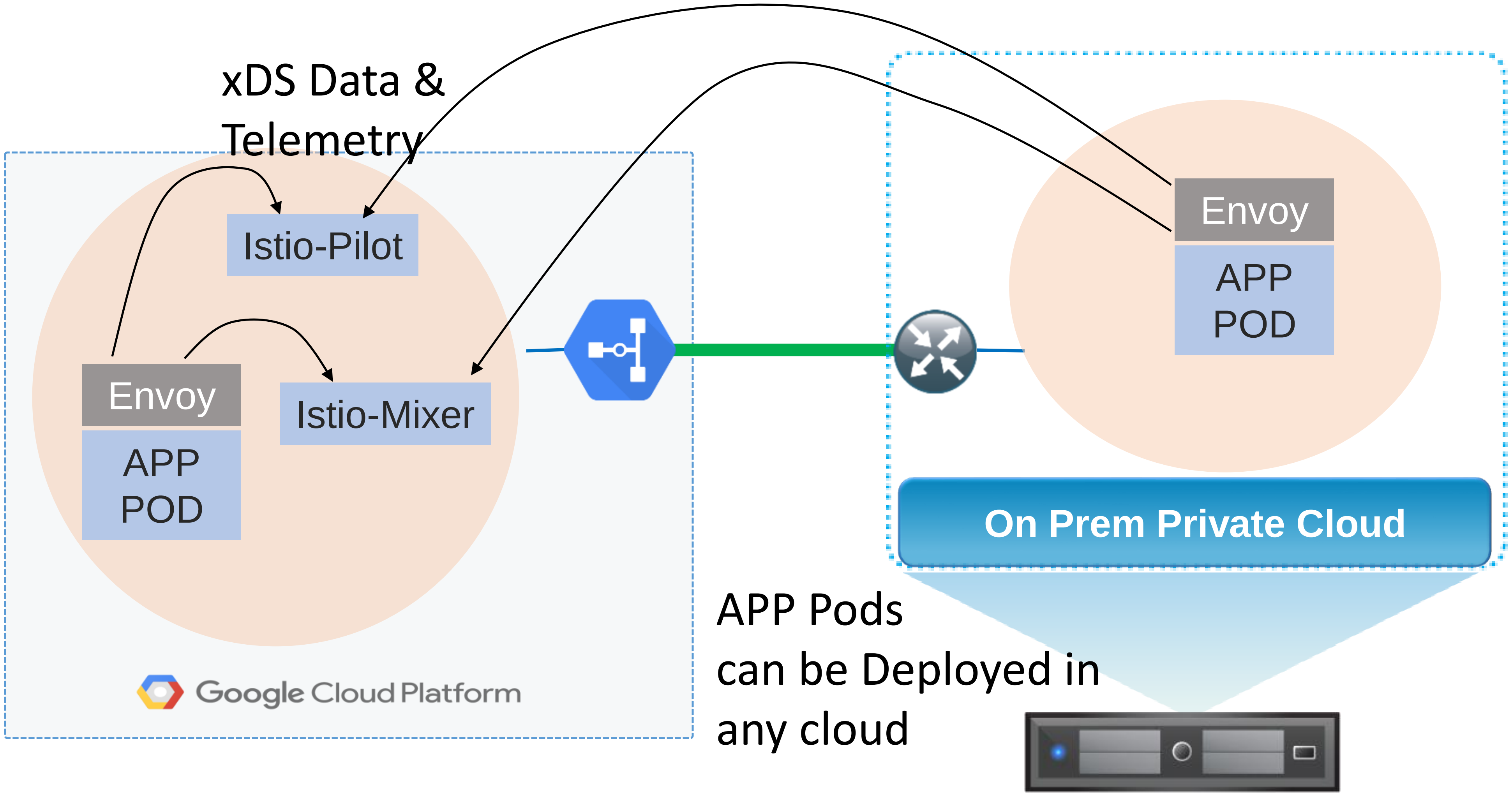


Envoy xDS Requests (grpc/REST-JSON)

Envoy xDS Responses (grpc/REST-JSON)

Services and Endpoints

Creating the Stretched Mesh



APP Pods can be Deployed in any cloud

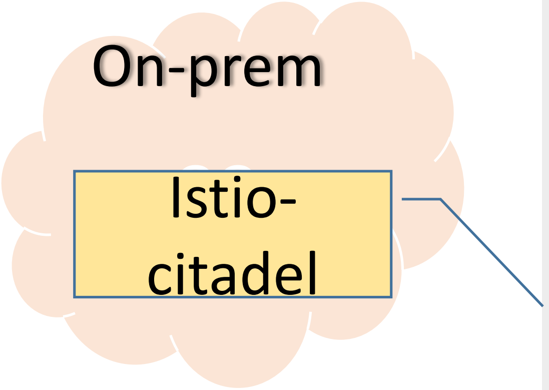
K8s Clusters

Envoy configured with Pilot & Mixer endpoints for xDS (Discovery Services

Envoy Proxy sidecar

uService Application Pods

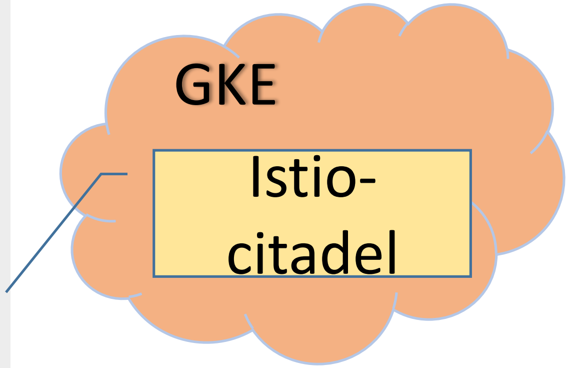
istio-citadel with same certificates



On-prem

Istio-citadel

- Generate the same ca-cert.pem, ca-key.pem, cert-chain.pem, and root-cert.pem in both clusters
- Create a k8s secret called cacerts from those files
- Add a secret volume from cacerts
- Mount the volume to /etc/cacerts
- Start istio-citadel with the following args:
  - ❖ --self-signed-ca=false
  - ❖ --signing-cert=/etc/cacerts/ca-cert.pem
  - ❖ --signing-key=/etc/cacerts/ca-key.pem
  - ❖ --root-cert=/etc/cacerts/root-cert.pem
  - ❖ --cert-chain=/etc/cacerts/cert-chain.pem



GKE

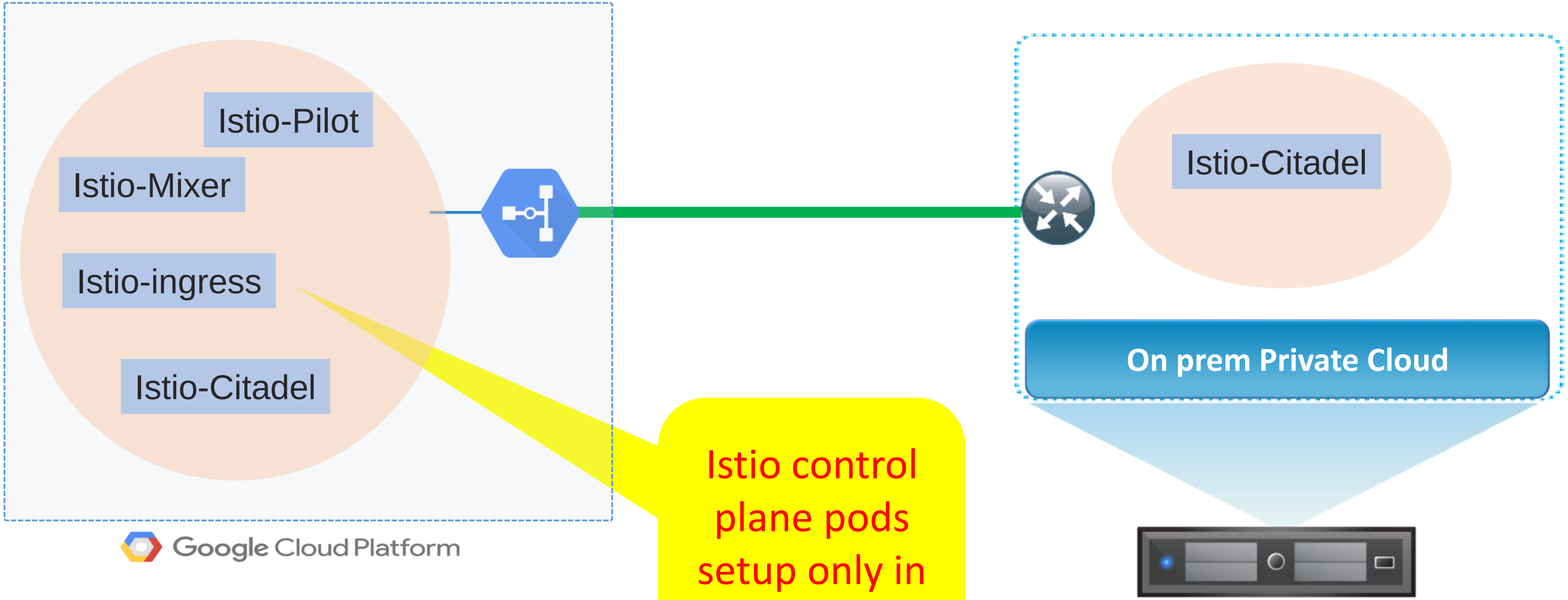
Istio-citadel

Deployment Details

Environment Requirements

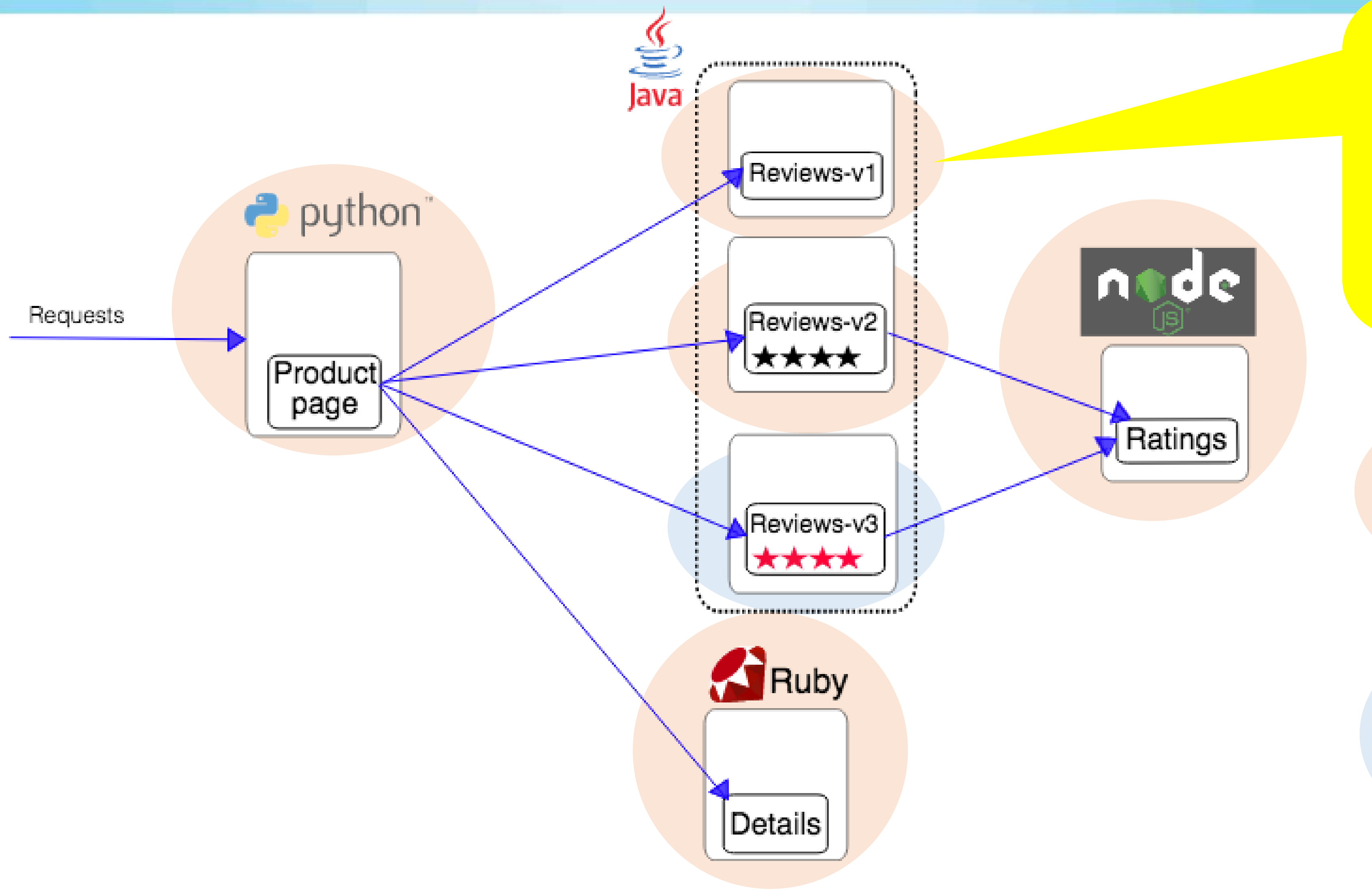
- Must have IP reachability between the clusters
  - For Istio control plane interactions between Pilot, Mixer and Citadel and Envoy Sidecars
  - For application pods to reach each other
- Solution doesn’t dictate a certain approach to achieve this reachability but generally a VPN would be needed based on current capabilities.
- Application relies on Kube-DNS to resolve service naming so special attention is needed during app deployment:
  - Use of headless or selectorless services typically required
  - Could be designated to a special purpose DNS server

Istio Control Plane Deployment



Istio control plane pods setup only in one Cluster

Bookinfo Application Microservice Architecture

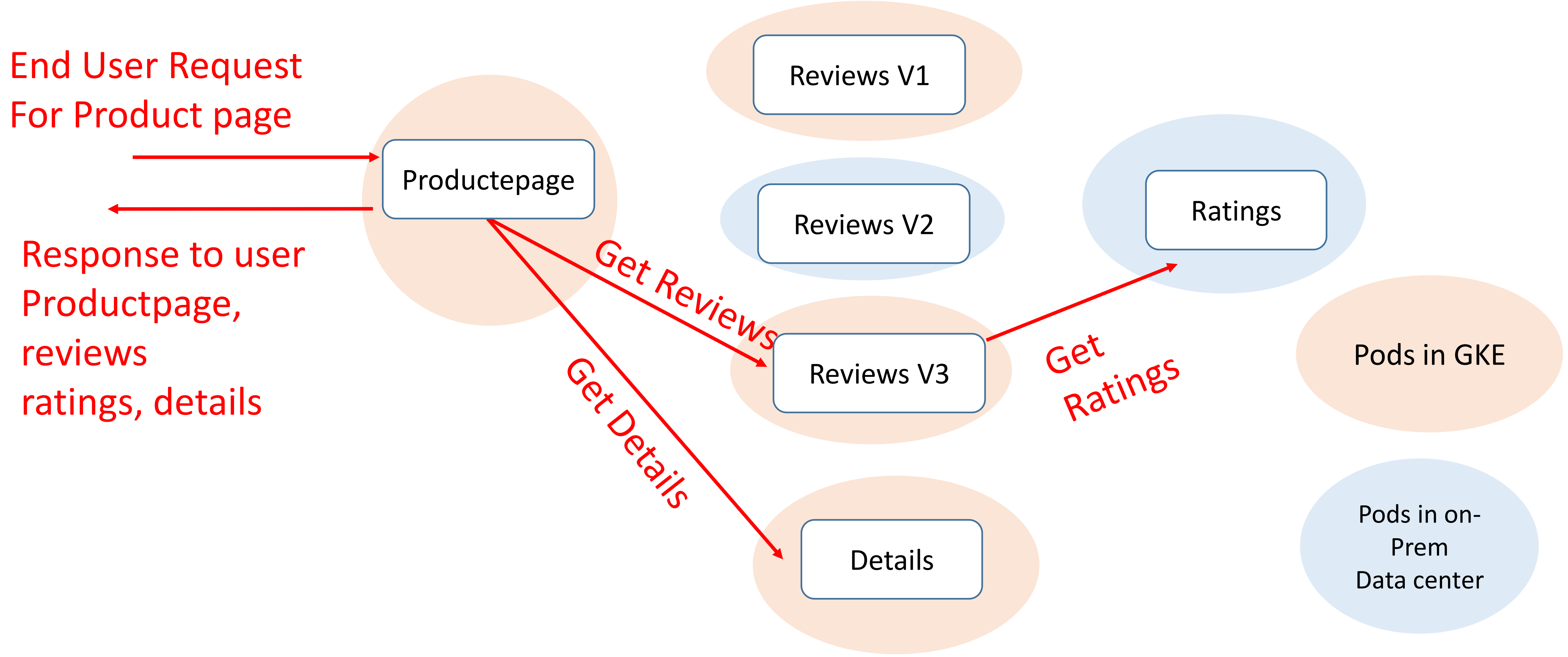


V1 = No stars V2 = Black stars V3 = Red stars

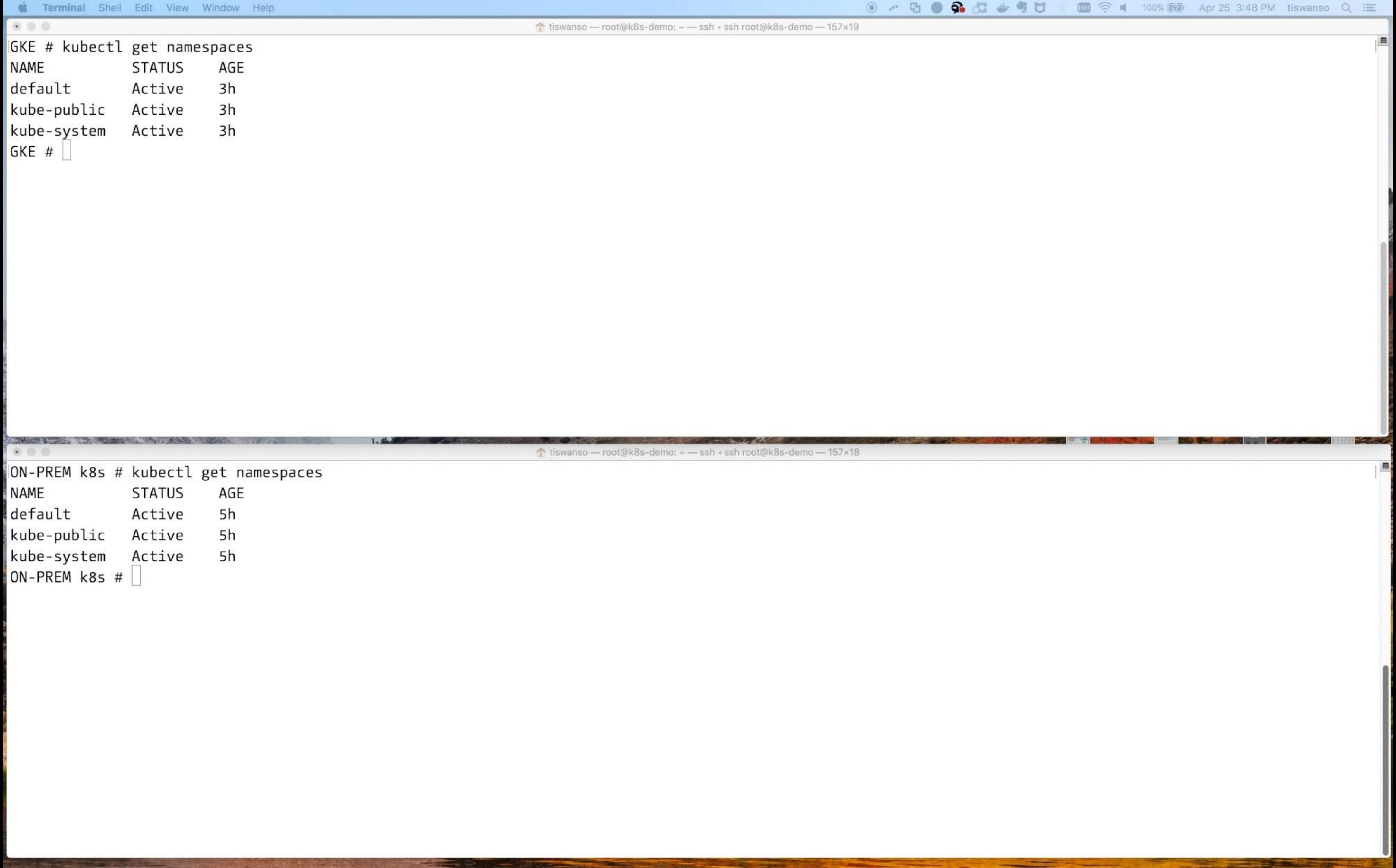
Pods in GKE

Pods in on-Prem Data center

Bookinfo Application Flow



Deployment in action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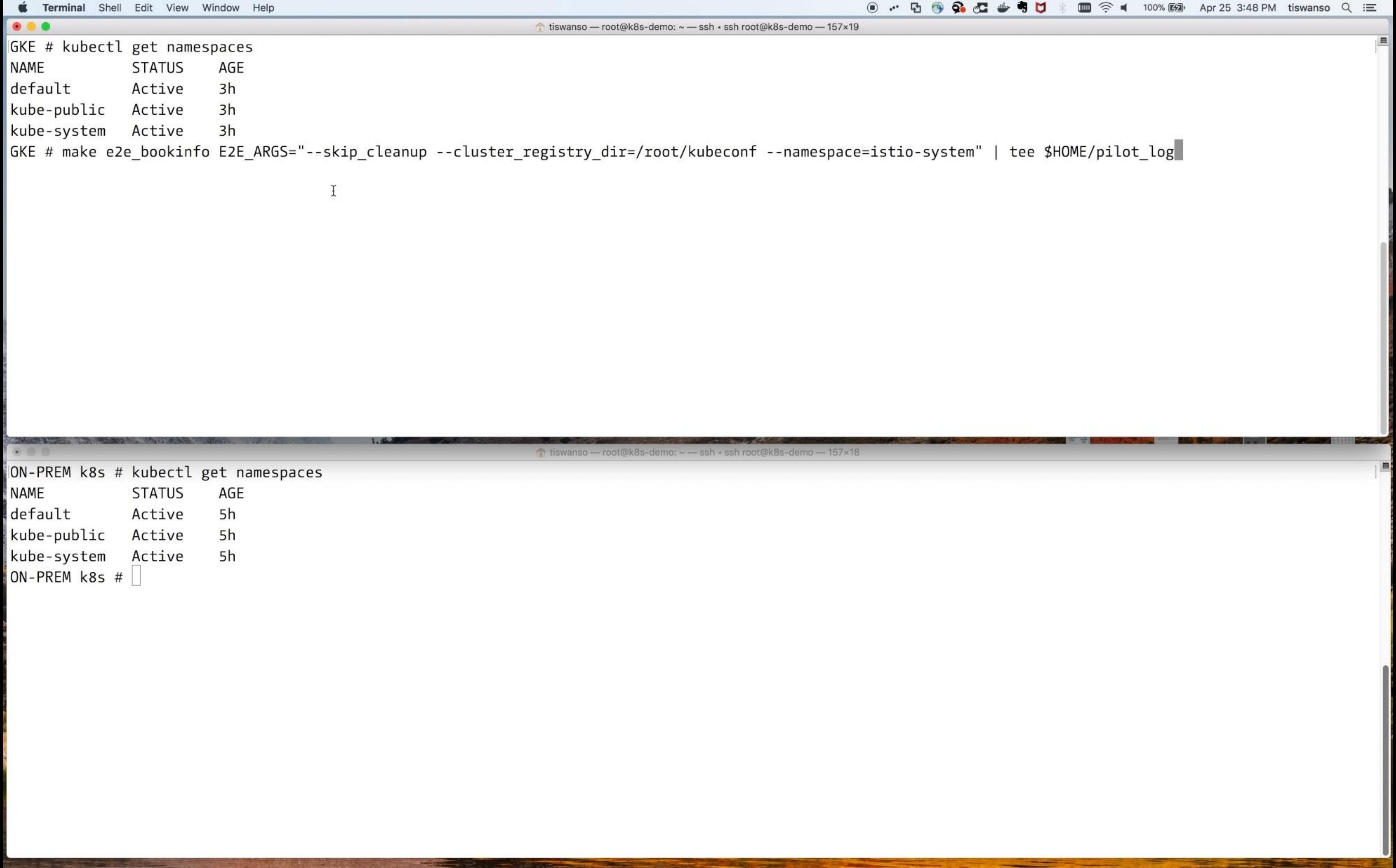
Apr 25 3:48 PM
tiswanso
tiswanso — root@k8s-demo: ~ — ssh ◂ ssh root@k8s-demo — 157×19
tiswanso — root@k8s-demo: ~ — ssh ◂ ssh root@k8s-demo — 157×18

```
GKE # kubectl get namespaces
NAME          STATUS    AGE
default       Active    3h
kube-public   Active    3h
kube-system   Active    3h
GKE # 
```

```
ON-PREM k8s # kubectl get namespaces
NAME          STATUS    AGE
default       Active    5h
kube-public   Active    5h
kube-system   Active    5h
ON-PREM k8s # 
```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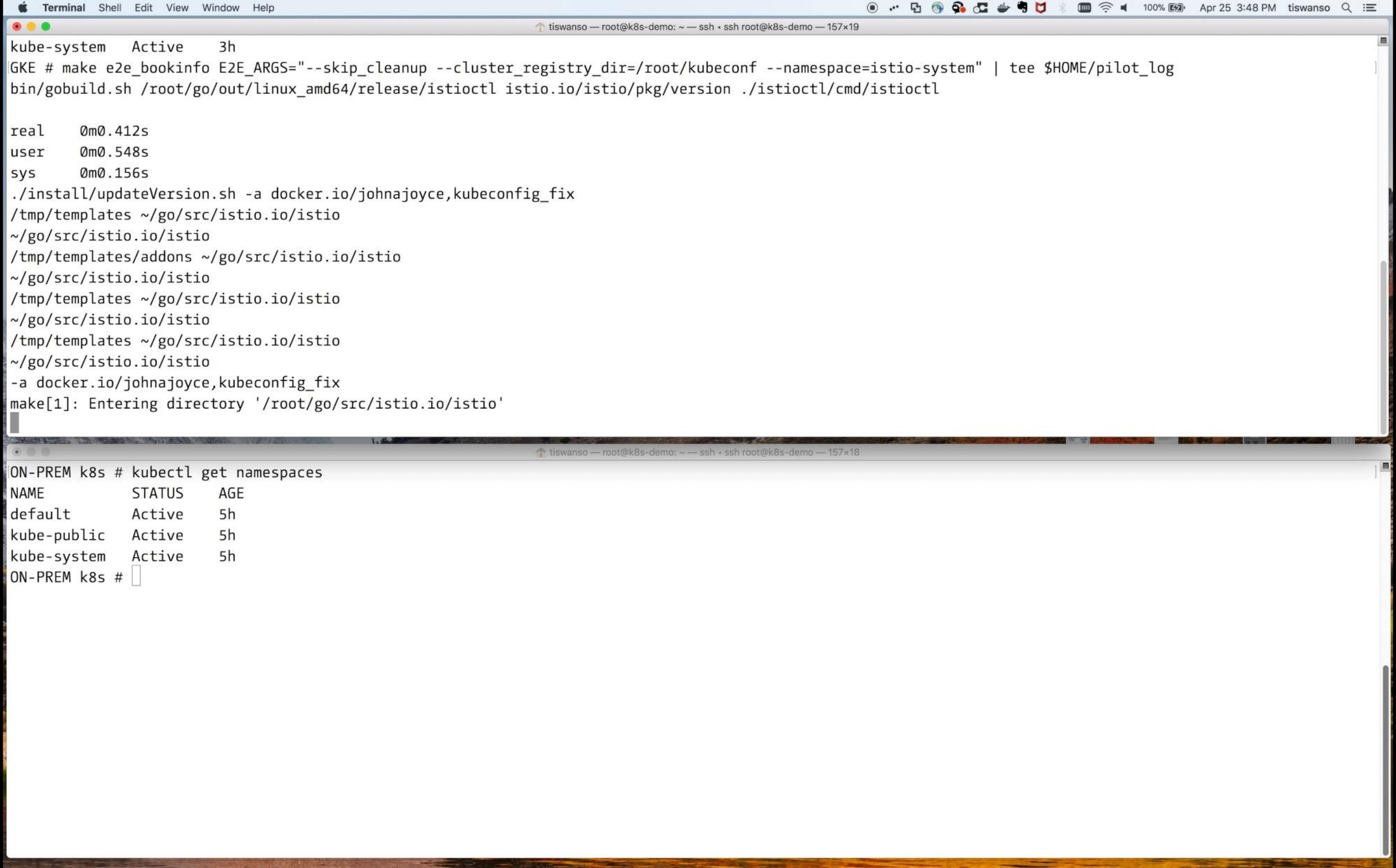
```
GKE # kubectl get namespaces
NAME          STATUS    AGE
default       Active    3h
kube-public   Active    3h
kube-system   Active    3h
GKE # make e2e_bookinfo E2E_ARGS="--skip_cleanup --cluster_registry_dir=/root/kubeconf --namespace=istio-system" | tee $HOME/pilot_log
```

```
ON-PREM k8s # kubectl get namespaces
NAME          STATUS    AGE
default       Active    5h
kube-public   Active    5h
kube-system   Active    5h
ON-PREM k8s #
```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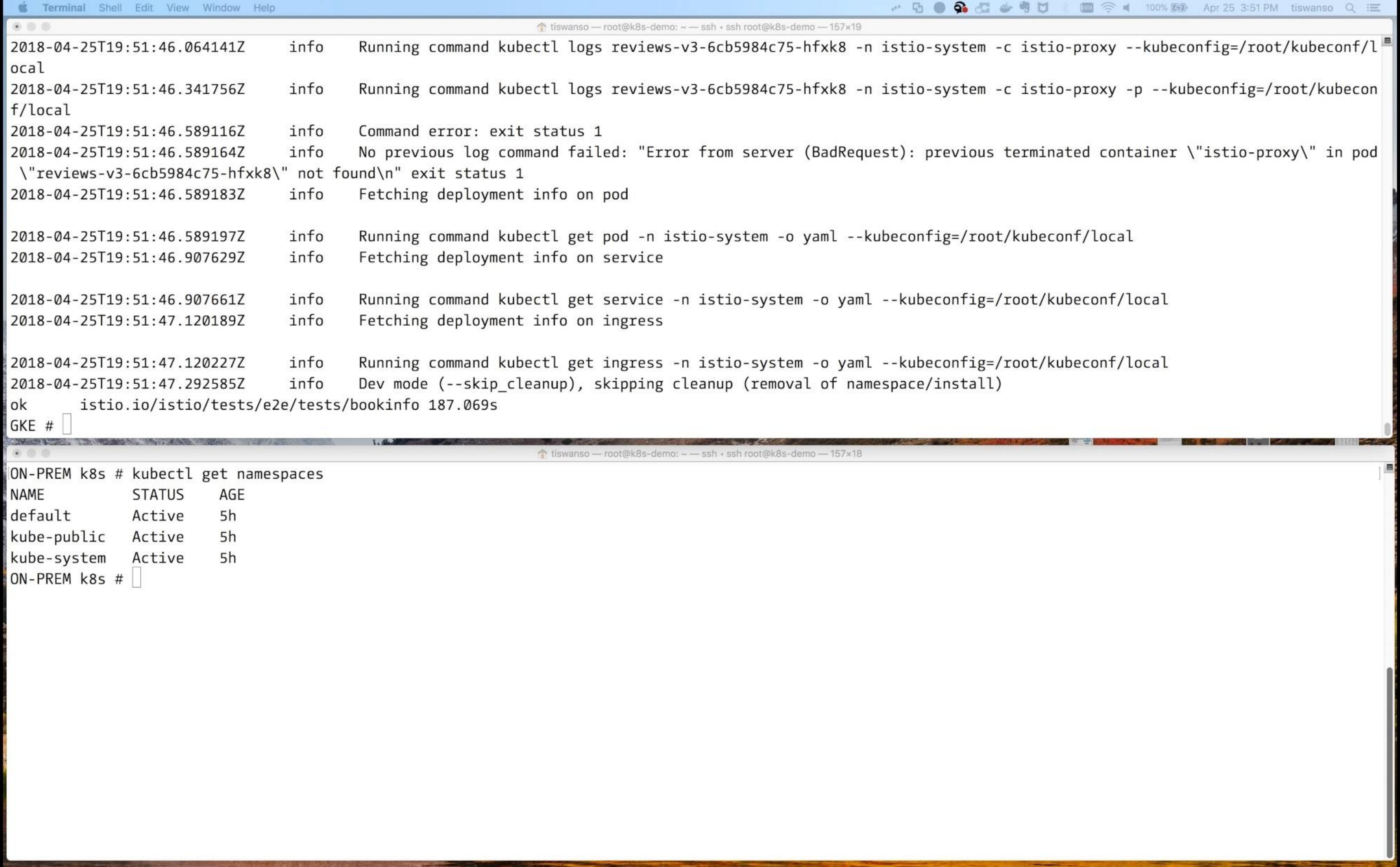
```
kube-system   Active    3h
GKE # make e2e_bookinfo E2E_ARGS="--skip_cleanup --cluster_registry_dir=/root/kubeconf --namespace=istio-system" | tee $HOME/pilot_log
bin/gobuild.sh /root/go/out/linux_amd64/release/istioctl istio.io/istio/pkg/version ./istioctl/cmd/istioctl

real    0m0.412s
user    0m0.548s
sys     0m0.156s
./install/updateVersion.sh -a docker.io/johnajoyce,kubeconfig_fix
/tmp/templates ~/go/src/istio.io/istio
~/go/src/istio.io/istio
/tmp/templates/addons ~/go/src/istio.io/istio
~/go/src/istio.io/istio
/tmp/templates ~/go/src/istio.io/istio
~/go/src/istio.io/istio
/tmp/templates ~/go/src/istio.io/istio
~/go/src/istio.io/istio
-a docker.io/johnajoyce,kubeconfig_fix
make[1]: Entering directory '/root/go/src/istio.io/istio'
```

```
ON-PREM k8s # kubectl get namespaces
NAME          STATUS    AGE
default       Active    5h
kube-public   Active    5h
kube-system   Active    5h
ON-PREM k8s #
```


Terminal Shell Edit View Window Help
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Apr 25 3:51 PM tiswanso
tiswanso — root@k8s-demo: ~ — ssh ‹ ssh root@k8s-demo — 157×19
tiswanso — root@k8s-demo: ~ — ssh ‹ ssh root@k8s-demo — 157×18

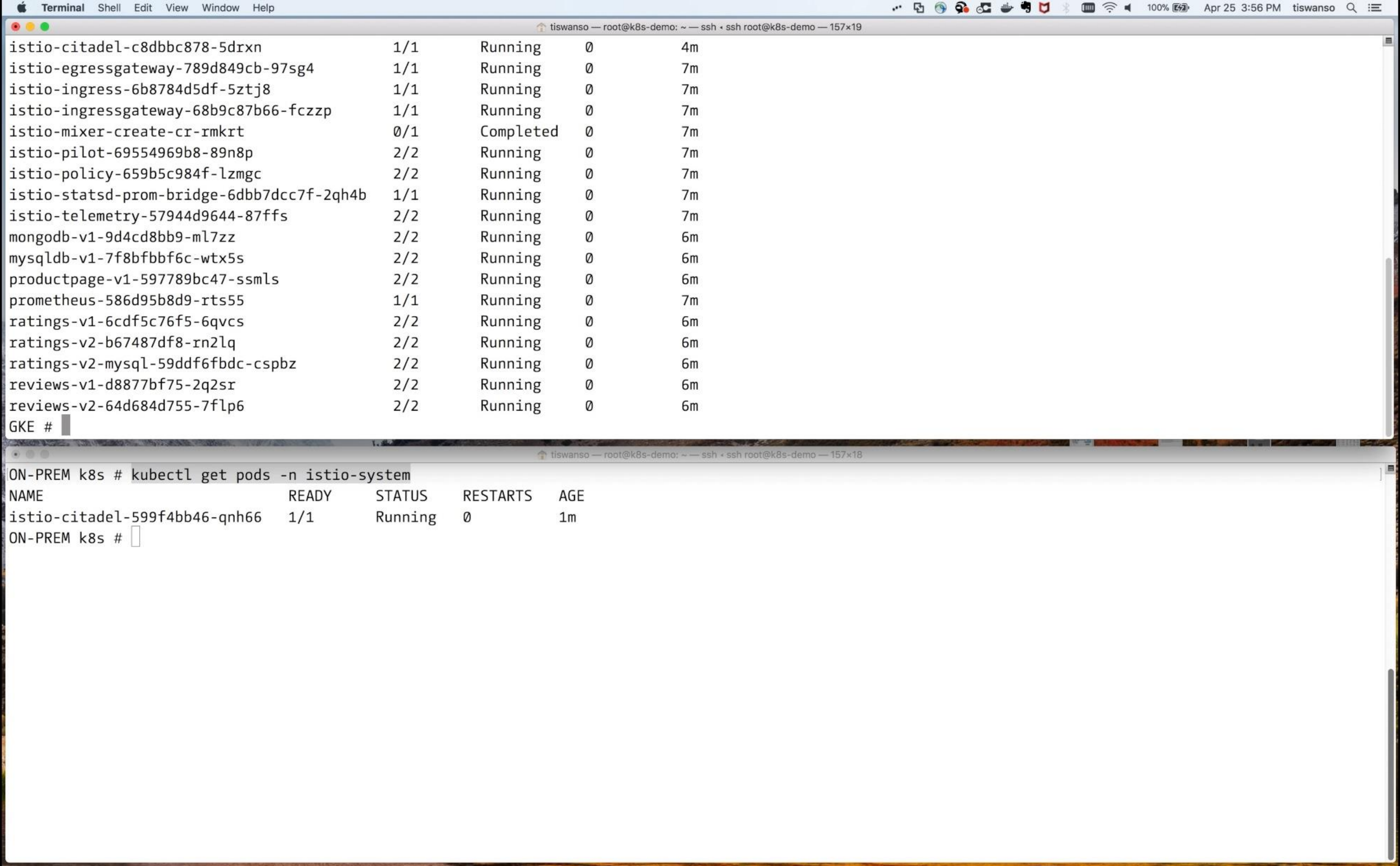
```
2018-04-25T19:51:46.064141Z     info    Running command kubectl logs reviews-v3-6cb5984c75-hfxk8 -n istio-system -c istio-proxy --kubeconfig=/root/kubeconf/l
ocal
2018-04-25T19:51:46.341756Z     info    Running command kubectl logs reviews-v3-6cb5984c75-hfxk8 -n istio-system -c istio-proxy -p --kubeconfig=/root/kubecon
f/local
2018-04-25T19:51:46.589116Z     info    Command error: exit status 1
2018-04-25T19:51:46.589164Z     info    No previous log command failed: "Error from server (BadRequest): previous terminated container \"istio-proxy\" in pod
 \"reviews-v3-6cb5984c75-hfxk8\" not found\n" exit status 1
2018-04-25T19:51:46.589183Z     info    Fetching deployment info on pod

2018-04-25T19:51:46.589197Z     info    Running command kubectl get pod -n istio-system -o yaml --kubeconfig=/root/kubeconf/local
2018-04-25T19:51:46.907629Z     info    Fetching deployment info on service

2018-04-25T19:51:46.907661Z     info    Running command kubectl get service -n istio-system -o yaml --kubeconfig=/root/kubeconf/local
2018-04-25T19:51:47.120189Z     info    Fetching deployment info on ingress

2018-04-25T19:51:47.120227Z     info    Running command kubectl get ingress -n istio-system -o yaml --kubeconfig=/root/kubeconf/local
2018-04-25T19:51:47.292585Z     info    Dev mode (--skip_cleanup), skipping cleanup (removal of namespace/install)
ok      istio.io/istio/tests/e2e/tests/bookinfo 187.069s
GKE # 
```

```
ON-PREM k8s # kubectl get namespaces
NAME          STATUS    AGE
default       Active    5h
kube-public   Active    5h
kube-system   Active    5h
ON-PREM k8s # 
```



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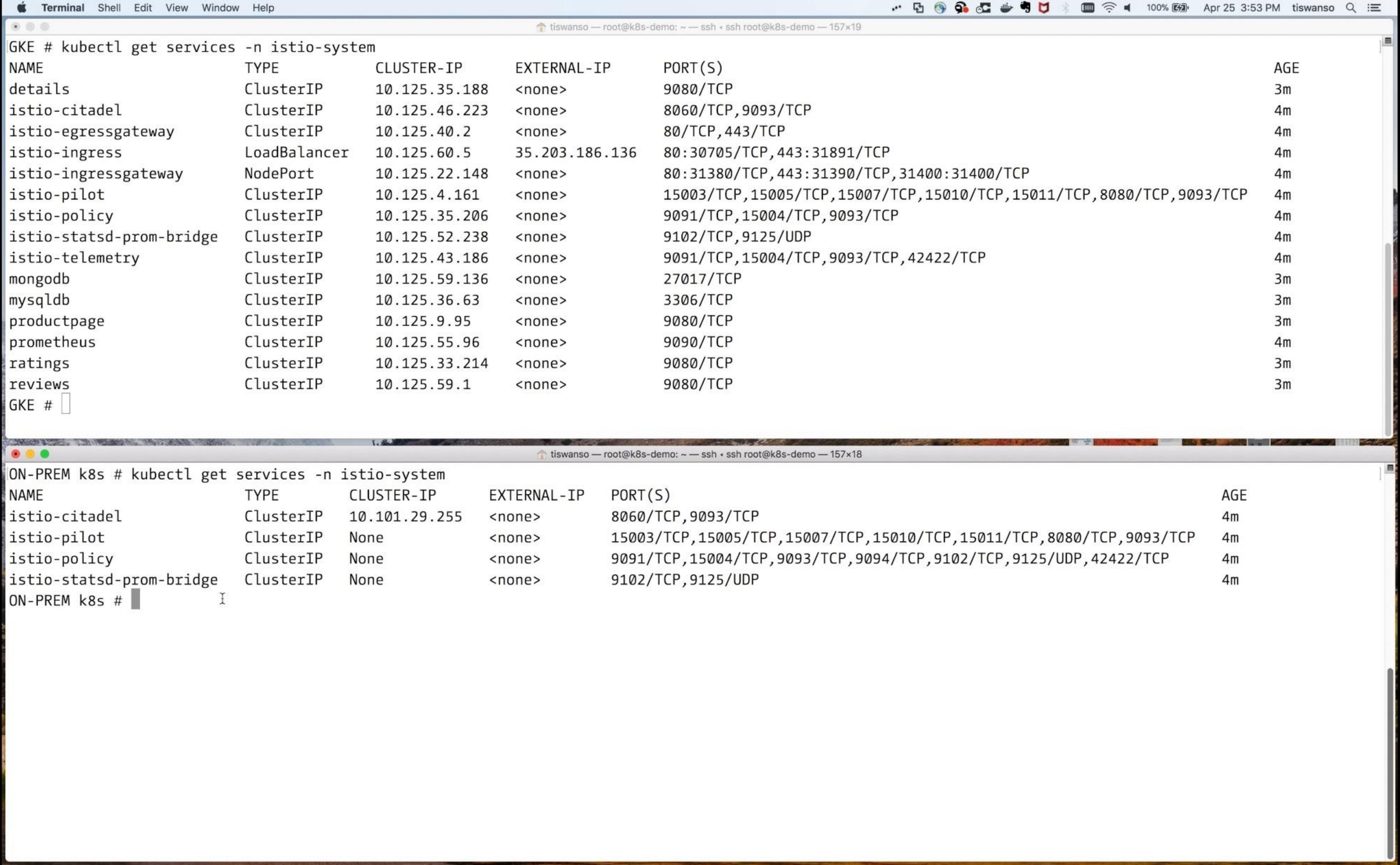
tiswanso — root@k8s-demo: ~ — ssh ◂ ssh root@k8s-demo — 157×18

```
istio-citadel-c8dbbc878-5drxn             1/1       Running     0          4m
istio-egressgateway-789d849cb-97sg4       1/1       Running     0          7m
istio-ingress-6b8784d5df-5ztj8            1/1       Running     0          7m
istio-ingressgateway-68b9c87b66-fczzp     1/1       Running     0          7m
istio-mixer-create-cr-rmkrt               0/1       Completed   0          7m
istio-pilot-69554969b8-89n8p              2/2       Running     0          7m
istio-policy-659b5c984f-lzmgc             2/2       Running     0          7m
istio-statsd-prom-bridge-6dbb7dcc7f-2qh4b 1/1       Running     0          7m
istio-telemetry-57944d9644-87ffs          2/2       Running     0          7m
mongodb-v1-9d4cd8bb9-ml7zz                2/2       Running     0          6m
mysqldb-v1-7f8bfbbf6c-wtx5s               2/2       Running     0          6m
productpage-v1-597789bc47-ssmls           2/2       Running     0          6m
prometheus-586d95b8d9-rts55               1/1       Running     0          7m
ratings-v1-6cdf5c76f5-6qvcs               2/2       Running     0          6m
ratings-v2-b67487df8-rn2lq                2/2       Running     0          6m
ratings-v2-mysql-59ddf6fbdc-cspbz         2/2       Running     0          6m
reviews-v1-d8877bf75-2q2sr                2/2       Running     0          6m
reviews-v2-64d684d755-7flp6               2/2       Running     0          6m
GKE #
```

```
ON-PREM k8s # kubectl get pods -n istio-system
NAME                             READY     STATUS    RESTARTS   AGE
istio-citadel-599f4bb46-qnh66    1/1       Running   0          1m
ON-PREM k8s #
```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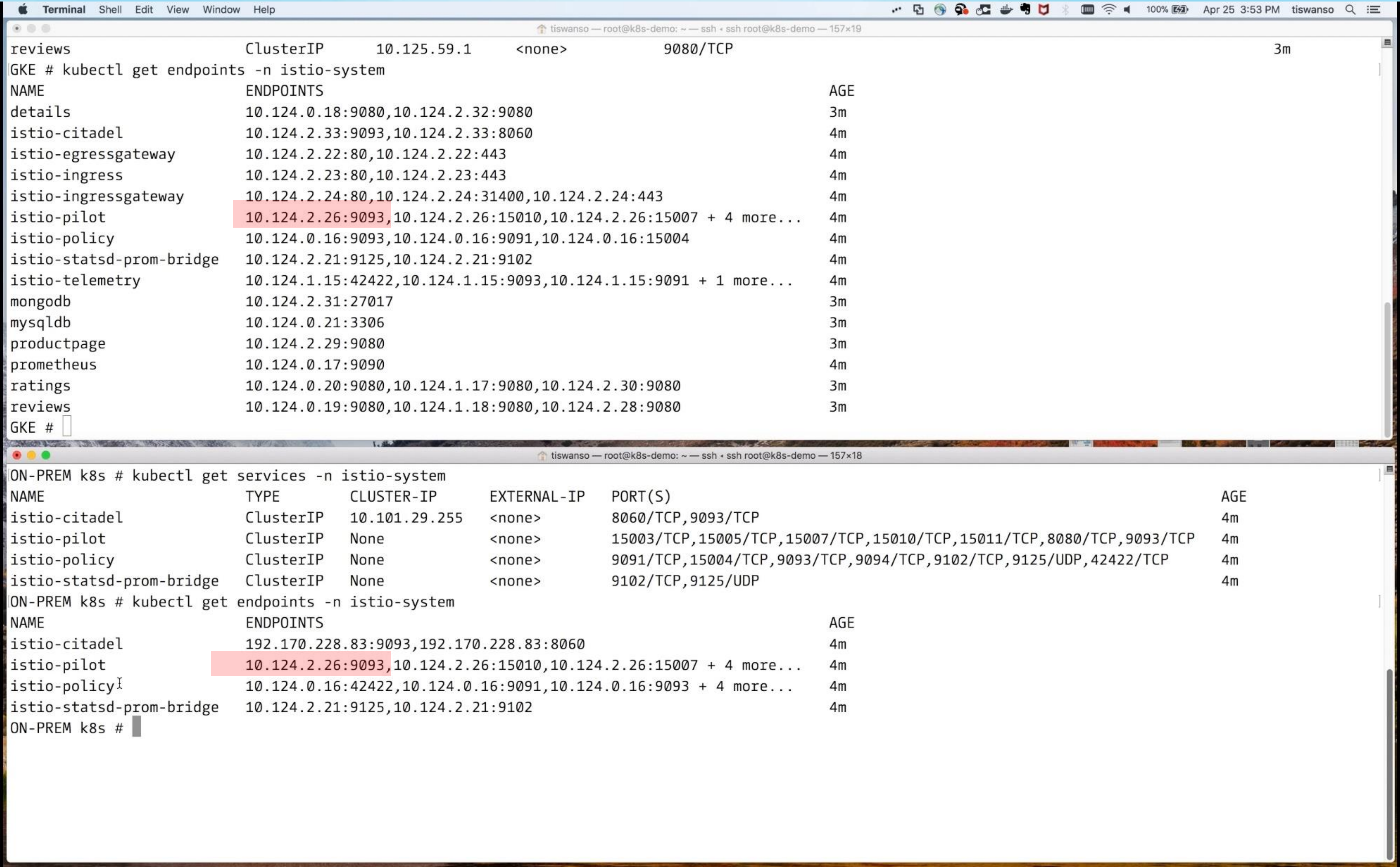
```
GKE # kubectl get services -n istio-system
NAME                       TYPE           CLUSTER-IP      EXTERNAL-IP      PORT(S)                                                             AGE
details                    ClusterIP      10.125.35.188   <none>           9080/TCP                                                            3m
istio-citadel              ClusterIP      10.125.46.223   <none>           8060/TCP,9093/TCP                                                   4m
istio-egressgateway        ClusterIP      10.125.40.2     <none>           80/TCP,443/TCP                                                      4m
istio-ingress              LoadBalancer   10.125.60.5     35.203.186.136   80:30705/TCP,443:31891/TCP                                          4m
istio-ingressgateway       NodePort       10.125.22.148   <none>           80:31380/TCP,443:31390/TCP,31400:31400/TCP                          4m
istio-pilot                ClusterIP      10.125.4.161    <none>           15003/TCP,15005/TCP,15007/TCP,15010/TCP,15011/TCP,8080/TCP,9093/TCP 4m
istio-policy               ClusterIP      10.125.35.206   <none>           9091/TCP,15004/TCP,9093/TCP                                         4m
istio-statsd-prom-bridge   ClusterIP      10.125.52.238   <none>           9102/TCP,9125/UDP                                                   4m
istio-telemetry            ClusterIP      10.125.43.186   <none>           9091/TCP,15004/TCP,9093/TCP,42422/TCP                               4m
mongodb                    ClusterIP      10.125.59.136   <none>           27017/TCP                                                           3m
mysqldb                    ClusterIP      10.125.36.63    <none>           3306/TCP                                                            3m
productpage                ClusterIP      10.125.9.95     <none>           9080/TCP                                                            3m
prometheus                 ClusterIP      10.125.55.96    <none>           9090/TCP                                                            4m
ratings                    ClusterIP      10.125.33.214   <none>           9080/TCP                                                            3m
reviews                    ClusterIP      10.125.59.1     <none>           9080/TCP                                                            3m
GKE # 
```

```
ON-PREM k8s # kubectl get services -n istio-system
NAME                       TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)                                                             AGE
istio-citadel              ClusterIP   10.101.29.255   <none>        8060/TCP,9093/TCP                                                   4m
istio-pilot                ClusterIP   None            <none>        15003/TCP,15005/TCP,15007/TCP,15010/TCP,15011/TCP,8080/TCP,9093/TCP 4m
istio-policy               ClusterIP   None            <none>        9091/TCP,15004/TCP,9093/TCP,9094/TCP,9102/TCP,9125/UDP,42422/TCP    4m
istio-statsd-prom-bridge   ClusterIP   None            <none>        9102/TCP,9125/UDP                                                   4m
ON-PREM k8s # 
```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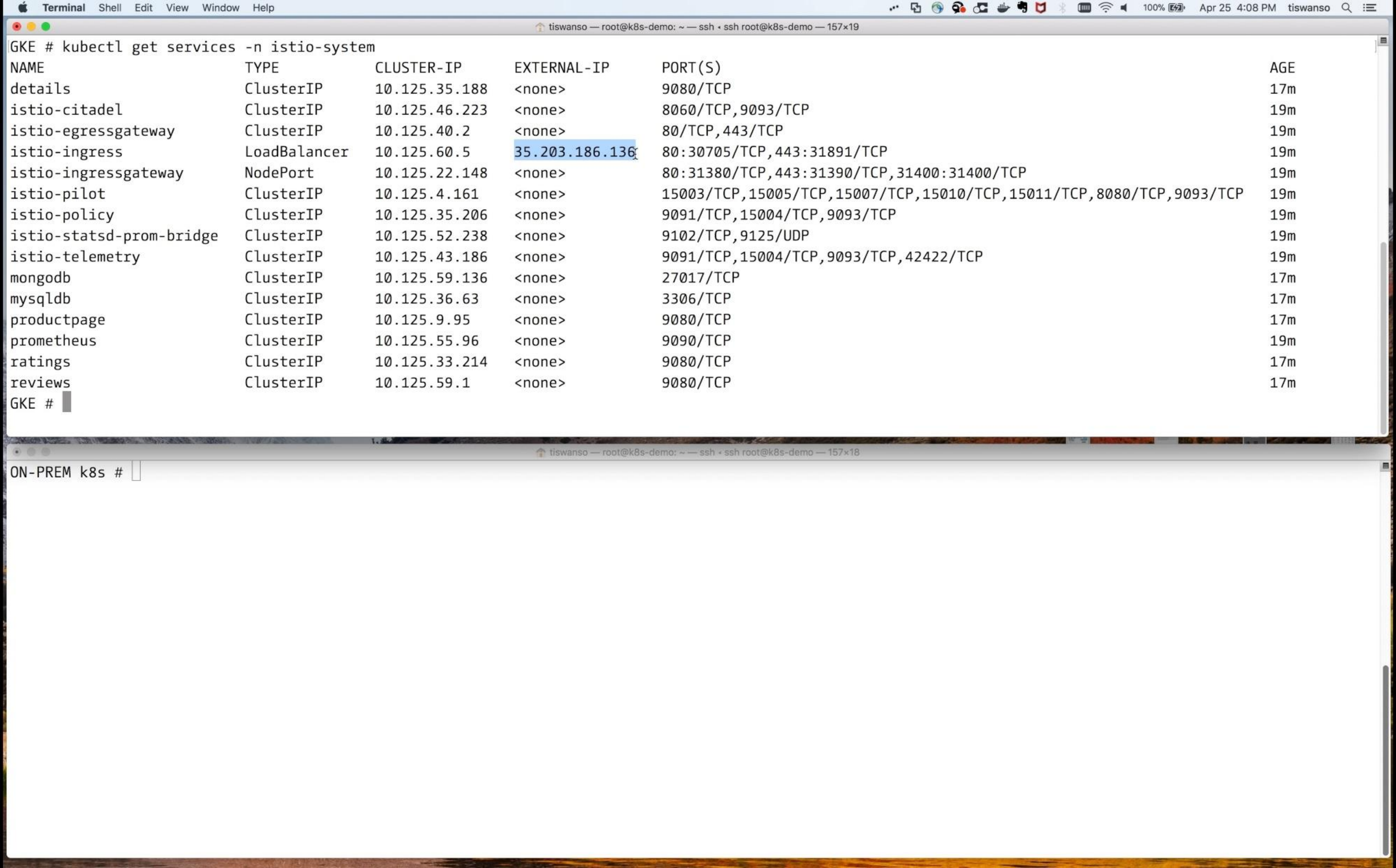
```
reviews                  ClusterIP    10.125.59.1     <none>          9080/TCP                                                        3m
GKE # kubectl get endpoints -n istio-system
NAME                     ENDPOINTS                                                           AGE
details                  10.124.0.18:9080,10.124.2.32:9080                                   3m
istio-citadel            10.124.2.33:9093,10.124.2.33:8060                                   4m
istio-egressgateway      10.124.2.22:80,10.124.2.22:443                                      4m
istio-ingress            10.124.2.23:80,10.124.2.23:443                                      4m
istio-ingressgateway     10.124.2.24:80,10.124.2.24:31400,10.124.2.24:443                    4m
istio-pilot              10.124.2.26:9093,10.124.2.26:15010,10.124.2.26:15007 + 4 more...    4m
istio-policy             10.124.0.16:9093,10.124.0.16:9091,10.124.0.16:15004                 4m
istio-statsd-prom-bridge 10.124.2.21:9125,10.124.2.21:9102                                   4m
istio-telemetry          10.124.1.15:42422,10.124.1.15:9093,10.124.1.15:9091 + 1 more...     4m
mongodb                  10.124.2.31:27017                                                   3m
mysqldb                  10.124.0.21:3306                                                    3m
productpage              10.124.2.29:9080                                                    3m
prometheus               10.124.0.17:9090                                                    4m
ratings                  10.124.0.20:9080,10.124.1.17:9080,10.124.2.30:9080                  3m
reviews                  10.124.0.19:9080,10.124.1.18:9080,10.124.2.28:9080                  3m
GKE #
```

```
ON-PREM k8s # kubectl get services -n istio-system
NAME                     TYPE         CLUSTER-IP      EXTERNAL-IP   PORT(S)                                                         AGE
istio-citadel            ClusterIP    10.101.29.255   <none>        8060/TCP,9093/TCP                                               4m
istio-pilot              ClusterIP    None            <none>        15003/TCP,15005/TCP,15007/TCP,15010/TCP,15011/TCP,8080/TCP,9093/TCP   4m
istio-policy             ClusterIP    None            <none>        9091/TCP,15004/TCP,9093/TCP,9094/TCP,9102/TCP,9125/UDP,42422/TCP     4m
istio-statsd-prom-bridge ClusterIP    None            <none>        9102/TCP,9125/UDP                                               4m
ON-PREM k8s # kubectl get endpoints -n istio-system
NAME                     ENDPOINTS                                                           AGE
istio-citadel            192.170.228.83:9093,192.170.228.83:8060                             4m
istio-pilot              10.124.2.26:9093,10.124.2.26:15010,10.124.2.26:15007 + 4 more...    4m
istio-policy             10.124.0.16:42422,10.124.0.16:9091,10.124.0.16:9093 + 4 more...     4m
istio-statsd-prom-bridge 10.124.2.21:9125,10.124.2.21:9102                                   4m
ON-PREM k8s #
```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NAME                       TYPE           CLUSTER-IP      EXTERNAL-IP      PORT(S)                                                               AGE
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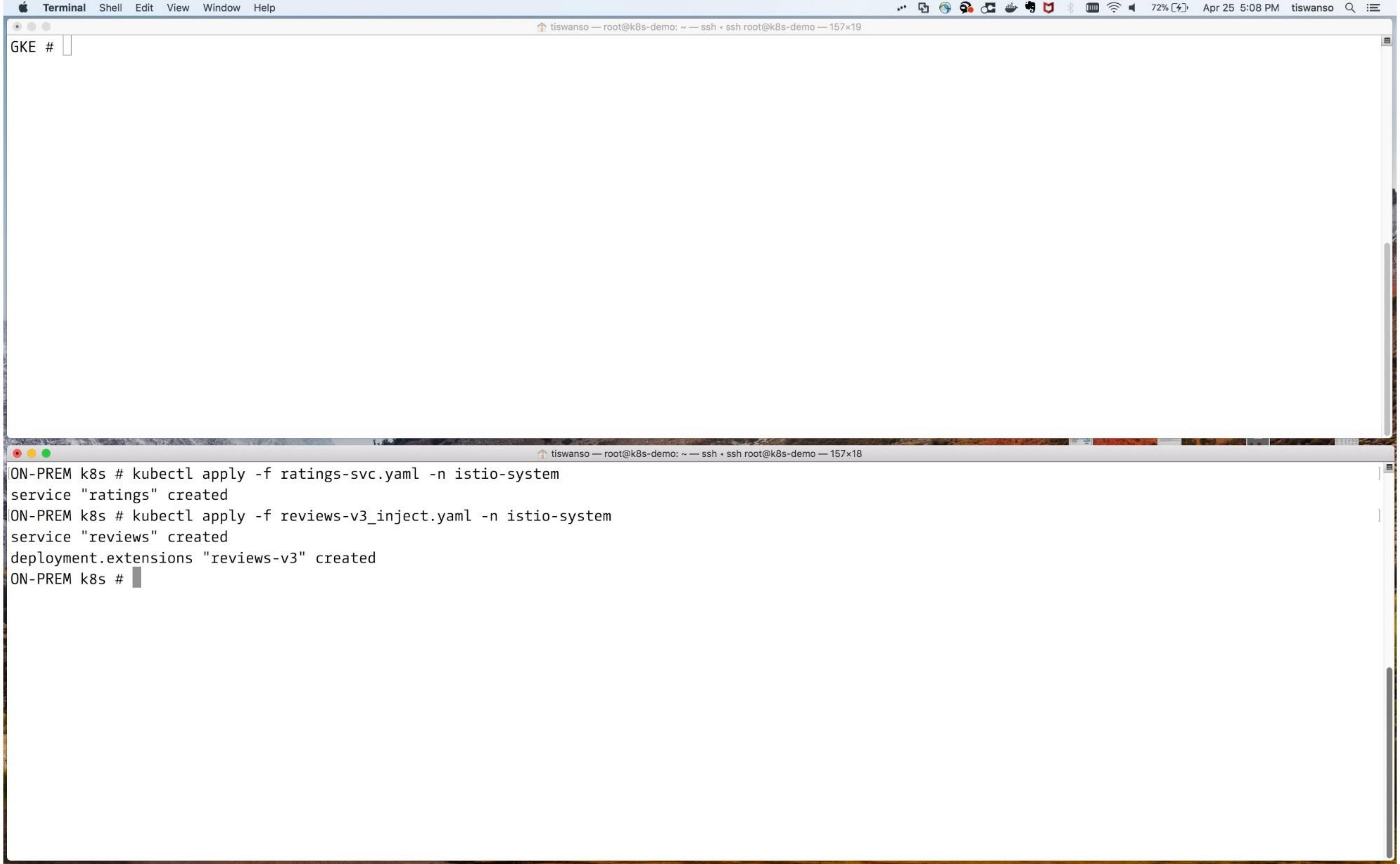
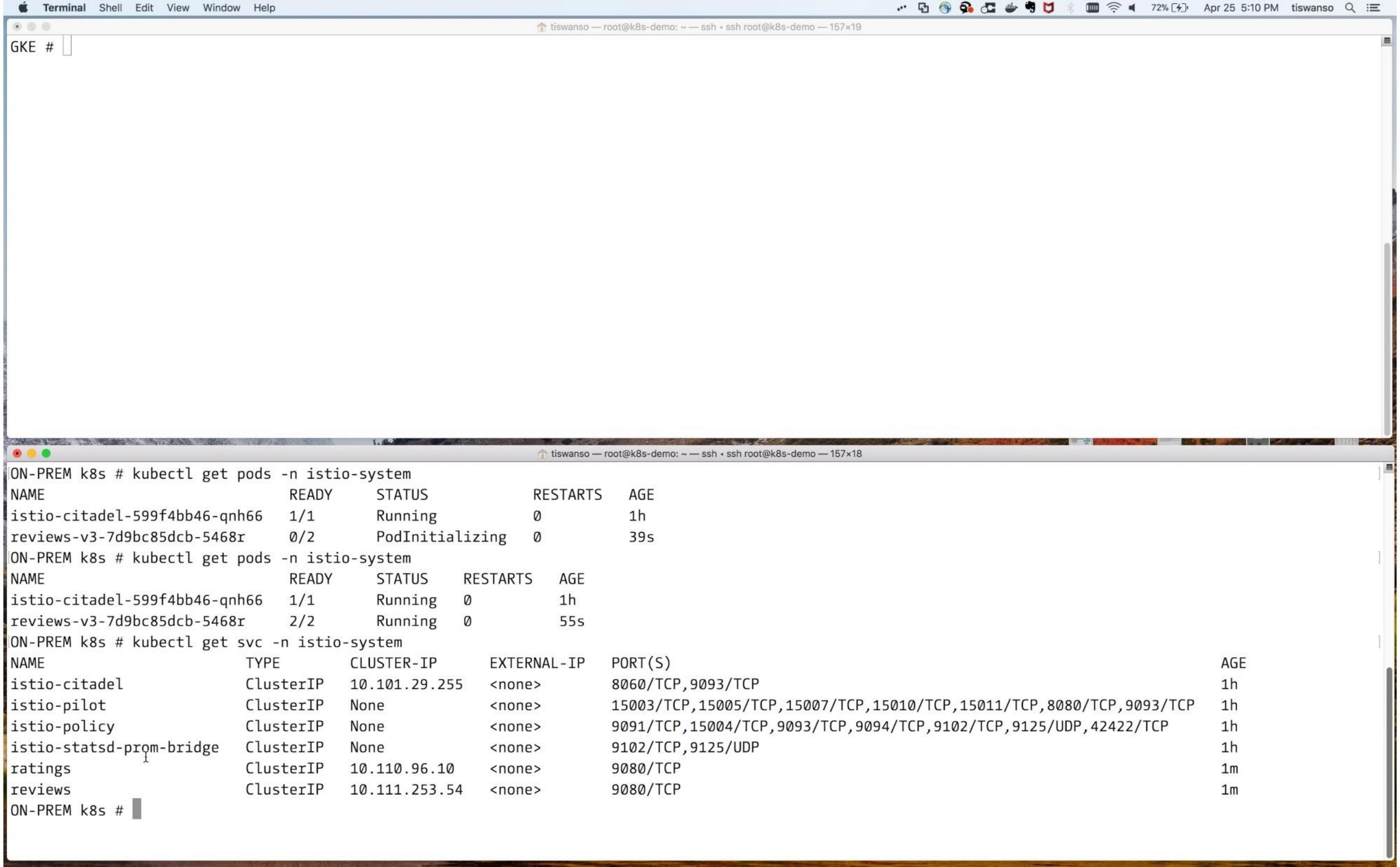
istio-citadel              ClusterIP      10.125.46.223   <none>           8060/TCP,9093/TCP                                                     19m
istio-egressgateway        ClusterIP      10.125.40.2     <none>           80/TCP,443/TCP                                                        19m
istio-ingress              LoadBalancer   10.125.60.5     35.203.186.136   80:30705/TCP,443:31891/TCP                                            19m
istio-ingressgateway       NodePort       10.125.22.148   <none>           80:31380/TCP,443:31390/TCP,31400:31400/TCP                            19m
istio-pilot                ClusterIP      10.125.4.161    <none>           15003/TCP,15005/TCP,15007/TCP,15010/TCP,15011/TCP,8080/TCP,9093/TCP   19m
istio-policy               ClusterIP      10.125.35.206   <none>           9091/TCP,15004/TCP,9093/TCP                                           19m
istio-statsd-prom-bridge   ClusterIP      10.125.52.238   <none>           9102/TCP,9125/UDP                                                     19m
istio-telemetry            ClusterIP      10.125.43.186   <none>           9091/TCP,15004/TCP,9093/TCP,42422/TCP                                 19m
mongodb                    ClusterIP      10.125.59.136   <none>           27017/TCP                                                             17m
mysqldb                    ClusterIP      10.125.36.63    <none>           3306/TCP                                                              17m
productpage                ClusterIP      10.125.9.95     <none>           9080/TCP                                                              17m
prometheus                 ClusterIP      10.125.55.96    <none>           9090/TCP                                                              19m
ratings                    ClusterIP      10.125.33.214   <none>           9080/TCP                                                              17m
reviews                    ClusterIP      10.125.59.1     <none>           9080/TCP                                                              17m
GKE #
```

```
ON-PREM k8s #
```


Terminal Shell Edit View Window Help
72% Apr 25 5:08 PM tiswanso
tiswanso — root@k8s-demo: ~ — ssh • ssh root@k8s-demo — 157×19
tiswanso — root@k8s-demo: ~ — ssh • ssh root@k8s-demo — 157×18

```
GKE # 
```

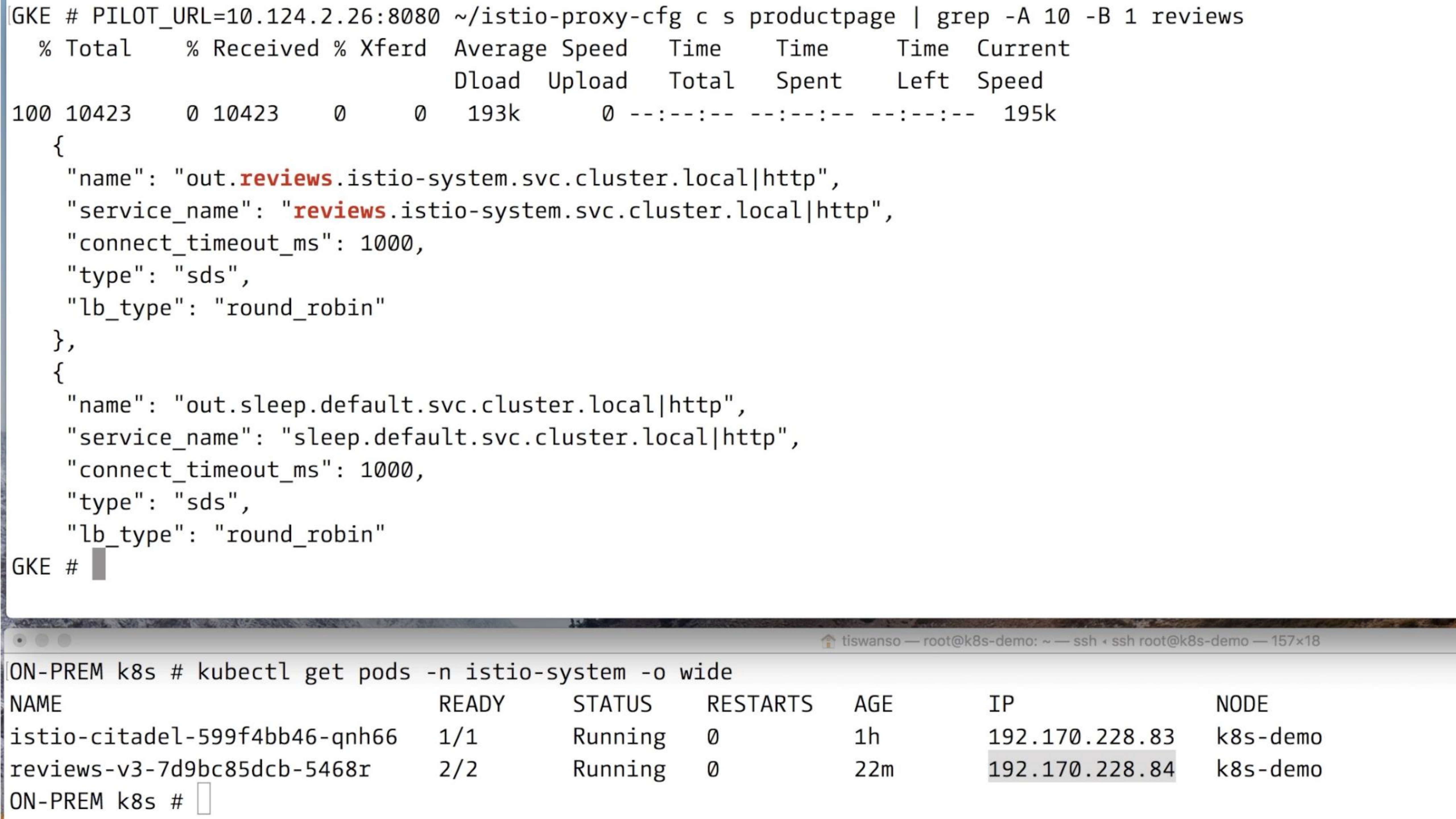
```
ON-PREM k8s # kubectl apply -f ratings-svc.yaml -n istio-system
service "ratings" created
ON-PREM k8s # kubectl apply -f reviews-v3_inject.yaml -n istio-system
service "reviews" created
deployment.extensions "reviews-v3" created
ON-PREM k8s # 
```



Terminal
Shell
Edit
View
Window
Help
72%
Apr 25 5:10 PM
tiswanso
tiswanso — root@k8s-demo: ~ — ssh ‹ ssh root@k8s-demo — 157×19
tiswanso — root@k8s-demo: ~ — ssh ‹ ssh root@k8s-demo — 157×18

```
GKE #
```

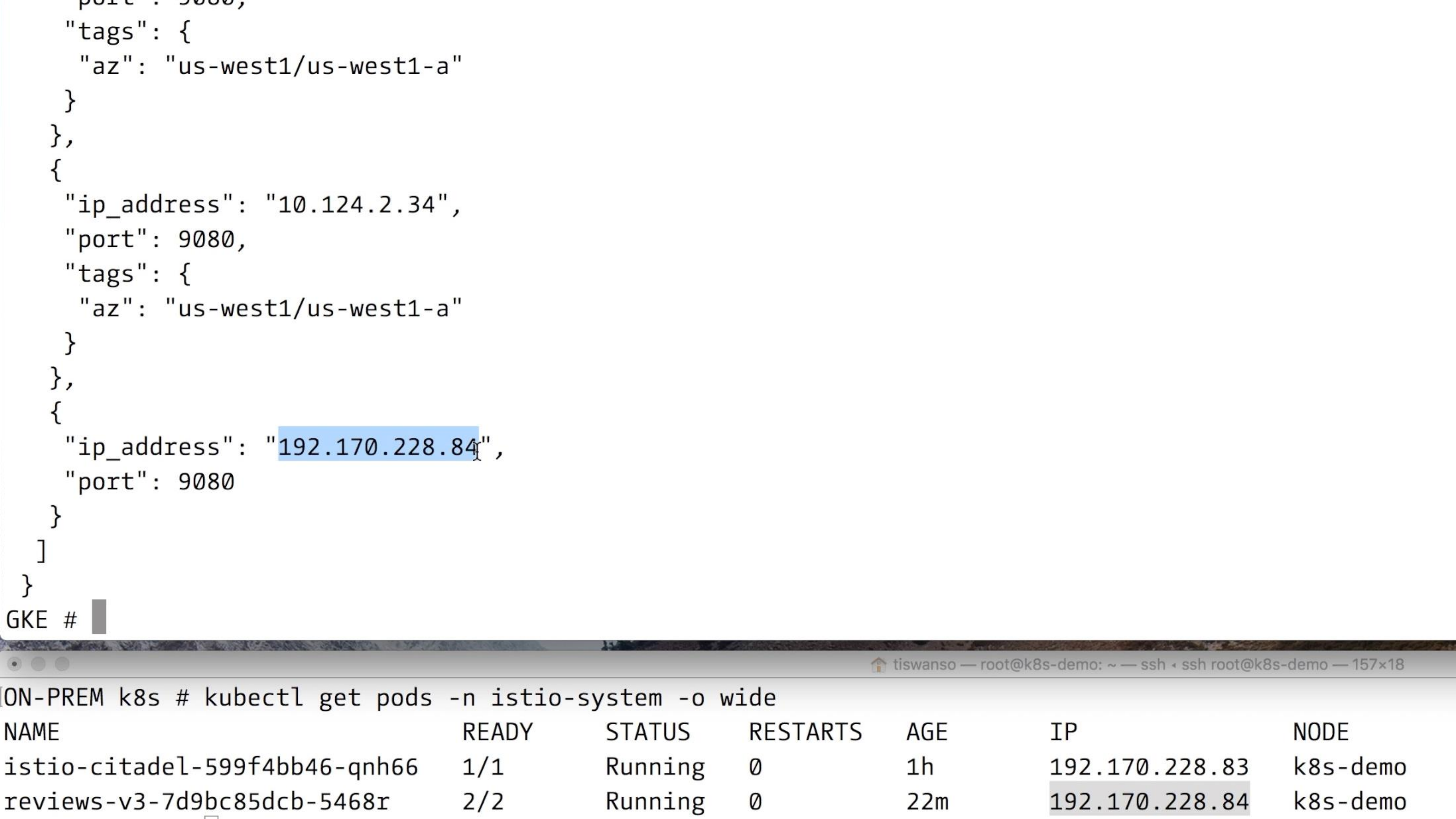
```
ON-PREM k8s # kubectl get pods -n istio-system
NAME                            READY     STATUS            RESTARTS   AGE
istio-citadel-599f4bb46-qnh66   1/1       Running           0          1h
reviews-v3-7d9bc85dcb-5468r     0/2       PodInitializing   0          39s
ON-PREM k8s # kubectl get pods -n istio-system
NAME                            READY     STATUS    RESTARTS   AGE
istio-citadel-599f4bb46-qnh66   1/1       Running   0          1h
reviews-v3-7d9bc85dcb-5468r     2/2       Running   0          55s
ON-PREM k8s # kubectl get svc -n istio-system
NAME                       TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)                                                              AGE
istio-citadel              ClusterIP   10.101.29.255   <none>        8060/TCP,9093/TCP                                                    1h
istio-pilot                ClusterIP   None            <none>        15003/TCP,15005/TCP,15007/TCP,15010/TCP,15011/TCP,8080/TCP,9093/TCP   1h
istio-policy               ClusterIP   None            <none>        9091/TCP,15004/TCP,9093/TCP,9094/TCP,9102/TCP,9125/UDP,42422/TCP     1h
istio-statsd-prom-bridge   ClusterIP   None            <none>        9102/TCP,9125/UDP                                                    1h
ratings                    ClusterIP   10.110.96.10    <none>        9080/TCP                                                             1m
reviews                    ClusterIP   10.111.253.54   <none>        9080/TCP                                                             1m
ON-PREM k8s #
```



```
GKE # PILOT_URL=10.124.2.26:8080 ~/istio-proxy-cfg c s productpage | grep -A 10 -B 1 reviews
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 10423    0 10423    0     0   193k      0 --:--:-- --:--:-- --:--:--  195k
   {
    "name": "out.reviews.istio-system.svc.cluster.local|http",
    "service_name": "reviews.istio-system.svc.cluster.local|http",
    "connect_timeout_ms": 1000,
    "type": "sds",
    "lb_type": "round_robin"
   },
   {
    "name": "out.sleep.default.svc.cluster.local|http",
    "service_name": "sleep.default.svc.cluster.local|http",
    "connect_timeout_ms": 1000,
    "type": "sds",
    "lb_type": "round_robin"
GKE # 
```

tiswanso — root@k8s-demo: ~ — ssh ◂ ssh root@k8s-demo — 157×18

```
ON-PREM k8s # kubectl get pods -n istio-system -o wide
NAME                           READY     STATUS    RESTARTS   AGE       IP                NODE
istio-citadel-599f4bb46-qnh66  1/1       Running   0          1h        192.170.228.83    k8s-demo
reviews-v3-7d9bc85dcb-5468r    2/2       Running   0          22m       192.170.228.84    k8s-demo
ON-PREM k8s # 
```



```
    "port": 9080,
    "tags": {
     "az": "us-west1/us-west1-a"
    }
   },
   {
    "ip_address": "10.124.2.34",
    "port": 9080,
    "tags": {
     "az": "us-west1/us-west1-a"
    }
   },
   {
    "ip_address": "192.170.228.84",
    "port": 9080
   }
  ]
 }
GKE #
```

tiswanso — root@k8s-demo: ~ — ssh ‹ ssh root@k8s-demo — 157×18

```
ON-PREM k8s # kubectl get pods -n istio-system -o wide
NAME                               READY     STATUS    RESTARTS   AGE       IP               NODE
istio-citadel-599f4bb46-qnh66      1/1       Running   0          1h        192.170.228.83   k8s-demo
reviews-v3-7d9bc85dcb-5468r        2/2       Running   0          22m       192.170.228.84   k8s-demo
```

Mesh Routing Demo

Future Improvements

Future improvements:

- Usability Improvements
- Increased test coverage
- Pilot to Pilot multi-cloud
- Full adoption of the clusterregistry (via API calls from Istio)
- Zero VPN work
- Bring your own Service Name
- Mixer Multicluster enabled

Q & A

References:

- Initial PR to enable Multicluster: https://github.com/istio/istio/pull/2880
- Installation documentation: https://github.com/istio/istio.github.io/pull/1139
- Multicloud Design Document: **https://tinyurl.com/y7scozvb**
- Zero VPN design document: **https://tinyurl.com/zerovpn**
- Bring Your own Service Name Design Document: **https://tinyurl.com/svc-name**