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Understanding Istio Service Mesh on Kubernetes

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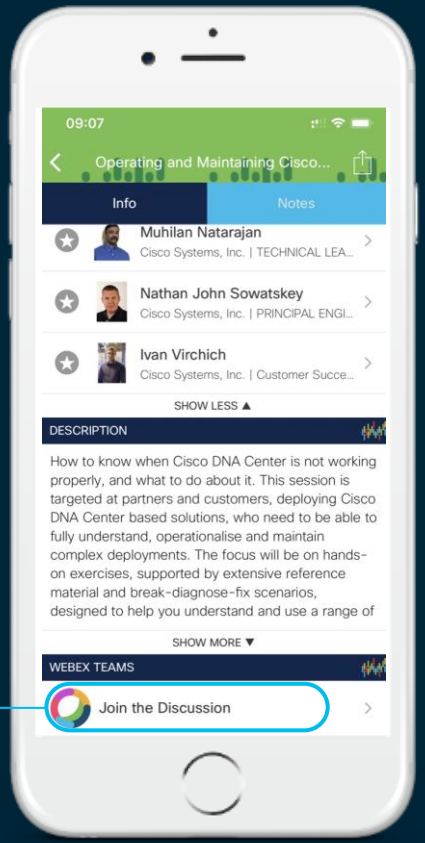


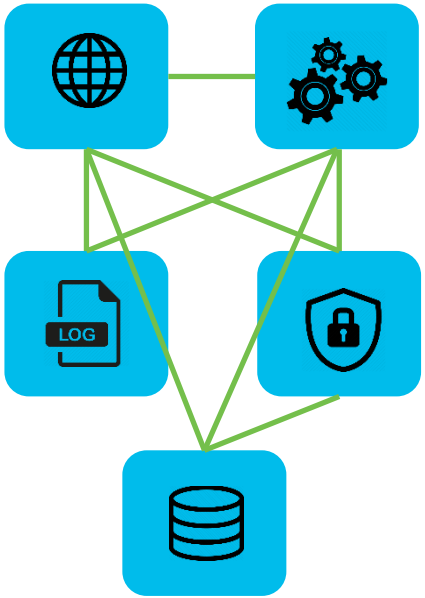
Agenda

- What is a Service Mesh and why do I want one?
- Istio Overview
- Demo
- How to get Istio
- How to contribute to Istio

What is a Service Mesh?

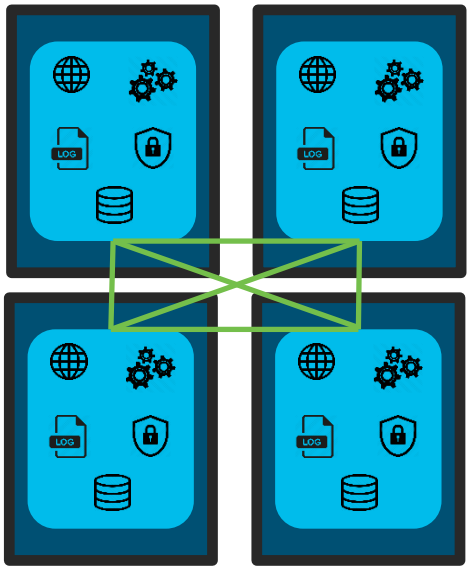
What's a Microservice?

Monolithic Application

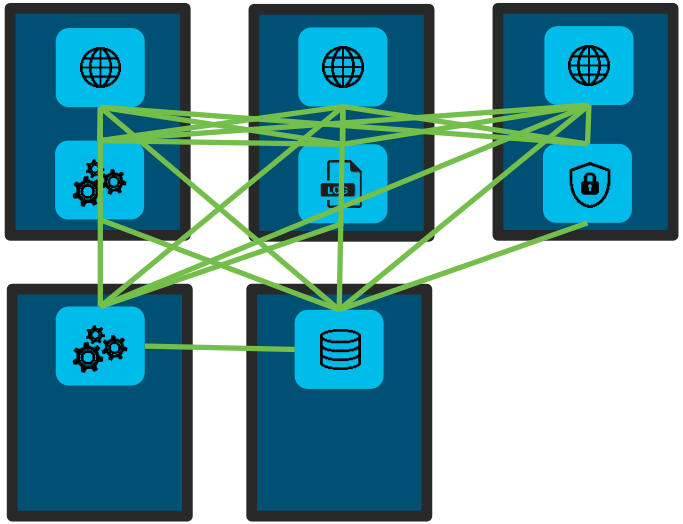


Microservices Application

Scaling a Microservice Application



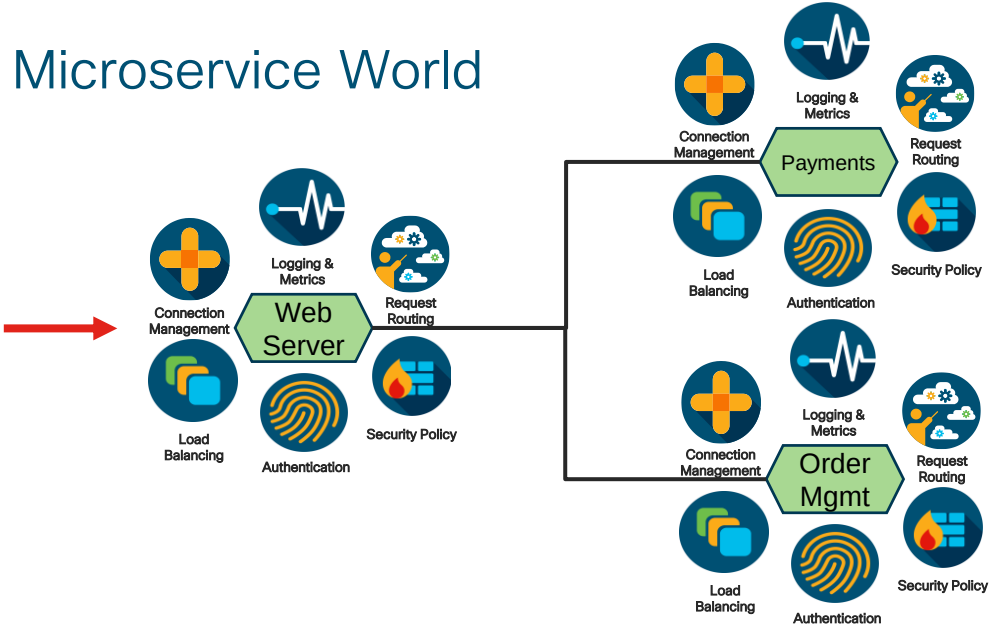
Monolithic Application



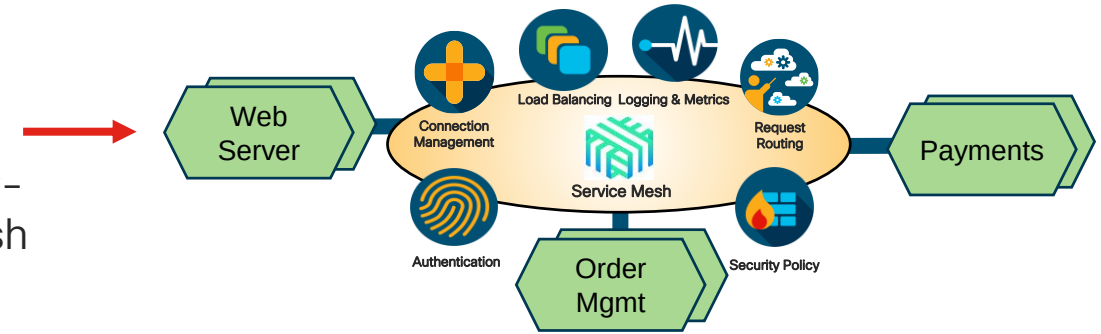
Microservice Application

Service Features in a Microservice World

- Deploy all the service features as independent components



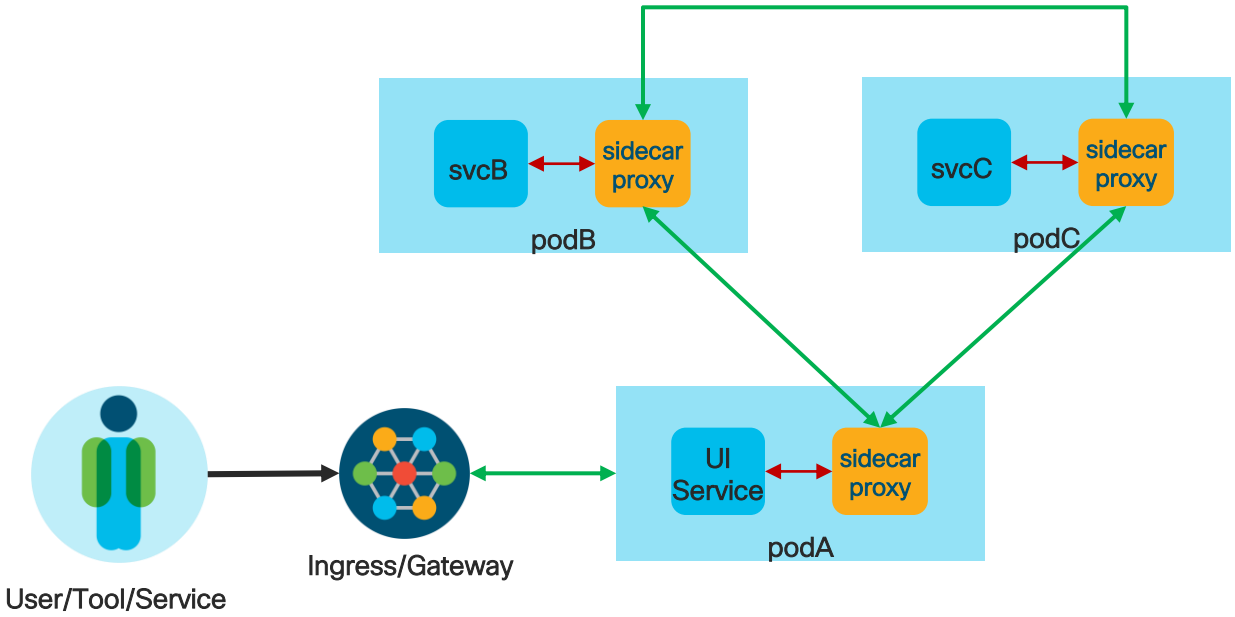
- Offload features for service-to-service communication to a policy-driven secure service mesh



Stuff I Want to Do

- I want to deploy a microservice
- I want to deploy using Kubernetes
- I have a bunch of requirements such as the need to handle:
  - Service failures
  - Retries
  - Circuit breaking
  - Topology changes
  - Monitoring
  - Tracing
  - Encryption between services
  - and more

What is a Service Mesh?



- *"The term **service mesh** is often used to describe the network of microservices that make up such applications and the interactions between them" – istio.io*
- Infrastructure layer for service-to-service communication
- Uses mesh of sidecar proxies:
  - Can inspect API transactions at Layer 7 or layer 3/4
  - Intelligent routing rules can be applied between endpoints

Istio Overview

Istio – Operator and Developer Goals

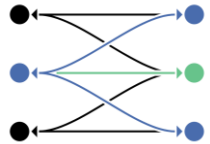
Operator Goals

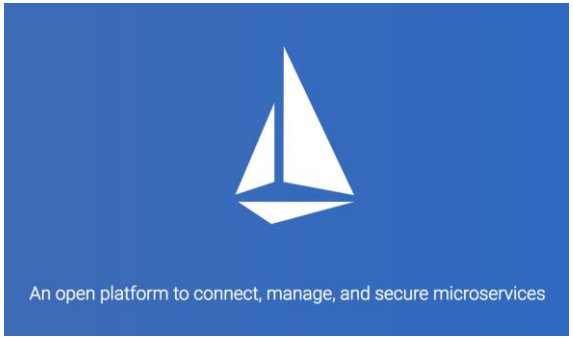
- ✓ Enable operators to move deployments between environments with less friction

Developer Goals

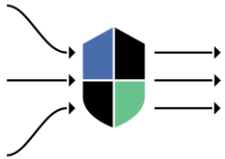
- ✓ Make services easier to implement for developers

Intelligent Routing and Load Balancing

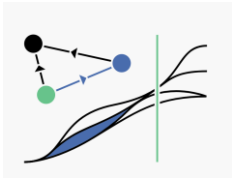




Policy Enforcement and Service Security



In-Depth Telemetry and Reporting



Resilience Across Languages and Platforms

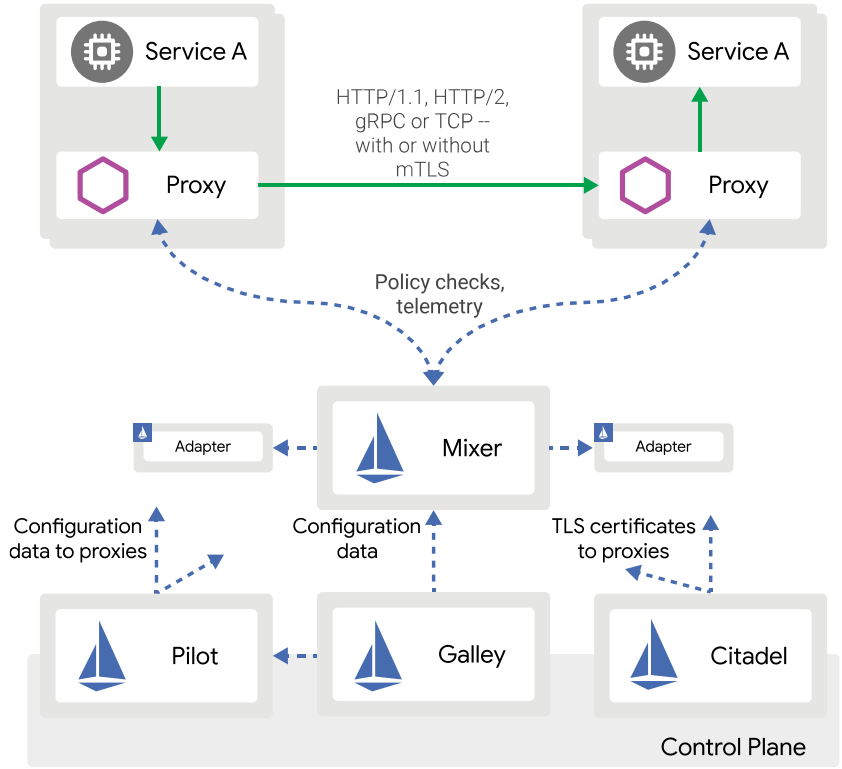
Istio Overview

- Open source project started by Google and IBM with help from the Envoy team at Lyft
  - https://istio.io/
  - https://github.com/istio
  - https://www.envoyproxy.io/
- https://istio.io/docs/concepts/what-is-istio/
  - Automatic load balancing for HTTP, gRPC, WebSocket, and TCP traffic
  - Fine-grained control of traffic behavior with rich routing rules, retries, failovers, and fault injection
  - A pluggable policy layer and configuration API supporting access controls, rate limits and quotas
  - Automatic metrics, logs, and traces for all traffic within a cluster, including cluster ingress and egress
  - Secure service-to-service authentication with strong identity assertions between services in a cluster

Istio Architecture

https://istio.io/docs/concepts/what-is-istio/

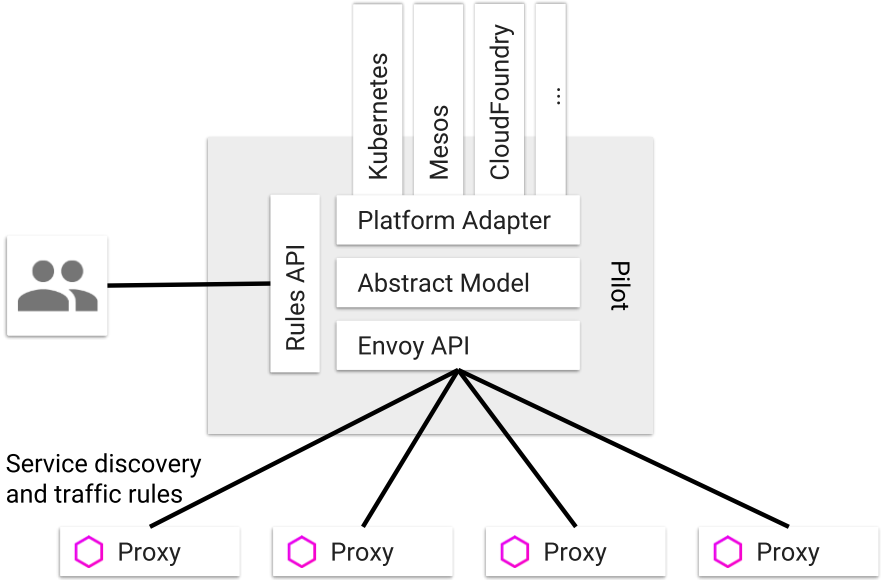
- Pilot
  - Handles service discovery and config data
  - Provides the Envoy proxies with the mesh topology and route rules
- Galley
  - Validates user authored Istio API configuration on behalf of other control plane components
  - Top-level config ingestion, processing and distribution
- Citadel
  - Provides certificates to the Envoy proxies for authentication and authorization
- Mixer
  - Handles Telemetry for back-end systems
  - Provides more sophisticated policy checks
  - Easily pluggable
- Envoy
  - A proxy attached to every microservice
  - The connection point for a microservice to attach to the mesh



Istio Control Plane

Pilot

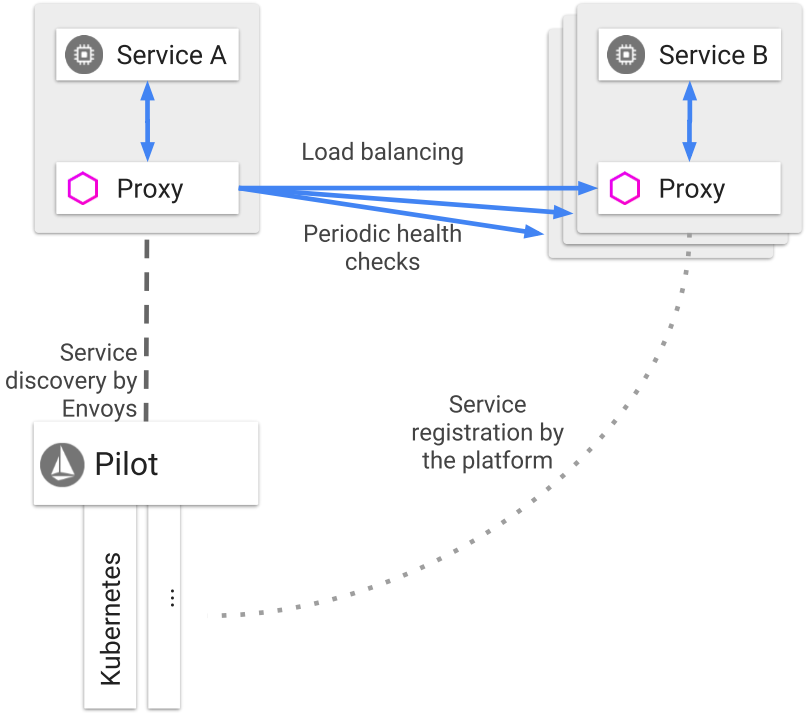
- Responsible for proxy configuration, exposes APIs for service discovery and traffic management (routing rules)
- Sends configuration data to the proxy at runtime
- Maintains a canonical representation of services in the mesh (abstract model)
- Platform-specific adapters (e.g. Kubernetes) watch for changes in pod info, ingress, etc. which is translated into proxy-specific (e.g. Envoy) configuration form



https://istio.io/docs/concepts/traffic-management/#pilot-and-envoy

Discovery and Load Balancing

- Service Registration and Discovery: Leverages platform-specific registration/discovery (e.g. K8s = environment variables or **DNS**)
- Pilot consumes info from the service registry and then provides that info in a platform agnostic way – Envoy updates load balancing info

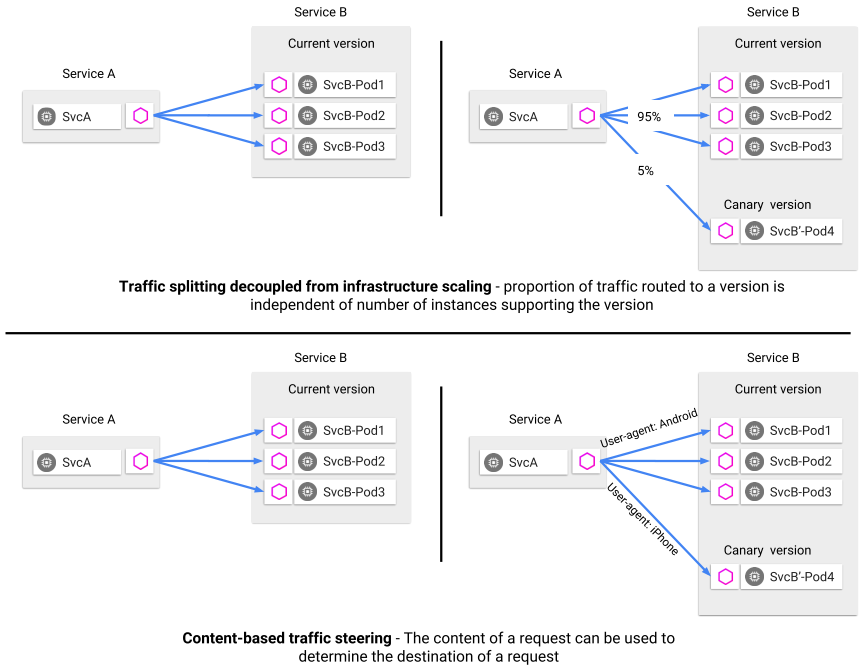


https://istio.io/docs/concepts/traffic-management/#discovery-and-load-balancing

Sophisticated Traffic Routing

- Istio provides a rich set options to route API requests.
- Matching criteria extends to layer 7 across numerous API formats (HTTP1, HTTP2, gRPC, etc.)
- Extends beyond just matching the request path to include headers and cookies.
- Multiple destination choices based on Kubernetes labels (e.g version labels)
- Various algorithms on how the requests are sent
  - Load balanced with a couple different hash options
  - Rate limited or quota enforced
  - Delay insertion
  - Circuit breakers
  - Time-outs and retries configurable per route

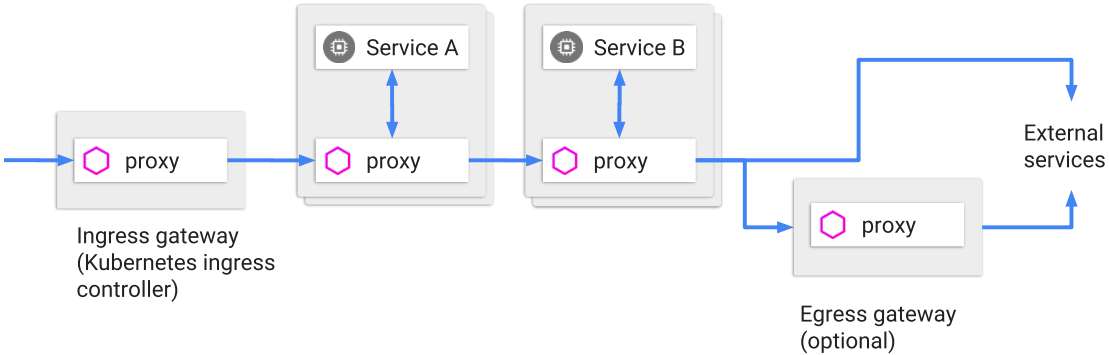
Istio Pilot – Traffic Management



- Maintains a canonical model of all the services in the mesh
- Rules are provided to route traffic between Envoy proxies (e.g: versions (v1, v2), environment (staging, prod))
- Configuration done for failure recovery features such as timeouts, retries, and circuit breakers
- Envoy's perform periodic service instance health-checks

https://istio.io/docs/concepts/traffic-management/

Istio Pilot - Traffic Management – Ingress and Egress



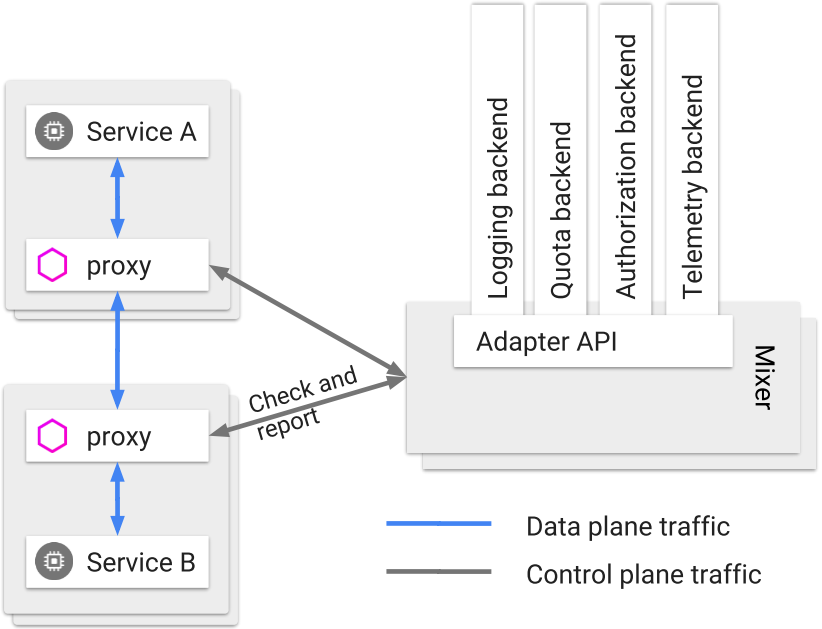
- Ingress Envoy's enable A/B testing, deploy canary services, etc. for user-facing services
- Egress failures gives failure recovery features such as timeouts, retries, circuit breakers, etc., and obtain detailed metrics on the connections to these services.

https://istio.io/docs/concepts/traffic-management/#ingress-and-egress

Mixer

Alpha: https://github.com/istio/istio/wiki/Mixerless-HTTP-Telemetry

- Policy engine for Istio
- Tracing, quotas, telemetry, access control, etc.
- Attribute processing:
  - Generated by Envoy
  - Call sent to backends via adapters
  - Policy actions (if/then actions)



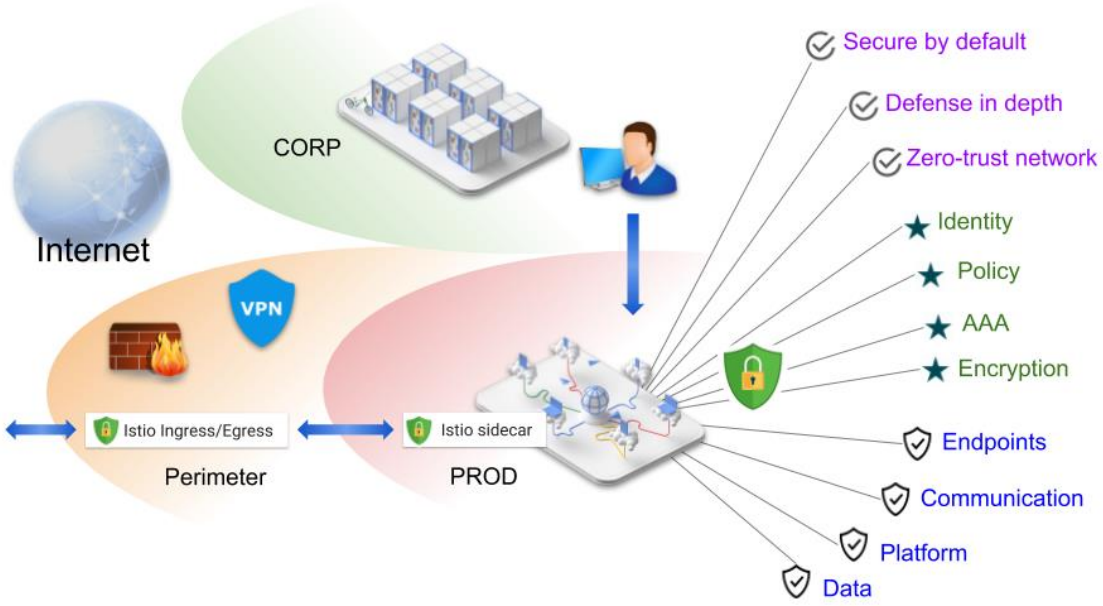
https://istio.io/docs/concepts/policies-and-telemetry/

Superior Visibility

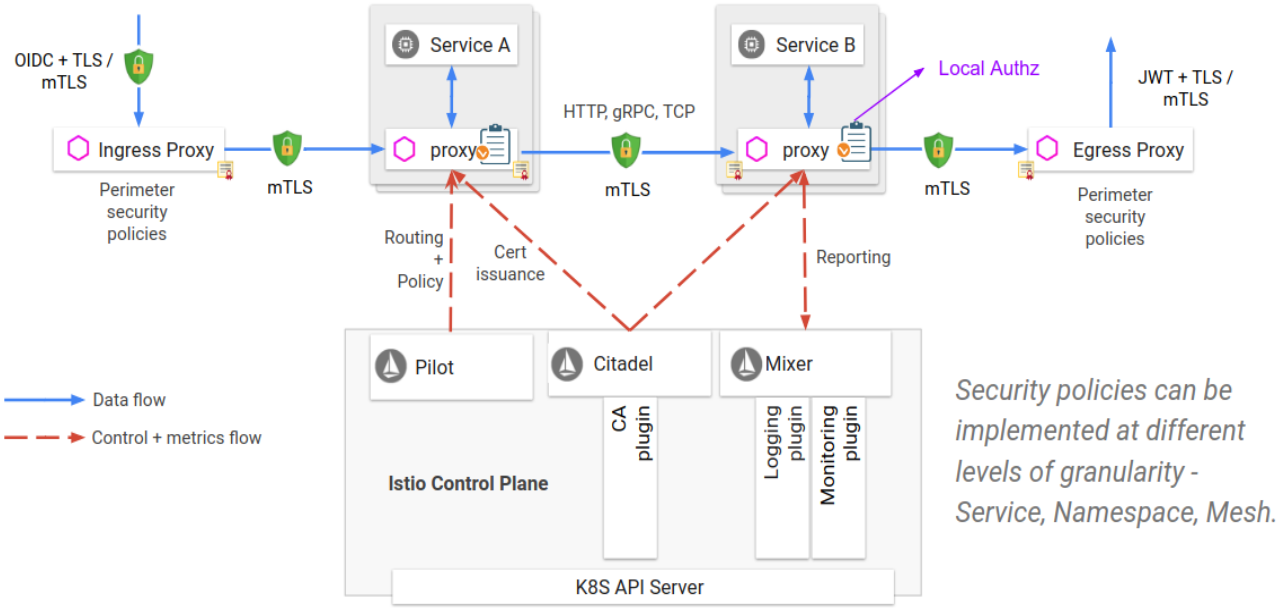
- Uniform set of metrics are collected across all microservices
- Tracing and collection is done by the proxy sidecar
  - On behalf of the microservice
  - Directly on the API transactions
- Passed to Mixer which has numerous integrations with cutting edge tools for analysis, logging and visibility.
- Maintainer of the application gets complete and uniform view across all microservices regardless of function.
- Developer of microservice is unburdened from developing individual tracing and metric module.

Istio Security Overview

https://istio.io/docs/concepts/security



Istio Security Architecture



Security policies can be implemented at different levels of granularity - Service, Namespace, Mesh.

Turbocharged Security for Applications

- Offers a huge shift in the security paradigm for applications
- Less emphasis on the enterprise firewall as the primary security vehicle
- Access control – Primarily layer 7 but also available at layer 3 and 4
  - Network policy much less important. Application policy much more
- Application security and policy definition moves more toward application owner versus network admin or IT admin
- Enables more granular admission control between the microservices that make up an application
- Less emphasis on in-band security enforcement and more capability to trigger out-of-band admission checks.
  - Allowing much higher level of intelligence and sophistication in the admission checks
  - Possibly significantly increasing latency and scale/performance concerns

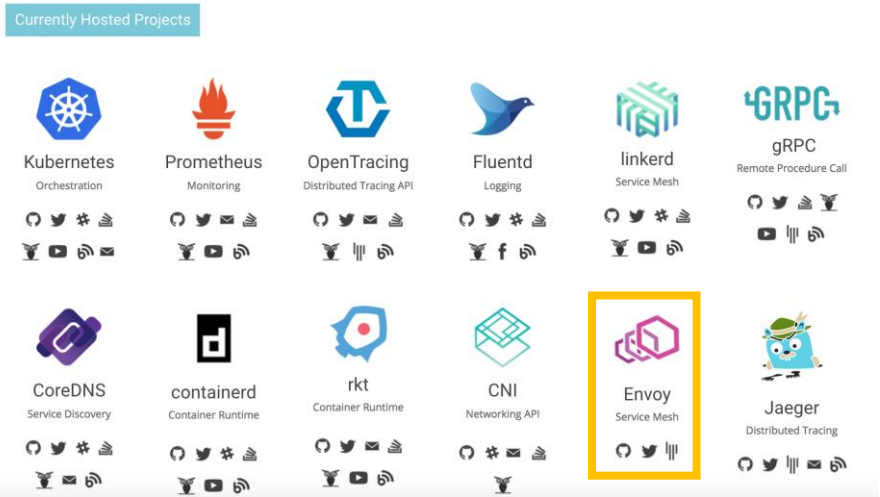
Istio Data Plane

Sidecar Proxy

- A sidecar container is companion to one or several other containers and it is meant to extend and enhance the main service container
- A sidecar proxy is a container as defined above only one that acts on behalf of the main service container for one/many uses
- A few of the many sidecar proxies:
  - Envoy, NGINX, haproxy, Linkerd

Envoy
https://www.envoyproxy.io

- Implemented by Lyft
- A C++ based L4/L7 proxy
- Can be used independently of any service mesh (Istio)



- API driven
- Traffic routing and splitting
- Transparent proxying
- Health checks, circuit breakers, etc.

USED BY

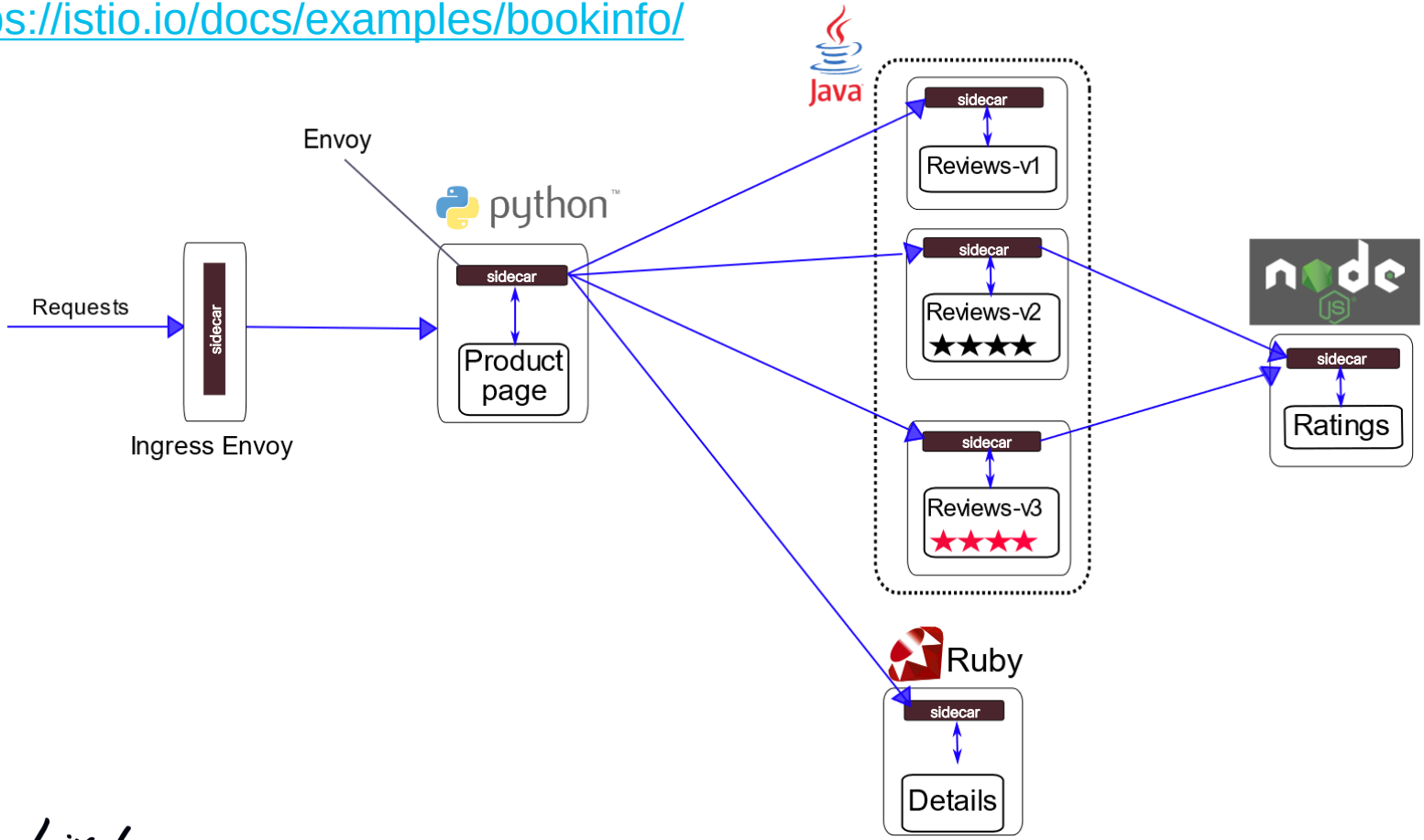
https://github.com/envoyproxy/envoy

Istio: How Does It Work?

- Istio Configuration Time
  - Injection of the Envoy proxy sidecar during application deployment
  - Envoy proxies are provided API endpoints of Pilot (to get the mesh state and routing rules) and Mixer (for telemetry reporting and dynamic access control)
  - Istio-Auth provides certificates and keys to the envoy proxies to both provide authentication and authorization capabilities to the proxies
- Service Deployment Time
  - Service Discovery – Pilot watches the Kubernetes APIs for creation and deletion of services
  - Mesh Creation – Pilot provides Envoy with xDS (service, cluster, endpoint and route Discovery Service (DS) database for mesh topology
- Active State and Policy Time
  - Security Model – Provided via Ingress policy, Route rules in the Mesh, and Attribute checking in Mixer
  - Route Rules – when operator configures route rules Pilot will update the mesh route rules
  - Server-side access control provided by Mixer by comparing incoming attributes against configured policy or propagating to 3rd party systems for access
  - Telemetry collection – Mixer collects the Envoy data and can provide it to 3rd Party add-ons (Prometheus, Grafana, Zipkin, etc.) for logging and analysis

Bookinfo

https://istio.io/docs/examples/bookinfo/



Other Stuff

Exciting New Stuff – You Can Help!

- Istio Feature Status: https://istio.io/about/feature-stages/
- Multicluster: https://istio.io/docs/setup/install/multicluster/
- IPv6 Support – Dual Stack is now supported!
- Istio and Network Service Mesh (NSM): https://networkservicemesh.io/docs/concepts/what-is-nsm
- Multitenancy
- Real world use cases

Istio: How Do I Get It?

Istio: How Do I Get It?

- Where to get it:
  - Istio currently is available directly from the Istio community at: https://istio.io/about/community/join/
  - It can also be built directly from Master at: https://github.com/istio/istio
  - It is likely to be available as an infrastructure option in some public clouds in the near future
  - It might be package in other distributions in the future
- How to install it (Kubernetes):
  - https://istio.io/docs/setup/getting-started/
  - Kubernetes installation is a prerequisite
  - Directly from the manifests included in the release
  - Using Helm charts included in the release

Contributing to Istio

Contribution

- Contribution Readme: https://github.com/istio/community/blob/master/CONTRIBUTING.md
- Contributing to the Docs: https://istio.io/about/contribute/
- Istio Discussion: https://discuss.istio.io/

It's About The Application... Not The Infrastructure

- Istio provides injection of proxy sidecars along with each microservice
- Injection is secure and automatic
- Allows the application developer to focus on the application
- The proxy sidecar connects cleanly to the microservice without additional development and regardless of the language used by the microservice
- Off-loads the authentication, authorization, telemetry (logs, metrics, tracing etc.), and network connectivity responsibilities
- Provides uniformity in both policy enforcement and telemetry collection
- Proxy sidecar (e.g. mesh state) updated automatically by Istio control plane

Summary

- Istio is a Service Mesh for microservices
- Istio allows you to enable security, health checking, optimized load-balancing and routing without adding code to the microservice directly
- Istio is young and maturing quickly
- Istio is a great community and you should get involved

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