SELA

Module 19: Microservices Architecture

Kubernetes Workshop

Agenda

- Microservices Architecture
- Service Mesh
- Introduction to Istio
- Lab 12: Managing Microservices with Istio

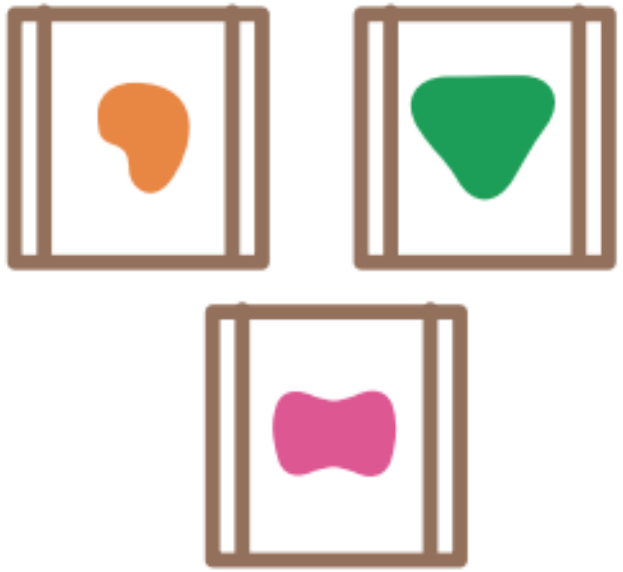
Microservices Architecture

Microservices architecture is a distinctive method of developing software systems in a modular way.

Monolith

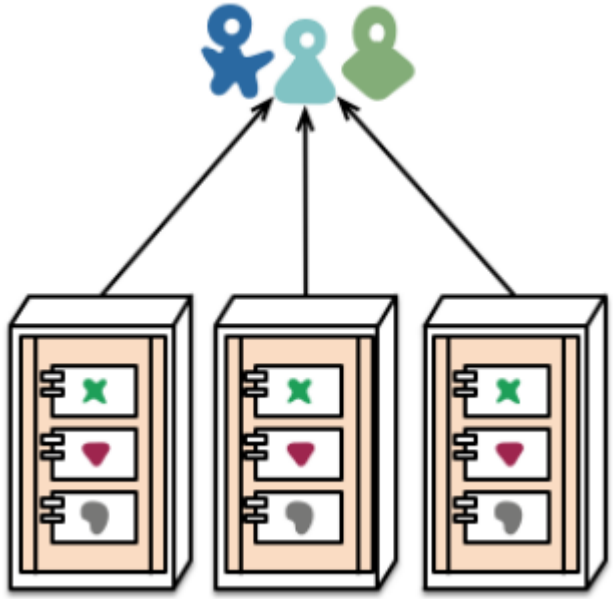
Puts all its functionality into a single service

Microservices



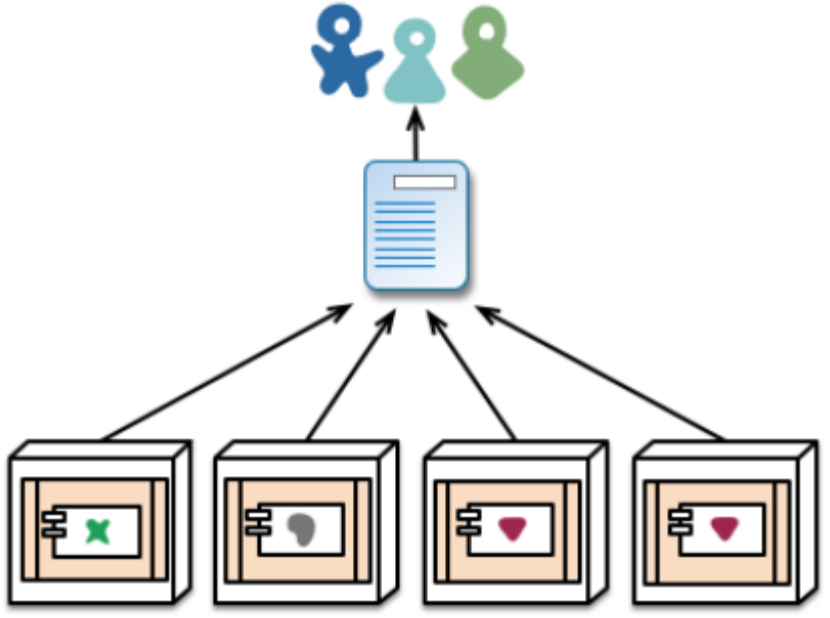
Puts each element of functionality into a separate service

Monolith



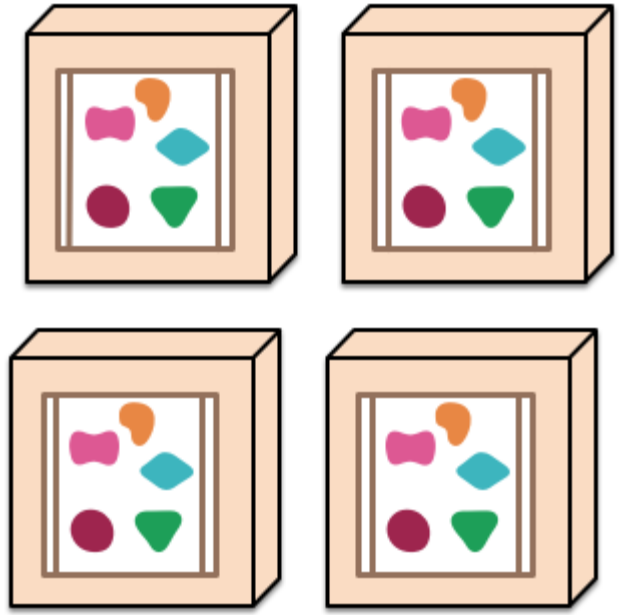
Multiple modules in the same process

Microservices



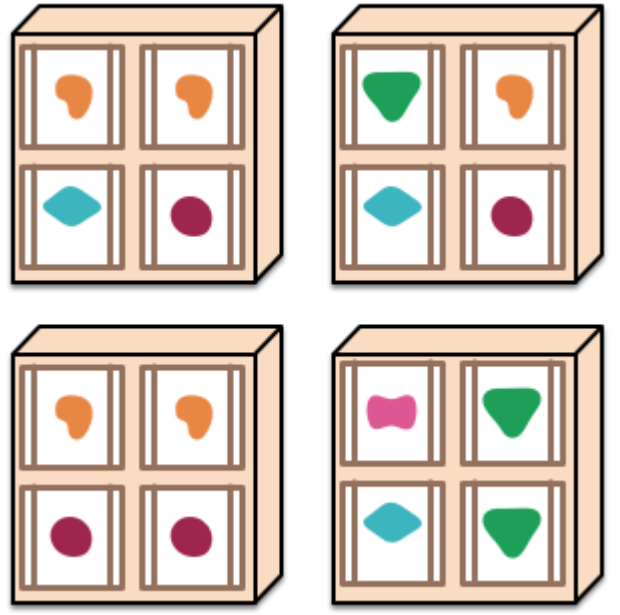
Modules running in different processes

Monolith



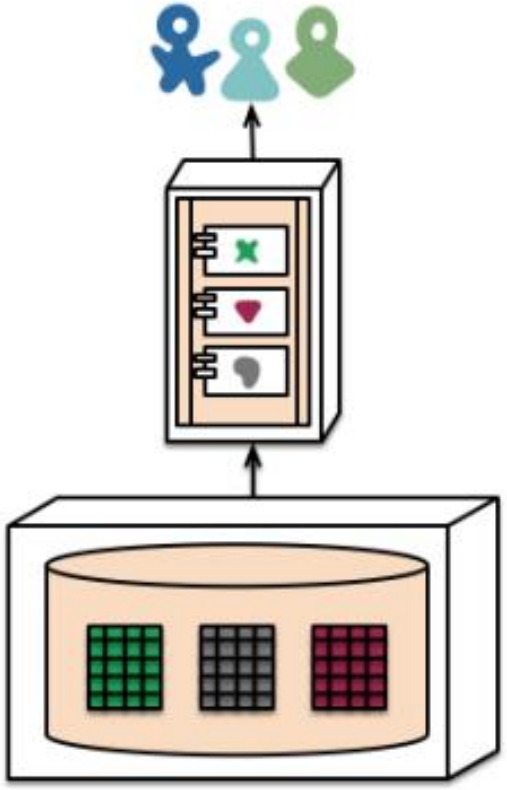
Scale by replicating the monolith on multiple servers

Microservices



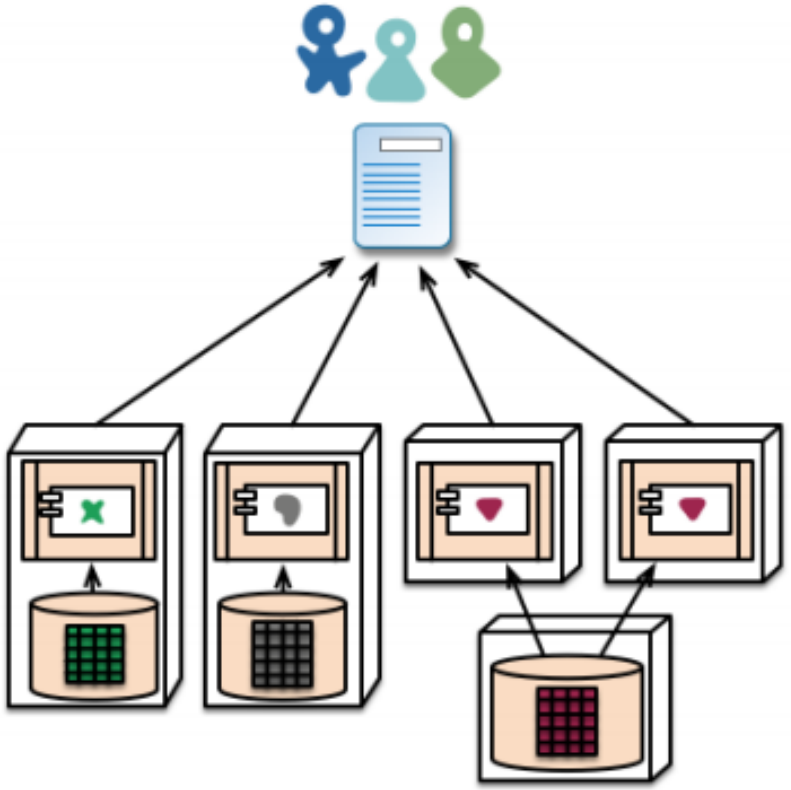
Scale by distributing the services across servers (by demand)

Monolith



Single Database

Microservices

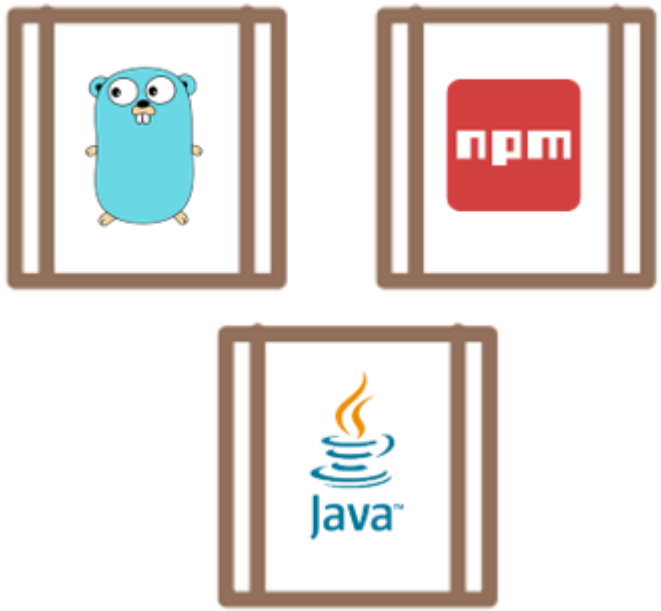


Applications Database

Monolith

Single language/technology

Microservices



Multiple languages and technologies

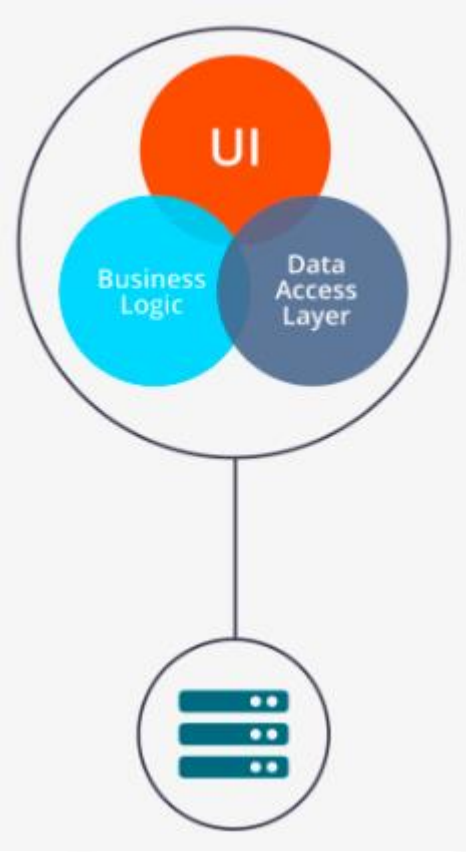
Monolith

Do everything

Microservices

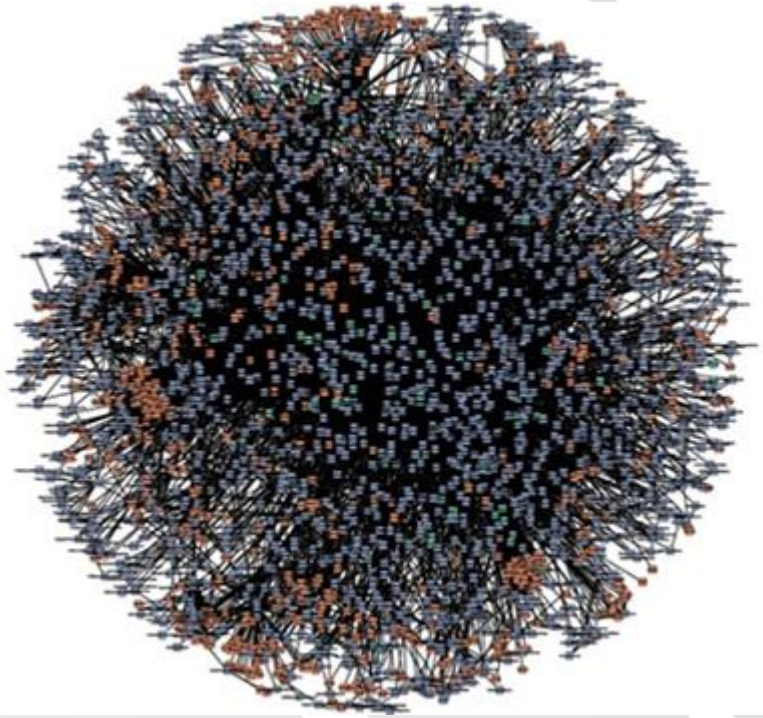
Do one thing well

Monolith



Simple Application Architecture

Microservices



Cognitive Complexity

Monolith

Single (long) CI/CD pipeline

Microservices

Multiple (short) CI/CD pipelines

Monolith
(Advantages)

- Simple to develop
- Simple to deploy
- Simple to scale
- Data consistency
- Only one app to monitor
- Only one app to operate
- Modules communicate by memory (fast)

Microservices
(Advantages)

- Deployability
- Reliability
- Availability
- Scalability
- Modifiability
- Decentralized data
- Freedom in technology
- Management

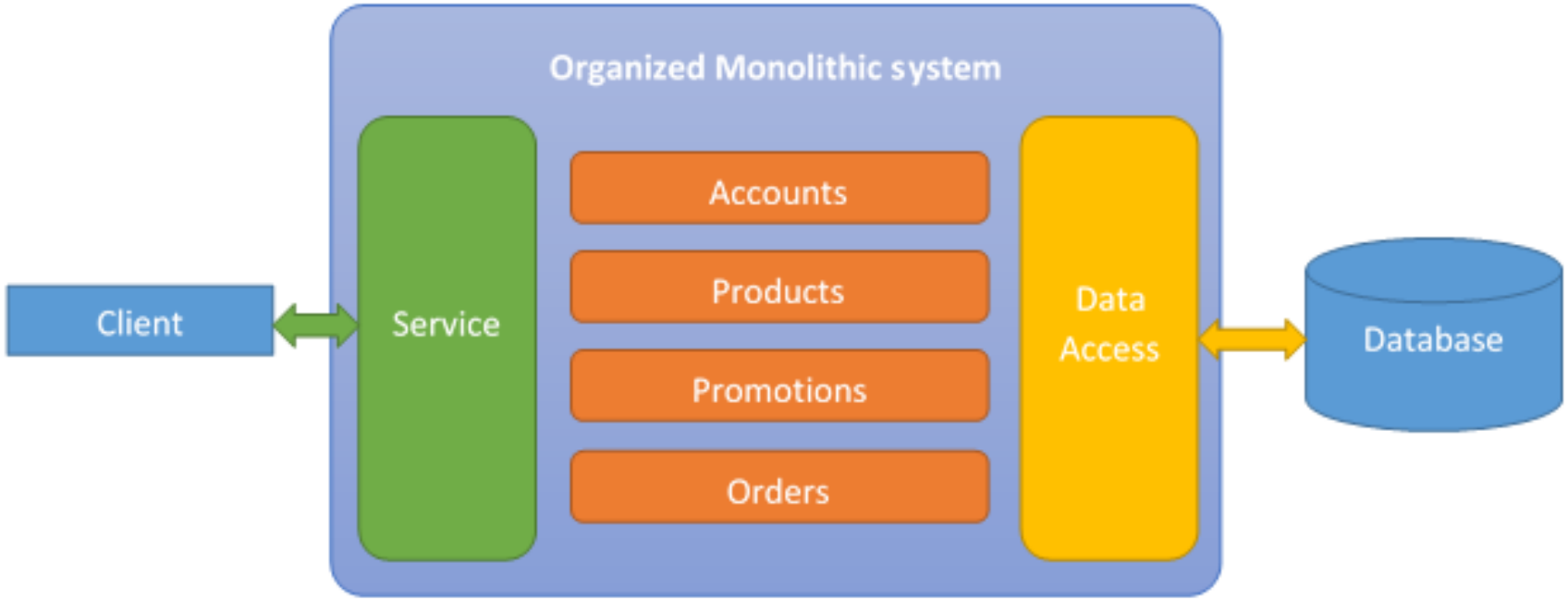
Monolith
(Drawbacks)

- Large codebase intimidate developers
- Difficult development scaling
- Modularity breaks over time
- Heavy CI/CD pipelines
- Small changes require the build/deploy of the entire app
- Long term technology stacks
- Difficult feature rollbacks

Microservices
(Drawbacks)

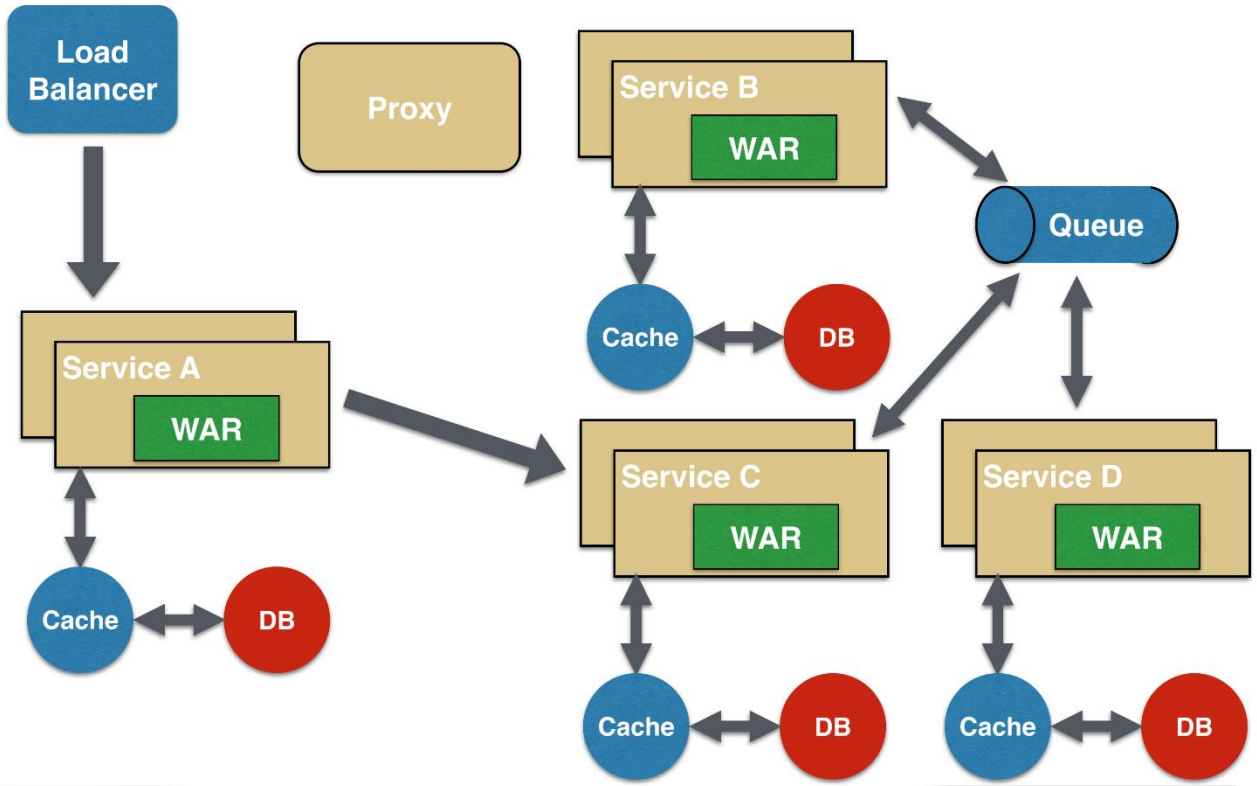
- Complexity
- Operations overhead
- Require closely monitoring
- Data consistency
- Testing is a lot more difficult
- Debug challenges
- Inter-service communications
- Failure tolerant

Monolith architecture is NOT an anti-pattern



But, it will not be the best solution if you grow enough

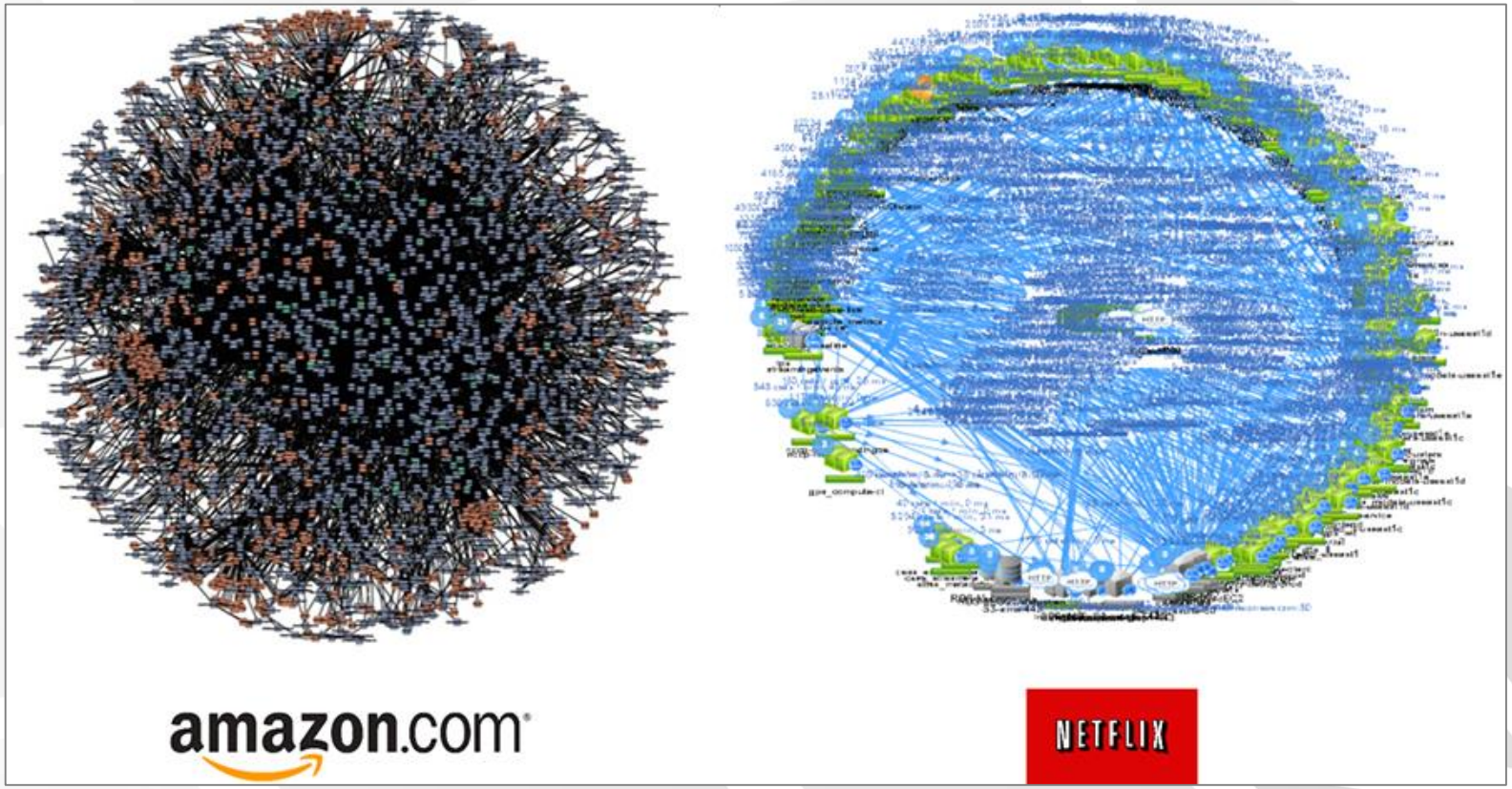
Microservices Architecture is Great!



But, microservices without the right DevOps = **CHAOS**

Who is using Microservices?

- Netflix
- eBay
- Amazon
- Twitter
- PayPal
- Uber
- Groupon



With simplicity, comes complexity

- How to deploy or update services with zero-downtime?
- How to A/B test the application?
- How to handle network failures?
- How to manage security between services?
- How to handle timeouts? Retries?
- How to rate limit? Add quotas?
- Telemetry, Logging, Monitoring?
- What about run multiple versions at the same time (canary)?
- Different Tech Stacks

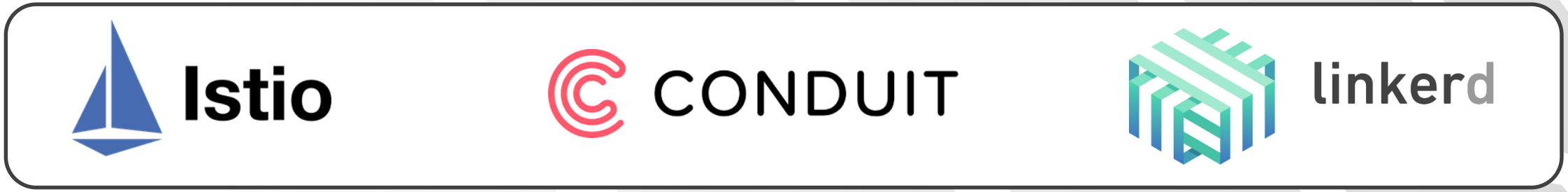
Micro-services applications are not that simple

Managing Microservices

- Integrating services and libraries for the following:
  - Eureka - Service Registry
  - Ribbon - Client Side Load Balancing
  - Hystrix - Circuit Breaker
  - Zipkin - Distributed Tracing
  - Prometheus - Monitoring
  - Grafana - Dashboards and Visualization
  - Nginx - API Gateway
- Many of them requires complicated code in our API libraries

Service Mesh

- The term service mesh is used to describe the network of microservices that make up such applications and the interactions between them.
- Service Meshes are taking care of all communication and policies needs between services and allows extensibility by middlewares
- Its requirements can include discovery, load balancing, failure recovery, metrics, and monitoring.



Istio

- Initiative from Google, IBM and Lyft
- Built for Kubernetes (but also supports Nomad and Consul)
- Provides a uniform way to connect, manage, and secure microservices
- It supports managing traffic flows between services, enforcing access policies, and aggregating telemetry data, all without requiring changes to the microservice code
- Istioctl – like Kubectl, only for Istio (we use Kubectl most of the time)

Why Istio?

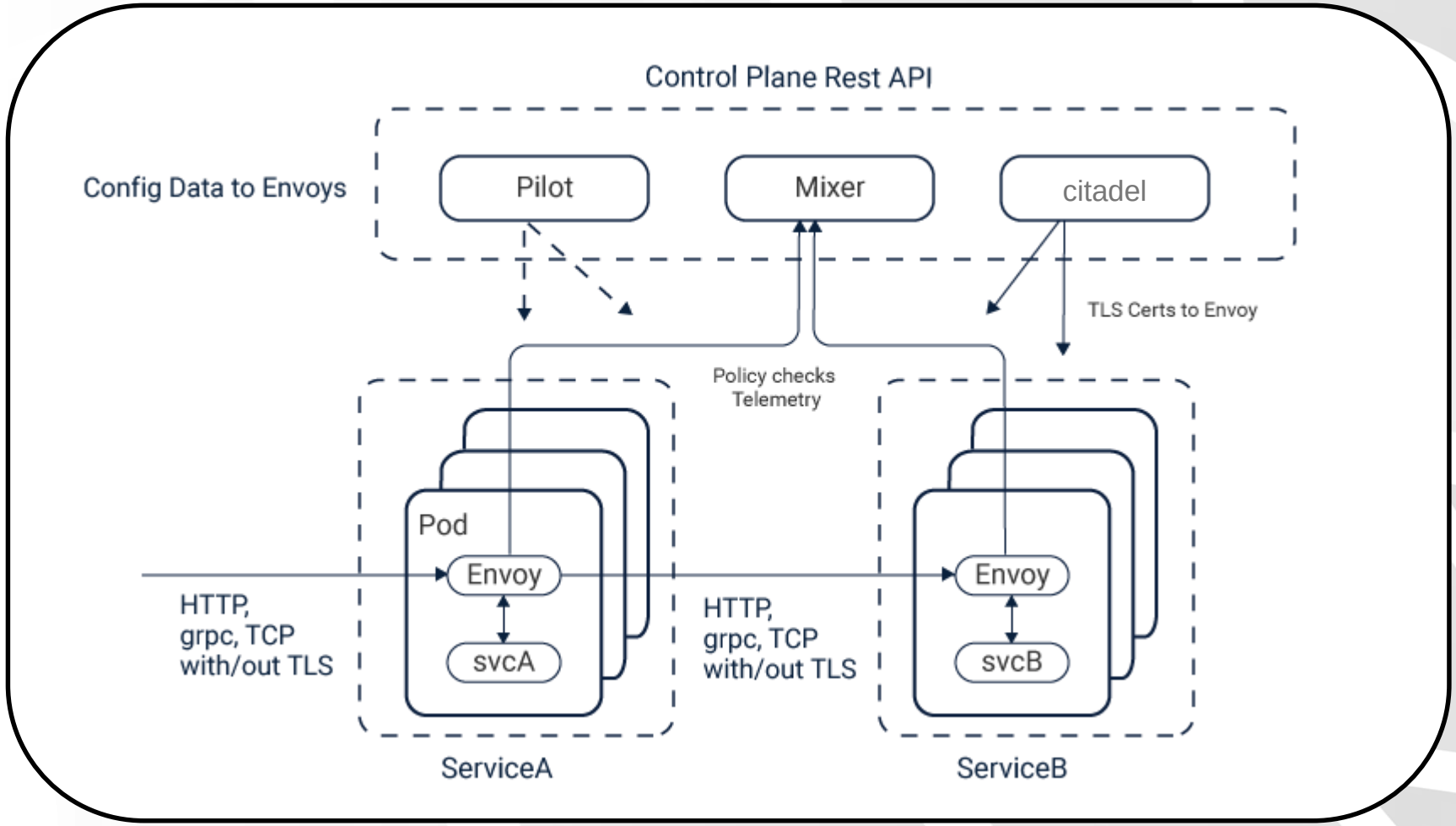
- Automatic **load balancing** for HTTP, gRPC, WebSocket, and TCP traffic.
- Fine-grained **control of traffic** behavior with rich routing rules, retries, failovers, and fault injection.
- A pluggable policy layer and configuration API supporting **access controls, rate limits and quotas**.
- **Automatic metrics, logs, and traces** for all traffic within a cluster, including cluster ingress and egress.
- **Secure service-to-service communication** in a cluster with strong identity-based authentication and authorization.

Architecture (data plane & control plane)

- The **data plane** is composed of a set of intelligent proxies (Envoy) deployed as sidecars. These proxies mediate and control all network communication between microservices along with Mixer, a general-purpose policy and telemetry hub.

- The **control plane** manages and configures the proxies to route traffic. Additionally, the control plane configures Mixers to enforce policies and collect telemetry.

Architecture

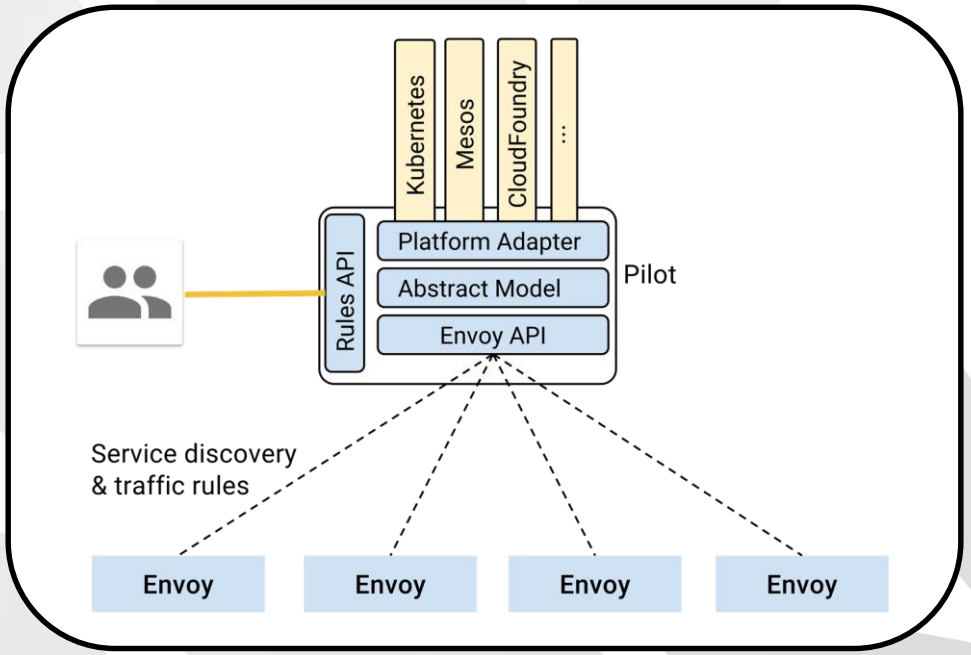


Architecture (envoy)

- Originally built at Lyft
- CNCF Graduate
- A C++ based L4/L7 proxy
- Battle-tested with great performance
- Acts as the smart Data-Plane managed by Istio
- Many built-in mechanism used by Istio
- API Driven updates (without hot-reload)
- Injected as a side-car

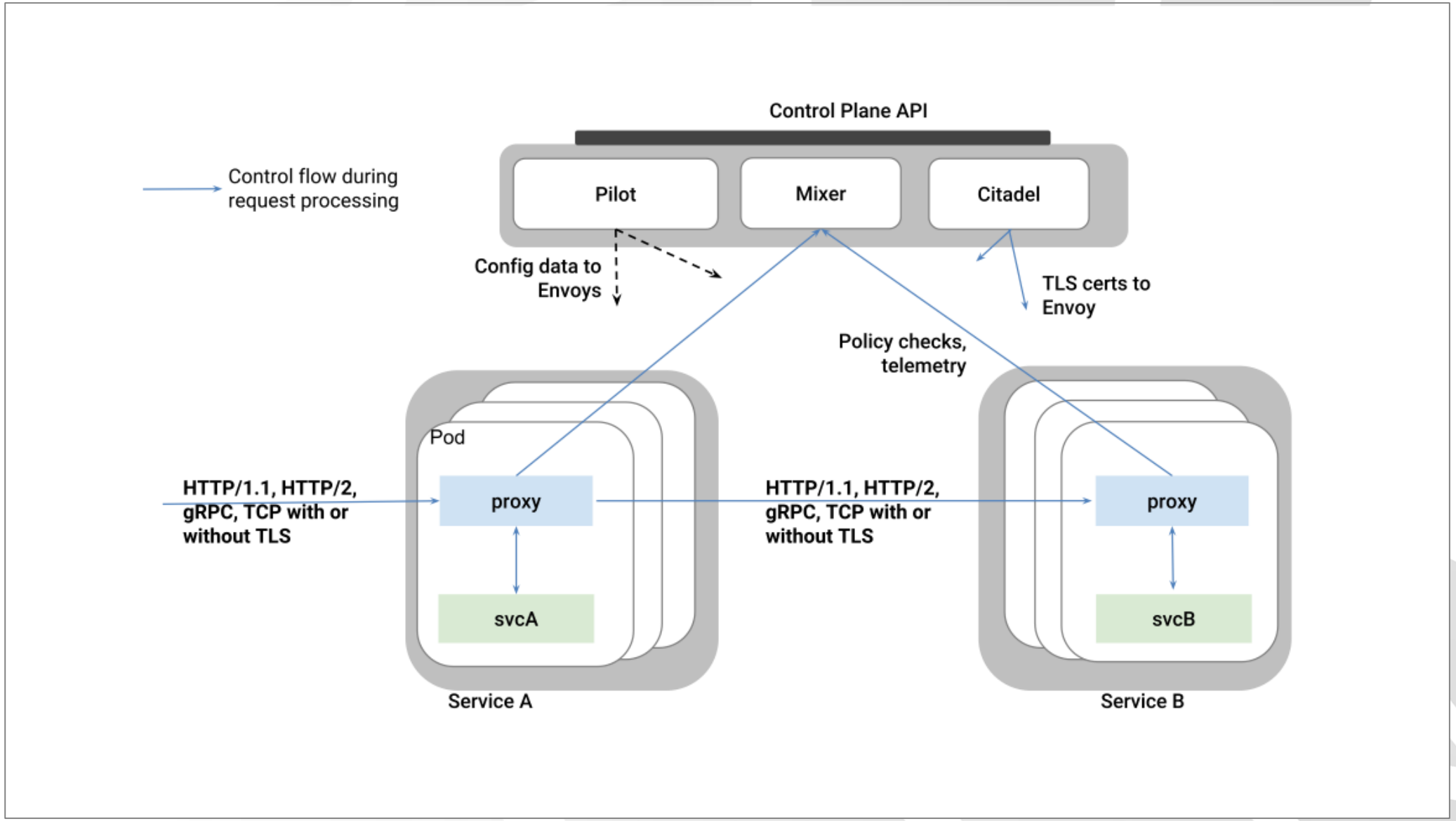
Architecture (pilot)

- Provides traffic management capabilities for intelligent routing
- Provides service discovery for Envoy sidecars
  - A/B tests
  - canary deployments
- Provides resiliency
  - Timeouts
  - Retries
  - circuit breakers



Architecture (mixer & citadel)

- **Mixer**
  - Manages Access Control and Policies
  - Extract request attributes
  - Collects Telemetry and metrics
- **Citadel**
  - Service-to-service authentication and Mutual TLS
  - Supports RBAC (Role-Based Access Control) - like Kubernetes
  - Automatically manages credentials and certificates



Architecture (built-in add-ons)

- Prometheus & Grafana
  - Out-of-the-box cluster-wide metric-collection, and support for alert's manager
  - Fully customizable dashboards using Grafana
- Service Graph (Kiali)
  - For Observability
- Open Tracing
  - Vendor-neutral APIs and instrumentation for distributed tracing
  - Jaeger / Zipkin

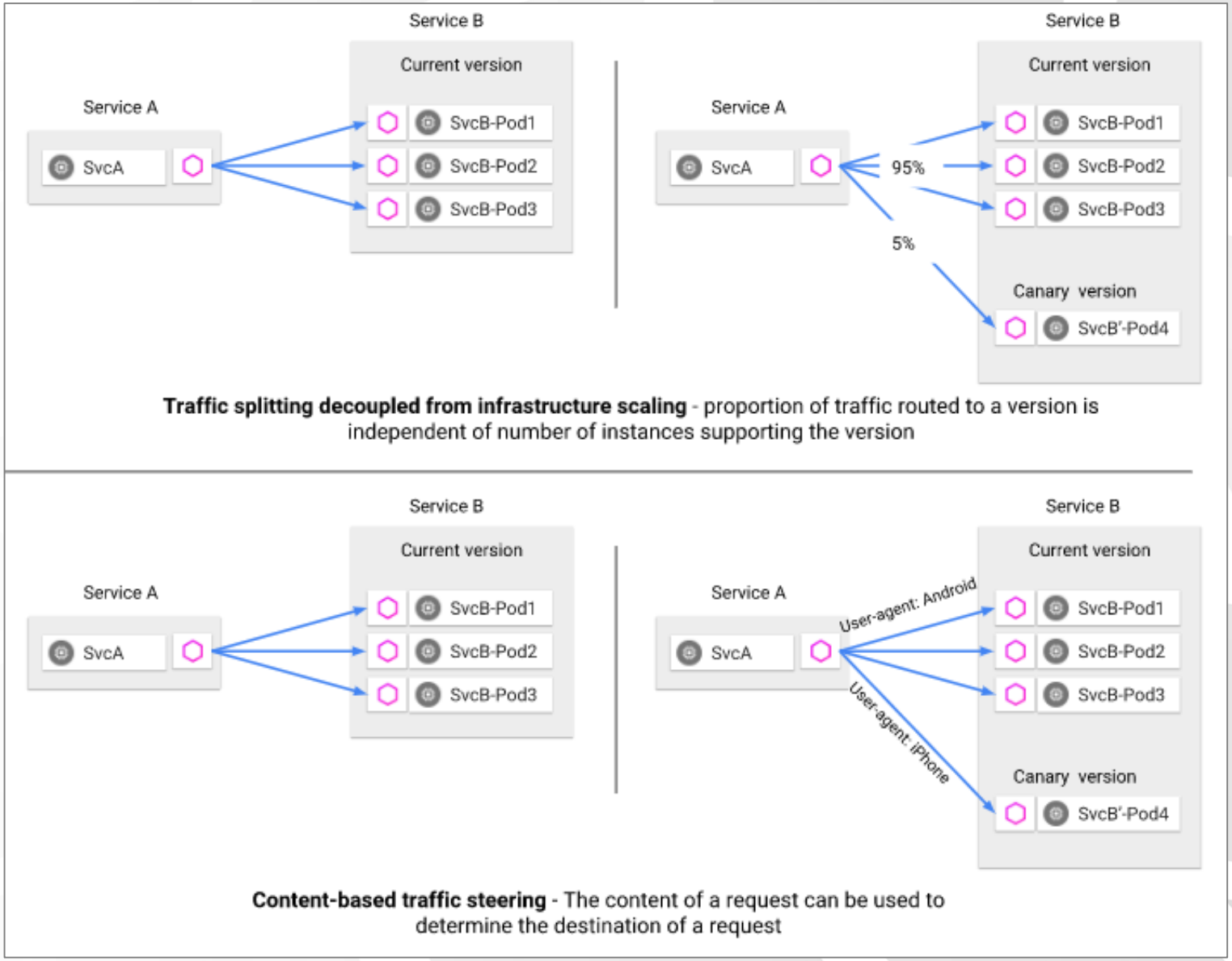
Features

- Intelligent Routing Capabilities
- Failure Handling
- Fault Injection
- Security
- Policies and Telemetry

Intelligent Routing Capabilities

Request Routing

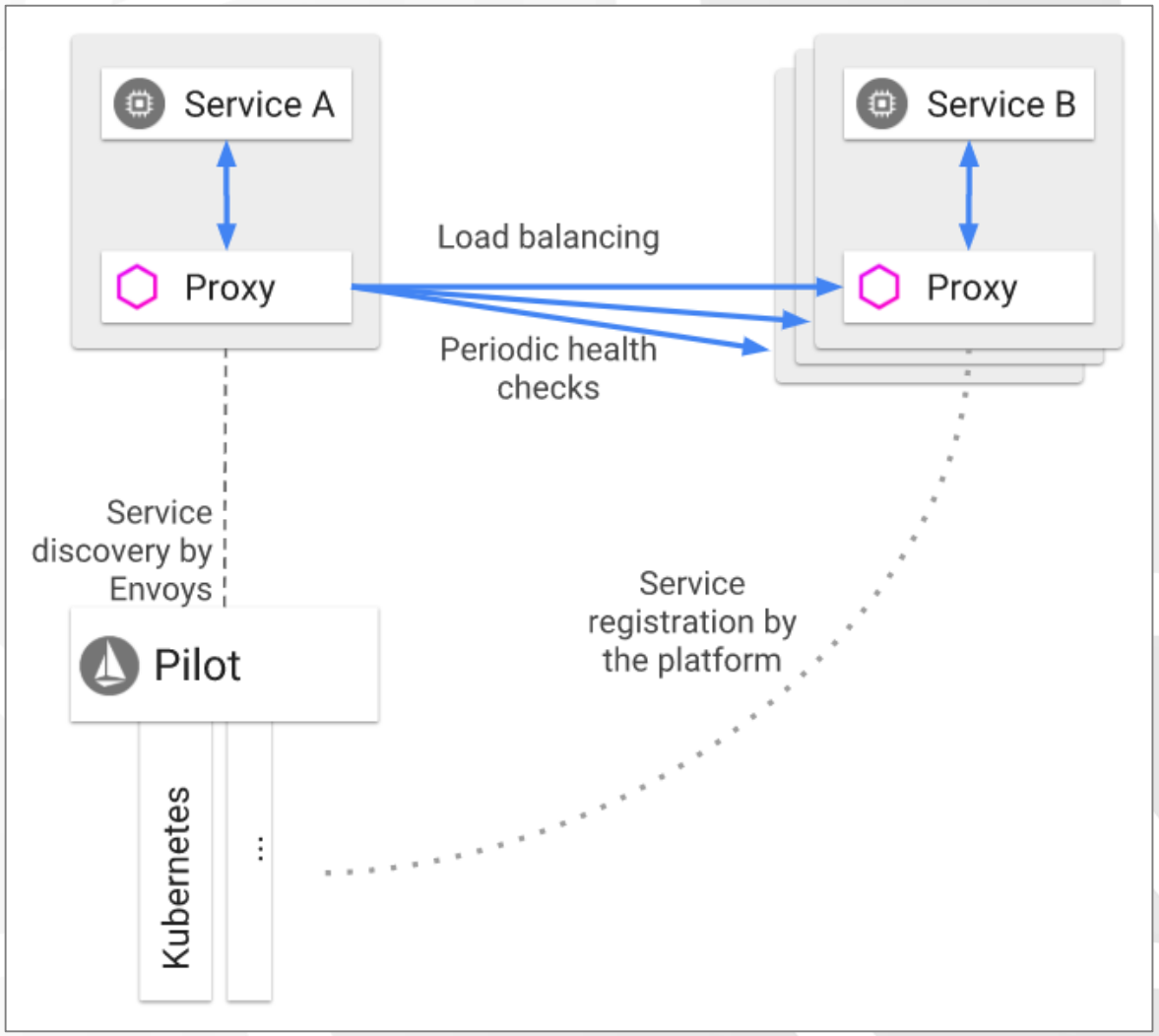
- Manage multiple environments (dev, test, prod) and multiple versions (vX, vY) at the same time while configuring sophisticated rules based-on Uri, Headers and more.
- Implement Weight-based version routing
- Allows A/B testing and Canary Deployments
- Handle Ingress and Egress routing rules and gateways
- Warm-up services with request mirroring



Intelligent Routing Capabilities

Load Balancing

- Handle service-registration and service-discovery
- Advanced Algorithms
  - Weighted round robin
  - Weighted least request
  - Ring-Hash
  - Maglev
  - Random
  - Orig-Destination
- Zone-awareness, priorities and more



Failure Handling

Timeouts and Deadlines

- Following request journey in the Service Mesh
- Supports per-request configuration

Retries

- Supports variable jitter between retries

Rate-limiting and Quotas

- Connection limits, requests throttling

Circuit-Breaker

- Help getting failed services back to shape after subsequent failures (fully configurable)

Fault Injection

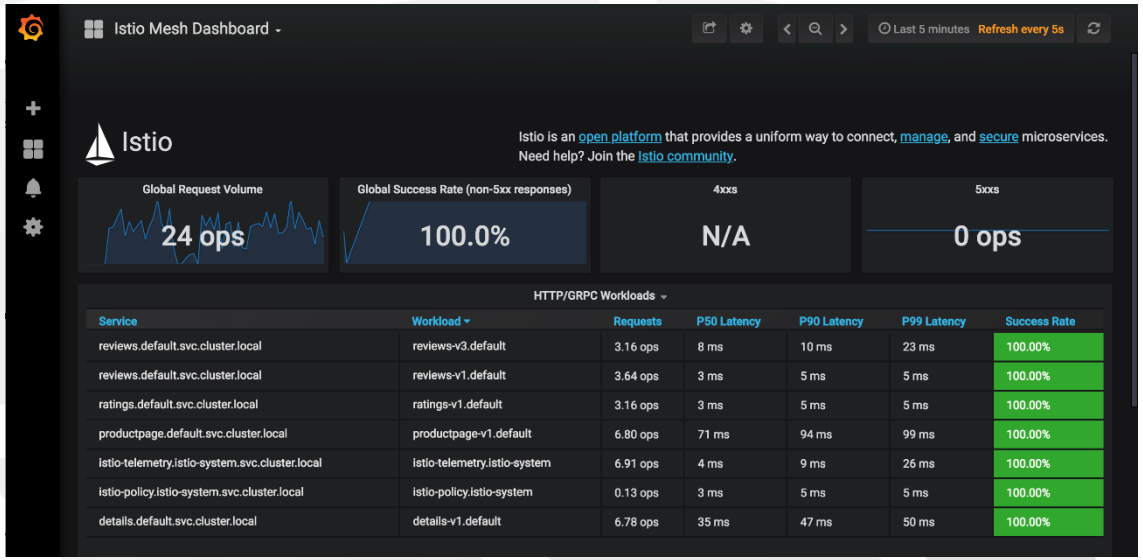
- Allows to test the failure handling mechanism
- Supports Chaos testing (i.e Netflix's Chaos Monkey)
- Introduce latency to specific services or users
- Inject statistical errors to requests

Security

- Authentication
  - Transport authentication (service-to-service authentication)
  - Origin authentication (end-user authentication)
- Mutual TLS authentication
- Permissive mode
  - Allows a service to accept both plain text traffic and mutual TLS traffic at the same time
- Secure naming
- Authentication policies

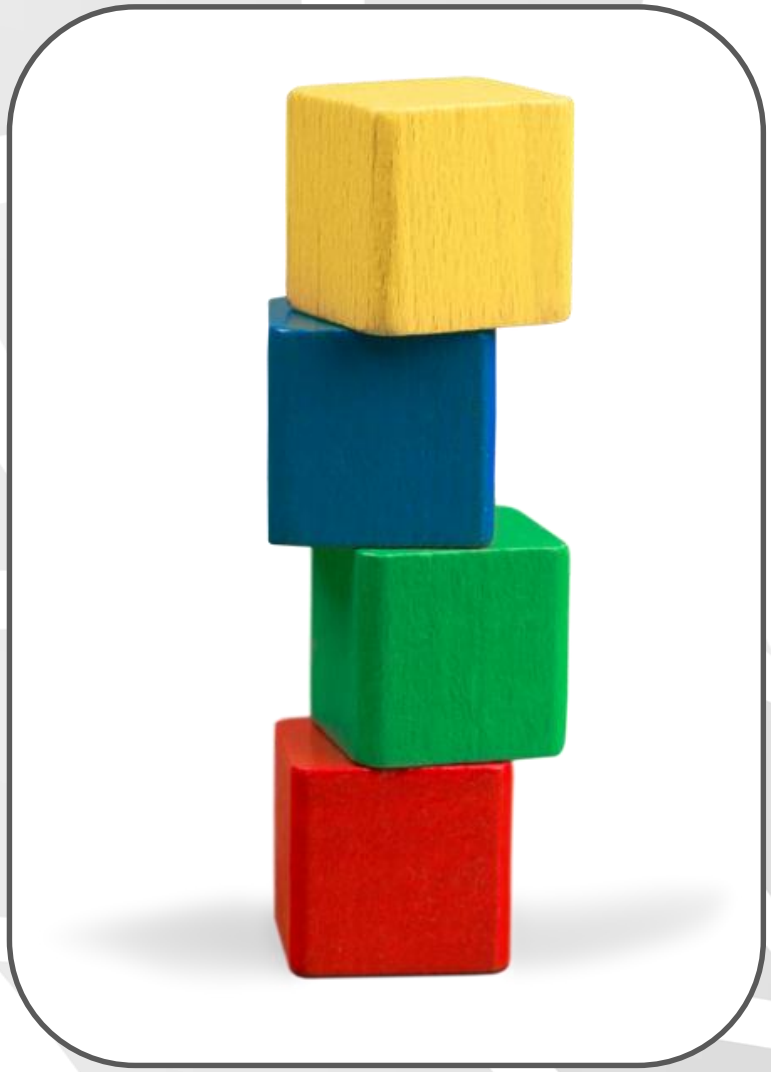
Observability

- Monitoring
  - Using Prometheus and Grafana
- Visibility
  - Using Kiali
- Tracing
  - Using Jaeger / Zipkin
- Attributes
  - Is a small bit of data that describes a single property of a specific service request or the environment for the request



Istio Building Blocks

- Gateway
- VirtualService
- DestinationRule
- etc



Gateway

```
apiVersion: networking.istio.io/v1alpha3
kind: Gateway
metadata:
  name: bookinfo-gateway
spec:
  selector:
    istio: ingressgateway   # use istio default controller
  servers:
  - port:
      number: 80
      name: http
      protocol: HTTP
    hosts:
    - "*"
```

Gateway describes a load balancer operating at the edge of the mesh receiving incoming or outgoing HTTP/TCP connections

VirtualService

```
apiVersion: networking.istio.io/v1alpha3
kind: VirtualService
metadata:
  name: reviews
spec:
  hosts:
  - "*"
  gateways:
  - bookinfo-gateway
  http:
  - route:
    - destination:
        host: reviews
        subset: v1
```

A VirtualService defines the rules that control how requests for a service are routed within an Istio service mesh

DestinationRule

```
apiVersion: networking.istio.io/v1alpha3
kind: DestinationRule
metadata:
  name: reviews
spec:
  host: reviews
  subsets:
  - name: v1
    labels:
      version: v1
  - name: v2
    labels:
      version: v2
  - name: v3
    labels:
      version: v3
```

DestinationRule defines policies that apply to traffic intended for a service after routing has occurred.

Questions

Lab 12: Managing Microservices with Istio

Lab

https://gitlab.com/sela-kubernetes-workshop/lab-12