white duck

Next-level Kubernetes networking with Cilium

Continuous Lifecycle / Container Conf 2023

Microsoft
Solutions Partner
Digital & App Innovation
Data & AI
Azure

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Migrate Enterprise Applications to Microsoft Azure

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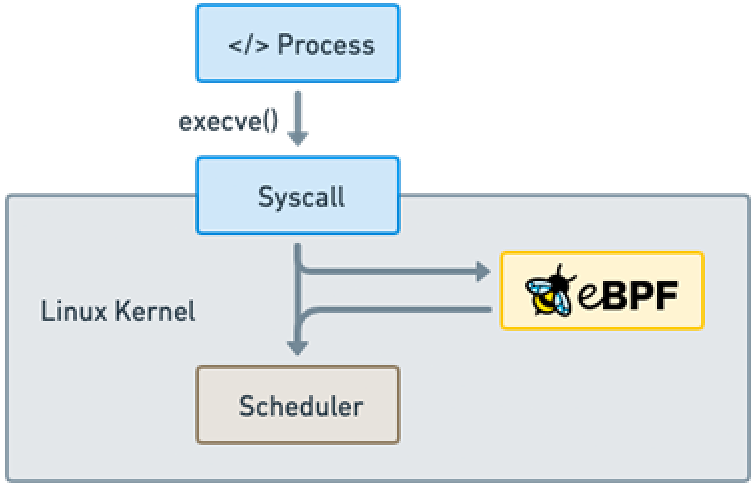
Agenda

- Cilium & eBPF introduction
- Zero trust networking and observability with Cilium CNI & Hubble
- Seamless multi-cluster connectivity with Cilium Cluster Mesh
- Application-centric networking with Cilium Service Mesh
- Cilium Mesh – one mesh to connect them all

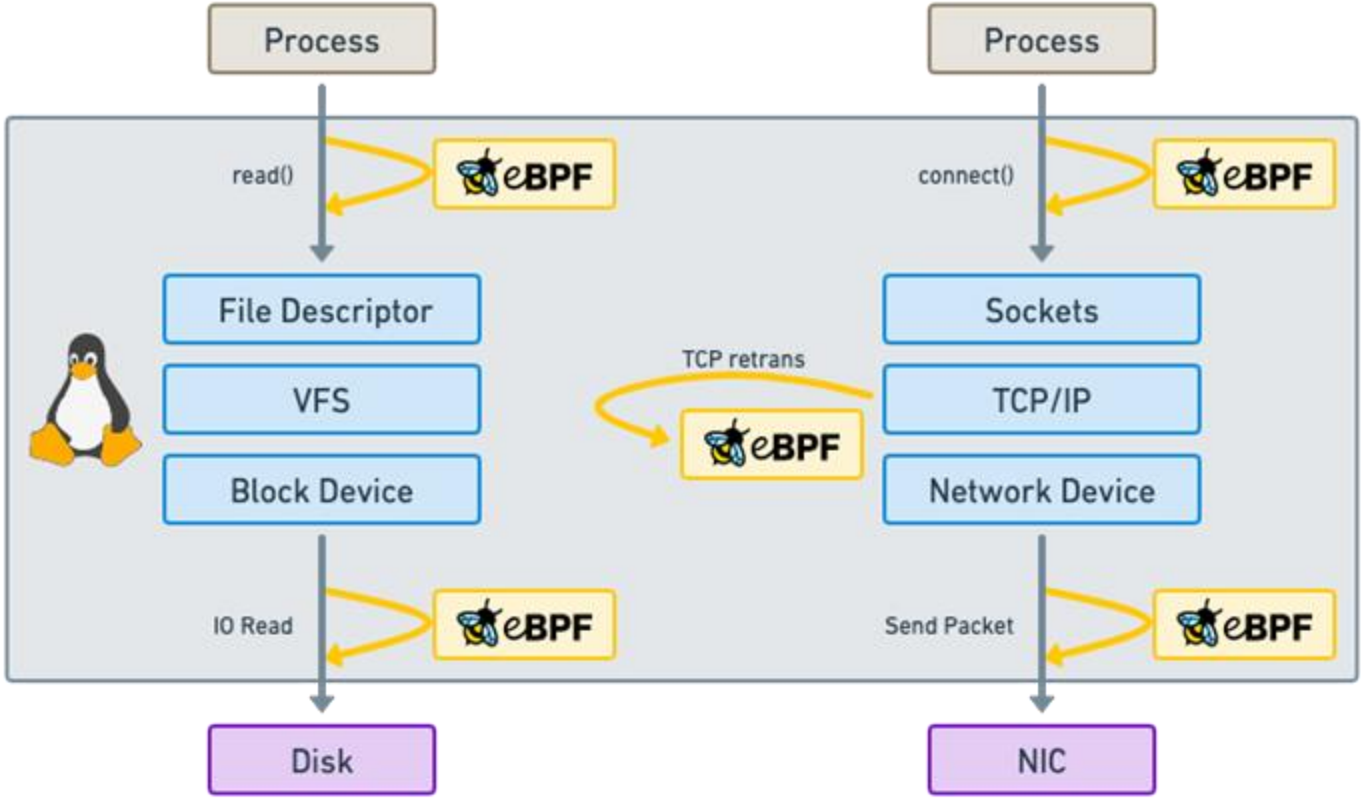
Cilium & eBPF introduction

What is eBPF?

- “What JavaScript is to the browser, eBPF is to the Linux Kernel”
- Makes the Linux kernel programmable in a secure and efficient way



eBPF programs act on events

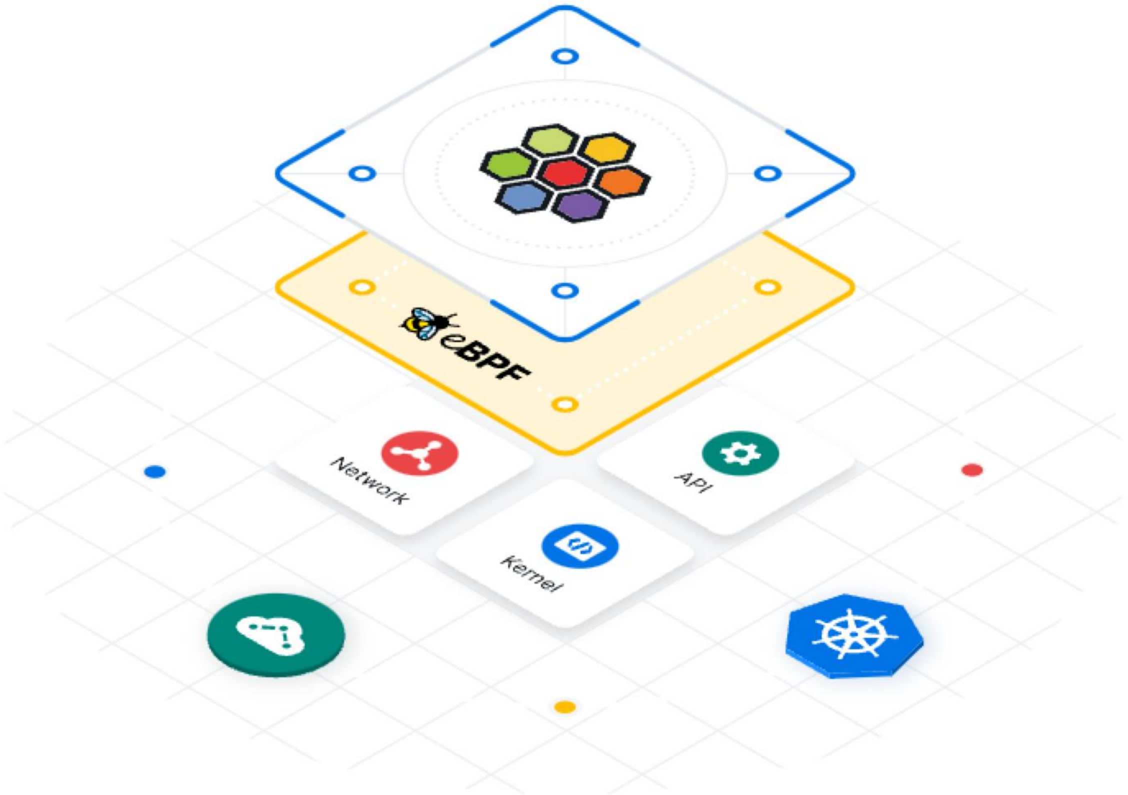


Attachment points:

- Kernel functions (kprobes)
- Userspace functions (uprobe)
- System calls
- Tracepoints
- Sockets
- Network devices
- …

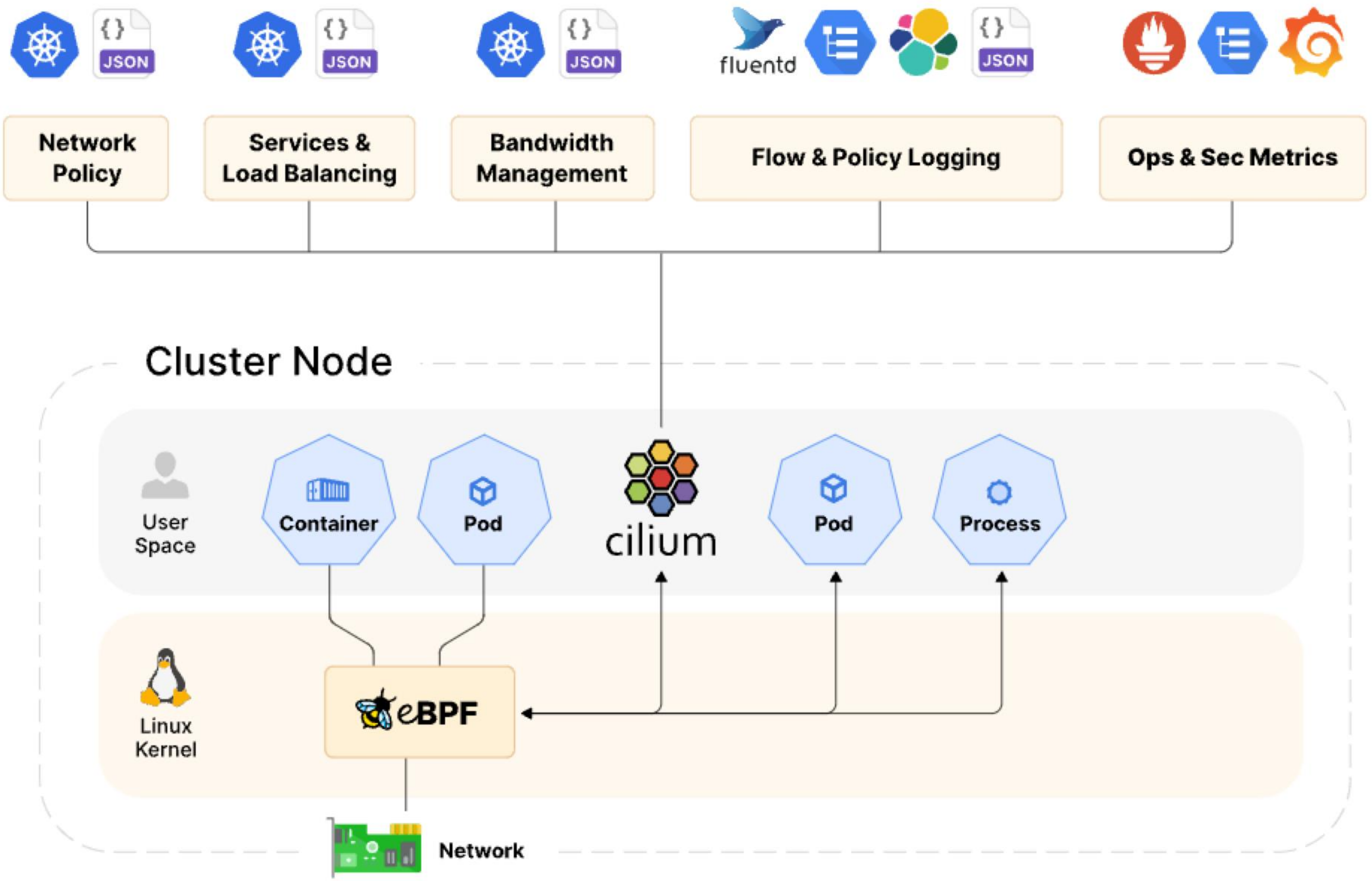
What is Cilium?

- „eBPF-based Networking, Observability, Security“
- A suite containing of
  - Cilium CNI
  - Hubble
  - Cilium Mesh
  - Cluster Mesh
  - Service Mesh
  - Tetragon (not covered today)
  - Isovalent Cilium Enterprise (not covered today)



Zero trust networking and Observability with Cilium CNI & Hubble

Cilium CNI (Container Network Interface)



Helps with:

- Enhanced networking speed
  - Abstracts kube-proxy
- Advanced Network Policies
- Traffic encryption
- Load-Balancing

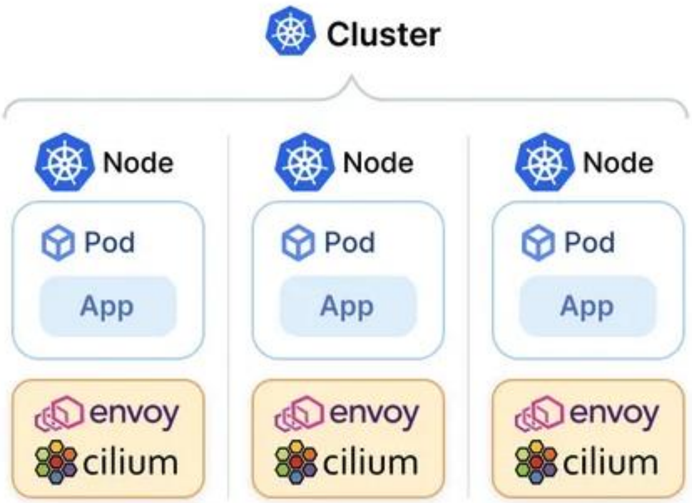
Cilium agent & Envoy proxy

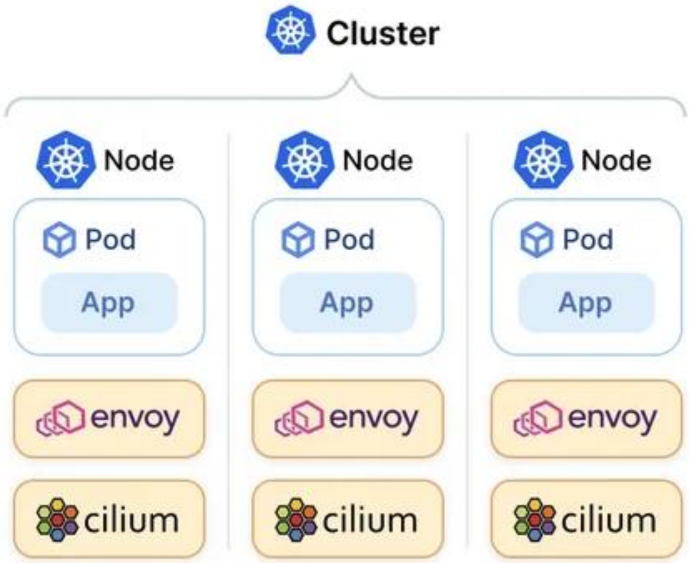
Cilium agent:

- Deployed on every node
- Injects eBPF program to the node
- Load-Balancing
- Identity

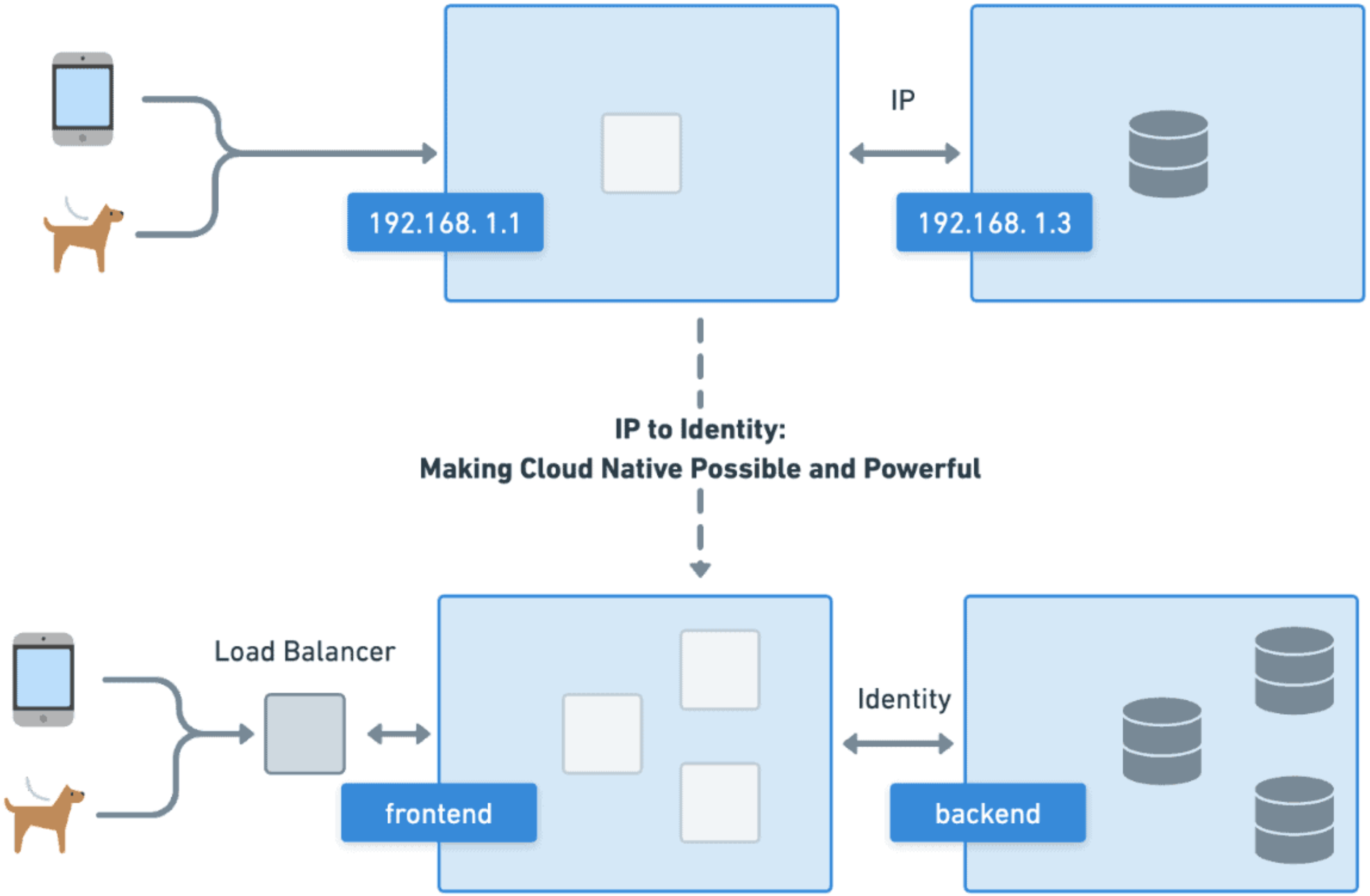
Envoy Proxy:

- Seperate process within the Cilium agent pod
- Layer 7
- Ingress / Gateway API
- Expected default mode soon

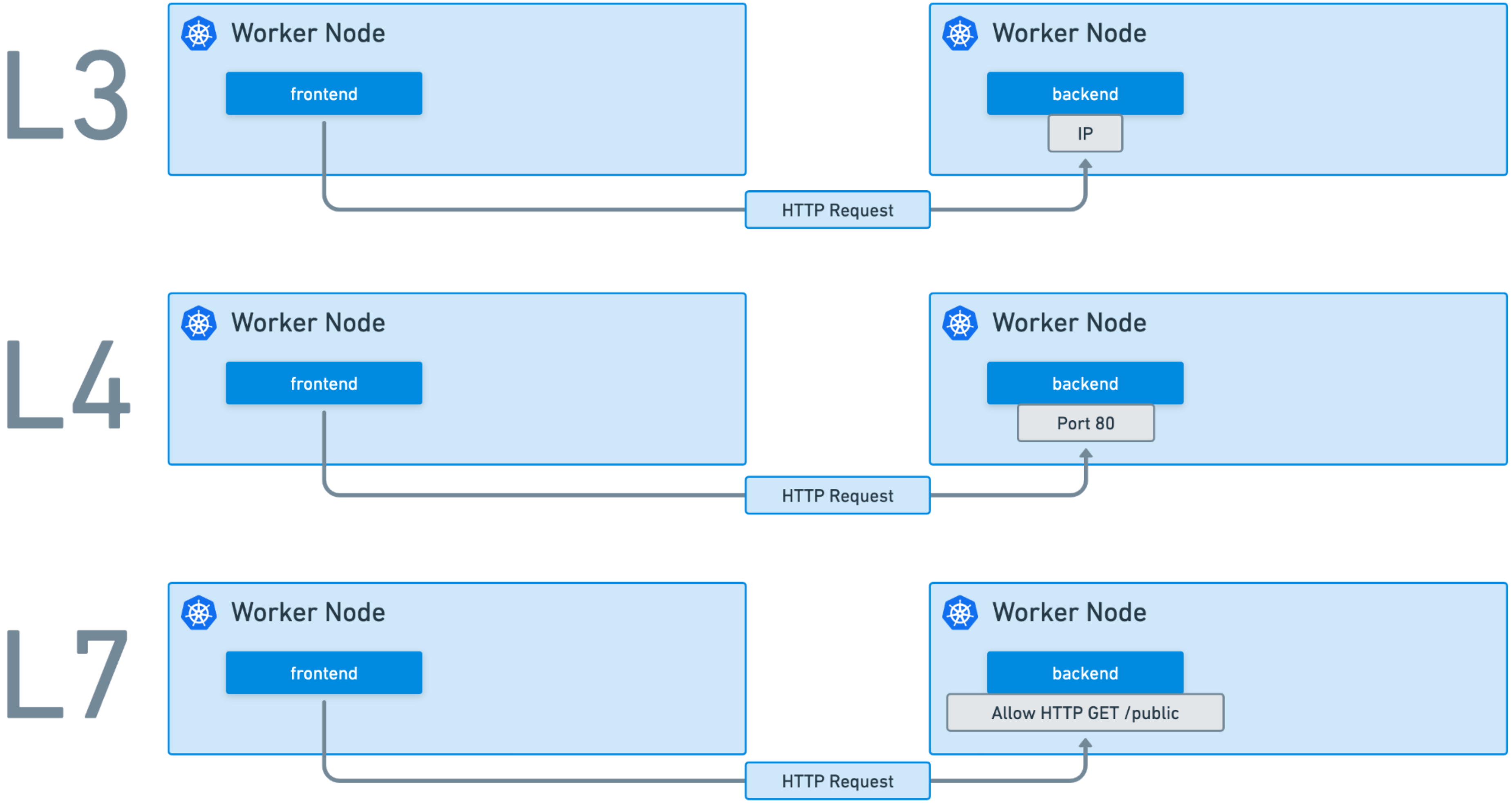




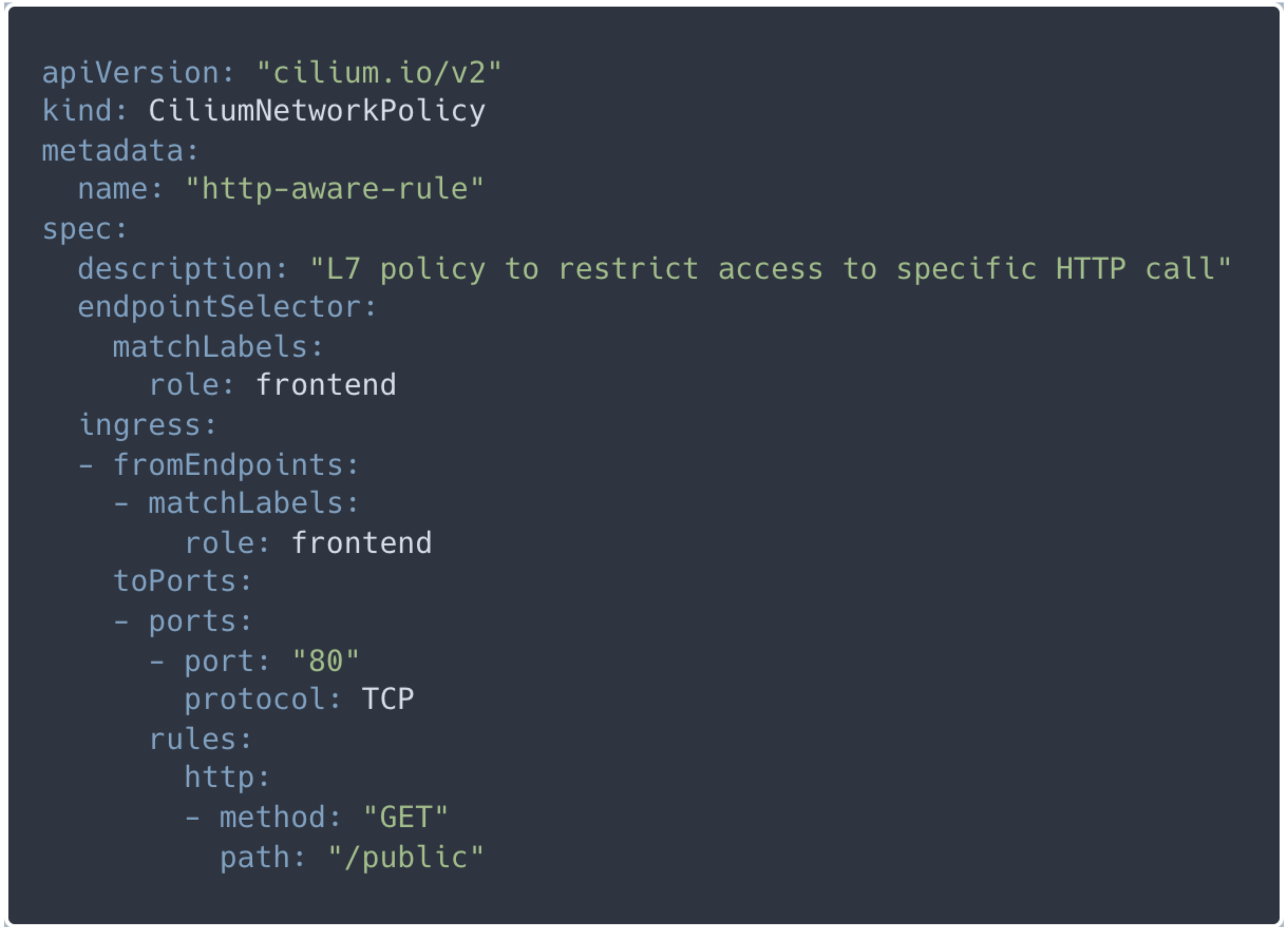
Identity-based Network Security



API-aware Authorization

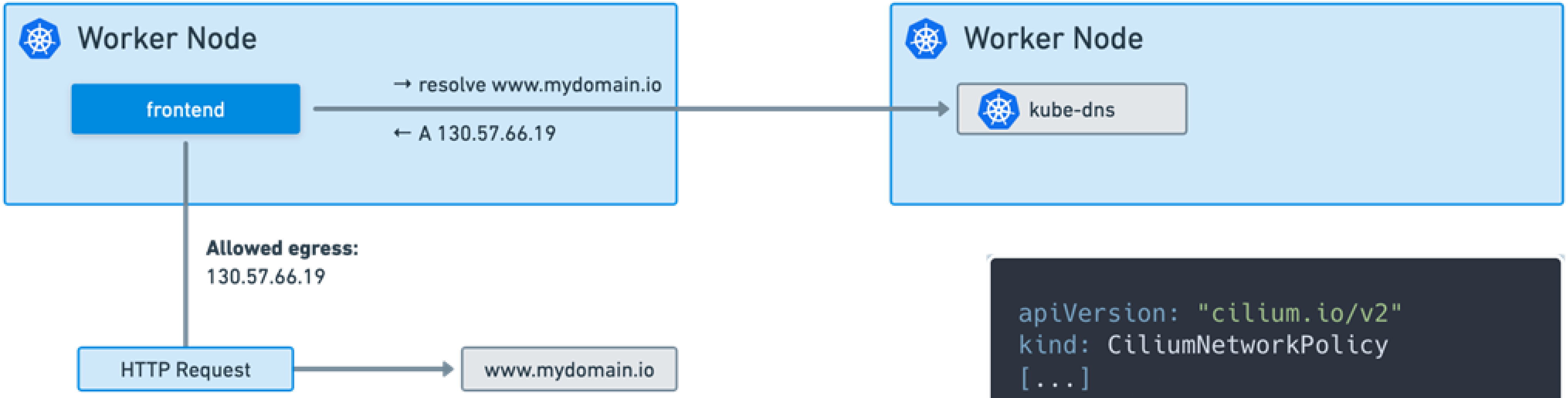


HTTP-Aware Cilium Network Policy



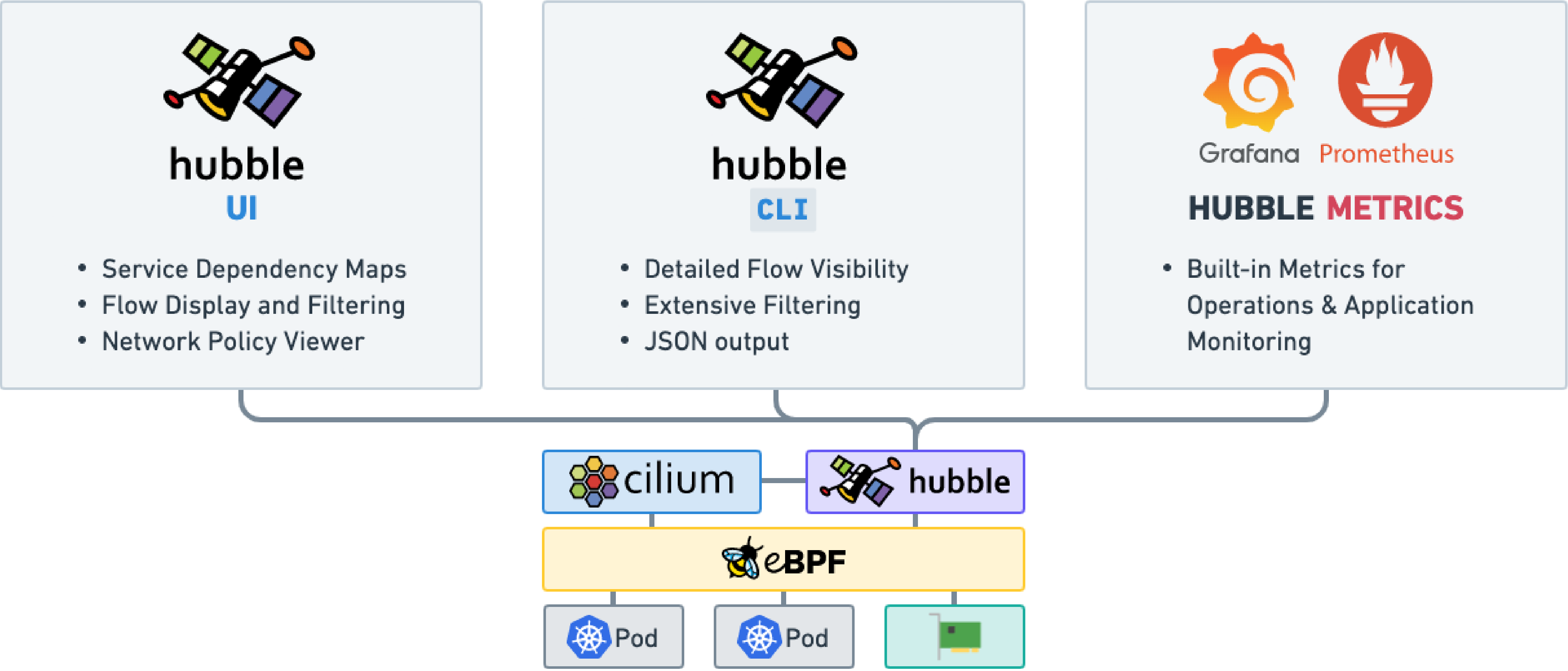
```yaml
apiVersion: "cilium.io/v2"
kind: CiliumNetworkPolicy
metadata:
  name: "http-aware-rule"
spec:
  description: "L7 policy to restrict access to specific HTTP call"
  endpointSelector:
    matchLabels:
      role: frontend
  ingress:
  - fromEndpoints:
    - matchLabels:
        role: frontend
    toPorts:
    - ports:
      - port: "80"
        protocol: TCP
      rules:
        http:
        - method: "GET"
          path: "/public"
```

DNS-aware Cilium Network Policy



```
apiVersion: "cilium.io/v2"
kind: CiliumNetworkPolicy
[...]
specs:
- endpointSelector:
  matchLabels:
    app: frontend
  egress:
  - toFQDNs:
    - matchName: "*.mydomain.io"
    toPorts:
    - ports:
      - port: "443"
        protocol: TCP
```

Network Observability with Hubble



hubble UI

- Service Dependency Maps
- Flow Display and Filtering
- Network Policy Viewer

hubble CLI

- Detailed Flow Visibility
- Extensive Filtering
- JSON output

Grafana Prometheus

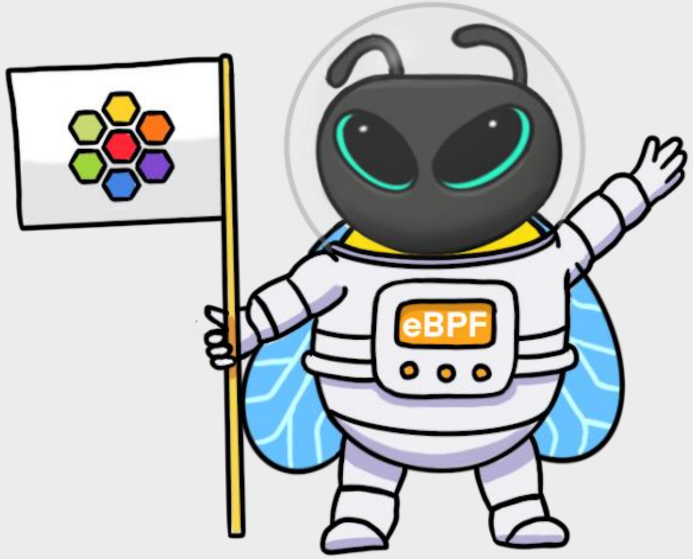
HUBBLE METRICS

- Built-in Metrics for Operations & Application Monitoring

Demo: Cilium Identity & Hubble

- Observe network traffic with Hubble CLI & UI
- Inspect Cilium Identities
- Create L3-L4 Cilium network policy
- Make L7 traffic visible and add L7 Cilium network policy

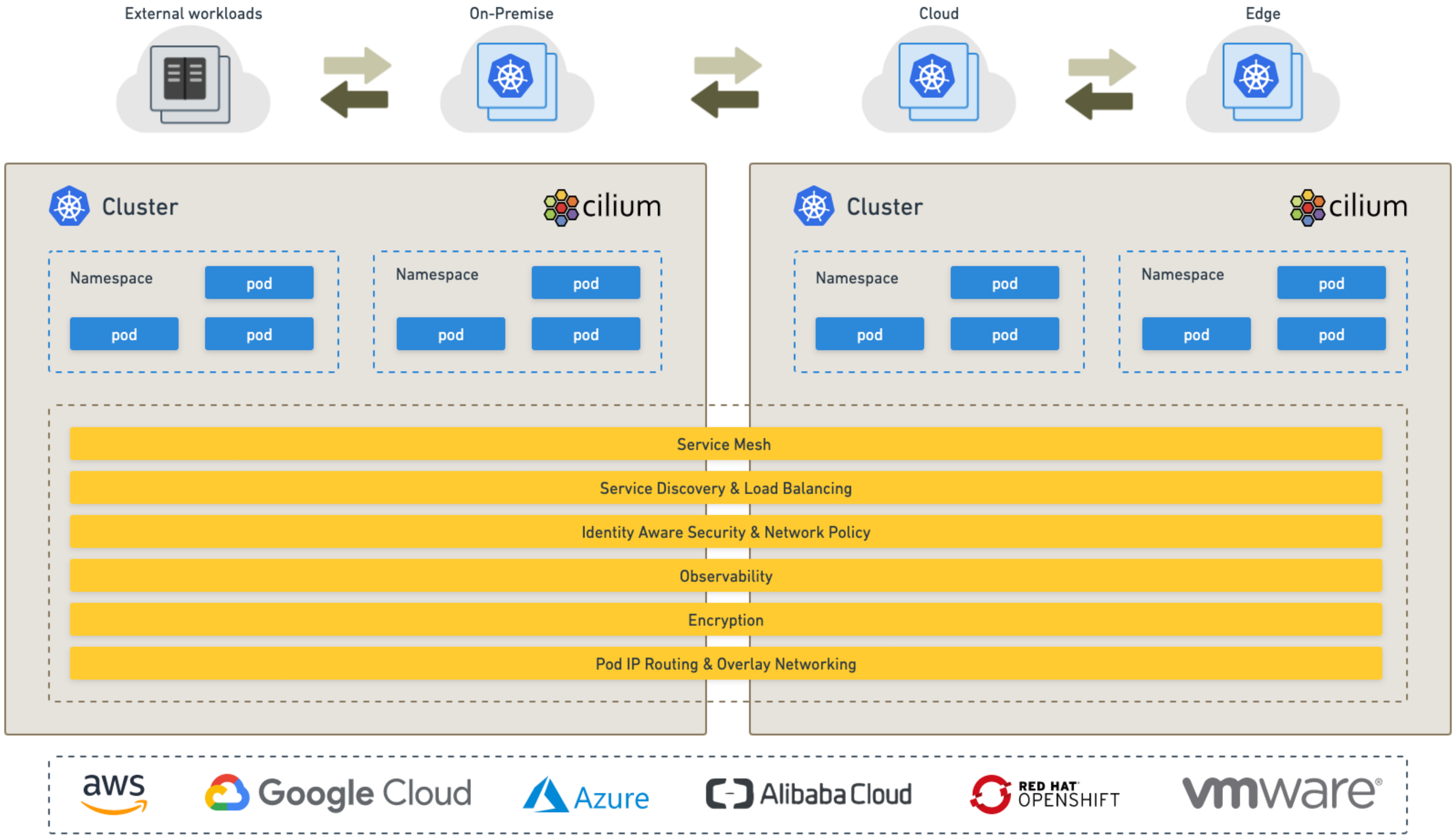
Seamless multi-cluster connectivity with Cluster Mesh



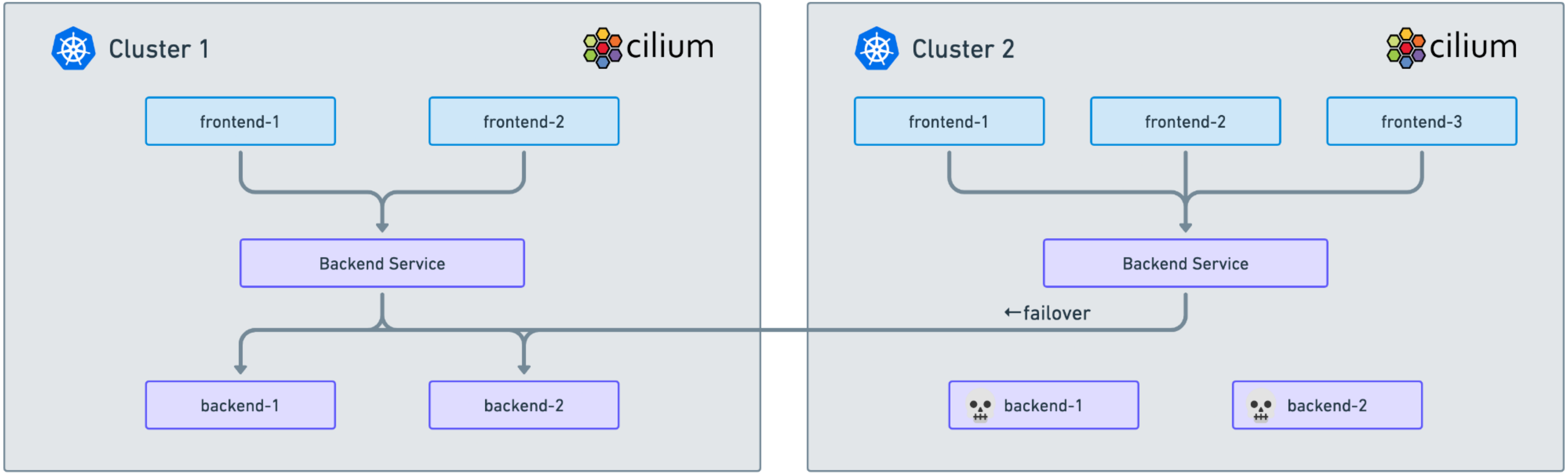
Cluster Mesh

- „Seamless Connectivity For Multiple Kubernetes Clusters“
- Helps with multi-cluster
  - High availability and fault tolerance
  - Transparent service discovery
  - Shared services across clusters
  - Effortless Pod IP routing (via direct-routing or tunneling)

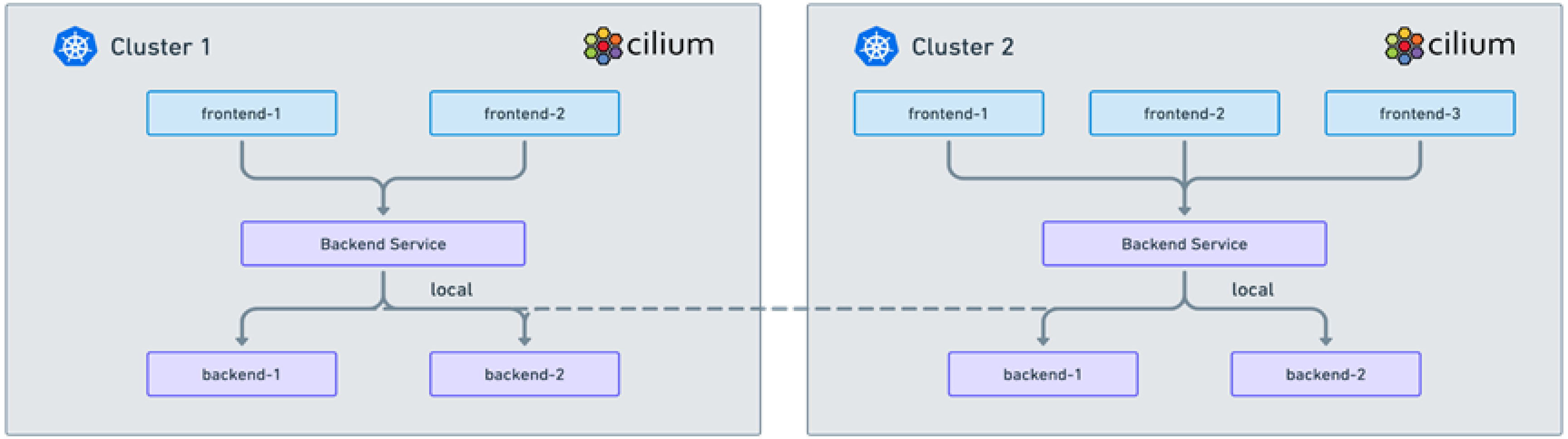
Big Picture

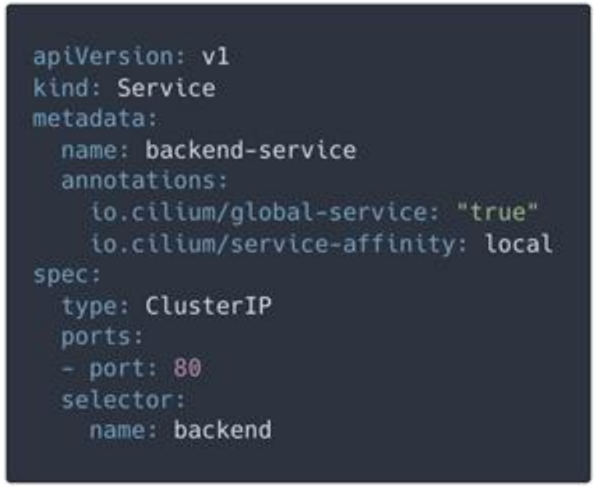

External workloads
On-Premise
Cloud
Edge
Cluster
cilium
Namespace
pod
pod
pod
Namespace
pod
pod
pod
Cluster
cilium
Namespace
pod
pod
pod
Namespace
pod
pod
pod
Service Mesh
Service Discovery & Load Balancing
Identity Aware Security & Network Policy
Observability
Encryption
Pod IP Routing & Overlay Networking
aws
Google Cloud
Azure
Alibaba Cloud
RED HAT OPENSHIFT
vmware

High Availability

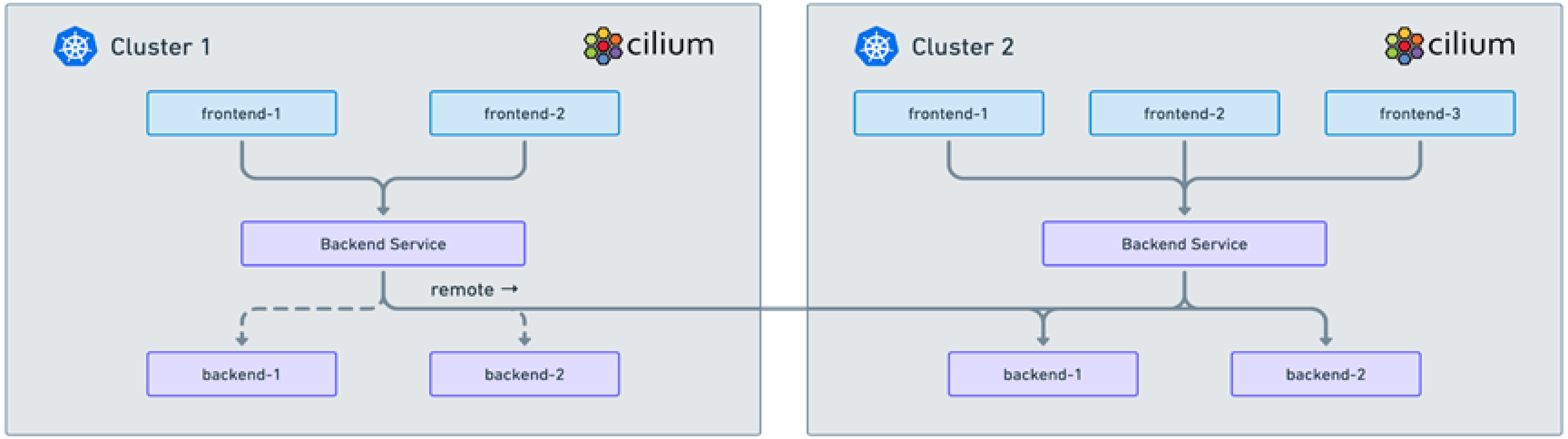


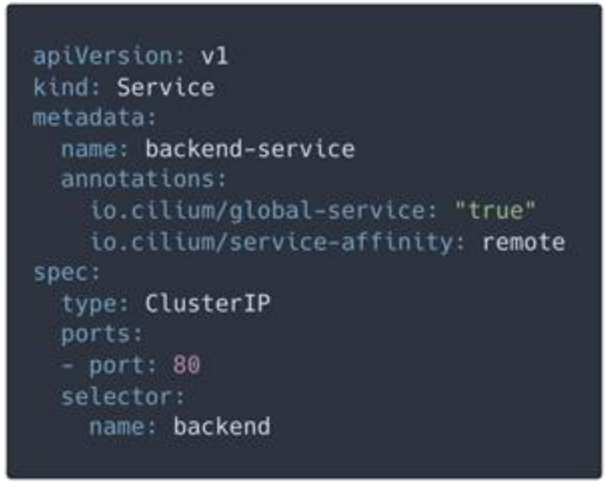
Cluster Network Affinity





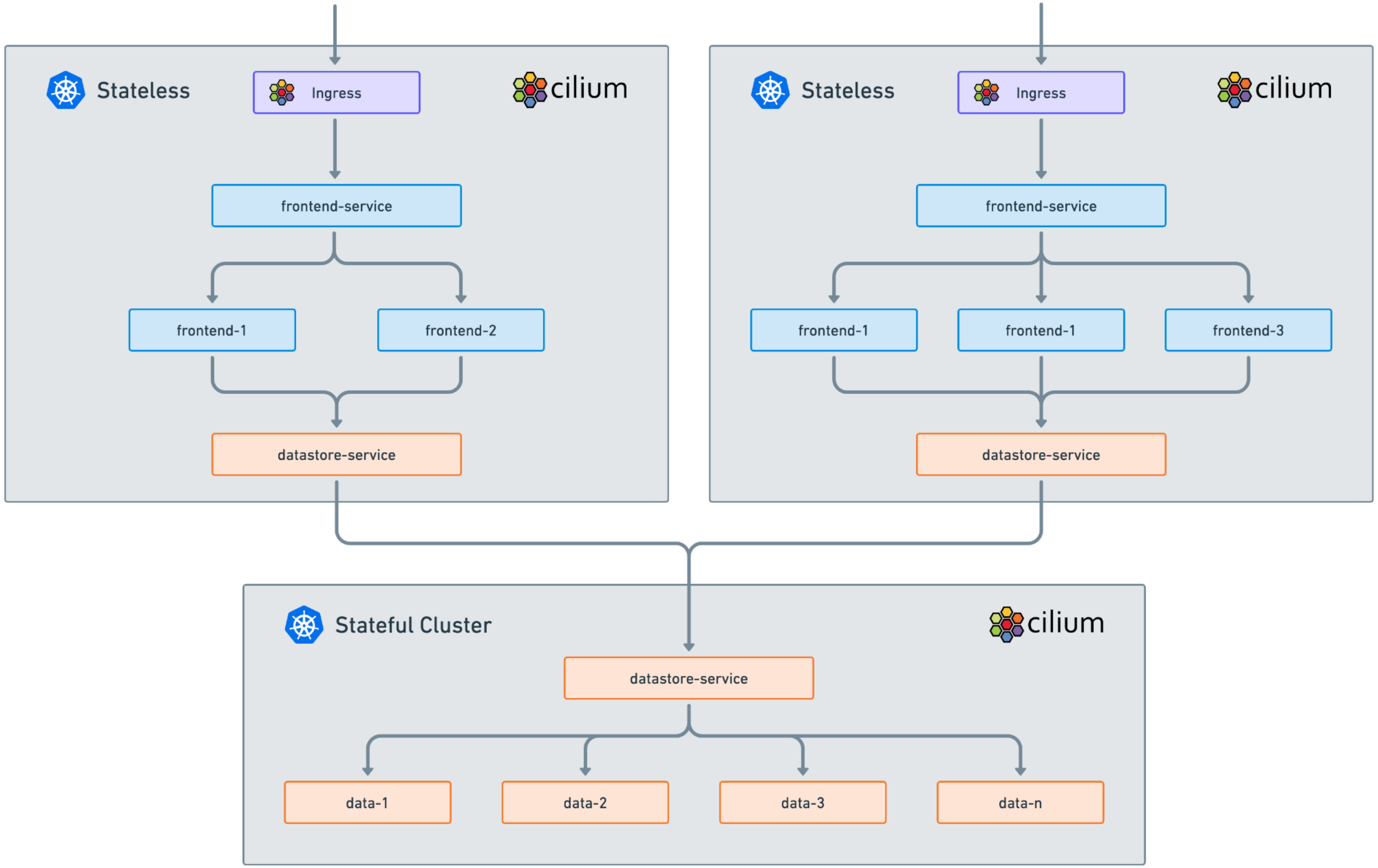
```yaml
apiVersion: v1
kind: Service
metadata:
  name: backend-service
  annotations:
    io.cilium/global-service: "true"
    io.cilium/service-affinity: local
spec:
  type: ClusterIP
  ports:
  - port: 80
  selector:
    name: backend
```



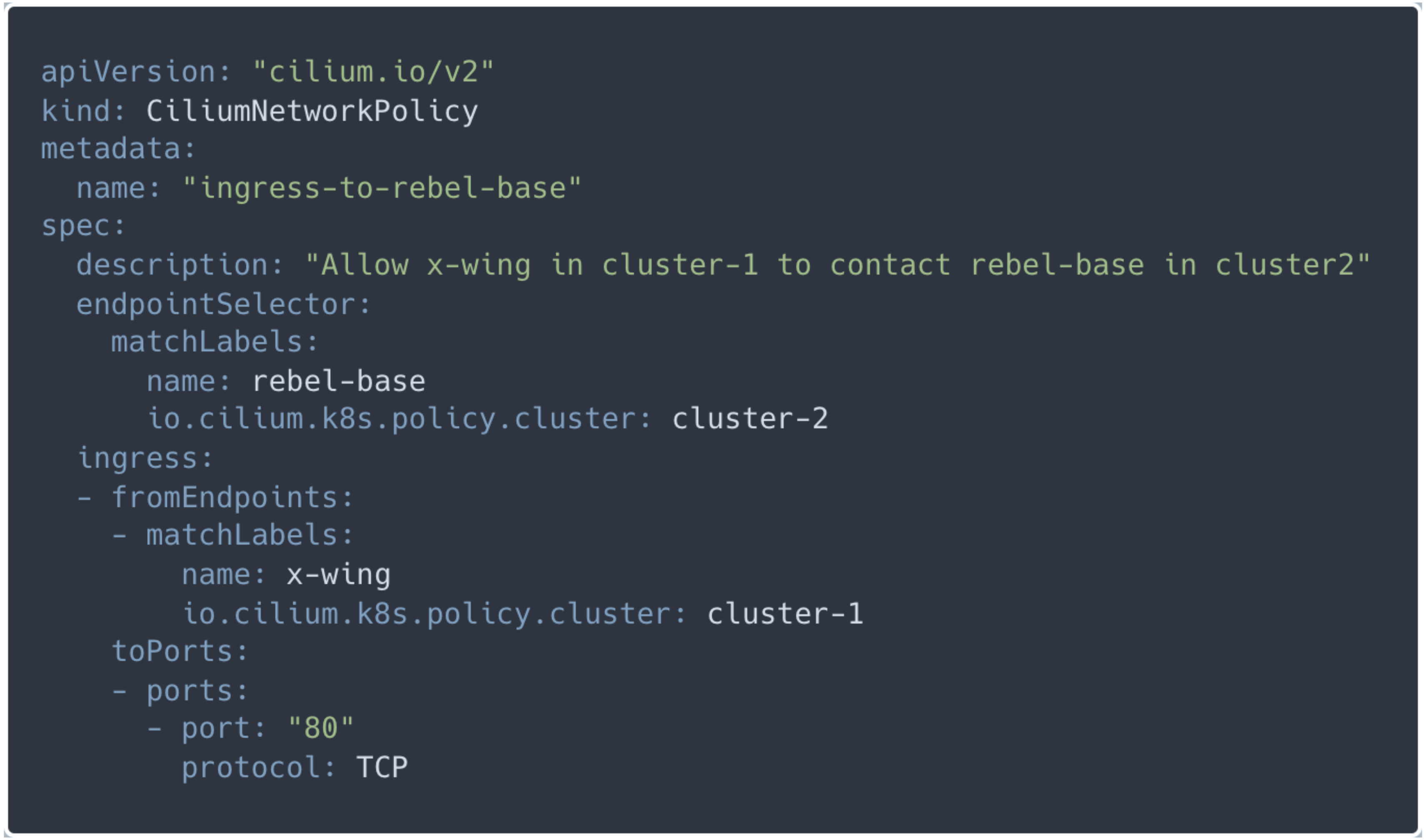


```yaml
apiVersion: v1
kind: Service
metadata:
  name: backend-service
  annotations:
    io.cilium/global-service: "true"
    io.cilium/service-affinity: remote
spec:
  type: ClusterIP
  ports:
  - port: 80
  selector:
    name: backend
```

Splitting Services across Clusters



Cilium Network Policies across Clusters

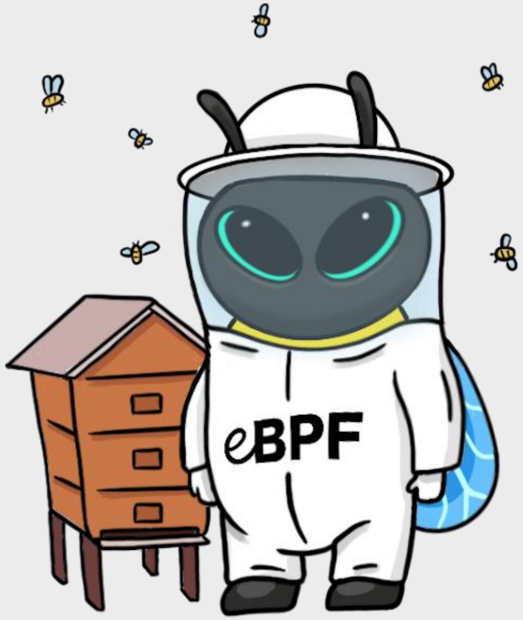


```yaml
apiVersion: "cilium.io/v2"
kind: CiliumNetworkPolicy
metadata:
  name: "ingress-to-rebel-base"
spec:
  description: "Allow x-wing in cluster-1 to contact rebel-base in cluster2"
  endpointSelector:
    matchLabels:
      name: rebel-base
      io.cilium.k8s.policy.cluster: cluster-2
  ingress:
  - fromEndpoints:
    - matchLabels:
        name: x-wing
        io.cilium.k8s.policy.cluster: cluster-1
    toPorts:
    - ports:
      - port: "80"
        protocol: TCP
```

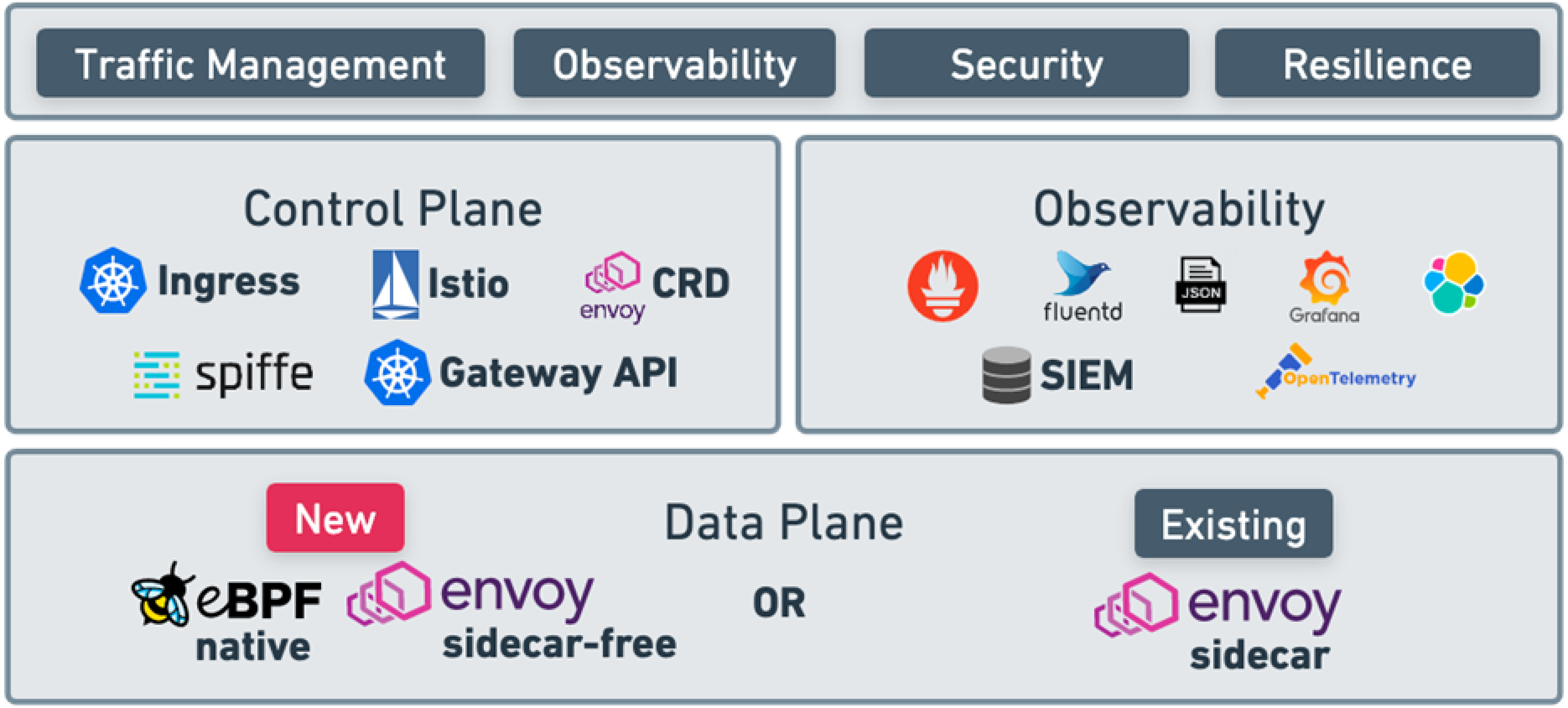
Demo: Global Service with Cluster Mesh

- Deploy application into two cluster
  - Service must exist on both Clusters with the same name and in the same namespace
- Verify high availability by scaling down the app to zero on cluster01
- Create cross cluster network policy

Application-centric networking with Cilium Service Mesh



Cilium Service Mesh



Traffic Management

Observability

Security

Resilience

Control Plane

Ingress

Istio

envoy CRD

spiffe

Gateway API

Observability

fluentd

JSON

Grafana

SIEM

OpenTelemetry

New

Data Plane

Existing

eBPF native

envoy sidecar-free

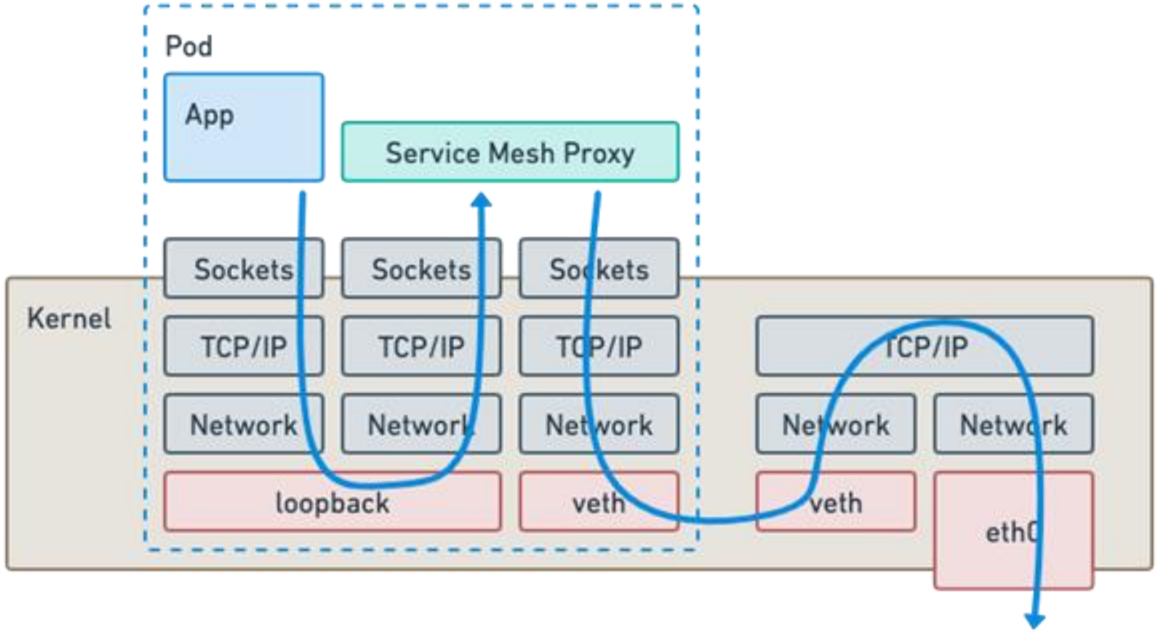
OR

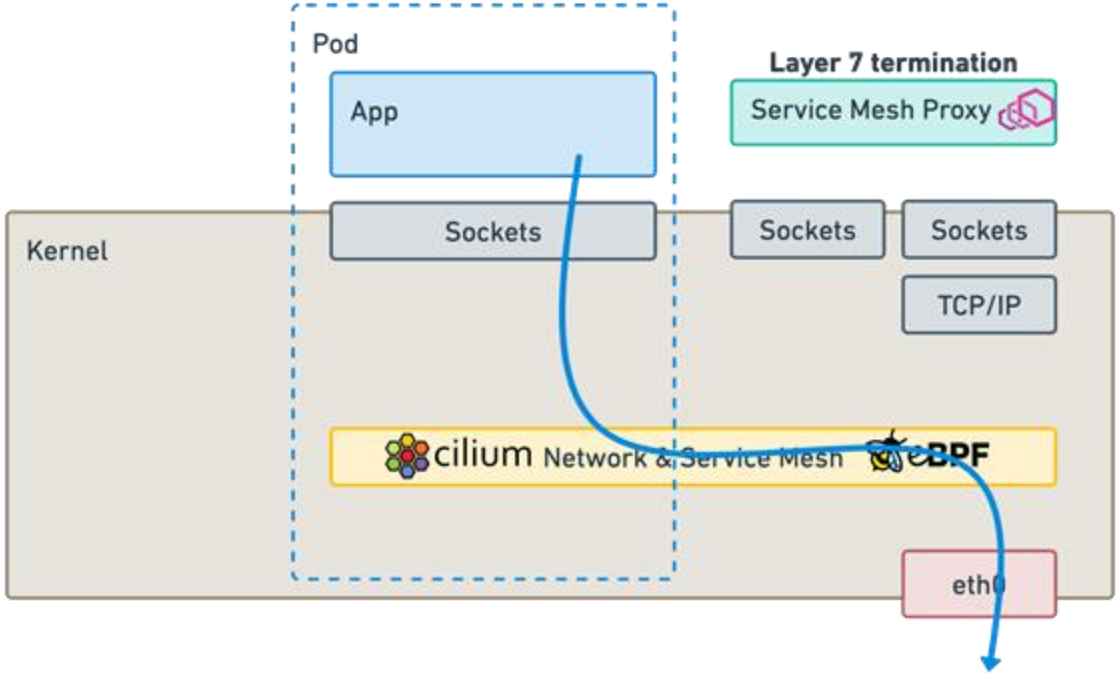
envoy sidecar

Service Mesh

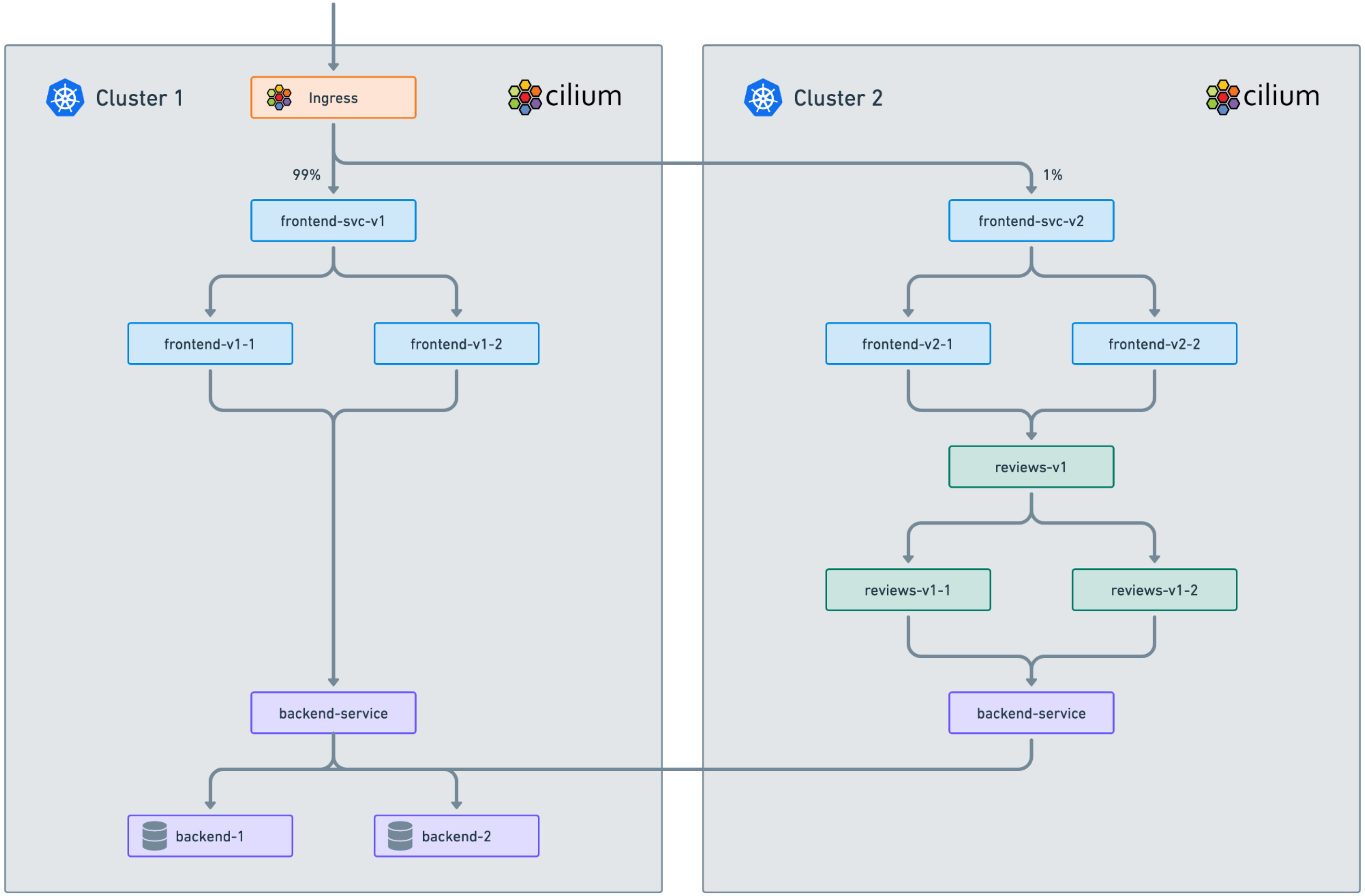
- Reduced operational complexity
- Reduced resource usage and better performance
  - sidecar-free routing (based on the Control plane)
- Flexible and supports everything you need
  - IP, TCP, UDP, HTTP, Kafka, gRPC and DNS
- Decide on your Control plane
  - Ingress, Gateway API, EnvoyConfig, Istio, Spiffe
- Identity-based Security

Cost of sidecar injection





Canary Rollout with Cluster & Service Mesh

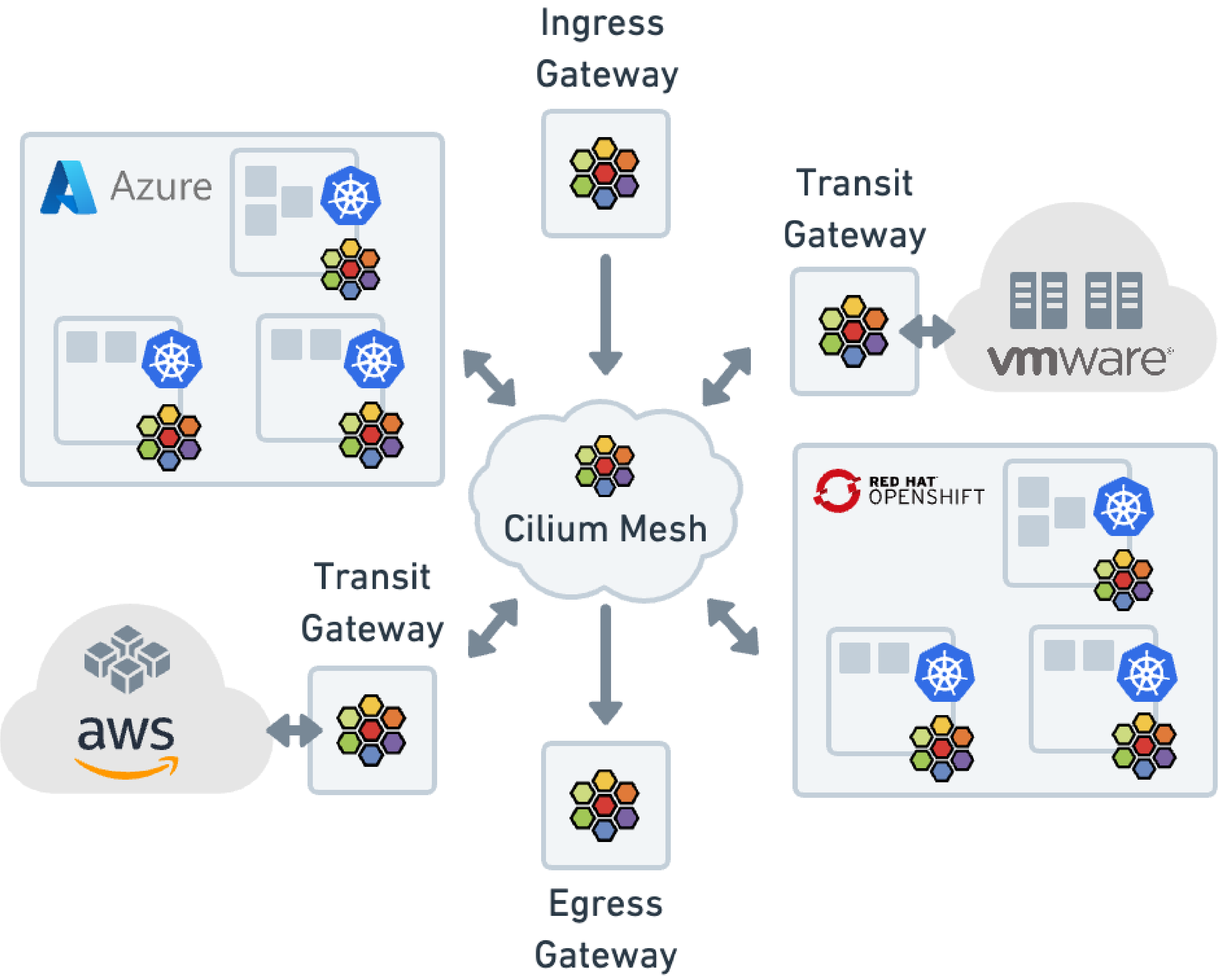


Demo: Canary Rollout with Cilium

- Application v1 running on Cluster 01
- Application v2 running on Cluster 02
  - Frontend and API
- Application “Ingress” via Cluster 01
  - GatewayAPI and Route
- Leverage Cilium Cluster Mesh and Cilium Service Mesh to control traffic distribution of the application

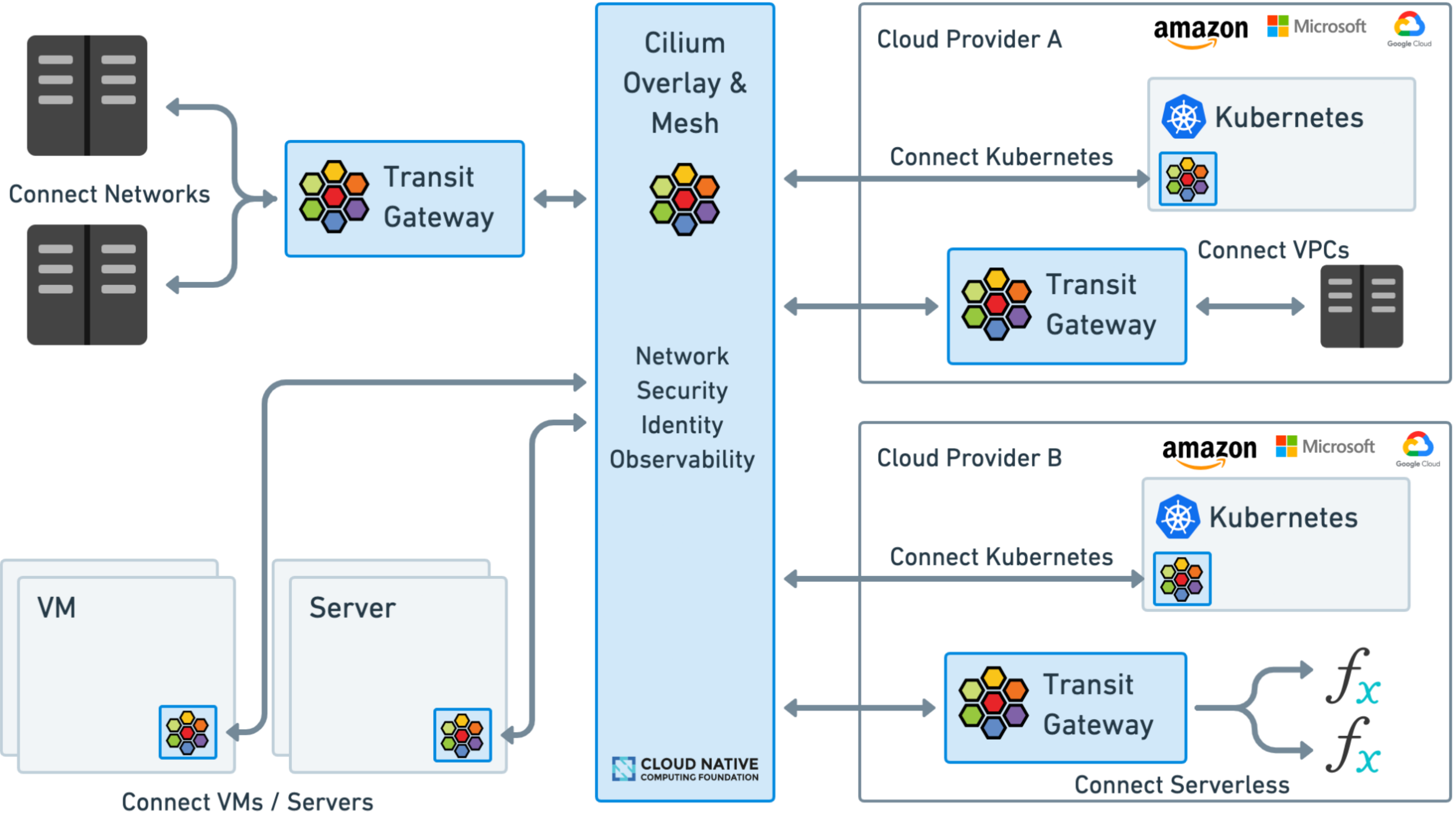
Cilium Mesh – one mesh to connect them all

Cilium Mesh – Big Picture



Transit Gateway requires Isovalent Cilium Enterprise

Connect them all



Links & Getting started

- https://github.com/whiteducksoftware/cilium-next-level-k8s-networking
- https://cilium.io
- https://docs.cilium.io
- https://networkpolicy.io
- https://github.com/cilium/cilium

Thanks to Isovalent for the graphics and bees!

Questions?

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Thank you!