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Service MESH without the MESS

FOSDEM 2023

Speaker: **Raymond de Jong**

@dejongraymond

Agenda

- eBPF & Cilium Introduction
- Service Mesh Evolution
- Cilium Service Mesh
- Features
- Demo

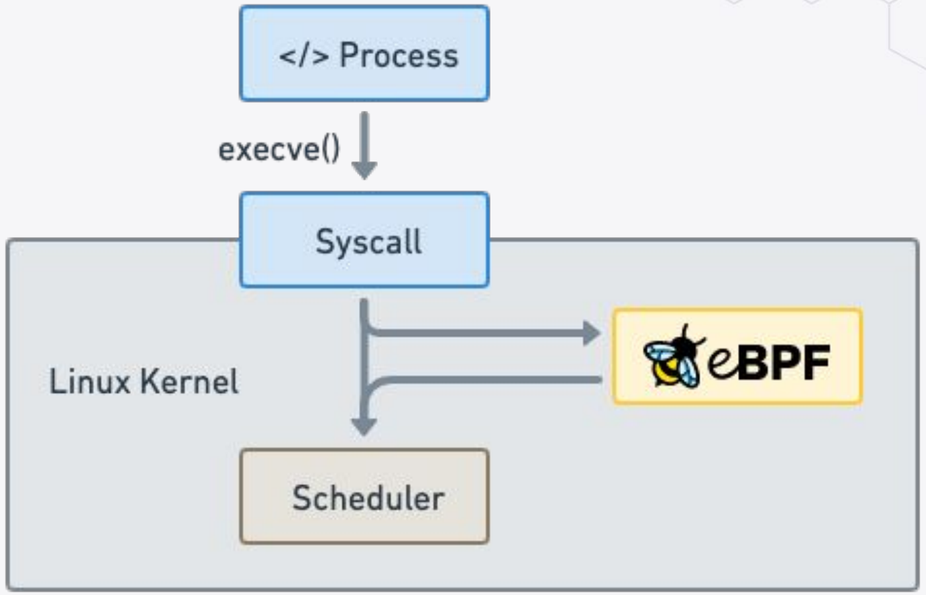
eBPF & Cilium Introduction

eBPF

eBPF

Makes the Linux kernel programmable in a secure and efficient way.

“What JavaScript is to the browser, eBPF is to the Linux Kernel”

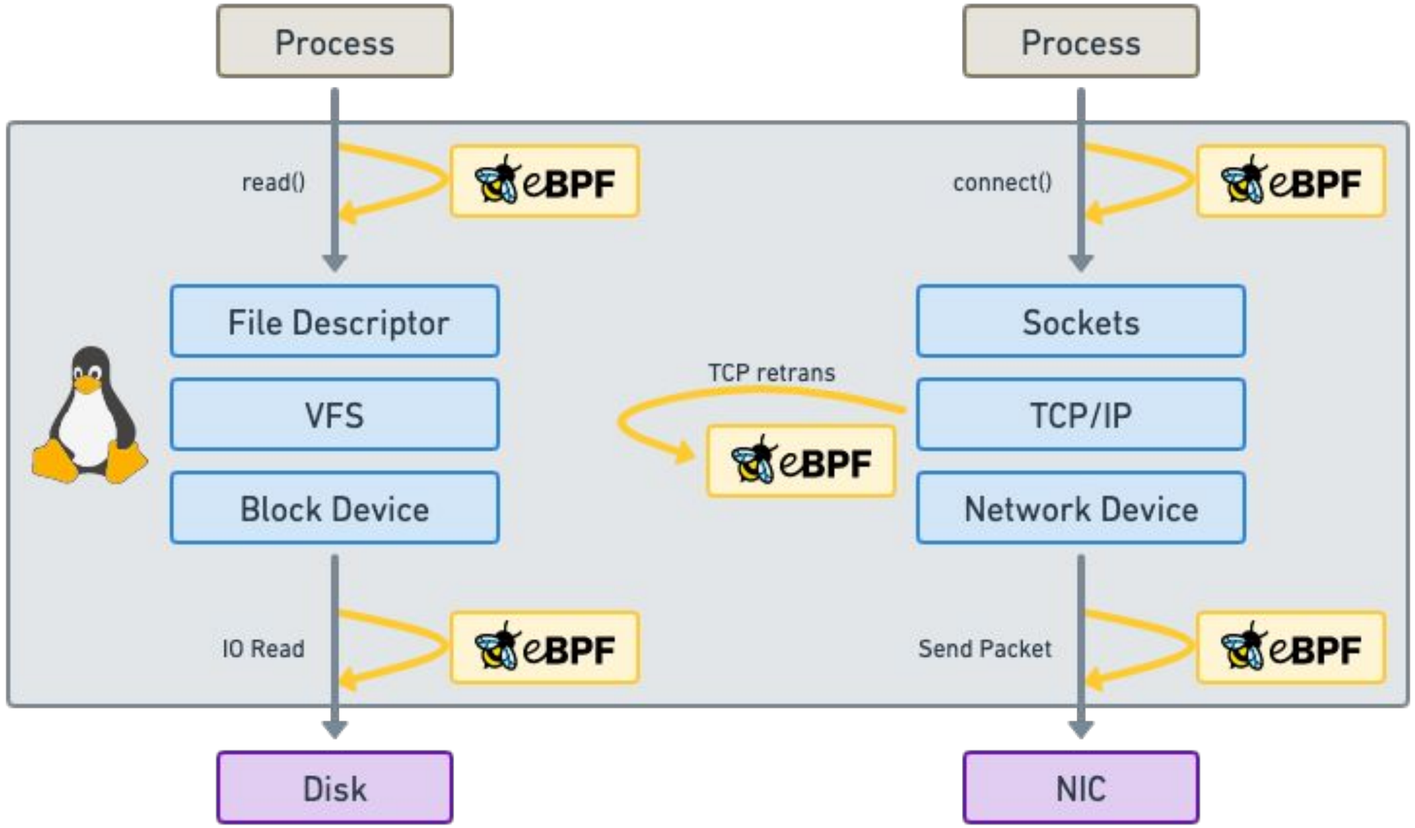



```
int syscall__ret_execve(struct pt_regs *ctx)
{
        struct comm_event event = {
                .pid = bpf_get_current_pid_tgid() >> 32,
                .type = TYPE_RETURN,
        };

        bpf_get_current_comm(&event.comm, sizeof(event.comm));
        comm_events.perf_submit(ctx, &event, sizeof(event));

        return 0;
}
```

Run eBPF programs on events

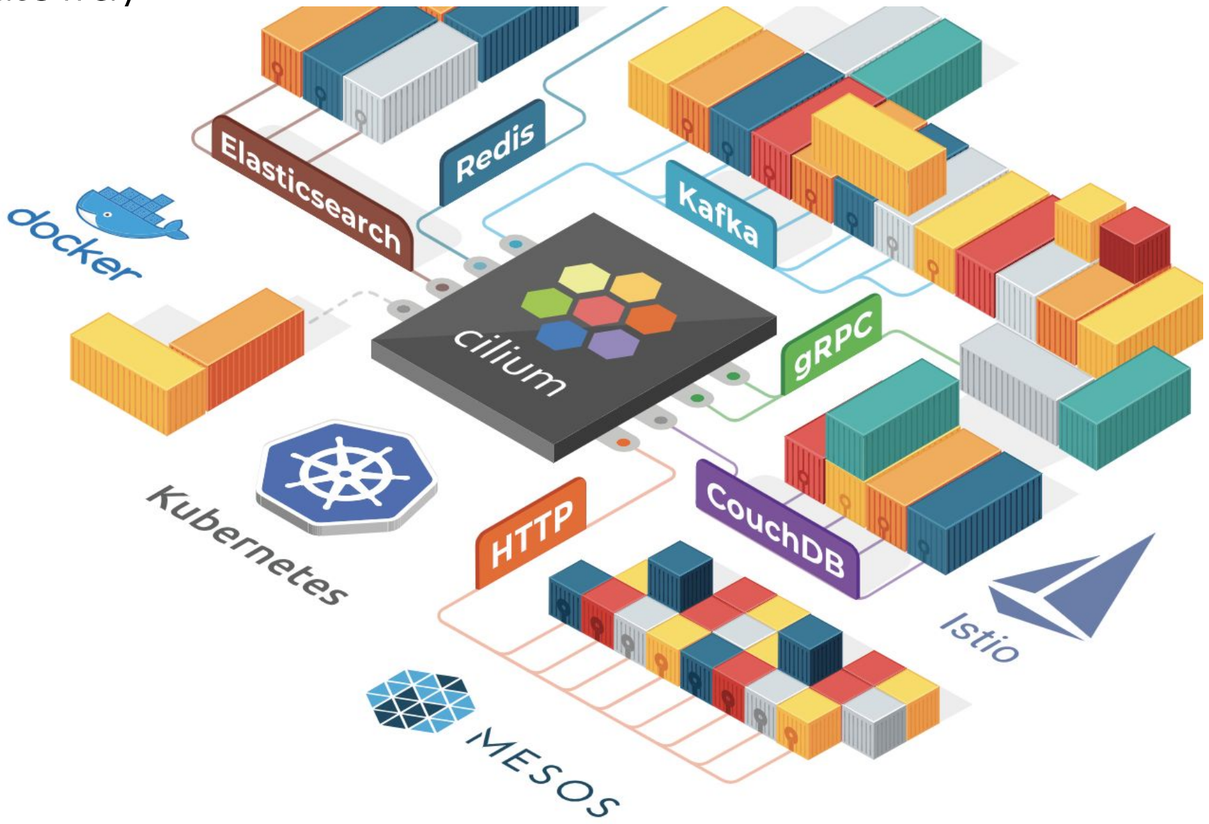


Attachment points

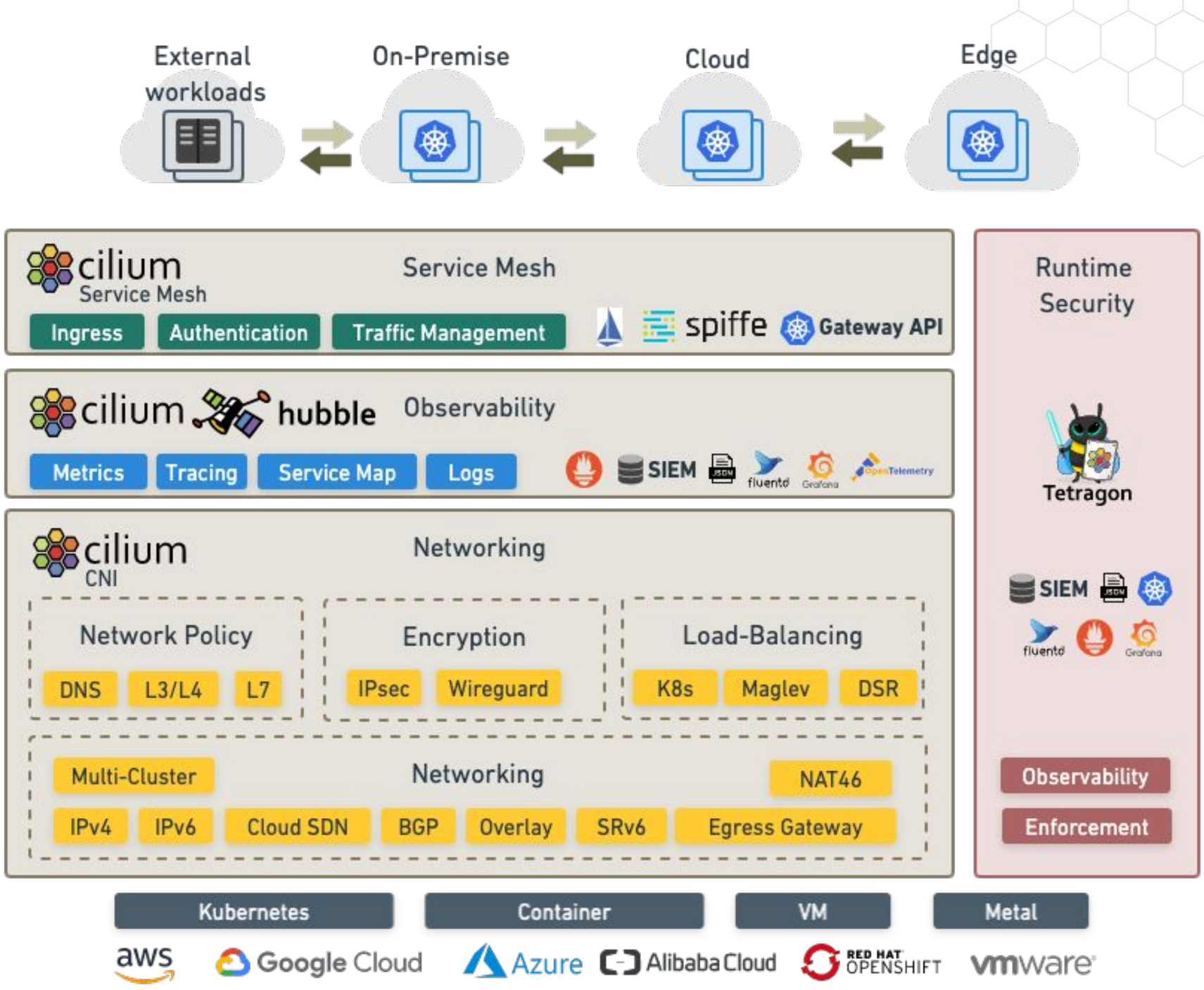
- Kernel functions (kprobes)
- Userspace functions (uprobe)
- System calls
- Tracepoints
- Sockets (data level)
- Network devices (packet level)
- Network device (DMA level) [XDP]
- ...

What is Cilium?

- **Networking & Load-Balancing**
  - CNI, Kubernetes Services, Multi-cluster, VM Gateway
- **Network Security**
  - Network Policy, Identity-based, Encryption
- **Observability**
  - Metrics, Flow Visibility, Service Dependency



At the foundation of Cilium is the new Linux kernel technology eBPF, which enables the dynamic insertion of powerful security, visibility, and networking control logic within Linux itself. Besides providing traditional network level security, the flexibility of BPF enables security on API and process level to secure communication within a container or pod.
Read More


External workloads
On-Premise
Cloud
Edge
cilium
Service Mesh
Service Mesh
Ingress
Authentication
Traffic Management
spiffe
Gateway API
cilium
hubble
Observability
Metrics
Tracing
Service Map
Logs
SIEM
fluentd
Grafana
OpenTelemetry
cilium
CNI
Networking
Network Policy
DNS
L3/L4
L7
Encryption
IPsec
Wireguard
Load-Balancing
K8s
Maglev
DSR
Multi-Cluster
Networking
NAT46
IPv4
IPv6
Cloud SDN
BGP
Overlay
SRv6
Egress Gateway
Runtime Security
Tetragon
SIEM
fluentd
Grafana
Observability
Enforcement
Kubernetes
Container
VM
Metal
aws
Google Cloud
Azure
Alibaba Cloud
RED HAT OPENSHIFT
vmware

cilium

Created by ISOVALENT

eBPF-based:

- Networking
- Security
- Observability
- Service Mesh & Ingress

Foundation

CLOUD NATIVE COMPUTING FOUNDATION

Technology

eBPF envoy

WILD LIFE

Building a Global Multi Cluster Gaming Infrastructure with Cilium

Adobe

What Makes a Good Multi-tenant Kubernetes Solution

Capital One

Building a Secure and Maintainable PaaS

Alibaba Cloud

Building High-Performance Cloud-Native Pod Networks

MÁSMÓVIL

Scaling a Multi-Tenant k8s Cluster in a Telco

Trip.com

First step towards cloud native networking

CENGN

Cloud Native Networking with eBPF

DigitalOcean

Managed Kubernetes: 1.5 Years of Cilium Usage at DigitalOcean

Google

Google chooses Cilium for Google Kubernetes Engine (GKE) networking

Bell

Why eBPF is changing the Telco networking space?

GitLab

Kubernetes Network Policies in Action with Cilium

aws

AWS picks Cilium for Networking & Security on EKS Anywhere

Scaleway

Scaleway uses Cilium as the default CNI for Kubernetes Kapsule

sportradar

Sportradar is using Cilium as their main CNI plugin in AWS (using kops)

Utmost

Utmost is using Cilium in all tiers of its Kubernetes ecosystem to implement zero trust

yahoo!

Yahoo is using Cilium for L4 North-South Load Balancing for Kubernetes Services

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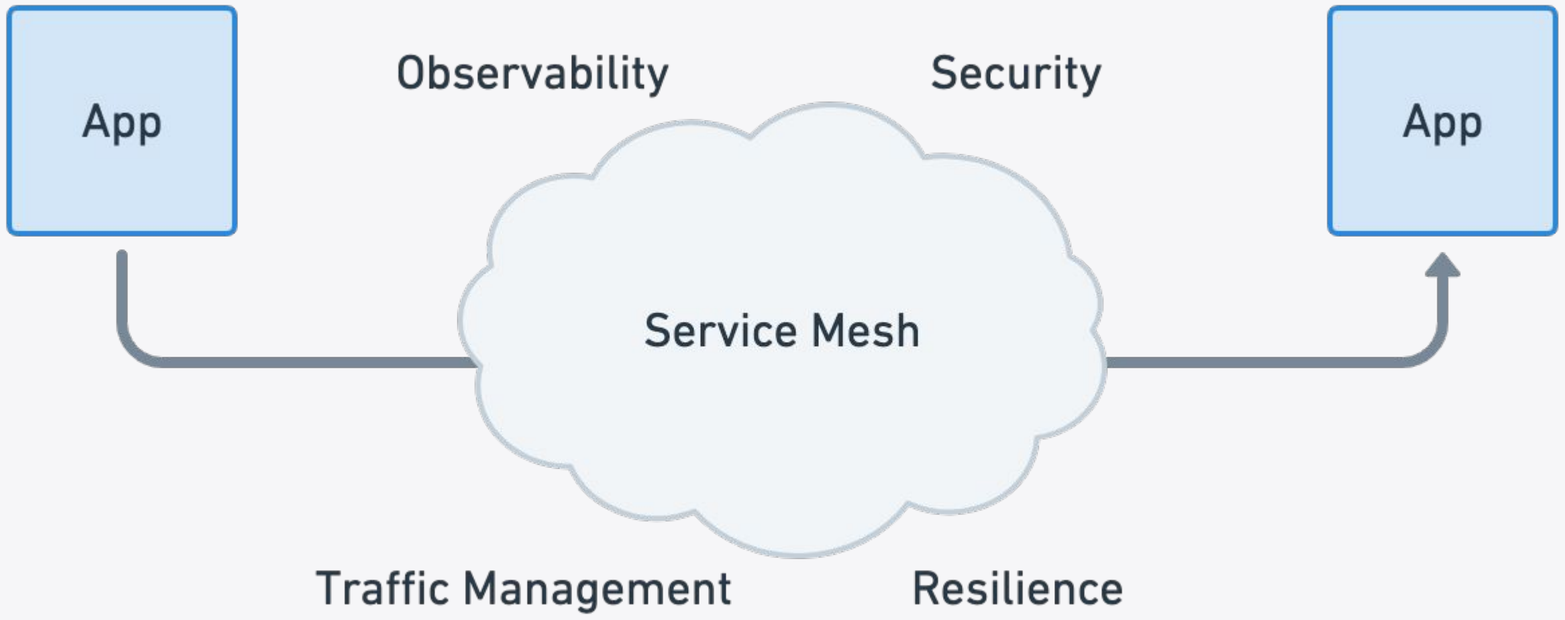
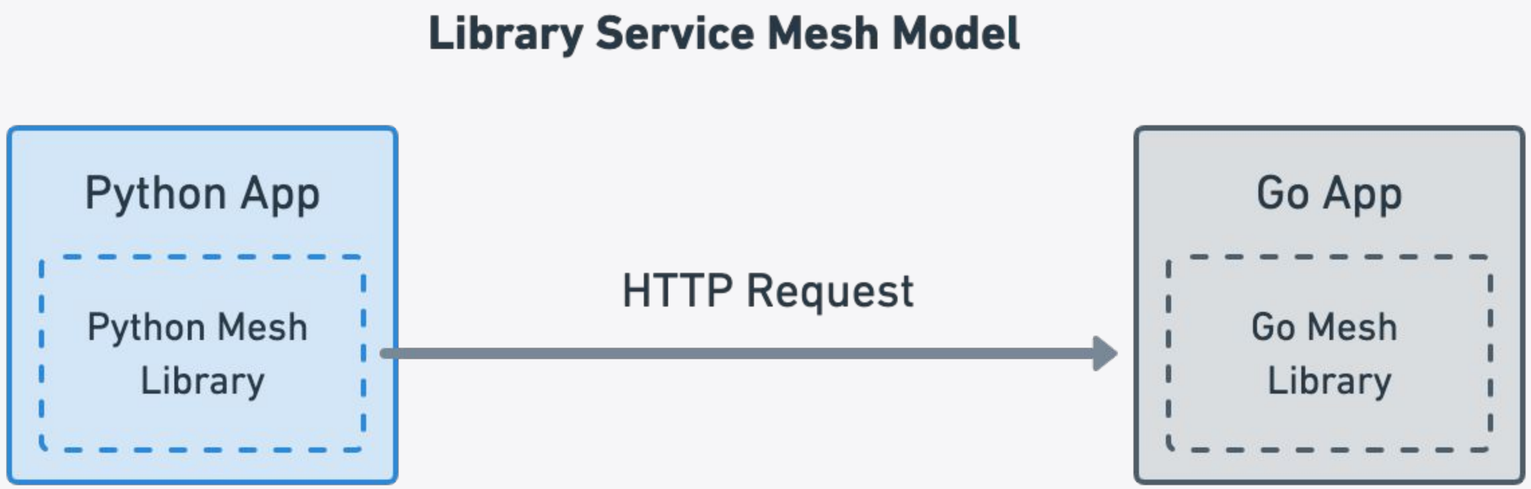
Service Mesh Introduction

Service Mesh

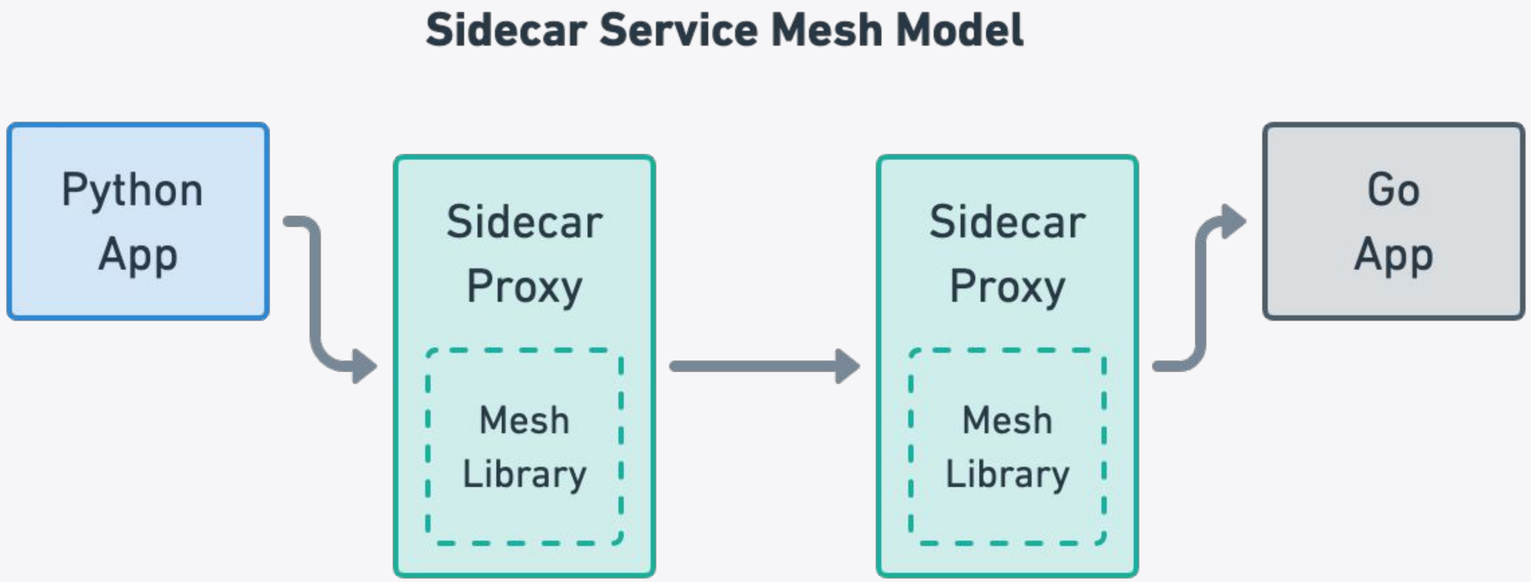


Service Mesh Origins



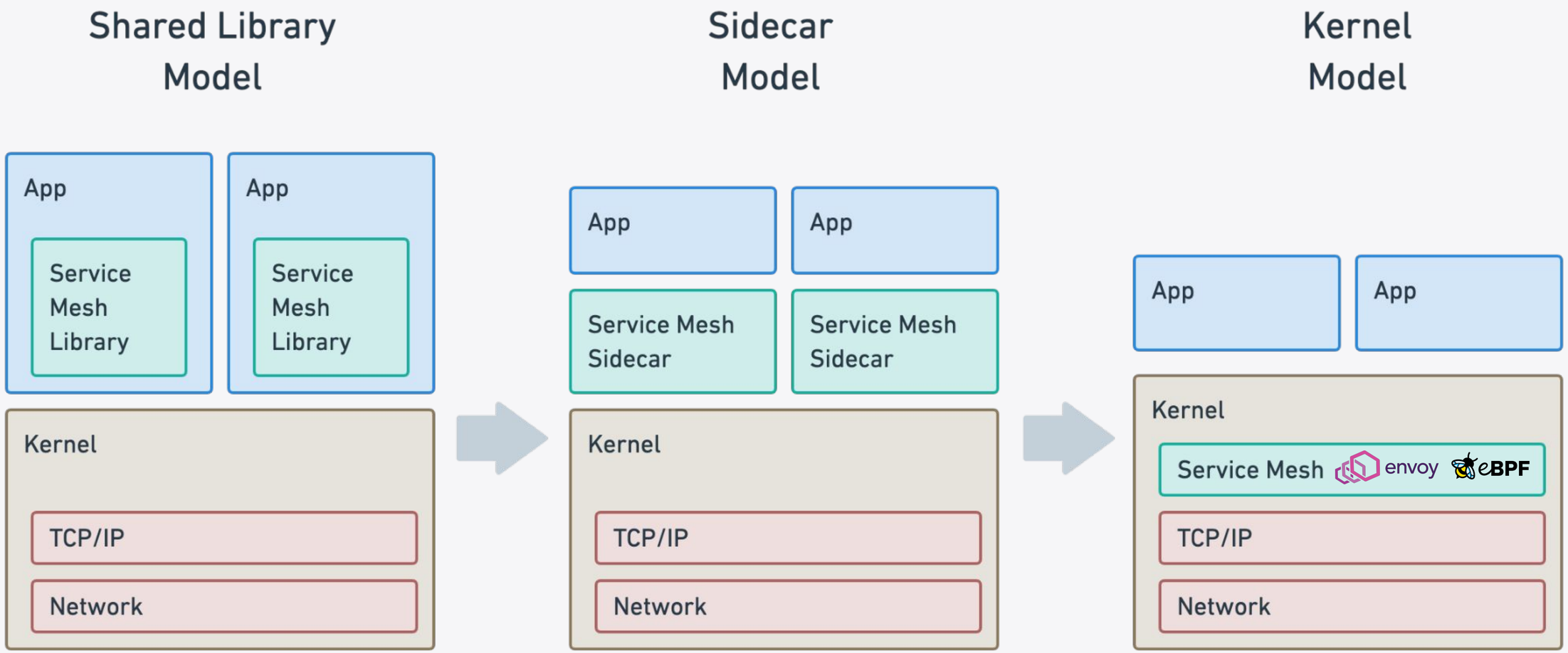
Each application requires a service mesh library written in the language framework of the application.

Service Mesh with Sidecars

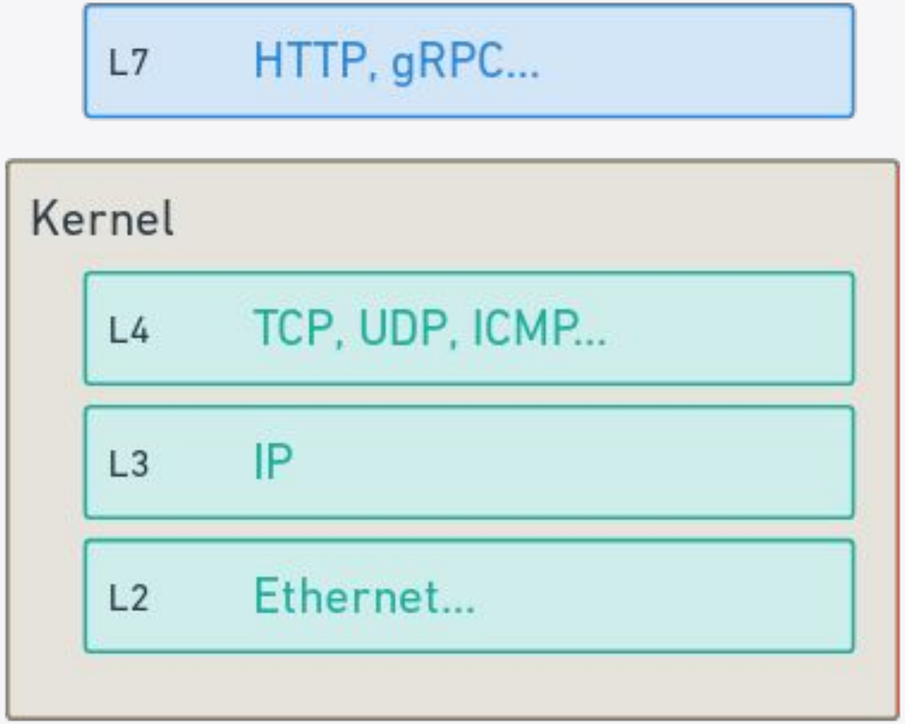


Service mesh is is embedded in a proxy running outside of the application.

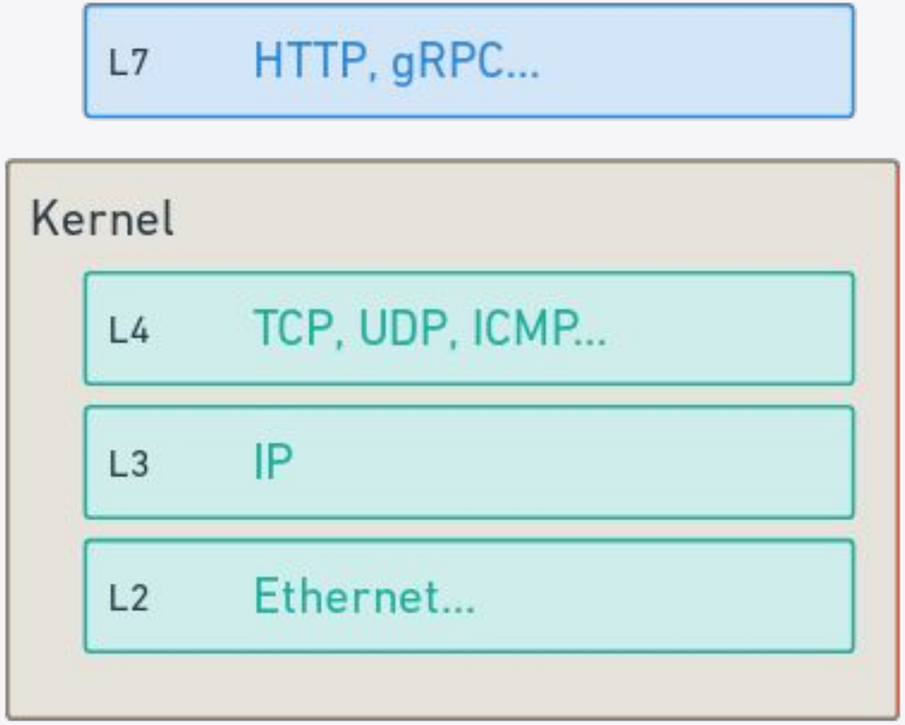
Service Mesh Evolution



Layer 7 is the only part which is not yet there

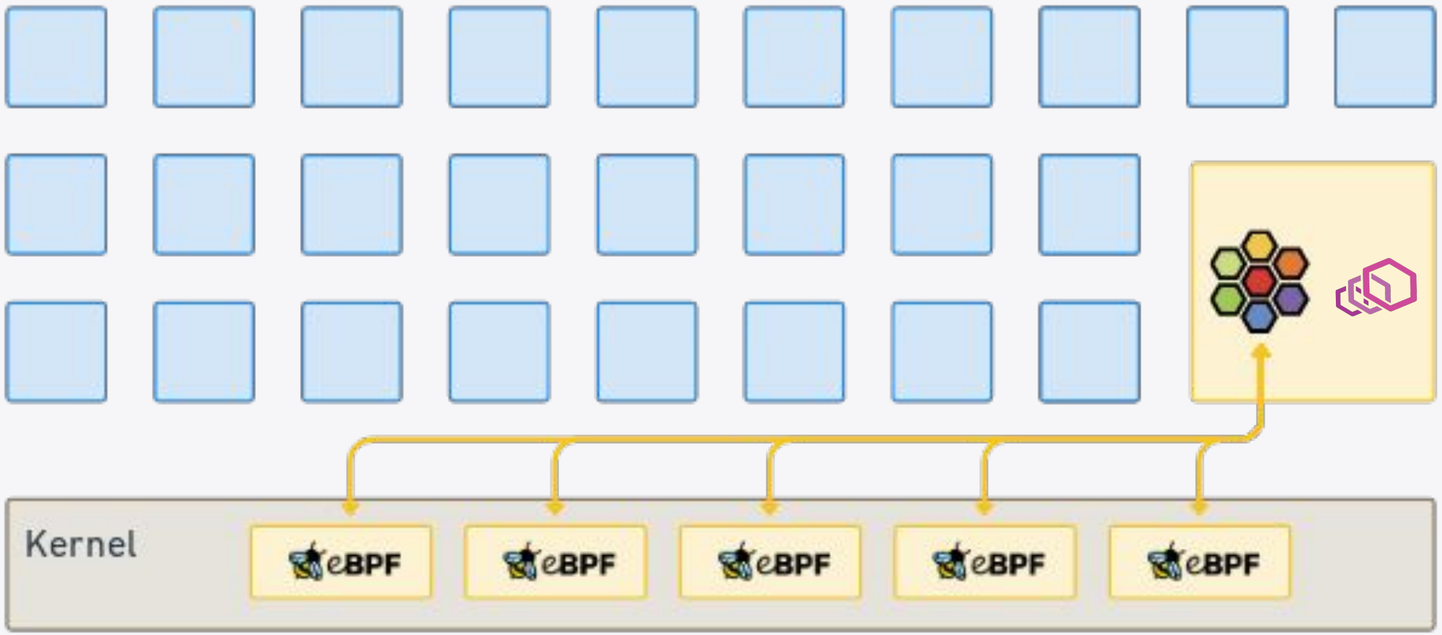


Yet, Cilium already has L7 network policies and visibility



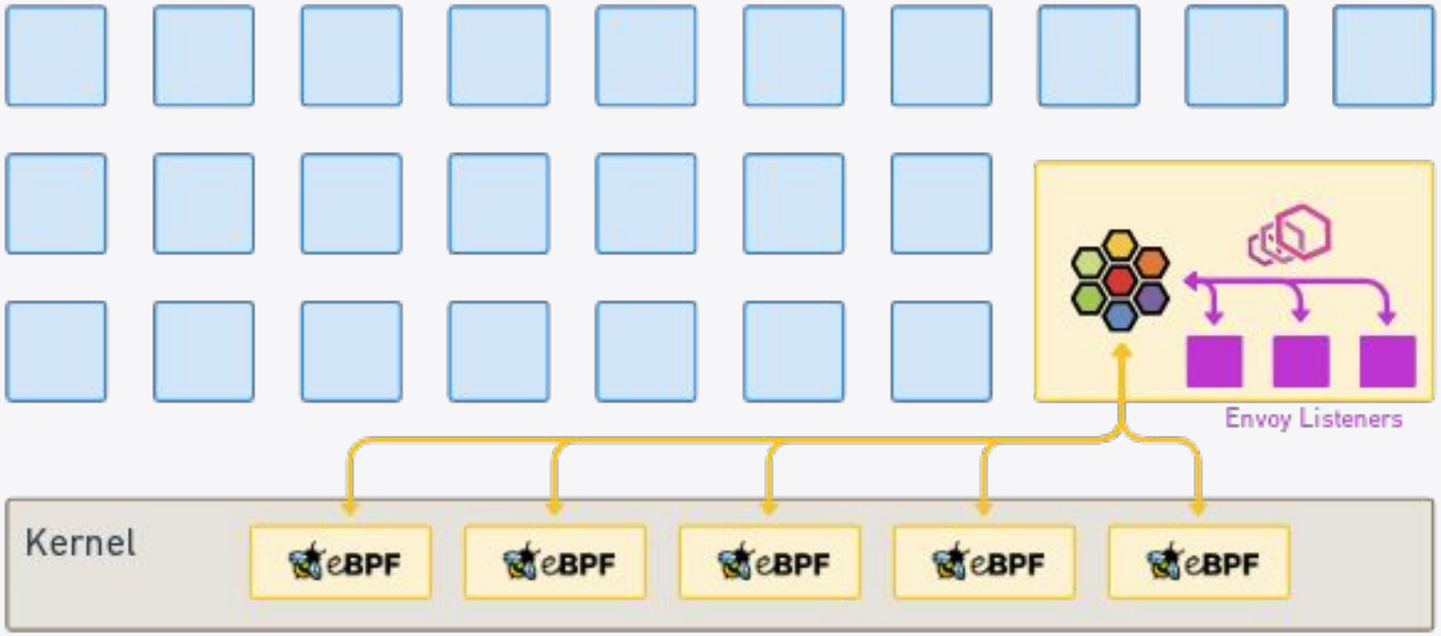
Cilium Service Mesh

Cilium agent per node



- Dynamic eBPF programs
- Envoy for L7 policies & observability

Cilium for sidecarless service mesh



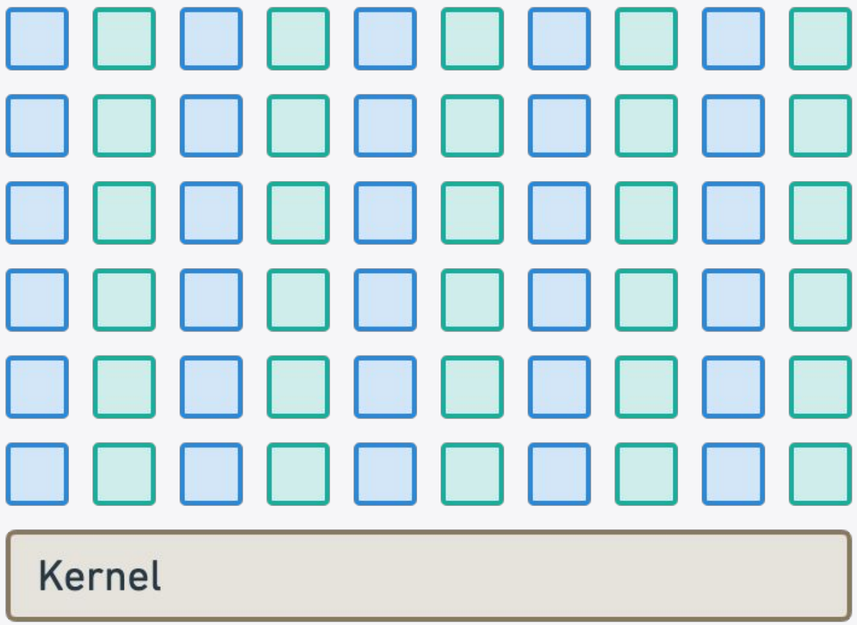
- Dynamic eBPF programs
- Envoy for L7 policies & observability and **traffic management rules** etc

What is different with Cilium Service Mesh?

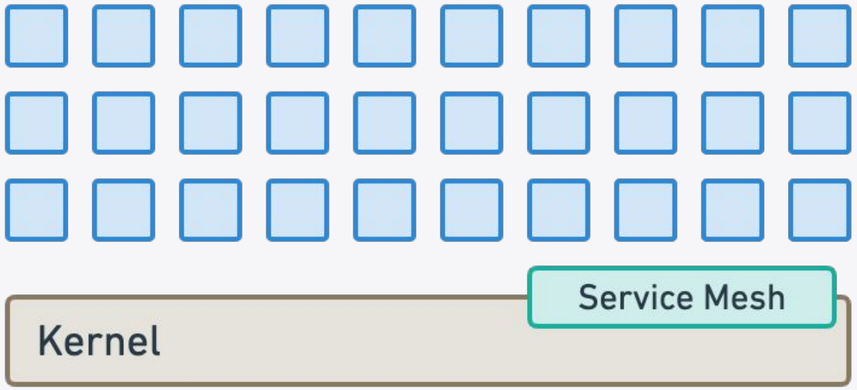
- Reduced operational complexity
- Reduced resource usage
- Better performance
- Avoid sidecar startup/shutdown race conditions

Reduce resource usage - sidecar vs proxy per node

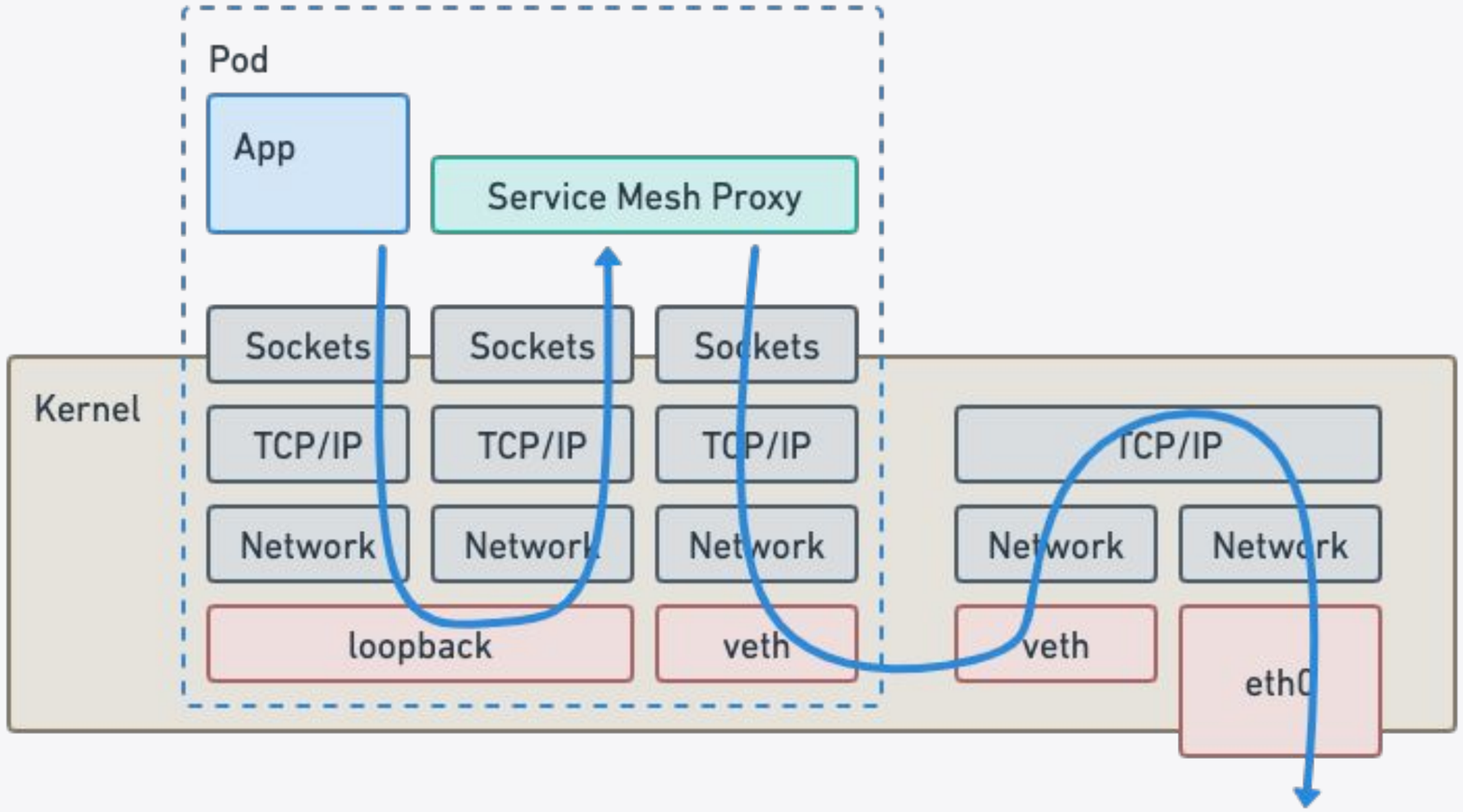
Total number of proxies required



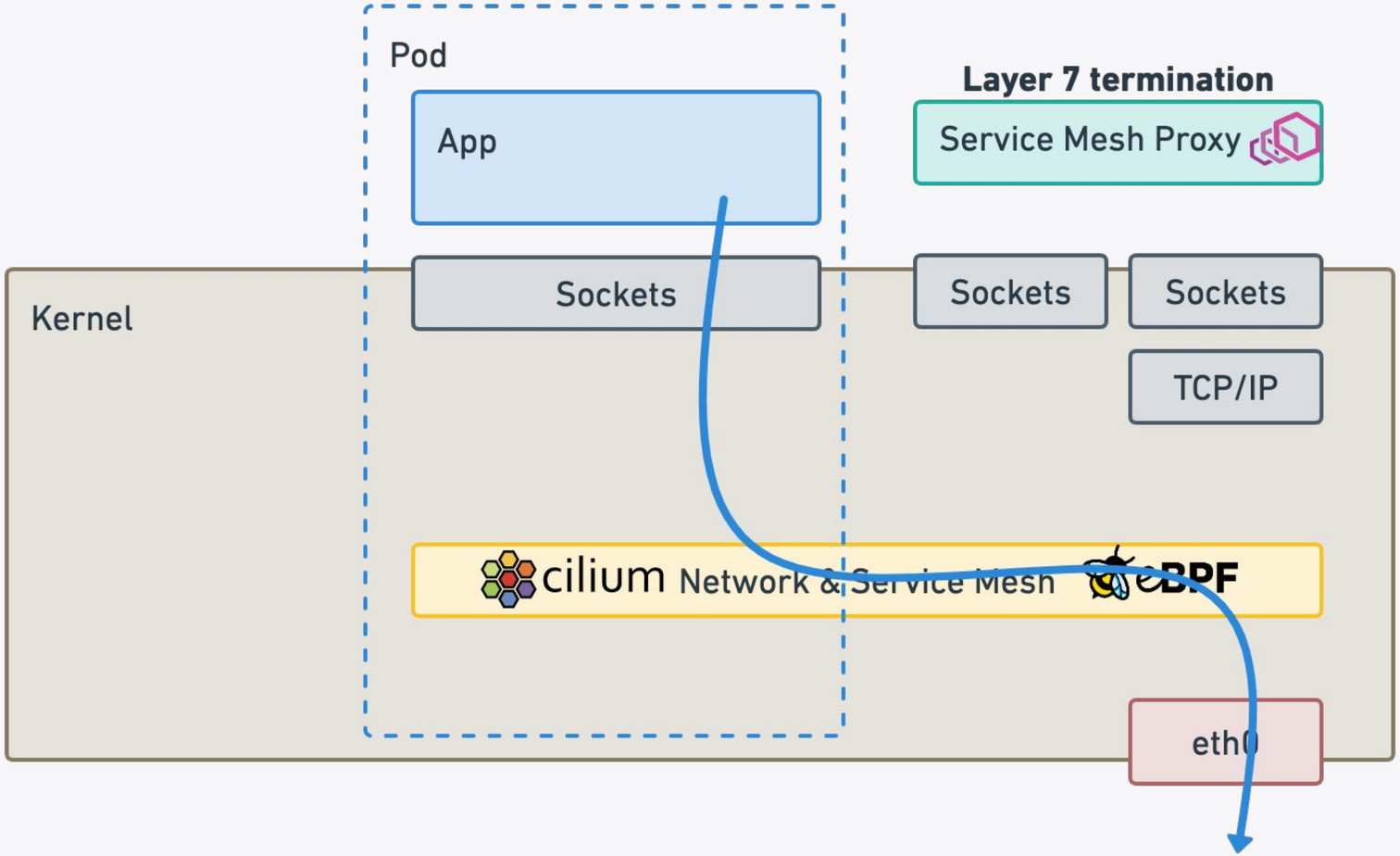
30 pods/node ⇒ 30 proxies/node



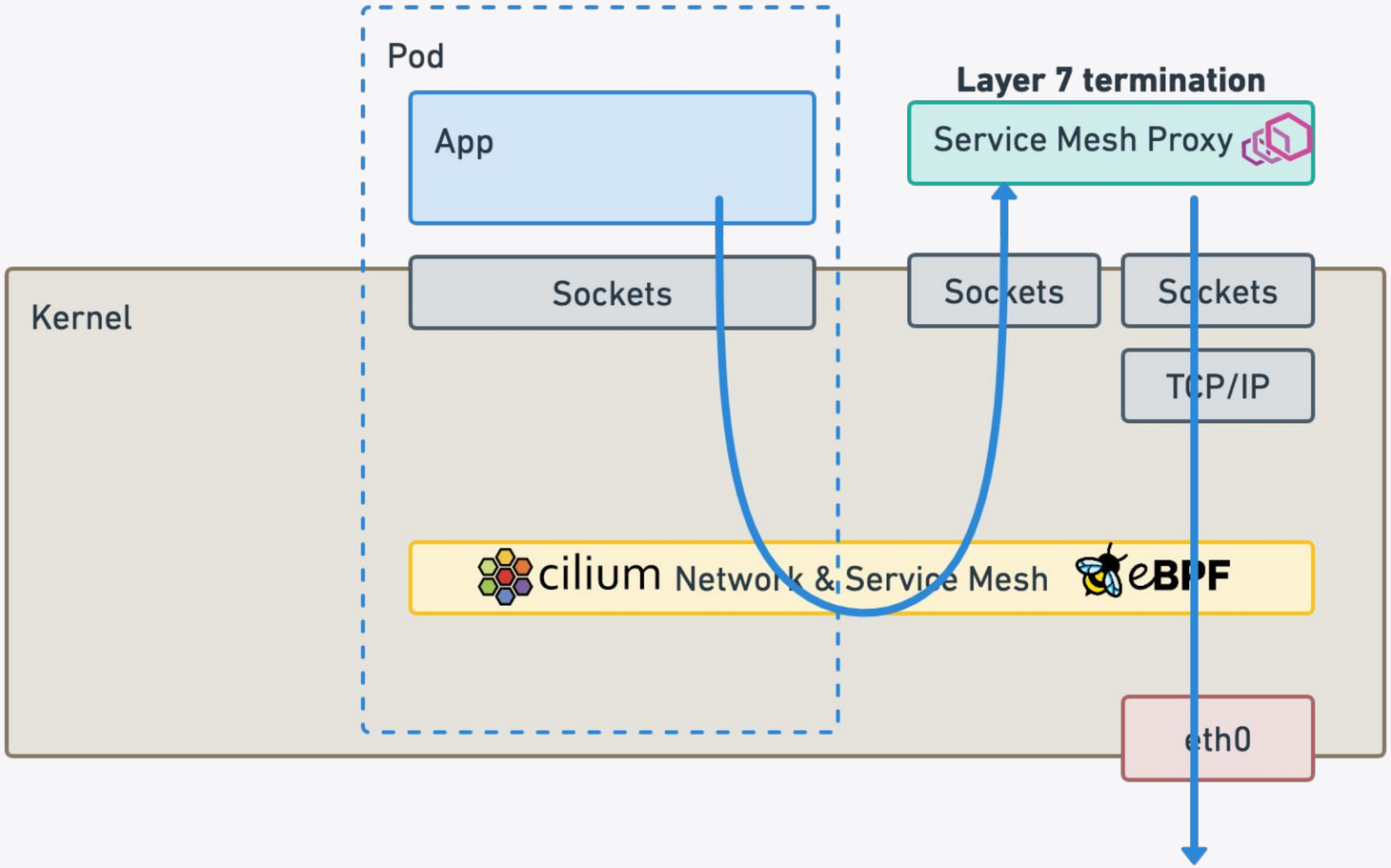
Cost of sidecar injection



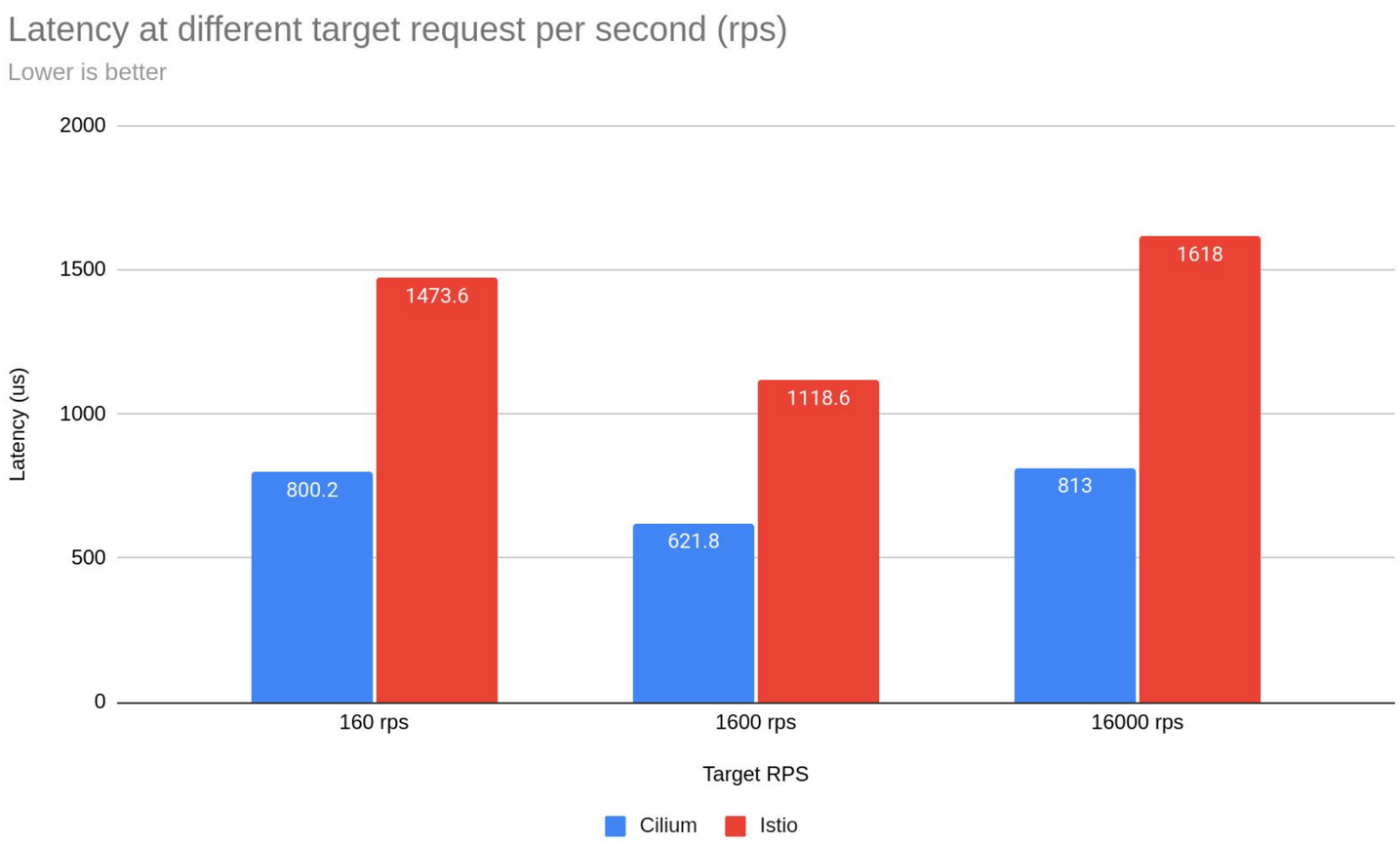
eBPF powered network path for L3/L4 traffic



Envoy for Layer 7 termination when needed

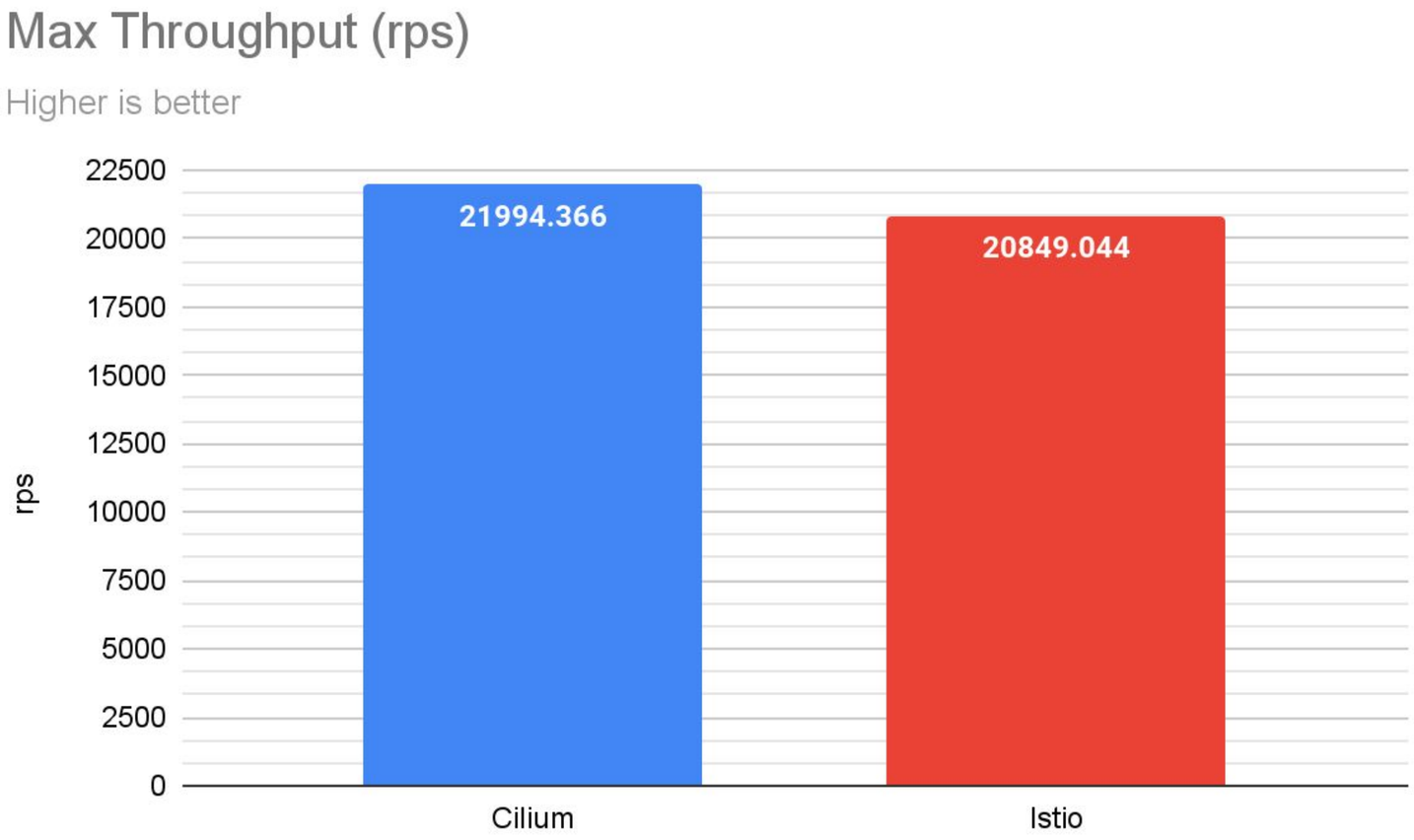


Latency performance



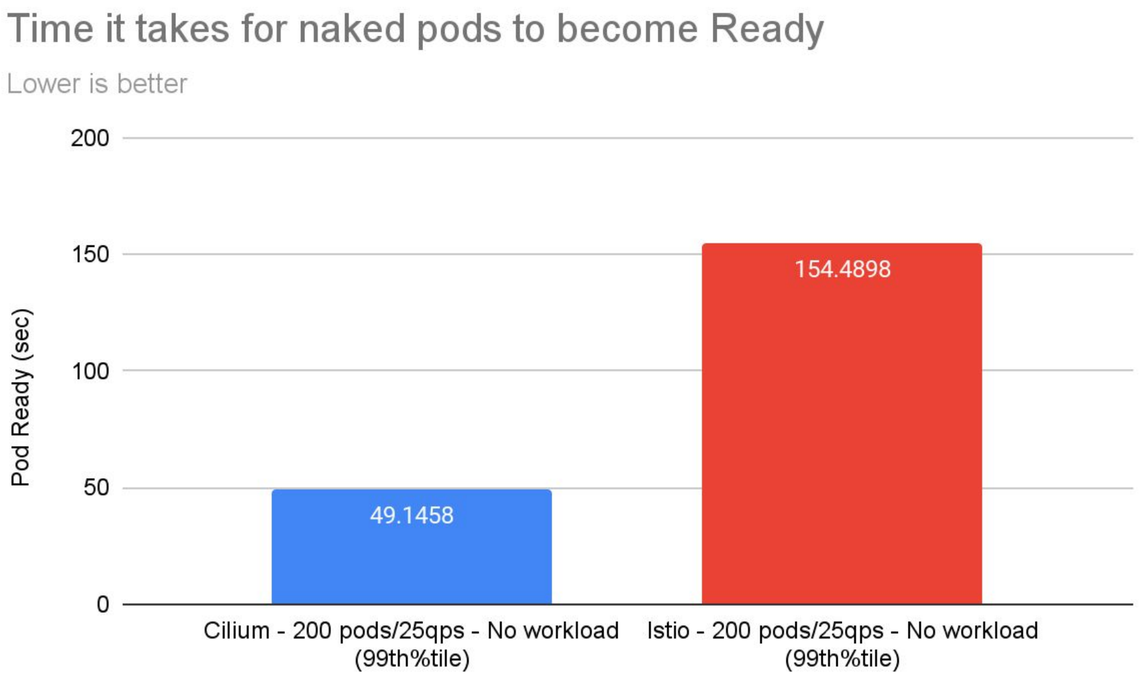
All data & Scripts: https://isovalent.com/blog/post/2022-05-03-servicemesh-security

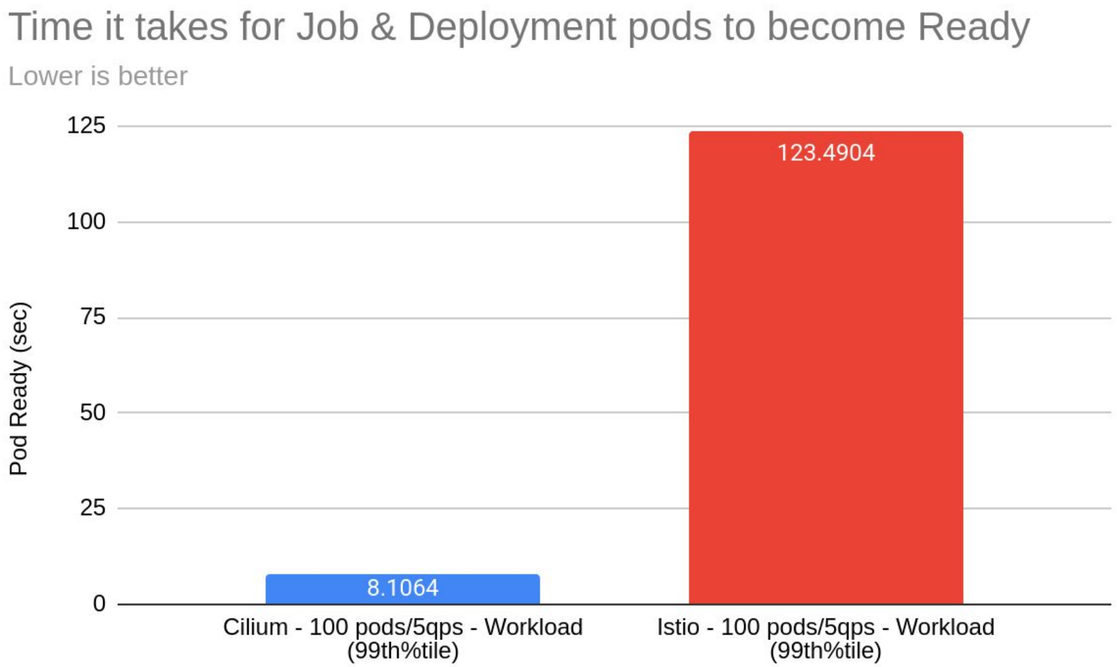
Throughput performance



All data & Scripts: https://isovalent.com/blog/post/2022-05-03-servicemesh-security

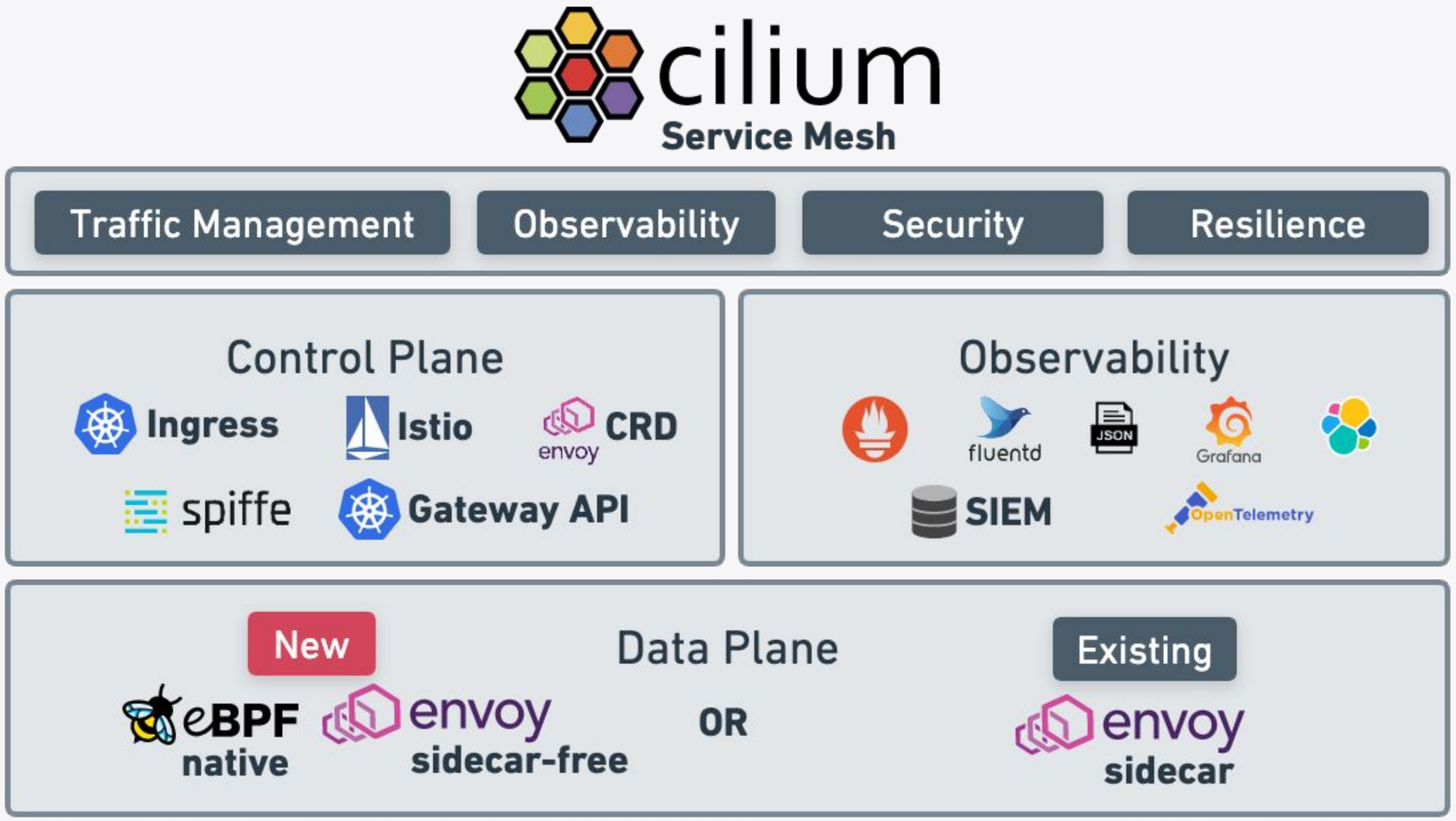
Pod ready performance





All data & Scripts: https://isovalent.com/blog/post/2022-05-03-servicemesh-security

Cilium Service Mesh



Cilium 1.12 Release

- Production Ready Cilium Service Mesh
- Conformant Ingress Controller
- Using Kubernetes as Service Mesh Control Plane
  - Simple to use sidecar-free Service Mesh configured using Kubernetes Services and Ingress
- Prometheus metrics and OpenTelemetry
- CiliumEnvoyConfig and CiliumClusterEnvoyConfig CRD
- Extended Grafana dashboards for L7 visibility

Roadmap 1.13

- Gateway API
  - HTTP Routing
  - TLS Termination
  - HTTP Traffic Splitting / Weighting
- Multiple Ingress per Load Balancer
- More L7 metrics collection through Isovalent Tetragon Enterprise

Features

Layer 7 Traffic Management Options

cilium

Ingress

Original L7 load-balancing standard in K8s

Simple

Supported since Cilium 1.12

Services

Use of K8s services with annotations

Simple

Support coming In Cilium 1.13

Gateway API

Originally labelled Ingress v2. Richer in features.

Simple

Support for v0.5.1 coming in Cilium 1.13

EnvoyConfig

Raw Envoy Config via CustomResource

Advanced Users & Integrations

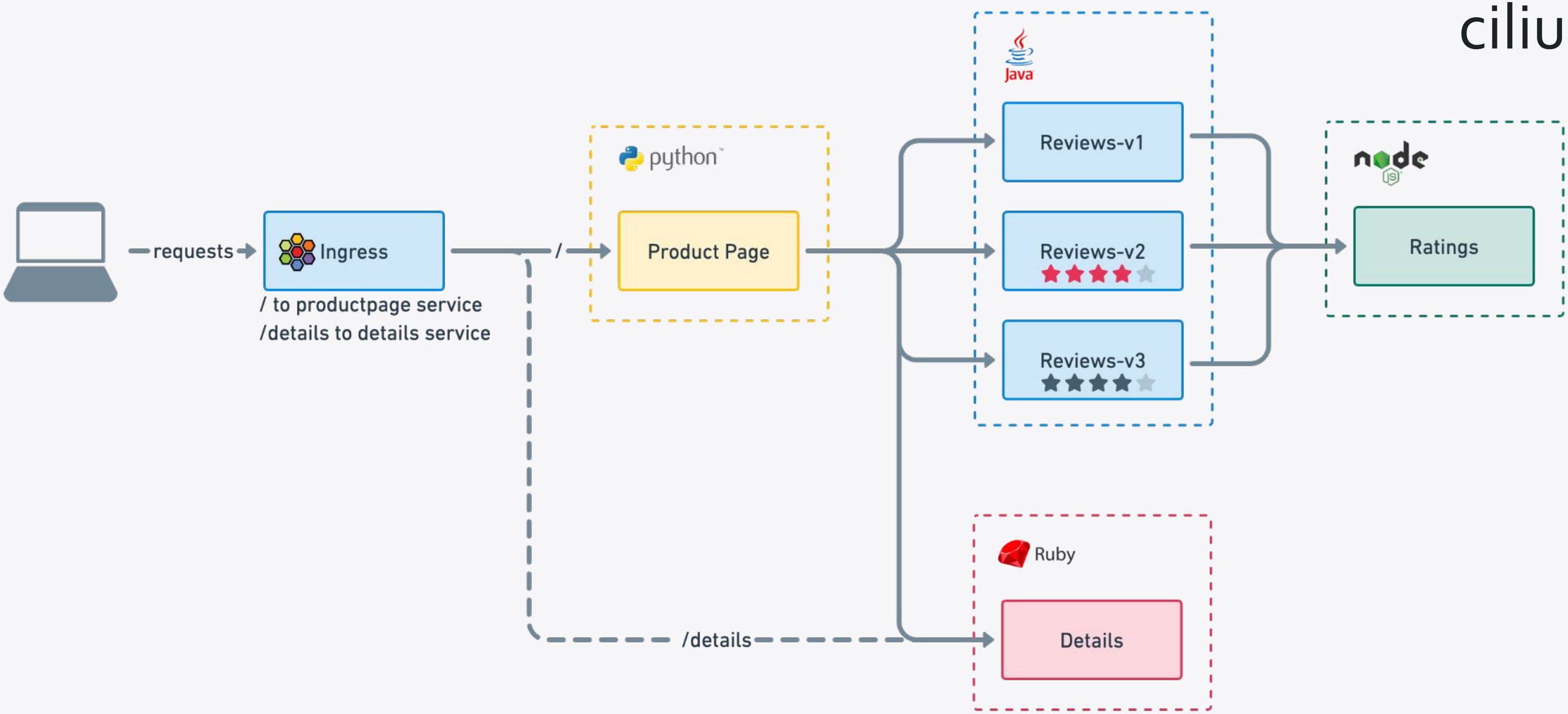
Supported since Cilium 1.12

Ingress

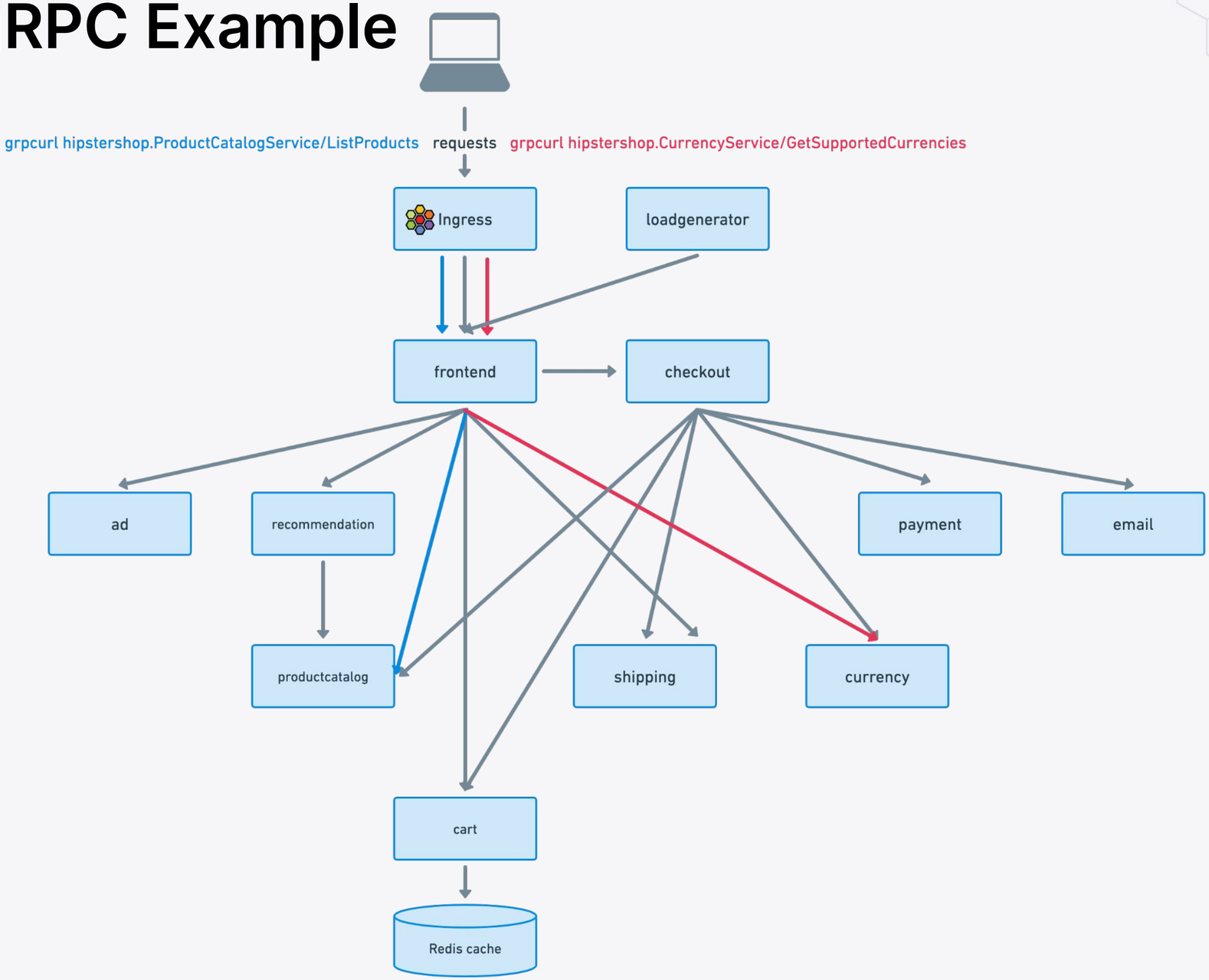
- Ingress can be used for path-based routing and TLS termination
- Cilium manages Ingress resources without external Ingress Controller
- Cilium Service Mesh Ingress Controller requires ability to create Service of Type LoadBalancer using either Cloud Provider integration or e.g. MetalLB
- Ingress CRD with `ingressClassName: cilium`

```yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: basic-ingress
  namespace: default
spec:
  ingressClassName: cilium
  rules:
    - http:
        paths:
          - backend:
              service:
                name: details
                port:
                  number: 9080
            path: /details
            pathType: Prefix
          - backend:
              service:
                name: productpage
                port:
                  number: 9080
            path: /
            pathType: Prefix
```

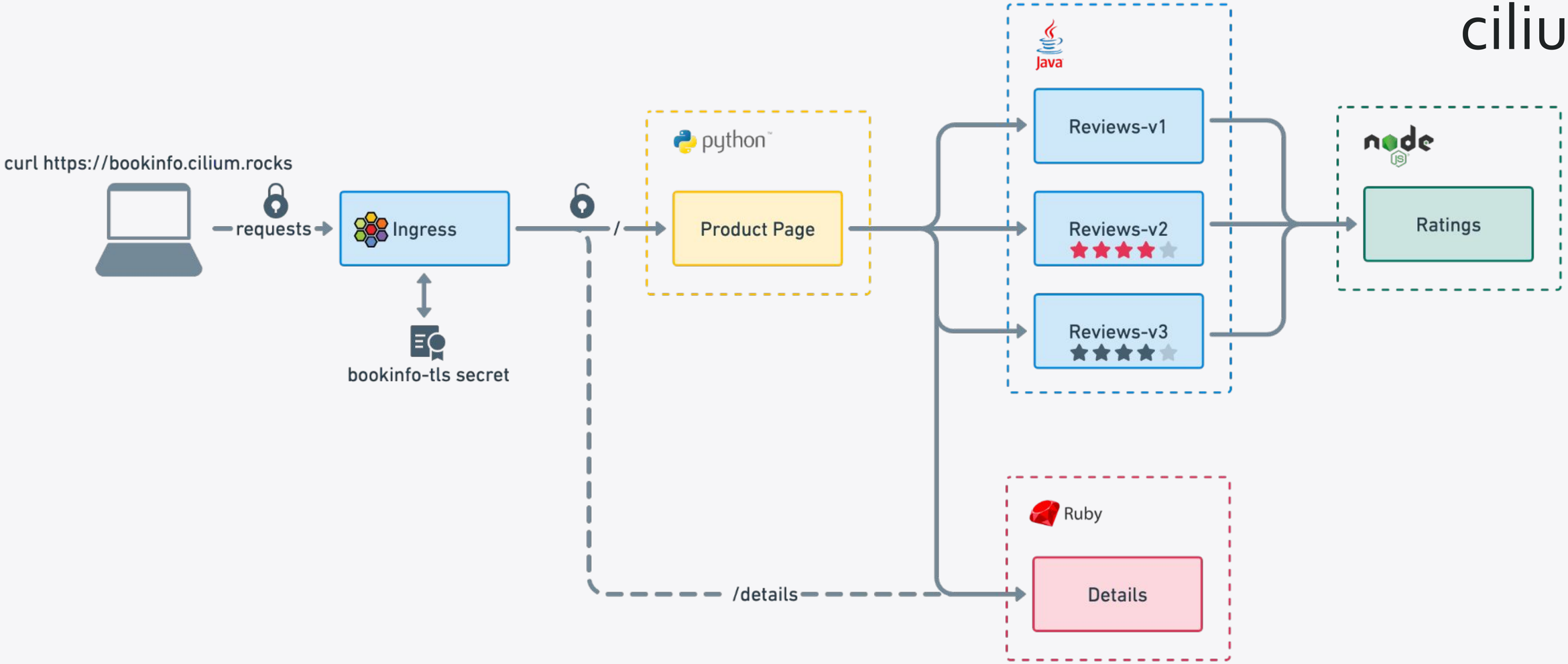
Ingress HTTP Example



Ingress gRPC Example



TLS Termination



Gateway API

Use of Gateway and HTTPRoute objects for path-based routing

```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: my-gateway
spec:
  gatewayClassName: cilium
  listeners:
  - protocol: HTTP
    port: 80
    name: web-gw
    allowedRoutes:
      namespaces:
        from: Same
```

```yaml
apiVersion: gateway.networking.k8s.io/v1alpha2
kind: HTTPRoute
metadata:
  name: http-app-1
spec:
  parentRefs:
  - name: my-gateway
    namespace: default
  rules:
  - matches:
    - path:
        type: PathPrefix
        value: /details
    backendRefs:
    - name: details
      port: 9080
```

Gateway API

Use of Gateway and HTTPRoute for TLS Termination

```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: Gateway
metadata:
  name: tls-gateway
spec:
  gatewayClassName: cilium
  listeners:
  - name: https
    protocol: HTTPS
    port: 443
    hostname: "bookinfo.cilium.rocks"
    tls:
      certificateRefs:
      - kind: Secret
        name: demo-cert
```

```yaml
apiVersion: gateway.networking.k8s.io/v1beta1
kind: HTTPRoute
metadata:
  name: https-app-route
spec:
  parentRefs:
  - name: tls-gateway
  hostnames:
  - "bookinfo.cilium.rocks"
  rules:
  - matches:
    - path:
        type: PathPrefix
        value: /details
    backendRefs:
    - name: details
      port: 9080
```

Gateway API

Traffic Splitting with Weighted Routes

```yaml
apiVersion: gateway.networking.k8s.io/v1alpha2
kind: HTTPRoute
metadata:
  name: example-weighted-route
spec:
  parentRefs:
  - name: my-gateway
  rules:
  - matches:
    - path:
        type: PathPrefix
        value: /echo
    backendRefs:
    - kind: Service
      name: echo-1
      port: 8080
      weight: 75
    - kind: Service
      name: echo-2
      port: 8090
      weight: 25
```

Service + Annotations

Simple way to enable gRPC weighted-least-request load balancing

```yaml
apiVersion: v1
kind: Service
metadata:
  name: backend
  annotations:
    io.cilium/lb-protocol: "grpc"
    io.cilium/lb-mode: "weighted-least-request"
spec:
  type: ClusterIP
  ports:
  - port: 80
  selector:
    name: backend
```

Service + Annotations + Multi-Cluster

Compatible with multi-cluster load balancing

```yaml
apiVersion: v1
kind: Service
metadata:
  name: backend
  annotations:
    io.cilium/global-service: "true"
    io.cilium/lb-protocol: "grpc"
    io.cilium/lb-mode: "weighted-least-request"
spec:
  type: ClusterIP
  ports:
  - port: 80
  selector:
    name: backend
```

Learn more!

ISOVALENT

For the Enterprise

Hardened, enterprise-grade eBPF-powered networking, observability, and security.

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OSS Community

eBPF-based Networking, Observability, Security

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Regular news

eBPF

Base technology

The revolution in the Linux kernel, safely and efficiently extending the capabilities of the kernel.

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What is eBPF? - ebook

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Thank you!