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Exiting Ingress with the Gateway API

Rob Scott, Google
Shane Utt, Kong

2 Questions

1. How many of you have used Ingress API?

2. How many of you have used Gateway API?

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BUILDING FOR THE ROAD AHEAD

DETROIT 2022

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API Overviews

The Ingress API

- Host and Path Matching
- Forward to Service
- TLS Configuration
- Stable for 5 years
- **Simple and broadly implementable**

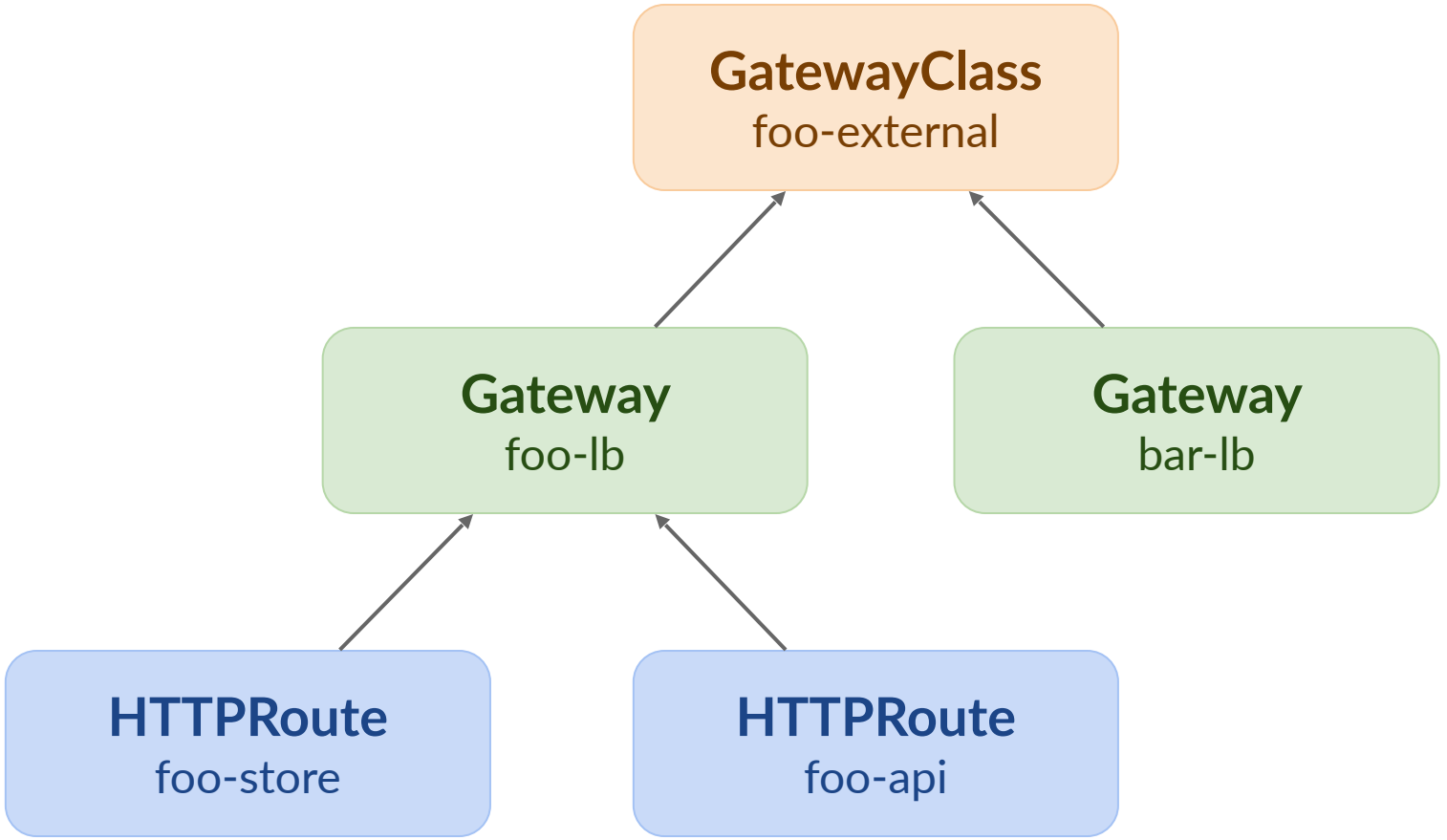
```yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: minimal-ingress
spec:
  ingressClassName: nginx-example
  rules:
  - http:
      paths:
      - path: /testpath
        pathType: Prefix
        backend:
          service:
            name: test
            port:
              number: 80
```

Ingress Limitations

- Not enough features
- Custom extensions everywhere
- Extensions were not portable:
  - Traffic splitting
  - Header matching
  - Sticky sessions
- Annotations were wild west
- Insufficient permission model

Gateway API

- Next generation of Kubernetes routing and load balancing APIs
- Designed to be expressive and extensible
- Role oriented resource model
- 15 implementations
- Graduated to beta in July



Gateway API Features

- TLS configuration
- HTTP matching
  - Host
  - Path
  - Header
  - Method
  - Query Param
- Cross namespace Gateway -> Route binding
- Cross namespace forwarding
- HTTP filters
  - Header modifier
  - Request mirroring
  - Request redirects
  - URL rewrites
- Weight based traffic splitting
- *More in progress…*

Gateway API Features

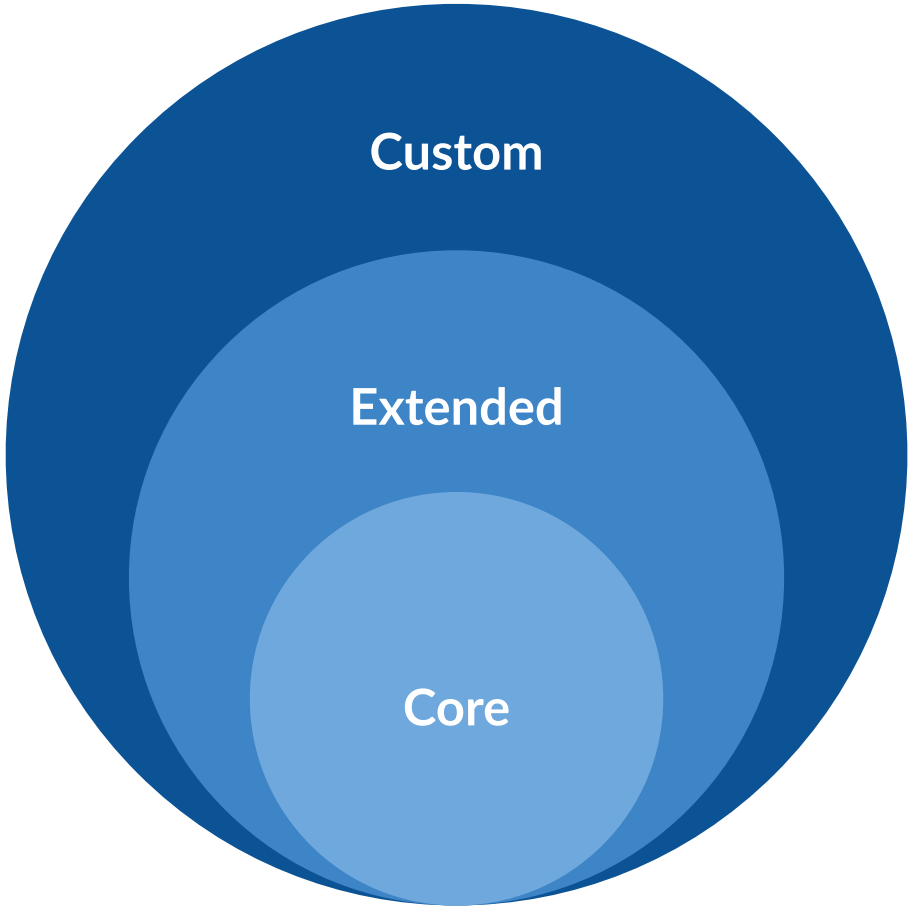
- TLS configuration
- HTTP matching
  - Host
  - Path

Only in Gateway API

- Header
- Method
- Query Param
- Cross namespace Gateway -> Route binding
- Cross namespace forwarding
- HTTP filters
  - Header modifier
  - Request mirroring
  - Request redirects
  - URL rewrites
- Weight based traffic splitting
- *More in progress…*

Conformance Levels

- **Core:** Every implementation expected to support feature in consistent way
  - *HTTP Prefix Path Matching*
- **Extended:** When this is supported, it must be done according to spec
  - *HTTP Header Modification*
- **Custom:** Implementations may have some variation in how they support this feature
  - *HTTP Regex Path Matching*



Ingress vs. HTTPRoute

Simple Path Match

Ingress

```yaml
ingressClassName: nginx
rules:
- http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

HTTPRoute

```yaml
parentRefs:
- name: nginx
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  backendRefs:
  - name: auth-svc
    port: 8080
```

Simple Path Match

Ingress

```yaml
ingressClassName: nginx
rules:
- http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

HTTPRoute

```yaml
parentRefs:
- name: nginx
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  backendRefs:
  - name: auth-svc
    port: 8080
```

Simple Path Match

Ingress

```
ingressClassName: nginx
rules:
- http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

HTTPRoute

```
parentRefs:
- name: nginx
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  backendRefs:
  - name: auth-svc
    port: 8080
```

Adding a Parent

HTTPRoute

```
parentRefs:
- name: nginx
- name: contour
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  backendRefs:
  - name: auth-svc
    port: 8080
```

Adding a Parent

Ingress

```yaml
ingressClassName: nginx
rules:
- http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

```yaml
ingressClassName: contour
rules:
- http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

Adding a Path Match

HTTPRoute

```yaml
parentRefs:
- name: nginx
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  - path:
      type: Exact
      value: /auth
  backendRefs:
  - name: auth-svc
    port: 8080
```

Adding a Path Match

Ingress

```
ingressClassName: nginx
rules:
- http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

```
- path: /auth
  pathType: Exact
  backend:
    service:
      name: auth-svc
      port:
        number: 8080
```

Adding Host Match

Ingress

```yaml
ingressClassName: nginx
rules:
- host: example.net
  http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

HTTPRoute

```yaml
parentRefs:
- name: nginx
hostnames:
- example.net
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  backendRefs:
  - name: auth-svc
    port: 8080
```

Adding Host Match

HTTPRoute

```yaml
parentRefs:
- name: nginx
hostnames:
- example.net
- example.com
rules:
- matches:
  - path:
      type: PathPrefix
      value: /login
  backendRefs:
  - name: auth-svc
    port: 8080
```

Adding Host Match

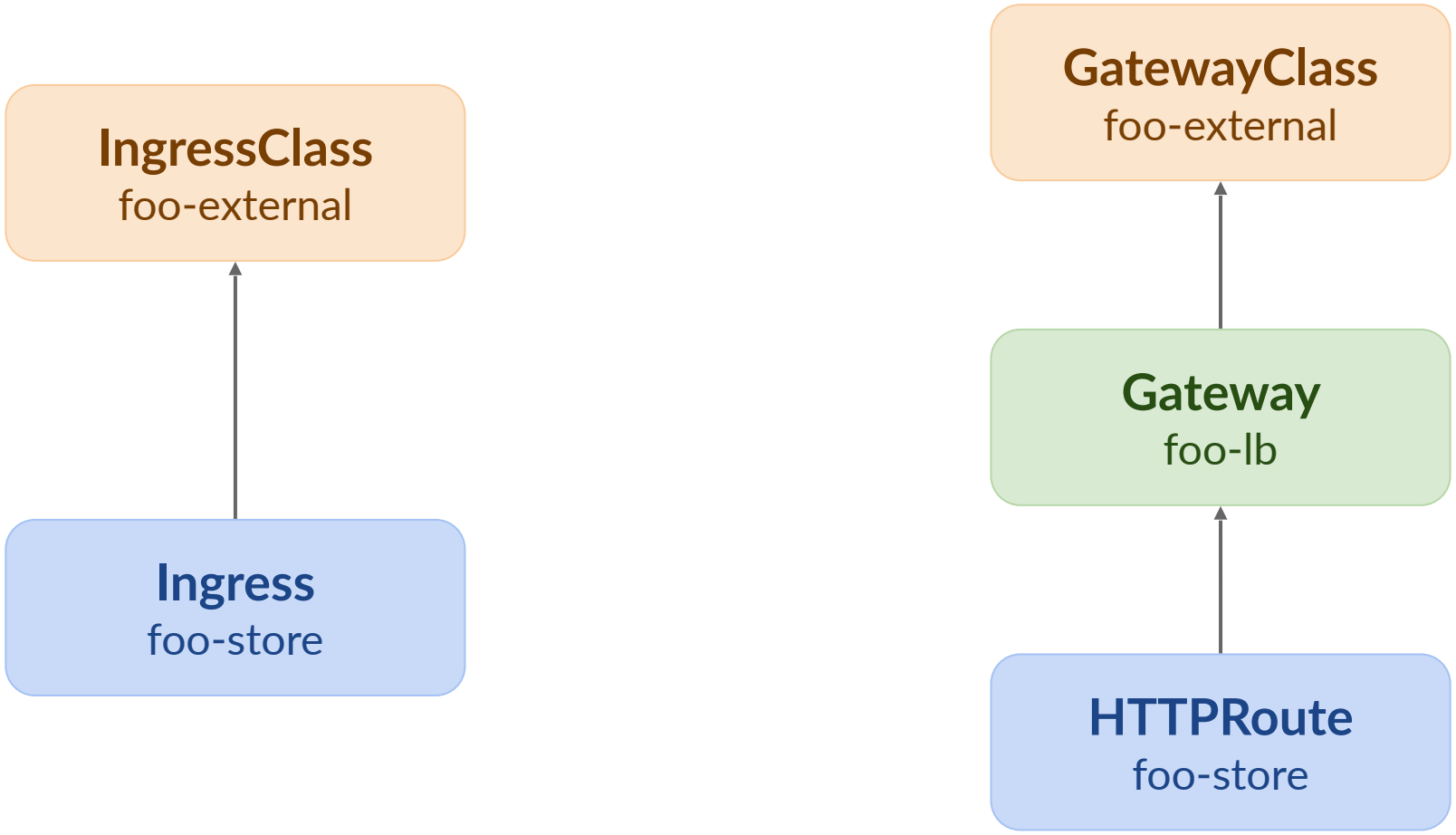
Ingress

```
ingressClassName: nginx
rules:
- host: example.net
  http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

```
- host: example.com
  http:
    paths:
    - path: /login
      pathType: Prefix
      backend:
        service:
          name: auth-svc
          port:
            number: 8080
```

Gateways

Resource Models



Gateways

- Represents an instance of a load balancer/proxy
- Defines listeners and addresses
- Attach routes
- Config stays the same across implementations

```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: prod-web
spec:
  gatewayClassName: gke-l7-gxlb
  listeners:
  - protocol: HTTPS
    port: 443
    hostname: example.com
    tls:
      certificateRefs:
      - name: example-com-cert
        namespace: prod-certs
```

Common Types of Implementations

In-Cluster

- Deploying a **Gateway** resource results in proxy **Pods** for serving traffic (e.g. the “data plane”)
- Often the addresses for the **Gateway** are provided via **LoadBalancer** type **Services**
- Behaves the same way on *any* Kubernetes cluster

Cloud Provider

- Deploying a **Gateway** resource provisions **Cloud Load Balancers**
- Load balance directly from Cloud LB to Pods, **no intermediate hop**
- Usually only available on clusters managed by the Cloud Provider

Route Attachment

- Routes attach to Gateways with **parentRefs** field
- Same route can be attached to multiple Gateways
- Useful for migrating between implementations

```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: HTTPRoute
metadata:
  name: prod-web
spec:
  parentRefs:
  - name: nginx
  - name: contour
  rules:
  - matches:
    - path:
        type: PathPrefix
        value: /login
    backendRefs:
    - name: auth-svc
      port: 8080
```

Allowed Routes

- **Gateway owners** can specify where Routes can be attached from
- **Developers** can attach their routes to Gateways in different namespaces

```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: prod-web
spec:
  gatewayClassName: gke-l7-gxlb
  listeners:
  - name: http
    protocol: HTTP
    port: 80
    allowedRoutes:
      namespaces:
        from: Selector
        selector:
          matchLabels:
            app: store
```

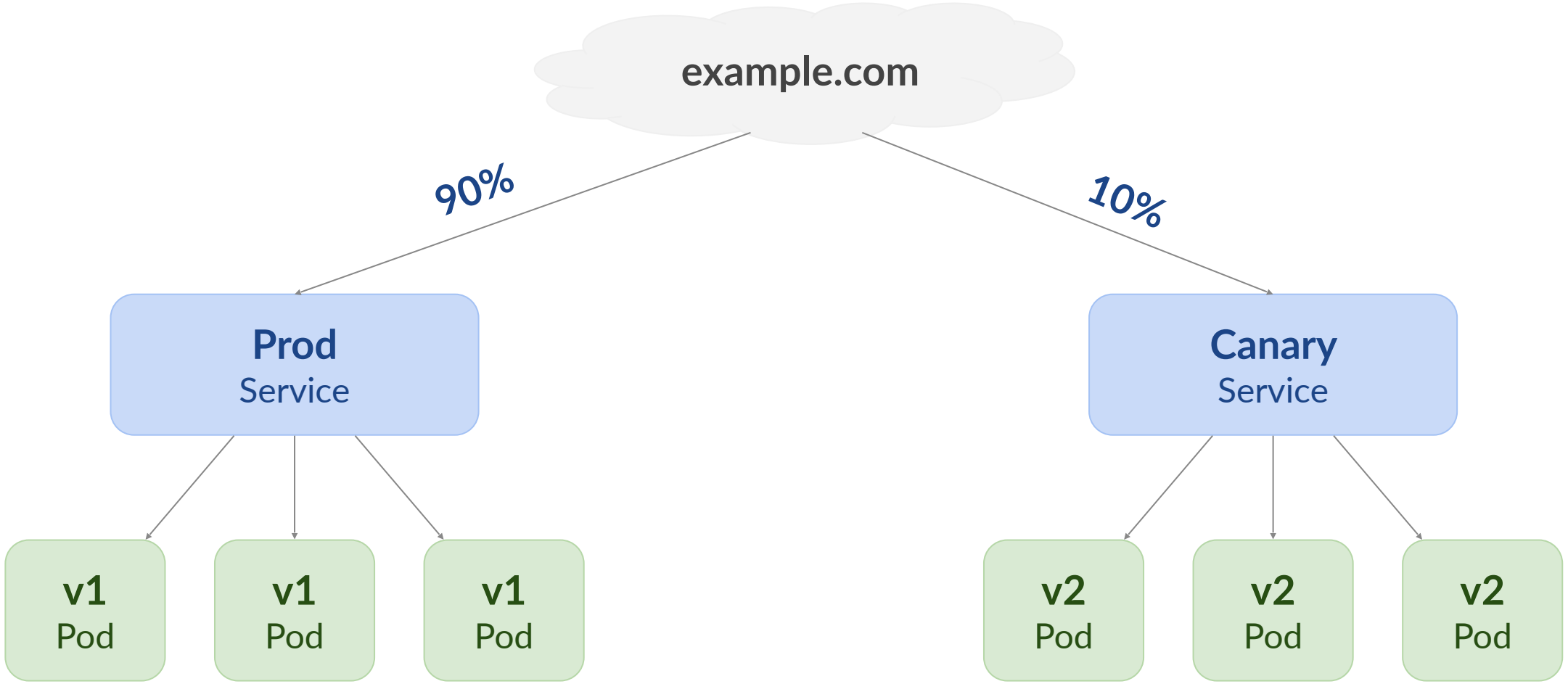
Allowed Routes

- Can specify different trusted namespaces per domain
- Optional extension, same namespace just works

```yaml
listeners:
- name: store
  hostname: store.example.com
  protocol: HTTP
  port: 80
  allowedRoutes:
    namespaces:
      from: Selector
      selector:
        matchLabels:
          app: store
- name: api
  hostname: api.example.com
  protocol: HTTP
  port: 80
  allowedRoutes:
    namespaces:
      from: Selector
        selector:
        matchLabels:
          app: api
```

Advanced Examples

Canary Routing with Ingress



Canary Routing with Ingress

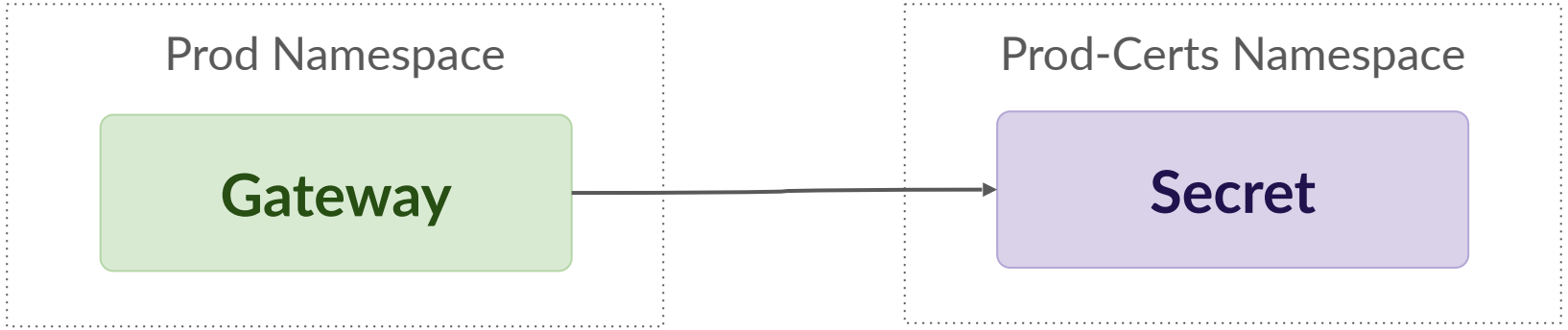

```yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: production
  annotations:
    kubernetes.io/ingress.class: nginx
spec:
  rules:
  - host: example.com
    http:
      paths:
      - pathType: Prefix
        path: "/"
        backend:
          service:
            name: production
            port:
              number: 80
```

```yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: canary
  annotations:
    kubernetes.io/ingress.class: nginx
    nginx.ingress.kubernetes.io/canary: "true"
    nginx.ingress.kubernetes.io/canary-weight: "10"
spec:
  rules:
  - host: example.com
    http:
      paths:
      - pathType: Prefix
        path: "/"
        backend:
          service:
            name: canary
            port:
              number: 80
```

Canary Routing with Gateway API


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: HTTPRoute
metadata:
  name: canary-example
spec:
  hostnames:
  - example.com
  rules:
  - backendRefs:
    - name: canary
      port: 80
      weight: 10
    - name: production
      port: 80
      weight: 90
    matches:
    - path:
        type: PathPrefix
        value: "/"
```

Cross-Namespace Secret Refs



Cross-Namespace Secret Refs

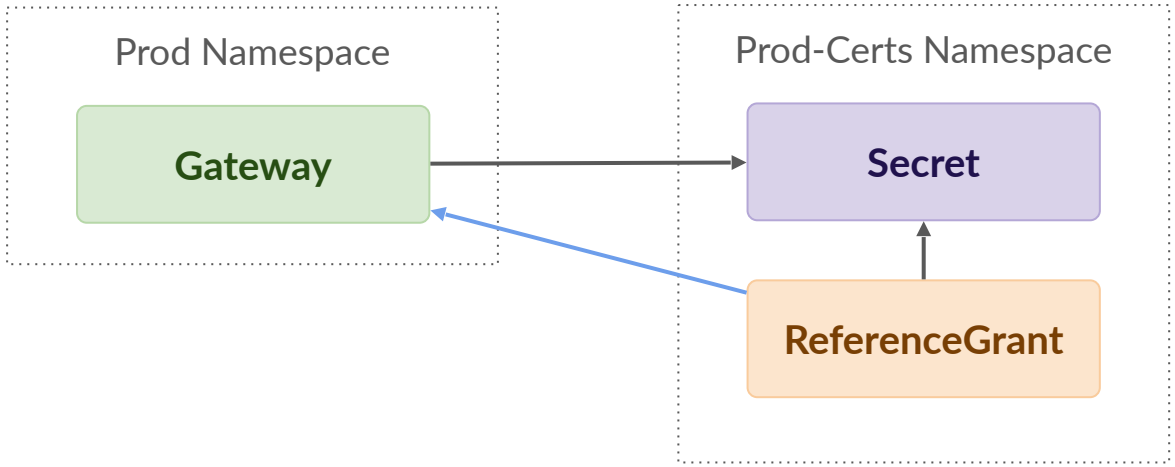

```yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: production
  annotations:
    projectcontour.io/tls-cert-namespace: prod-certs
spec:
  tls:
  - hosts:
      - example.com
    secretName: testsecret-tls
  rules:
  - host: example.com
    http:
      paths:
      ...
```

Cross-Namespace Secret Refs


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: tls-basic
spec:
  gatewayClassName: acme-lb
  listeners:
  - name: example-com-https
    protocol: HTTPS
    port: 443
    hostname: example.com
    tls:
      certificateRefs:
      - name: example-com-cert
        namespace: prod-certs
```

ReferenceGrant


```yaml
kind: ReferenceGrant
metadata:
  name: allow-prod-cert-refs
  namespace: prod-certs
spec:
  from:
  - group: networking.gateway.k8s.io
    kind: Gateway
    namespace: prod
  to:
  - group: ""
    kind: Secret
    name: example-com-cert
```



Should you switch?

Should you switch?

No

- Ingress API and ecosystem are quite stable
- If everything you need is covered by Ingress today, there's no need to upgrade

Should you switch?

No

- Ingress API and ecosystem are quite stable
- If everything you need is covered by Ingress today, there's no need to upgrade

Yes

- Ingress is not getting new features
- Gateway API is much more expressive, extensible, and portable
- Broader than ingress, same APIs can be used for:
  - Mesh
  - L4 (TCP, UDP)
- Gateway API has graduated to beta
- Gateway API can be installed in any Kubernetes 1.16+ cluster

Getting Started

First Steps

- Install CRDs
- Install an implementation
- Follow our guides at gateway-api.sigs.k8s.io/guides
  - Simple Gateway (a good one to start out with)
  - HTTP routing
  - HTTP redirects and rewrites
  - HTTP traffic splitting
  - Routing across Namespaces
  - Configuring TLS

Picking an implementation

gateway-api.sigs.k8s.io/implementations

and several more…

Demo

Create a Cluster


```
gcloud container clusters create gw-demo \
  --gateway-api=standard
```

```
➜  gw-demo
```

```
➜  gw-demo
```

```
➜  gw-demo
```

Create a Gateway


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: gke-gateway
spec:
  gatewayClassName: gke-l7-rilb
  listeners:
  - name: http
    protocol: HTTP
    port: 80
```

```
➜  gw-demo
```

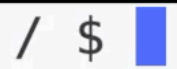
```
➜  gw-demo kubectl get gateway --watch
NAME           CLASS          ADDRESS   READY   AGE
gke-gateway    gke-l7-rilb                      14s
```

Deploy a HTTPRoute


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: HTTPRoute
metadata:
  name: store
spec:
  parentRefs:
  - name: gke-gateway
  rules:
  - backendRefs:
    - name: store-v1
      port: 8080
```

```
➜  gw-demo
```

```
➜  gw-demo
```



```
}/ $ curl -s http://10.128.15.206 | grep "namespace\|pod"
```

Kong Gateway Operator

- Technical Preview, “Kong Incubator”
- In-Cluster Implementation
- Gateway/Proxy in Pods

```
→ gw-demo
```

Install Kong GatewayClass


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: GatewayClass
metadata:
  name: kong
spec:
  controllerName: konghq.com/gateway-operator
```

```
→ gw-demo
```

Deploy a Kong Gateway


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: kong-gateway
spec:
  gatewayClassName: kong
  listeners:
  - name: http
    protocol: HTTP
    port: 80
```

```
→ gw-demo
```

```
→ gw-demo kubectl apply -f kong-gateway.yaml
gateway.gateway.networking.k8s.io/kong created
→ gw-demo kubectl wait --for=condition=Ready=true gateways.gateway.networking.k8s.io/kong
```

Add Kong Gateway to HTTPRoute


```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: HTTPRoute
metadata:
  name: store
spec:
  parentRefs:
  - name: gke-gateway
  - name: kong-gateway
  rules:
  - backendRefs:
    - name: store-v1
      port: 8080
```

```
→ gw-demo
```

Traffic Splitting

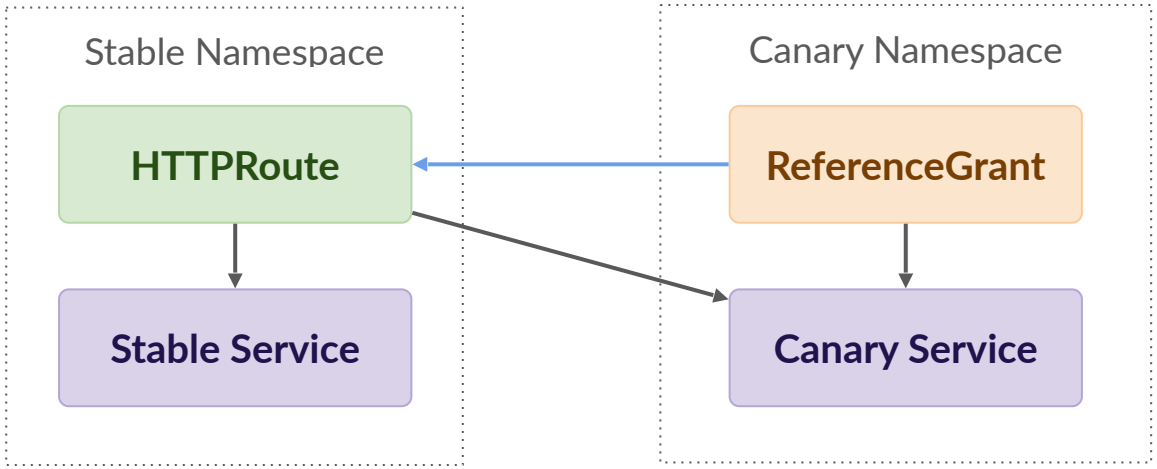

```yaml
parentRefs:
- name: gke-gateway
- name: kong-gateway
rules:
- backendRefs:
  - name: store-v1
    port: 8080
    weight: 50
  - name: store-canary
    port: 8080
    weight: 50
```

```
→ gw-demo
```

```
/ $ curl -s http://10.128.15.206 | grep "namespace\|pod"
 "namespace": "default",
 "pod": "store-v1-6bdfffb54-78nfb"
/ $ curl -s http://10.128.15.206 | grep "namespace\|pod"
 "namespace": "default",
 "pod": "store-canary-5c748f4f6b-l6pw9"
/ $
```

Cross Namespace Traffic Splitting?


```yaml
kind: ReferenceGrant
metadata:
  name: allow-prod-cert-refs
  namespace: canary
spec:
  from:
  - group: networking.gateway.k8s.io
    kind: HTTPRoute
    namespace: stable
  to:
  - group: ""
    kind: Service
    name: canary
```



This looks like a **lot of work**

Ingress2Gateway

- Automatically reads Ingress config from cluster
- Outputs corresponding Gateways and HTTPRoutes
- github.com/kubernetes-sigs/ingress2gateway

```
$ go install sigs.k8s.io/ingress2gateway
$ ingress2gateway
```

What's next?

What's Next?

- **Service Mesh:**
  - GAMMA Initiative
- **GatewayClass, Gateway, and HTTPRoute**:
  - May graduate to v1 soon
- **TCPRoute, TLSRoute, UDPRoute:**
  - Need more feedback, want to get to beta
- **GRPCRoute:**
  - alpha in v0.6.0
- stretch goal: **Gateways as an alternative to Service load-balancing**

Get Involved

- Weekly community meetings on Mondays
- Weekly GAMMA meetings on Tuesdays
- Contributors from all backgrounds welcome

gateway-api.sigs.k8s.io

#sig-network-gateway-api

kubernetes-sigs/gateway-api

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Questions?

Leave us some feedback


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