innovestx
บริษัทหลักทรัพย์ในกลุ่ม SCBX

eBPF

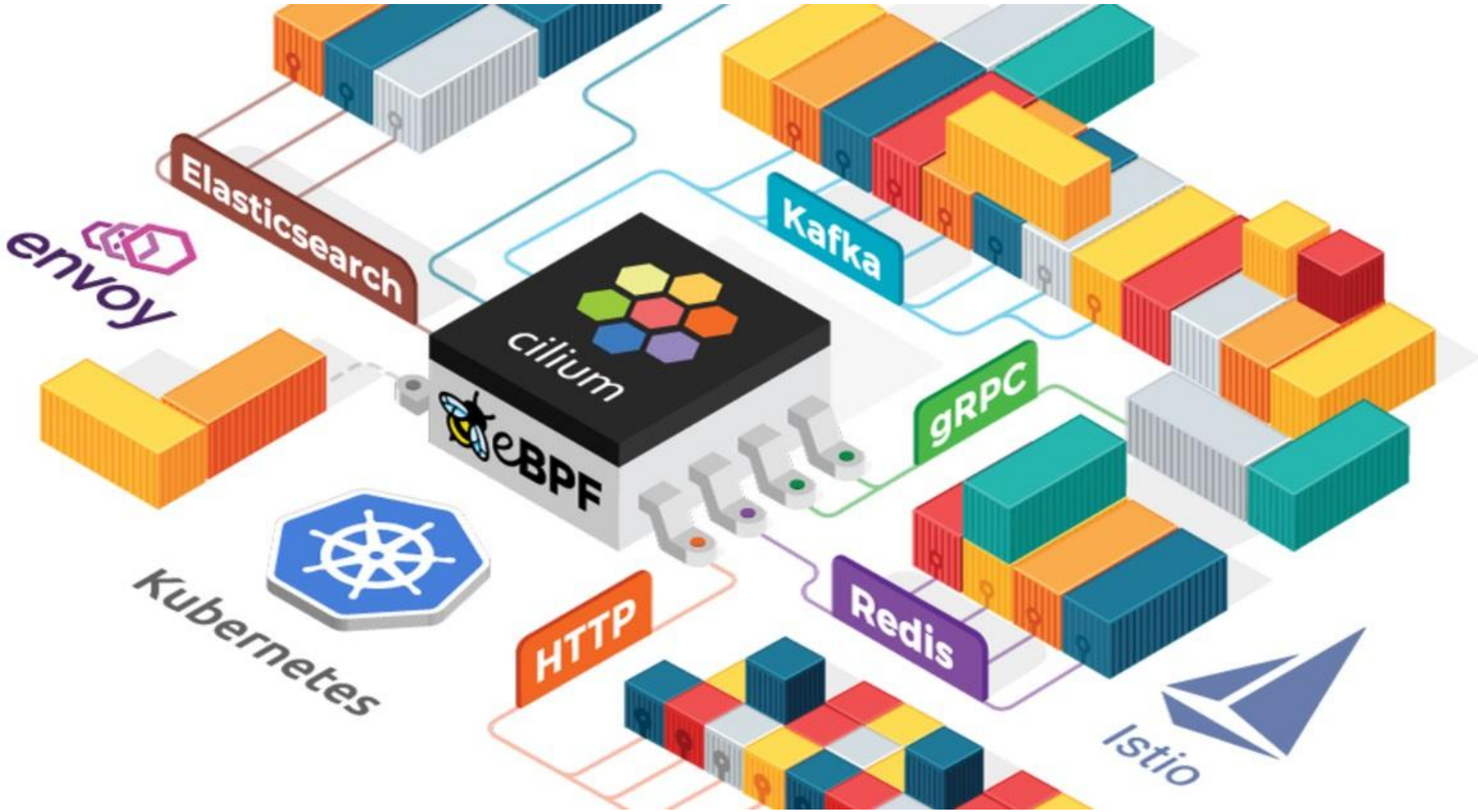
Introduction to Cilium Network with eBPF Technology

(Prparn Lueangpoonlap)

Agenda

- What is Cilium ?
- Why this matter ?
- Demo session
- What next ?

What is Cilium?



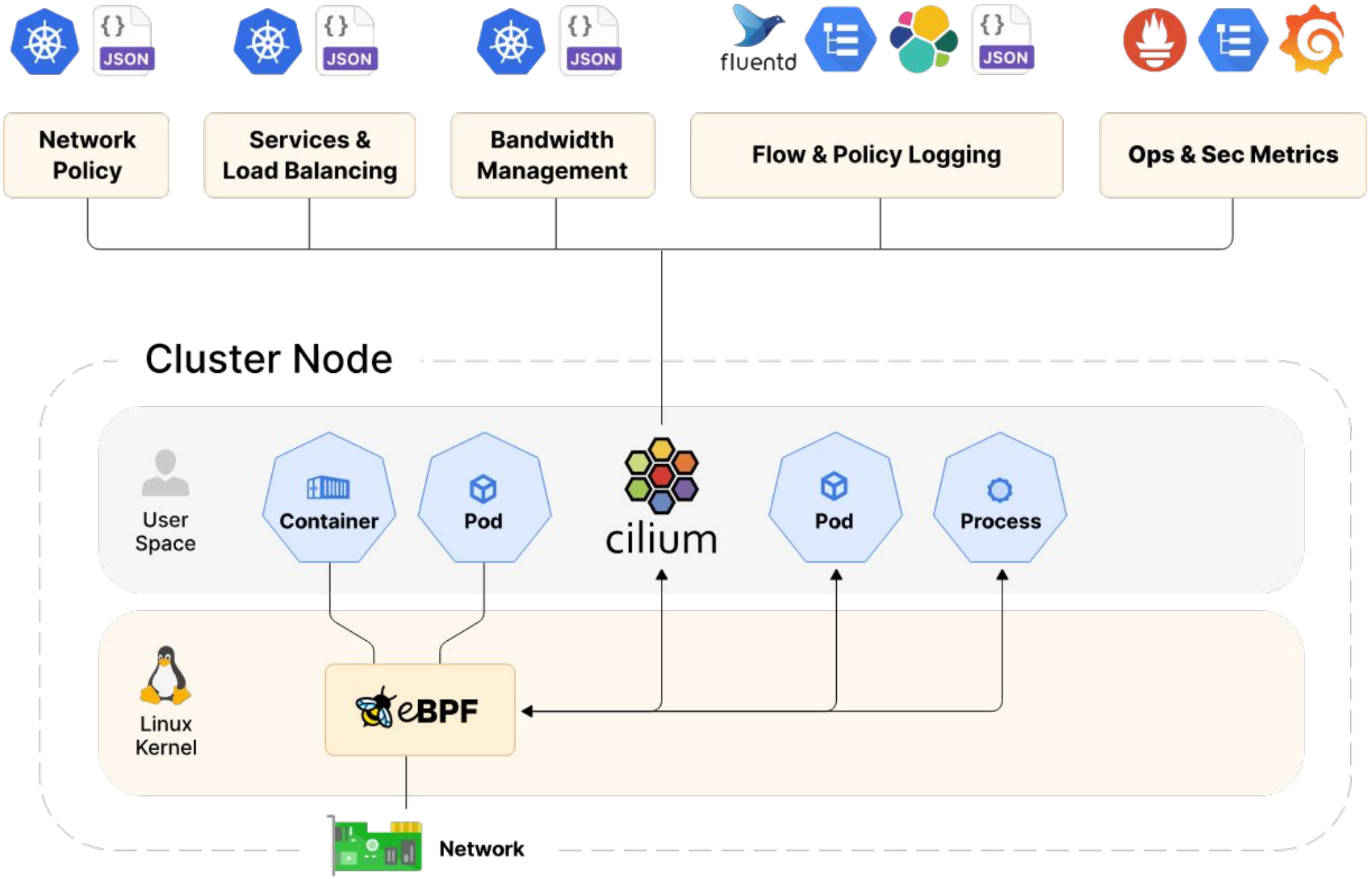
What is Cilium?

- **Cilium** is an open source, **cloud native solution** for providing, securing, and observing network connectivity between workloads, fueled by the revolutionary **Kernel technology eBPF.**

- As CNCF member (Graduation). Cilium is now open source project for provide **networking, security, observability** in cloud native environment **(Kubernetes as CNI standard)**

- With incredible **performance in Cilium**. Many cloud provider had been added cilium to their Kubernetes platform already since year 2021

What is Cilium?



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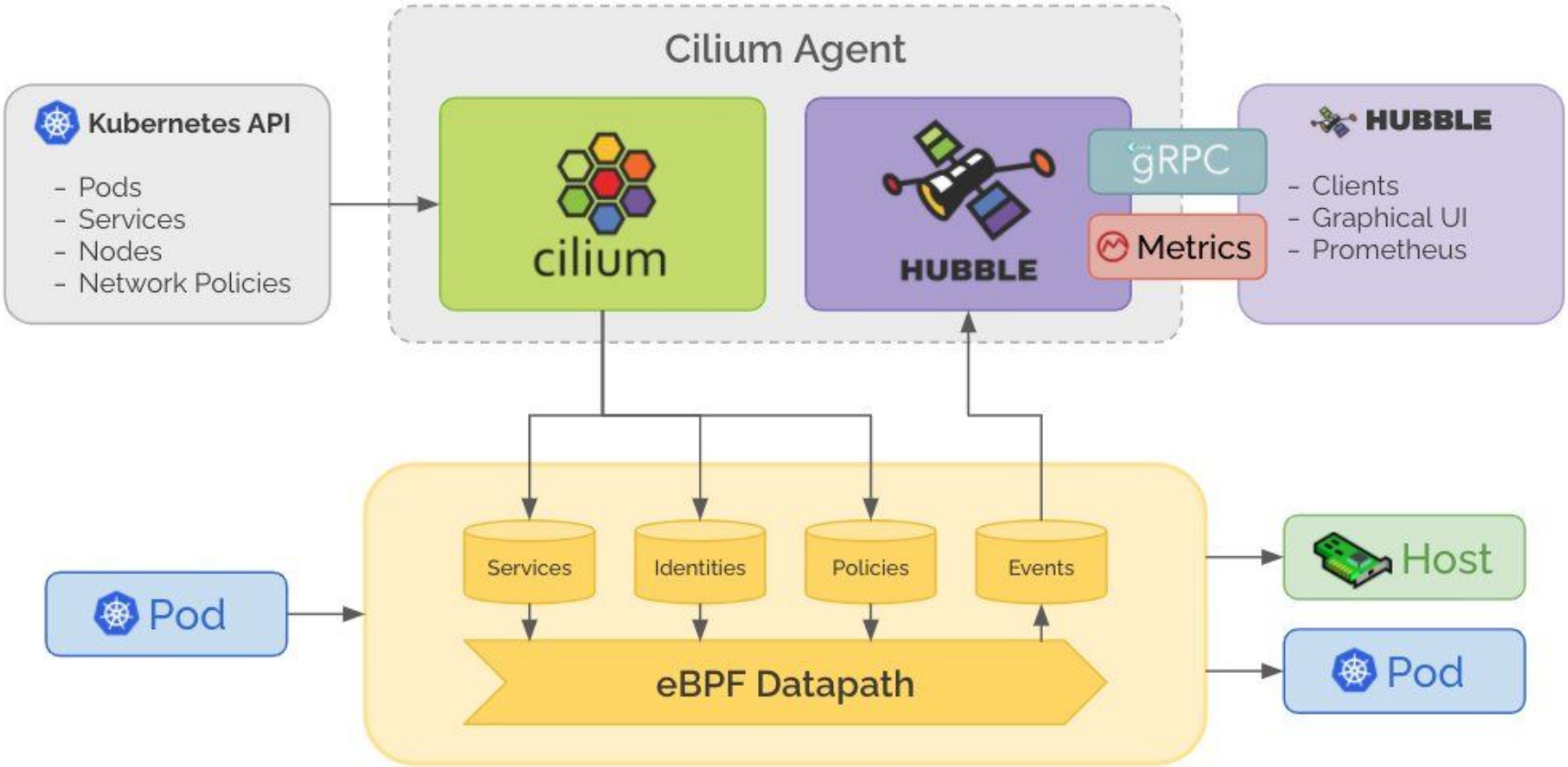

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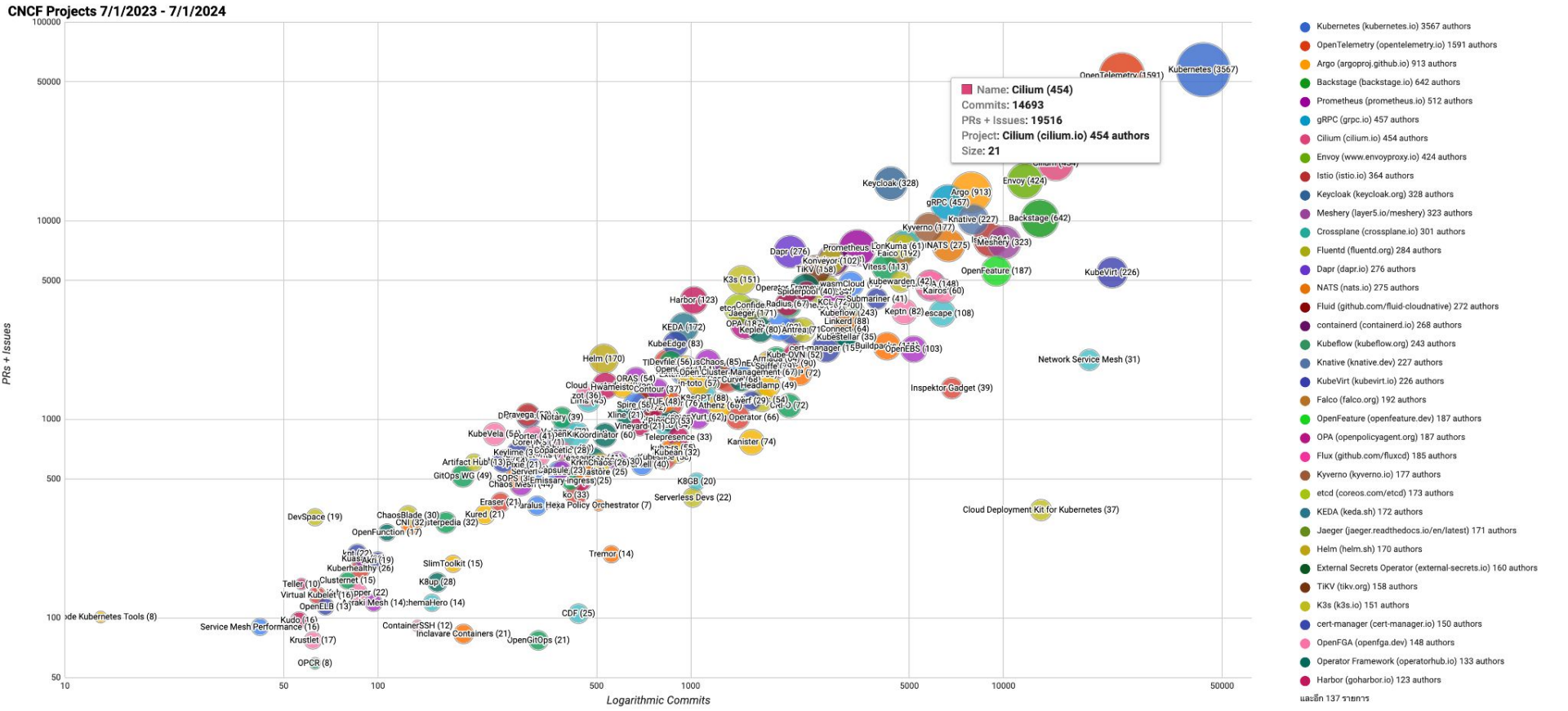


Ref: https://docs.google.com/spreadsheets/d/1FyVjdO9kMnz4hmEkyYLpl101cBDg_ZGHMkR5j_ce5JU/edit?gid=976519966#gid=976519966

Introduction to Cilium Network

What is Cilium?

- Networking


High Performance Networking (CNI) →


Layer 4 Load Balancer →


Cluster Mesh →


Bandwidth and Latency Optimization →


Kube-proxy Replacement →


BGP →

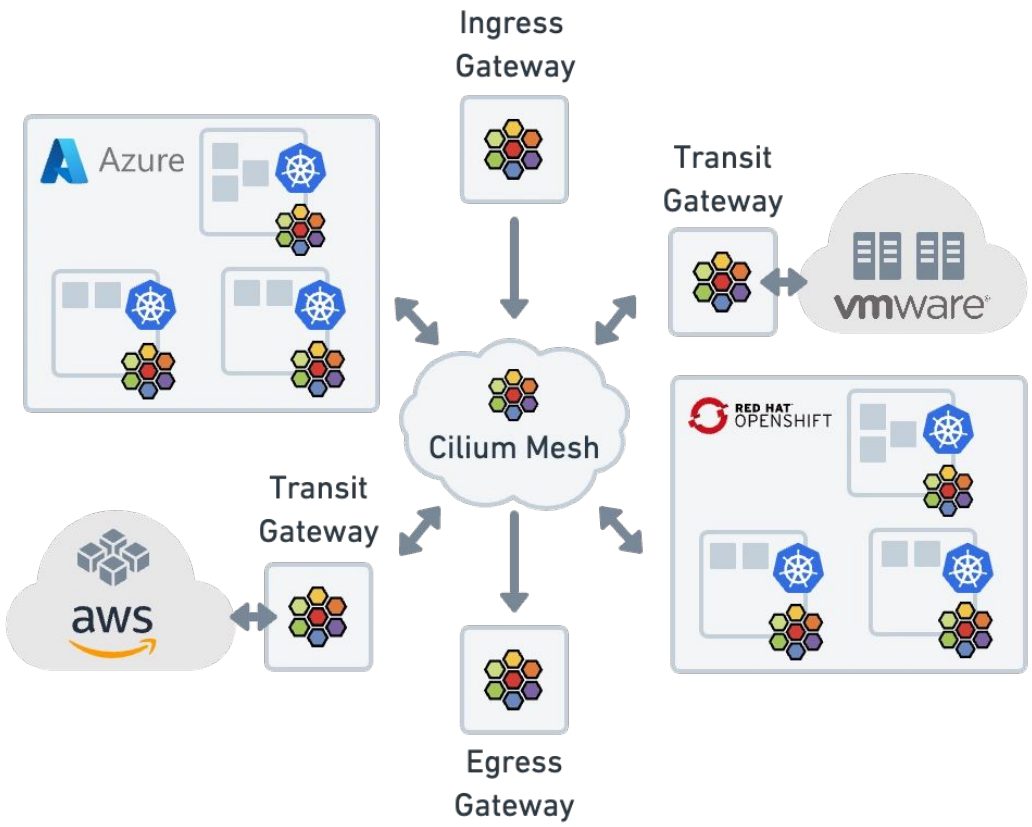

Egress Gateway →


Service Mesh →


Gateway API →


Multicast →

What is Cilium ?



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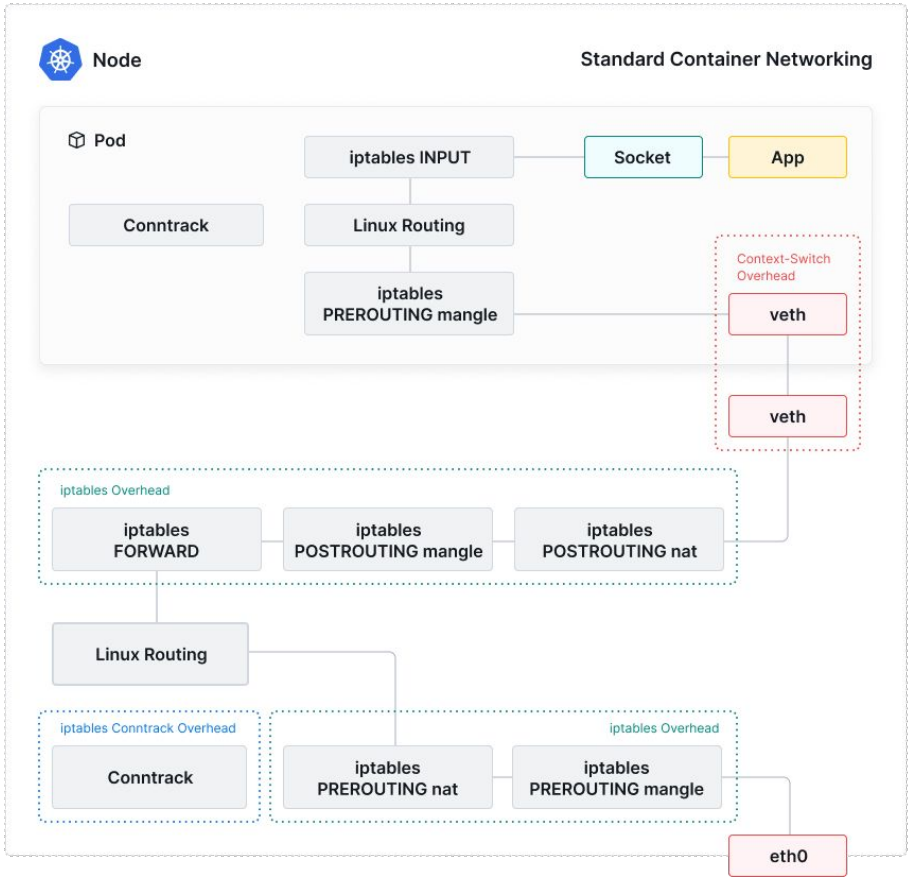

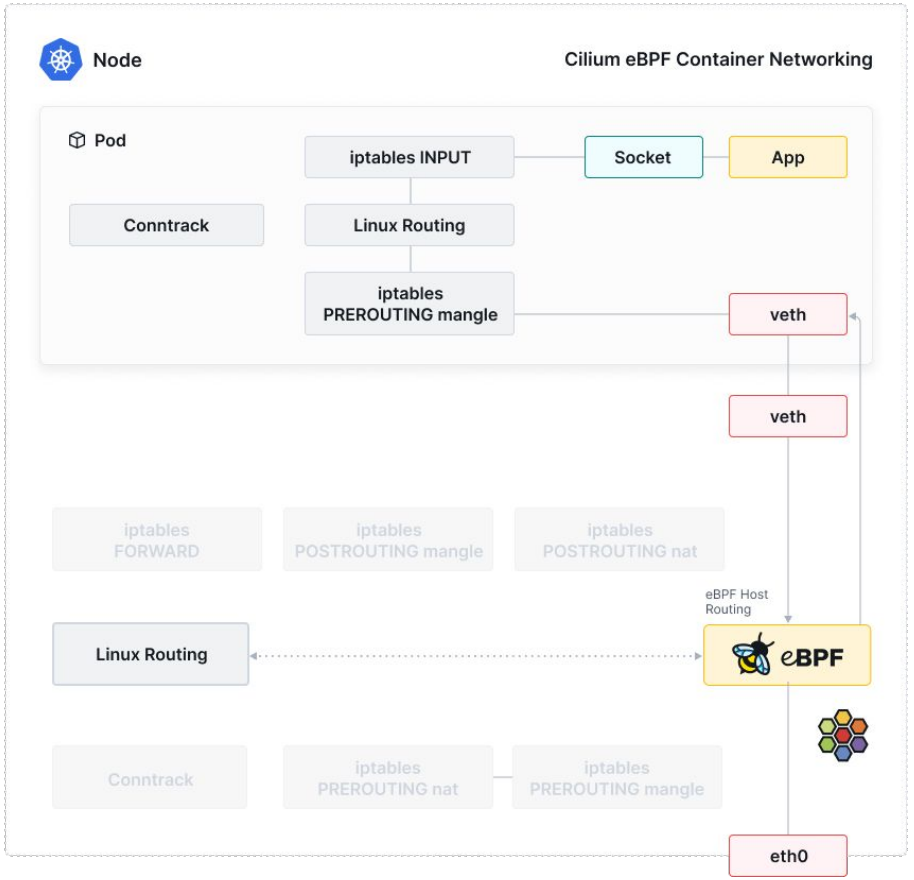

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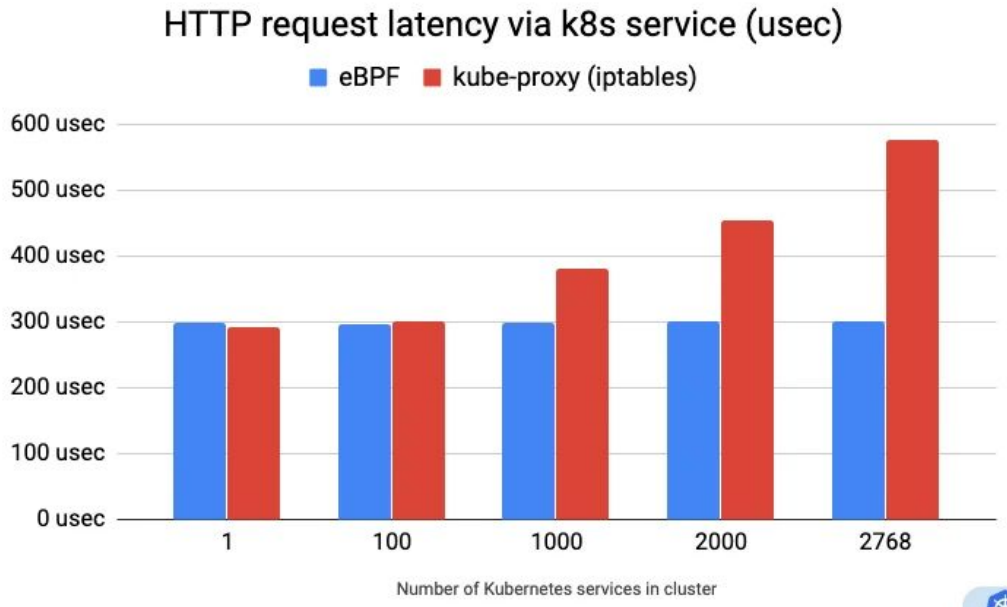

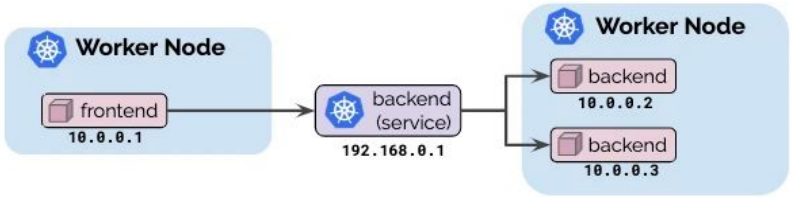

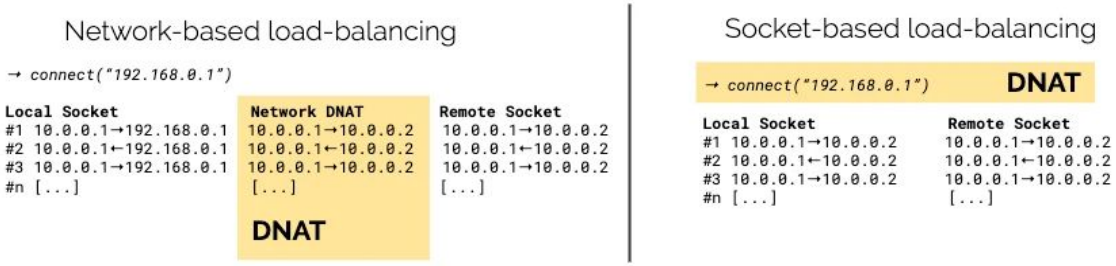

Ref:https://cilium.io/blog/2019/08/20/cilium-1 _

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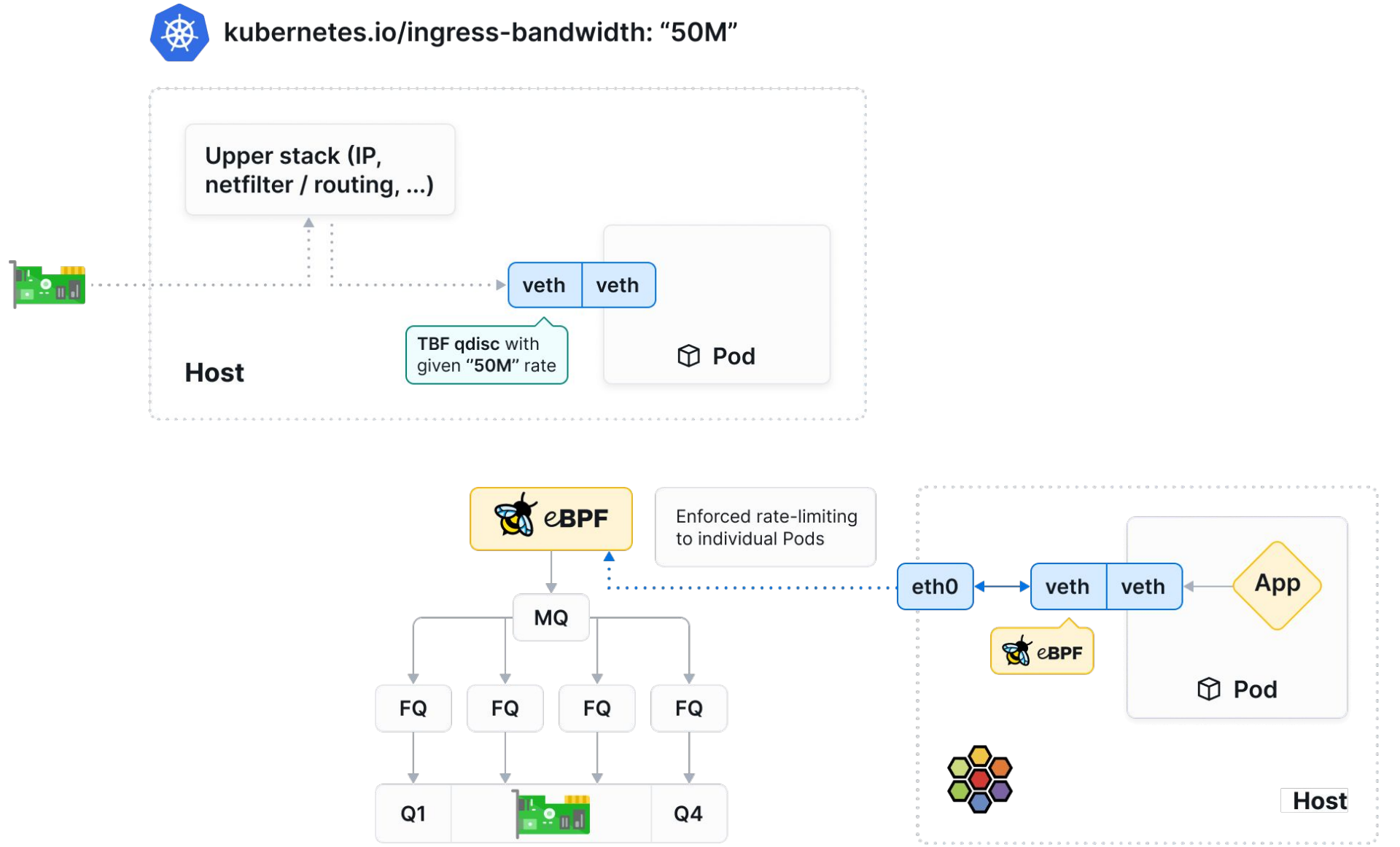

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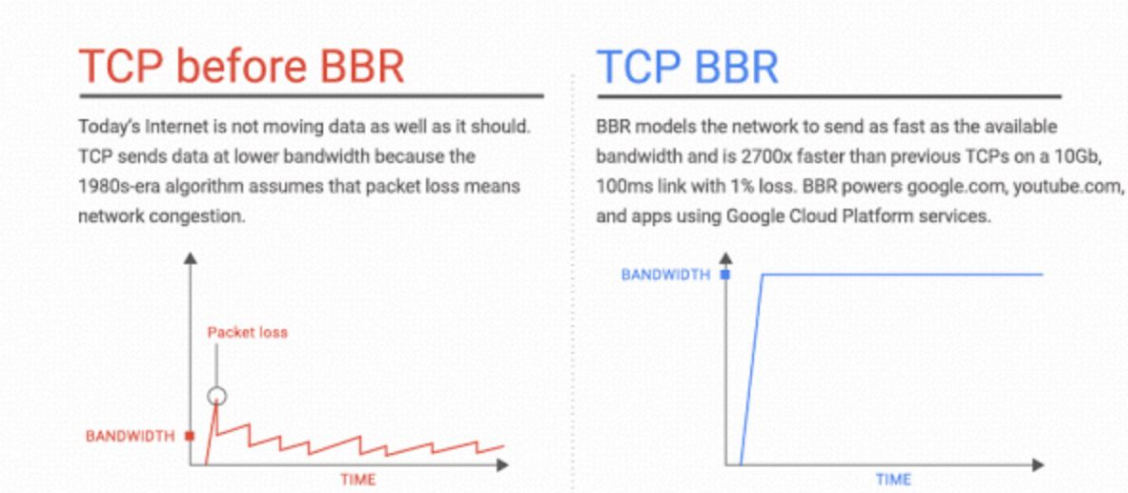
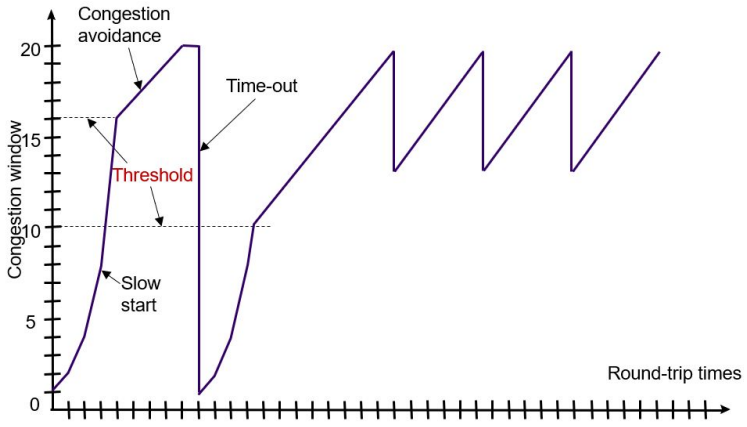
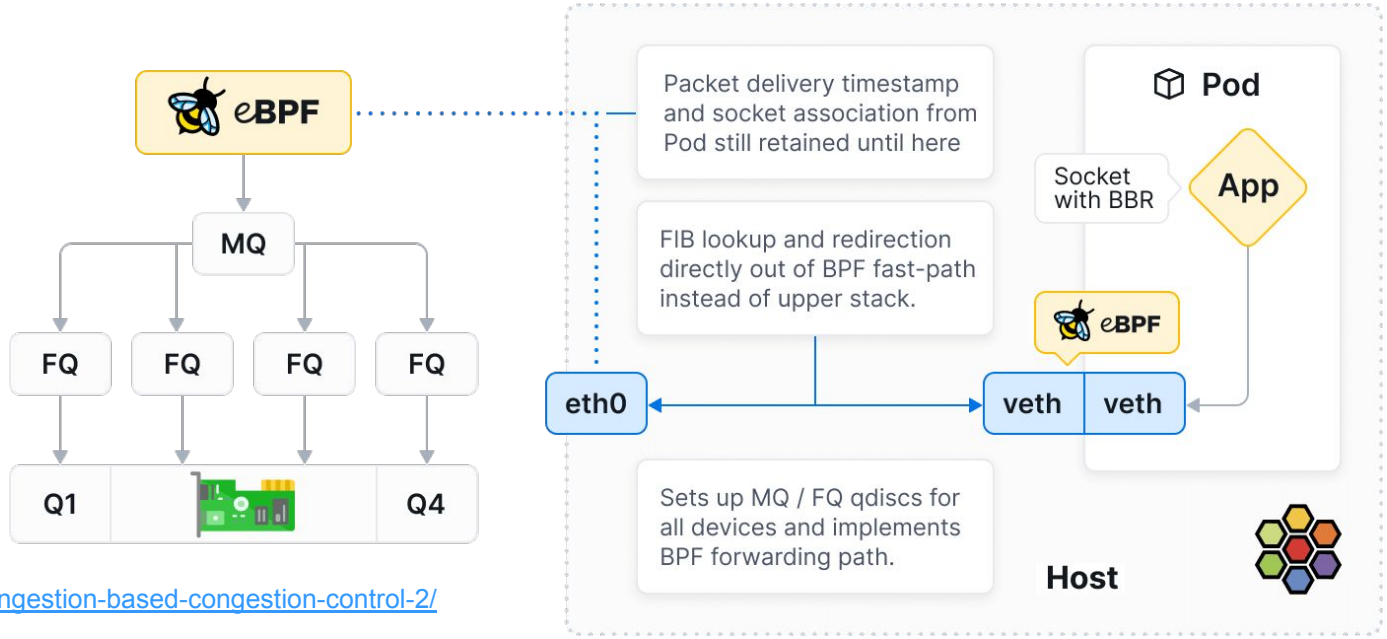






Ref:https://research.google/pubs/bbr-congestion-based-congestion-control-2/

Introduction to Cilium Network

What is Cilium?

- Observability

Service Map →

Metrics & Tracing Export →

Identity-aware L3/L4/DNS Network Flow Logs →

Advanced Network Protocol Visibility →

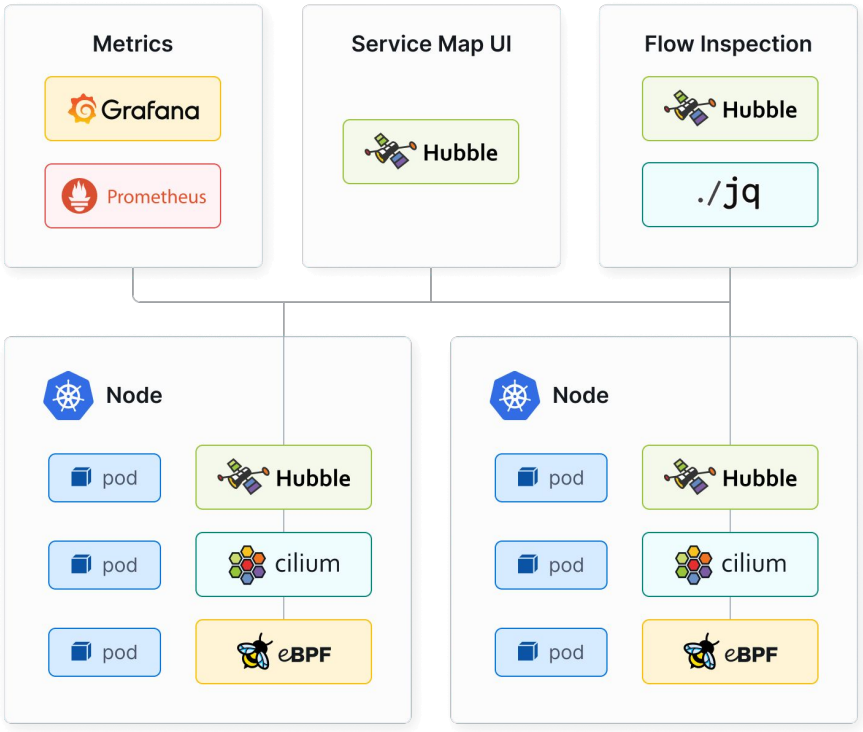
- Security

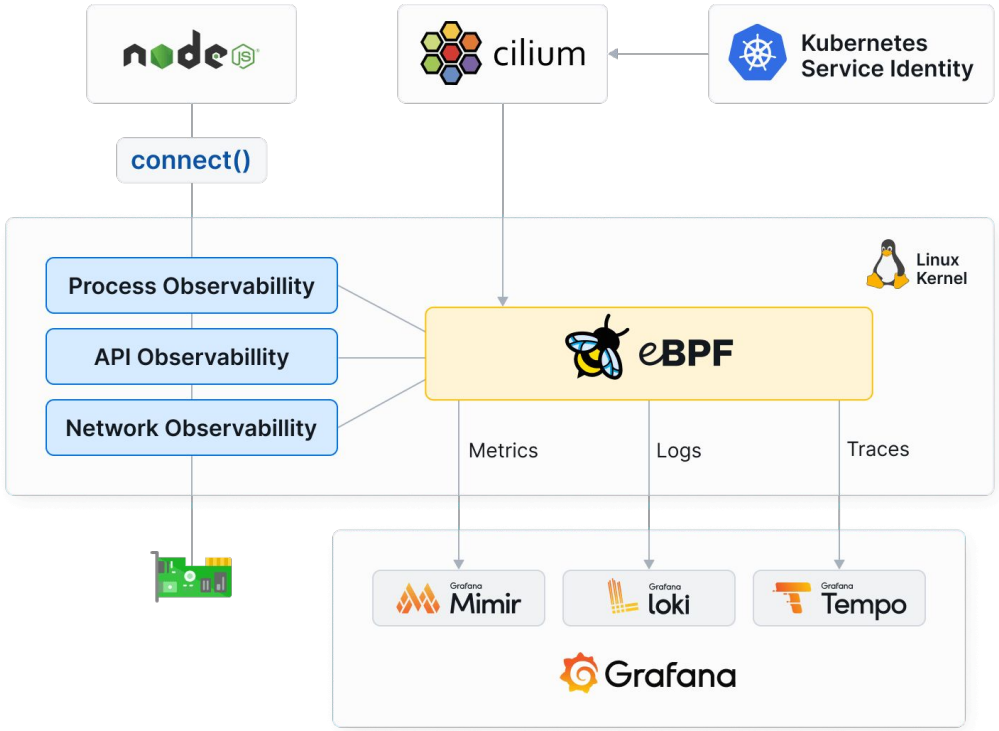
Transparent Encryption →

Network Policy →

Runtime Enforcement →

What is Cilium?





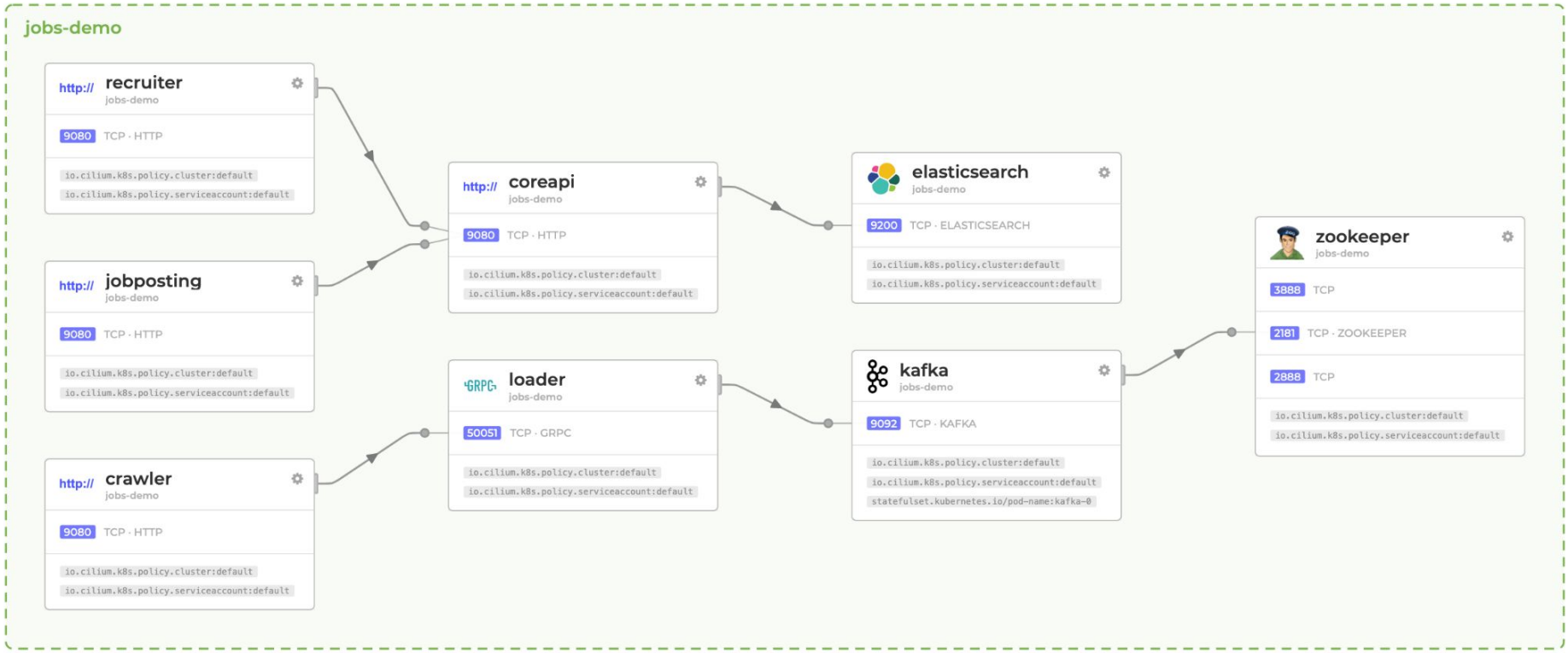
What is Cilium?

```
ubuntu@ip-10-21-1-233:~$ hubble observe
Feb 12 01:36:06.300: 10.0.4.83:14888 -> 10.0.3.10:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.556: 10.0.3.10:4240 <> 10.0.5.110:52348 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.556: 10.0.5.110:52348 -> 10.0.3.10:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.864: 10.0.3.142:15558 <> 10.0.0.25:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.870: 10.0.3.142:15558 -> 10.0.0.25:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.927: 10.0.3.142:58984 <> 10.0.4.148:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.935: 10.0.1.57:52076 <> 10.0.4.148:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:06.946: ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:443 <> 10.0.1.57:46590 to-overlay FORWARDED (TCP Flags: SYN, ACK)
Feb 12 01:36:06.946: 10.0.1.57:46590 -> ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:443 to-endpoint FORWARDED (TCP Flags: ACK, RST)
Feb 12 01:36:06.946: 10.0.1.57:47310 -> ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:80 to-endpoint FORWARDED (TCP Flags: ACK, RST)
Feb 12 01:36:06.959: 10.0.1.57:47310 <> ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:80 to-overlay FORWARDED (TCP Flags: SYN)
Feb 12 01:36:06.959: 10.0.1.57:46590 <> ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:443 to-overlay FORWARDED (TCP Flags: SYN)
Feb 12 01:36:06.960: 10.0.1.57:46590 <> ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:443 to-overlay FORWARDED (TCP Flags: ACK, RST)
Feb 12 01:36:06.960: 10.0.1.57:47310 <> ingress-nginx/ingress-nginx-controller-8cf5559f8-h2sr7:80 to-overlay FORWARDED (TCP Flags: ACK, RST)
Feb 12 01:36:07.019: 10.0.3.142:16908 <> 10.0.5.215:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.026: 10.0.1.57:48222 <> 10.0.5.215:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.036: 10.0.3.142:24910 <> 10.0.1.248:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.045: 10.0.1.248:4240 <> 10.0.3.142:24910 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.045: 10.0.1.57:14258 <- 10.0.1.248:4240 to-stack FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.045: 10.0.1.57:14258 -> 10.0.1.248:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.045: 10.0.3.142:24910 -> 10.0.1.248:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.068: 10.0.3.10:4240 <> 10.0.1.57:39218 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.068: 10.0.3.142:55422 <- 10.0.3.10:4240 to-stack FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.068: 10.0.3.142:55422 -> 10.0.3.10:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.068: 10.0.1.57:39218 -> 10.0.3.10:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.077: 10.0.1.57:39218 <> 10.0.3.10:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.083: 10.0.2.154:4240 <> 10.0.3.142:30542 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.083: 10.0.1.57:36562 -> 10.0.2.154:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.083: 10.0.3.142:30542 -> 10.0.2.154:4240 to-endpoint FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.084: 10.0.3.142:30542 <> 10.0.2.154:4240 to-overlay FORWARDED (TCP Flags: ACK)
Feb 12 01:36:07.092: 10.0.1.57:36562 <> 10.0.2.154:4240 to-overlay FORWARDED (TCP Flags: ACK)
```

Ref:https://github.com/cilium/hubble

Introduction to Cilium Network

What is Cilium?



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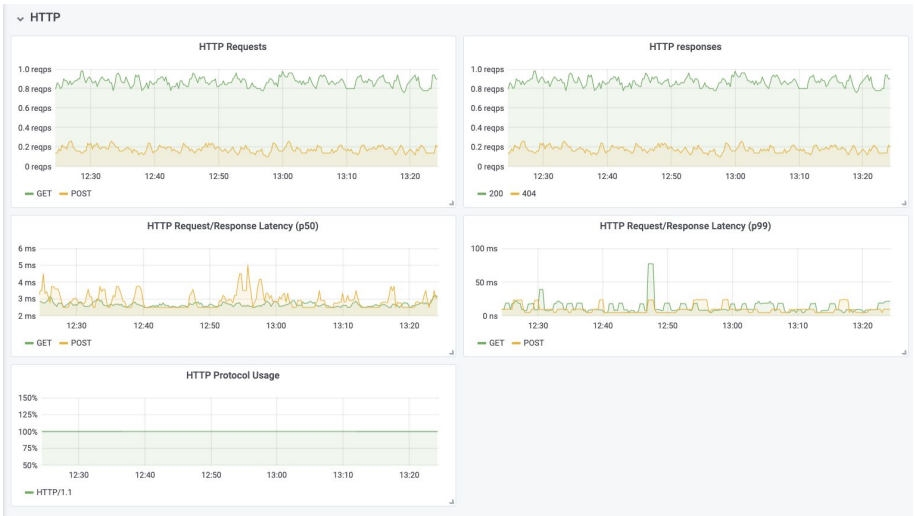

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Introduction to Cilium Network

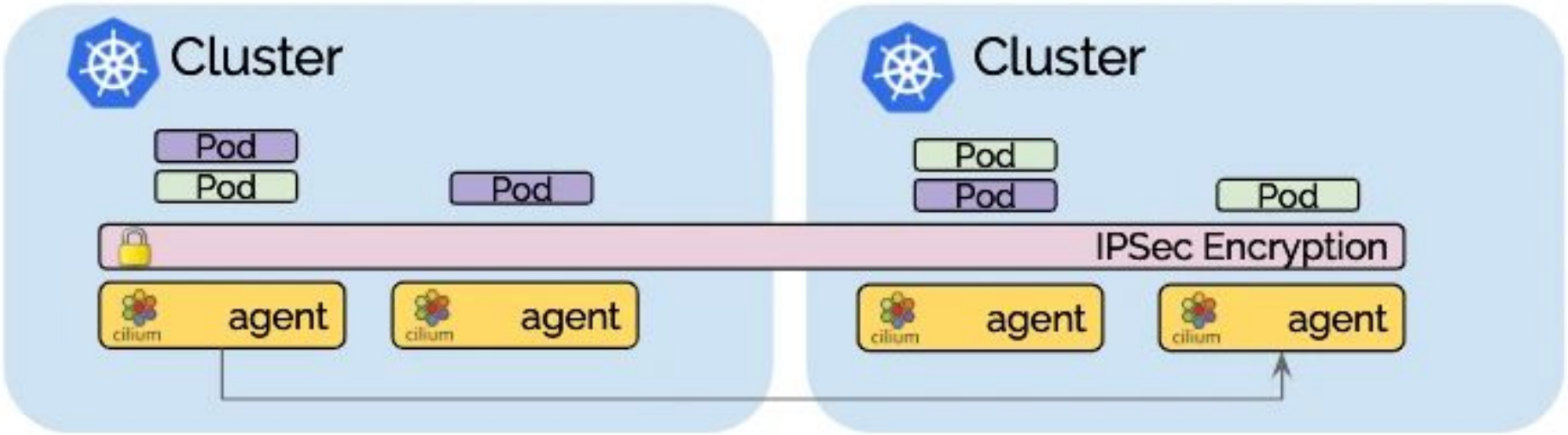
What is Cilium?

- Security


Transparent Encryption →


Network Policy →


Runtime Enforcement →



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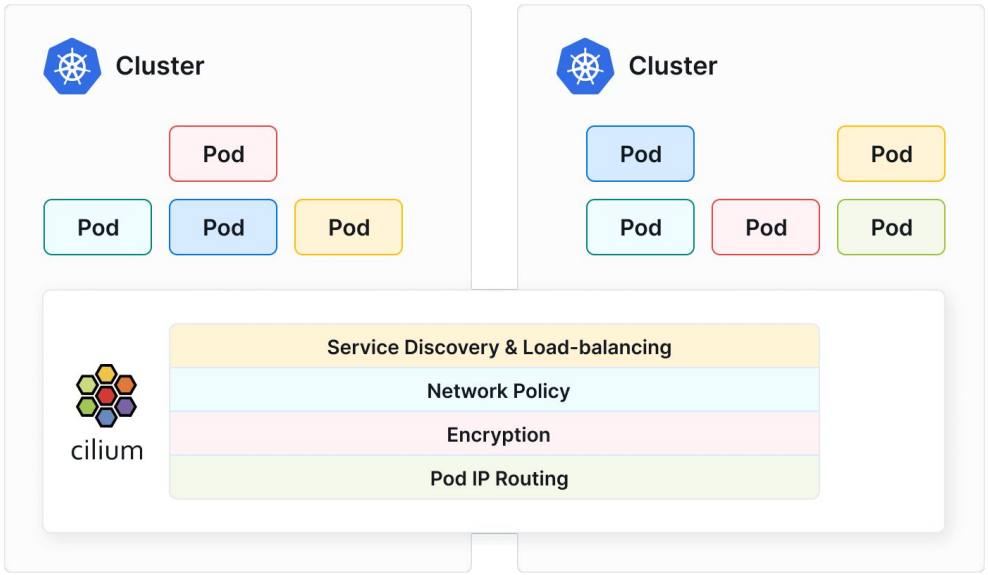

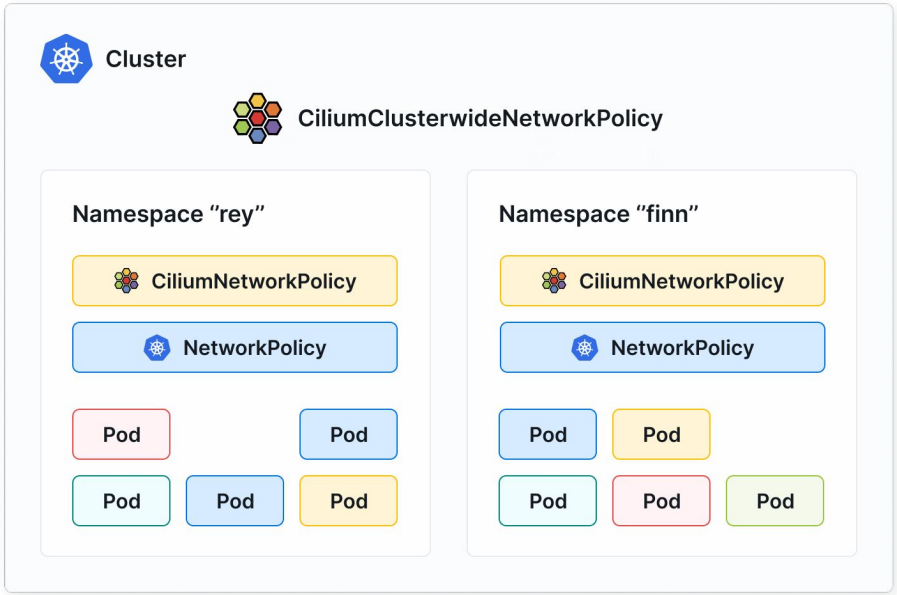

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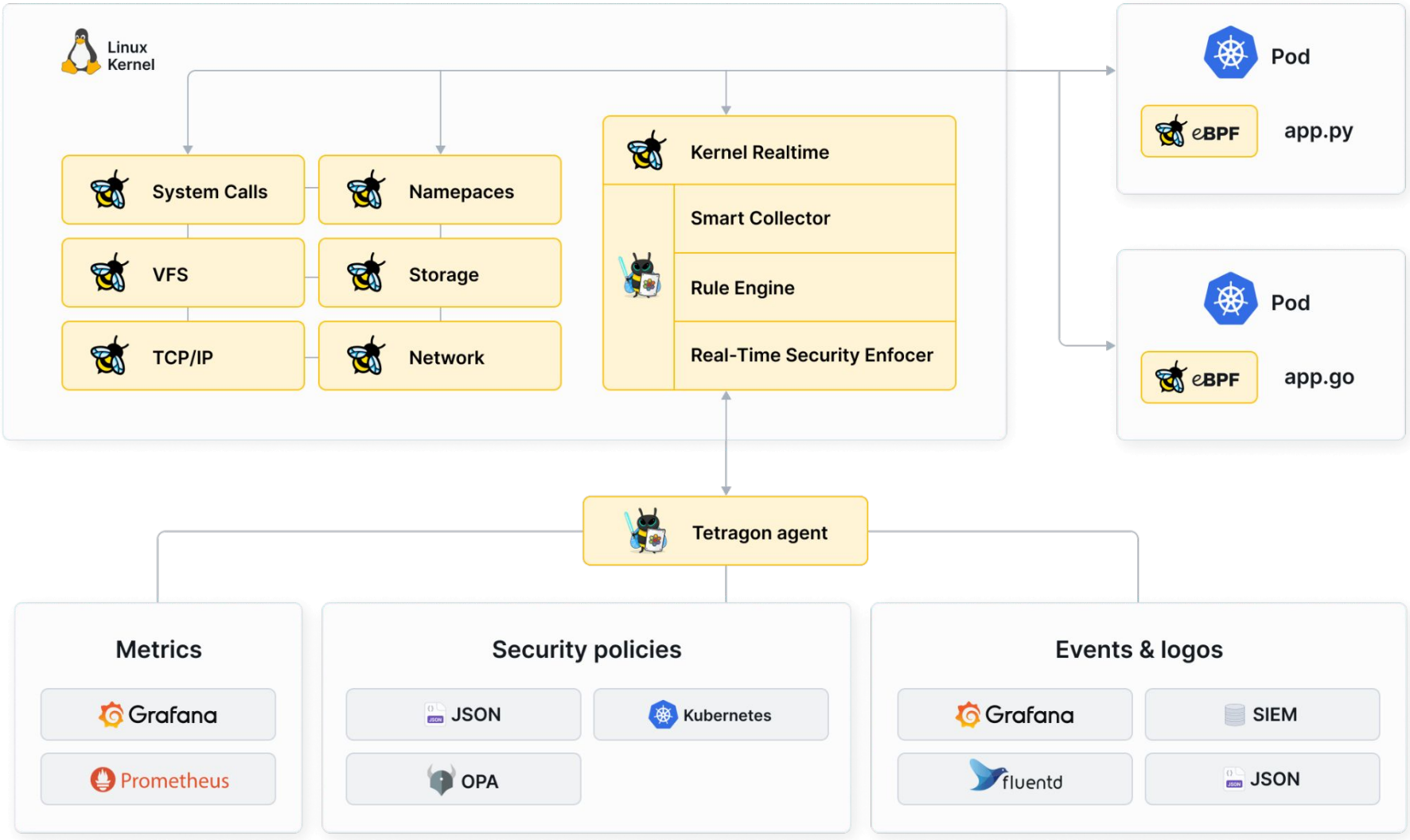
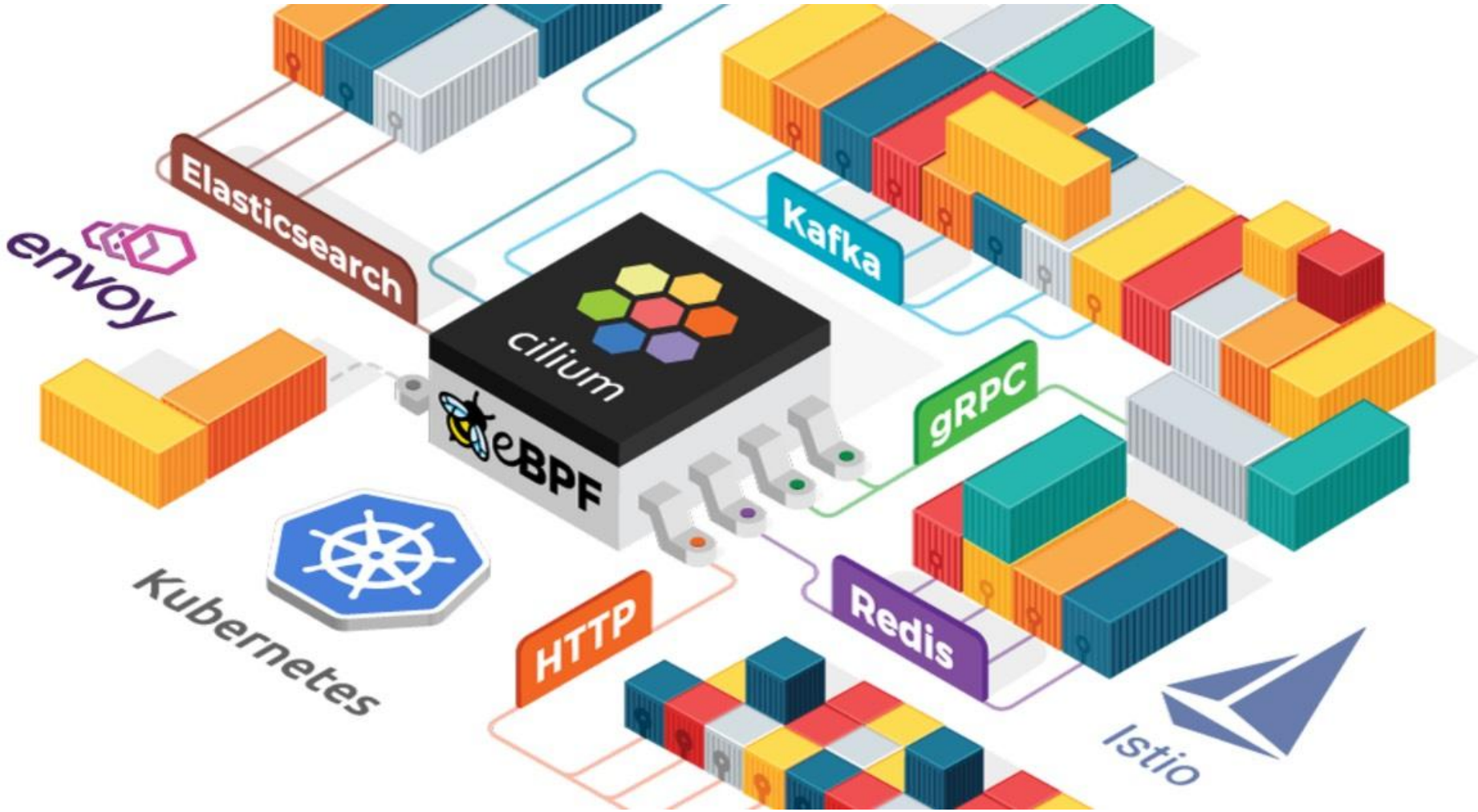


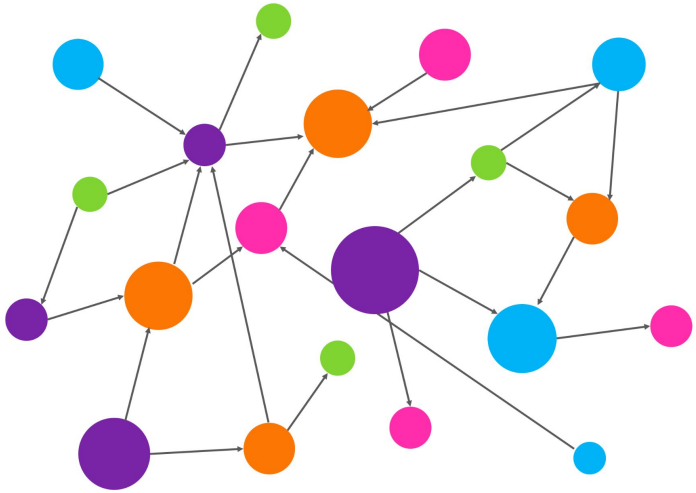
Introduction to Cilium Network

Why this matter ?

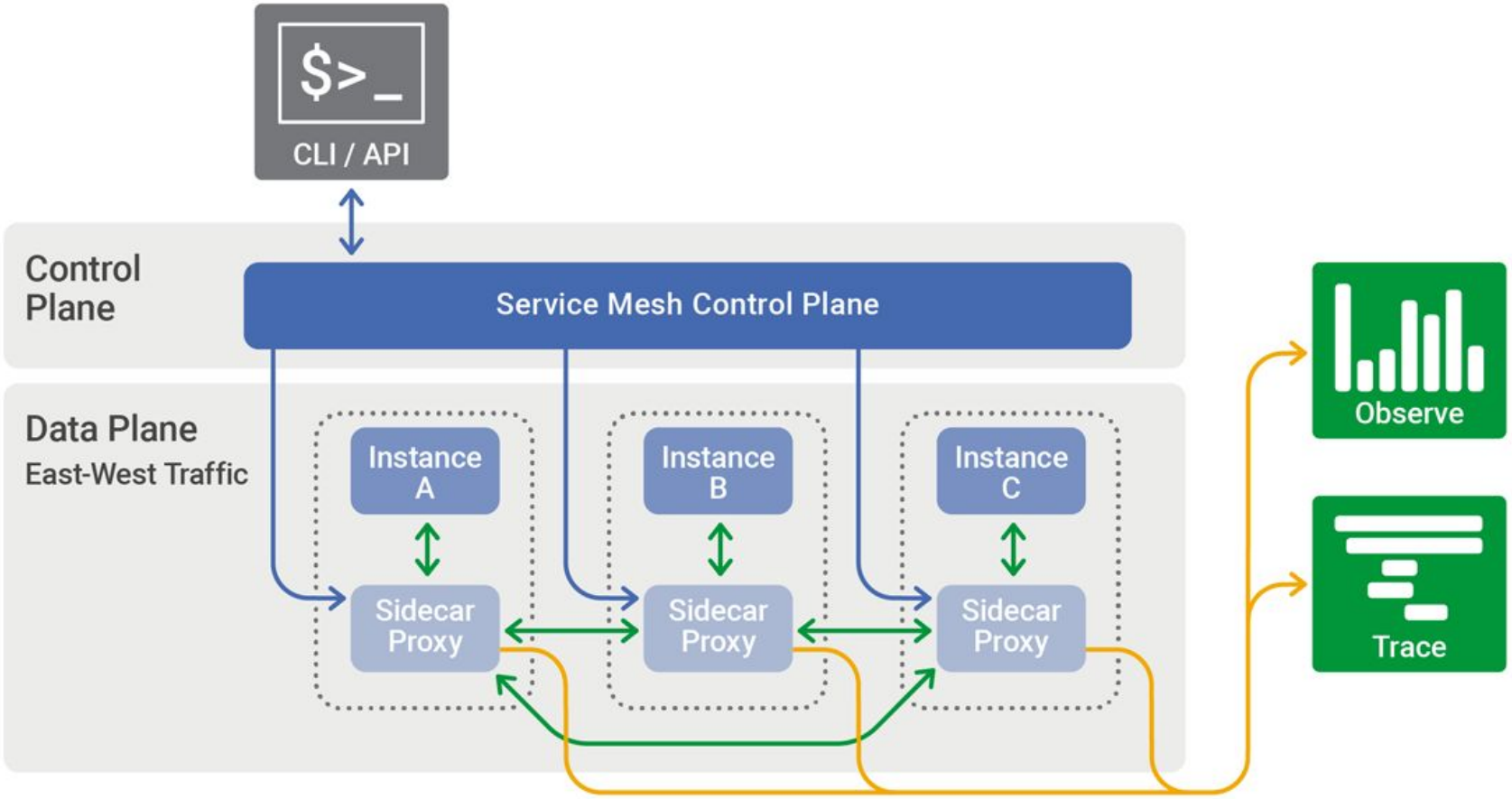


Why this matter ?

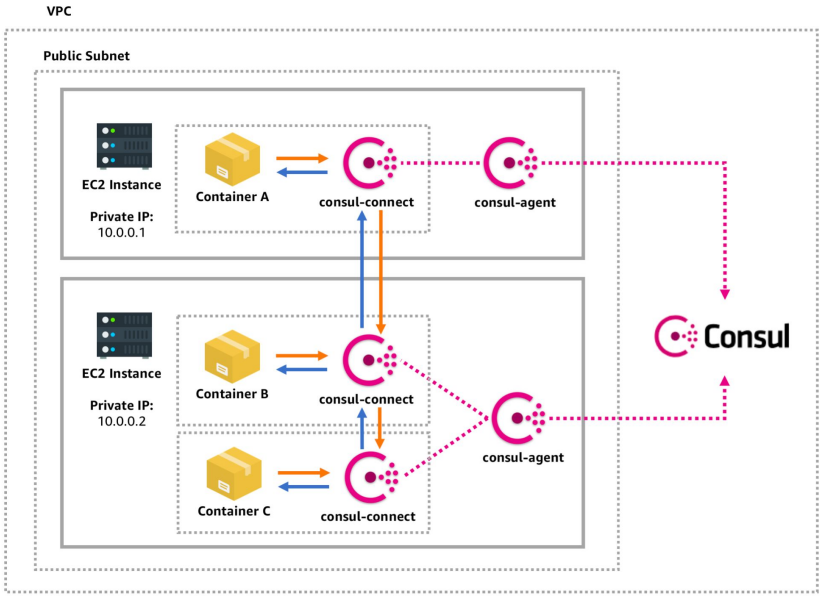
- **Cilium** given some special feature on network / observability / security than other CNI network on Kubernetes
- But why this matter ?
  - **Case Study:** Service Mesh & Observability
    - Many solution in option. How about Kuma/Istio/Dynatrace etc.

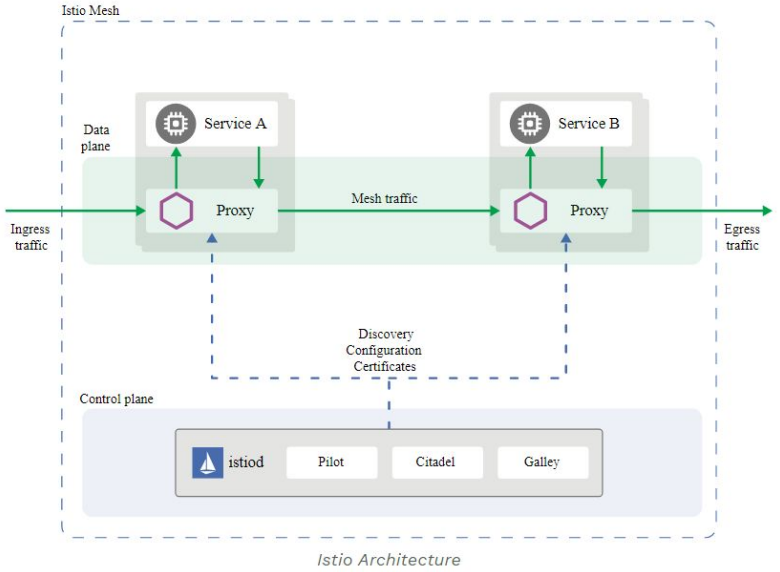


Service Mesh & Observability

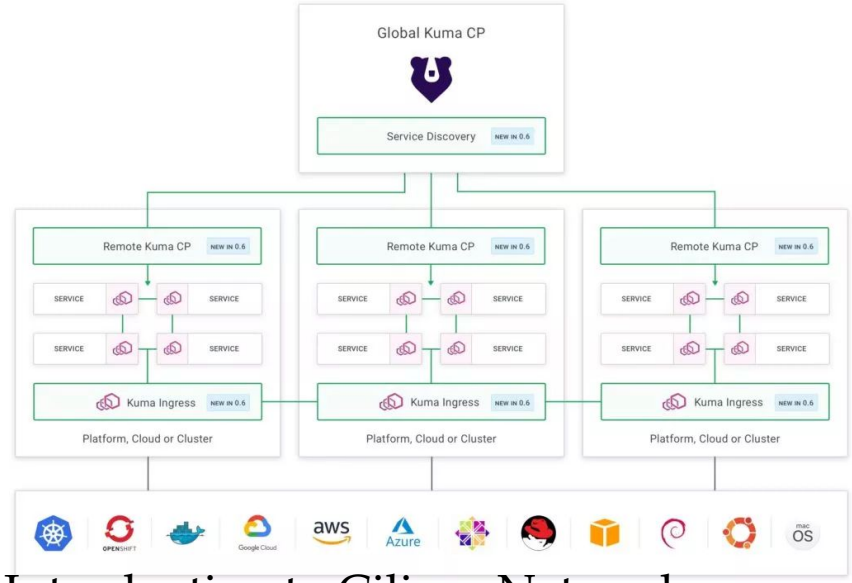


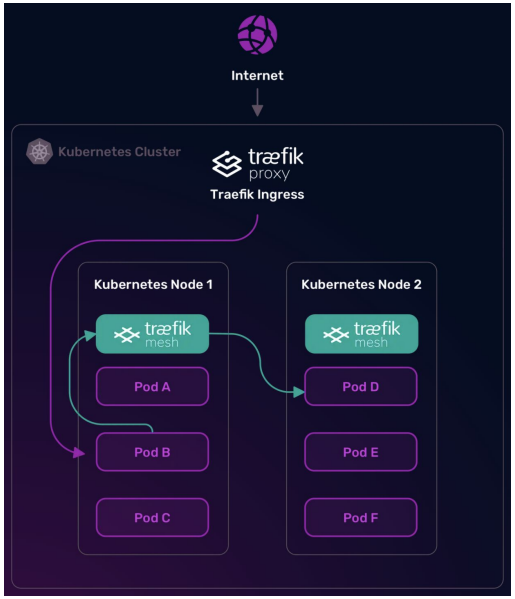
Service Mesh & Observability



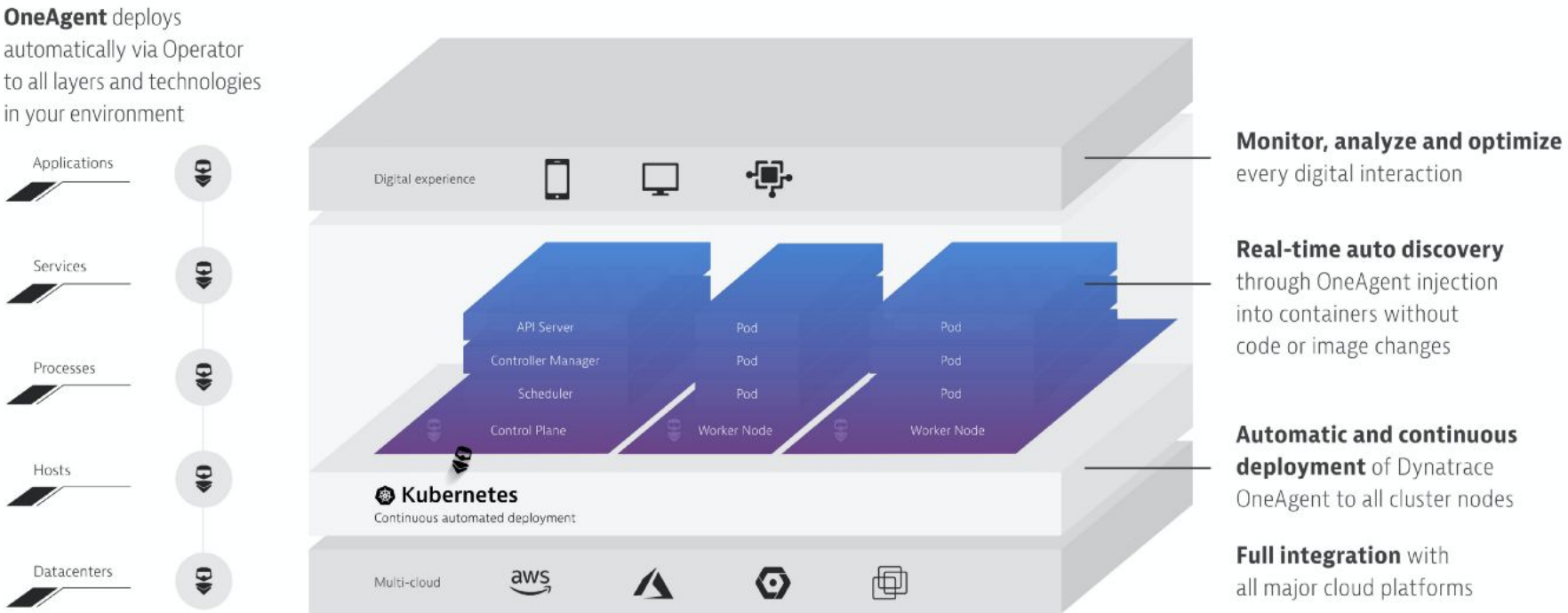


Istio Architecture

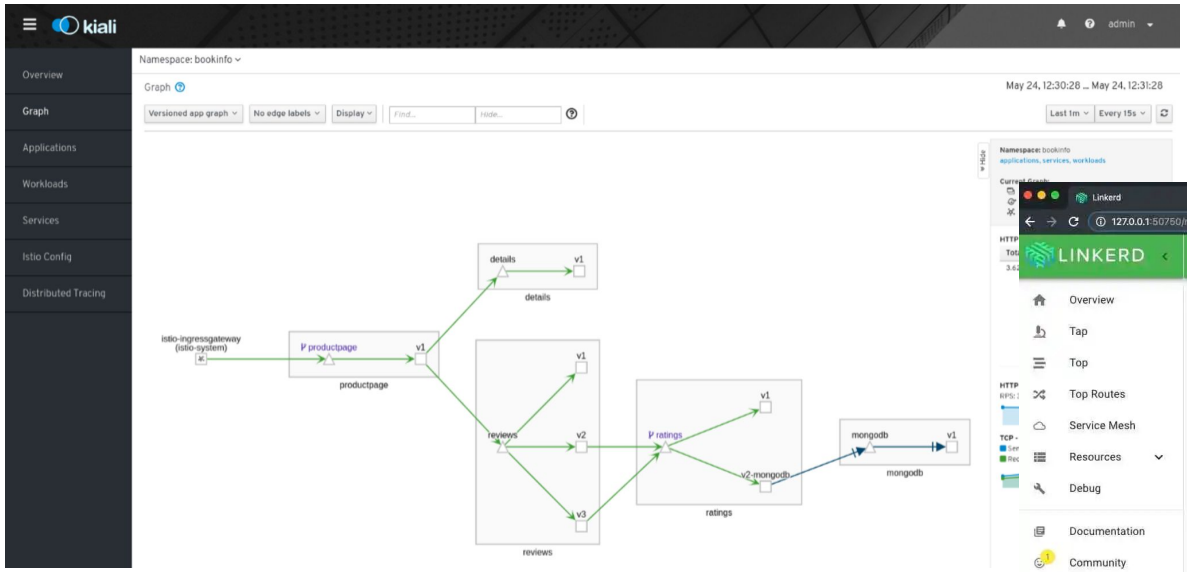


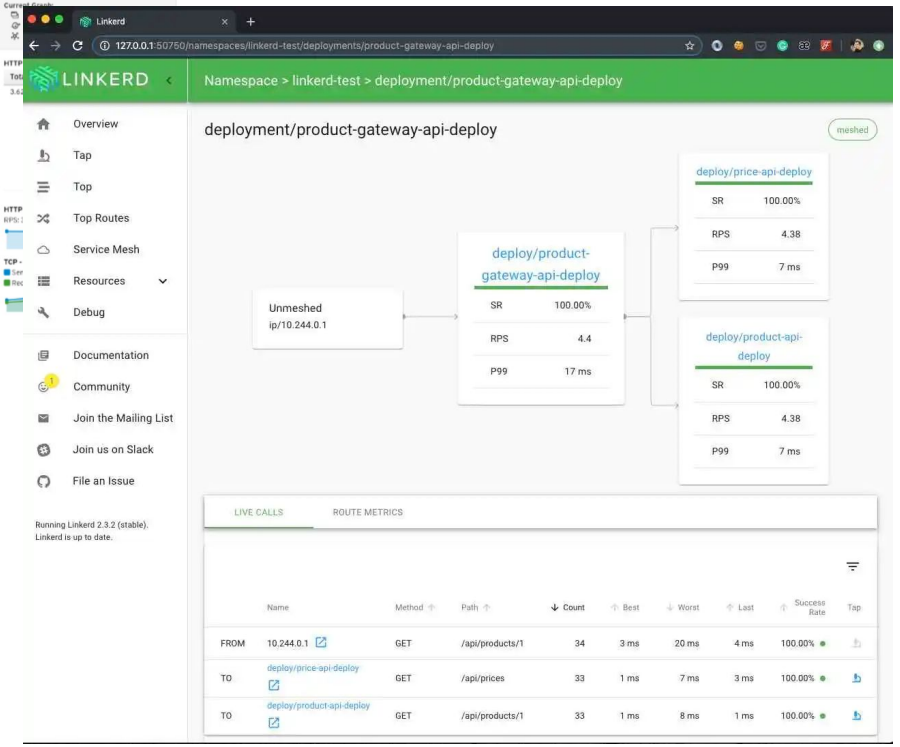


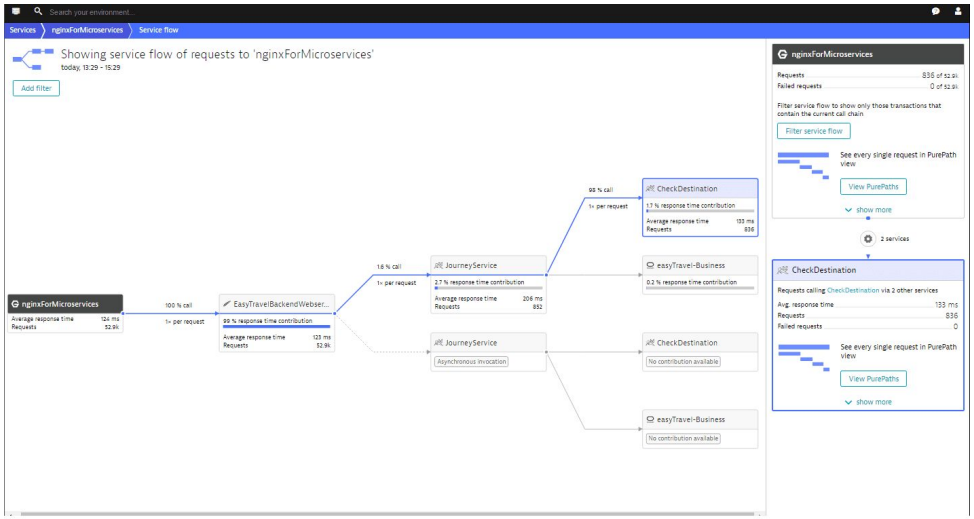
Service Mesh & Observability



Service Mesh & Observability







Introduction to Cilium Network

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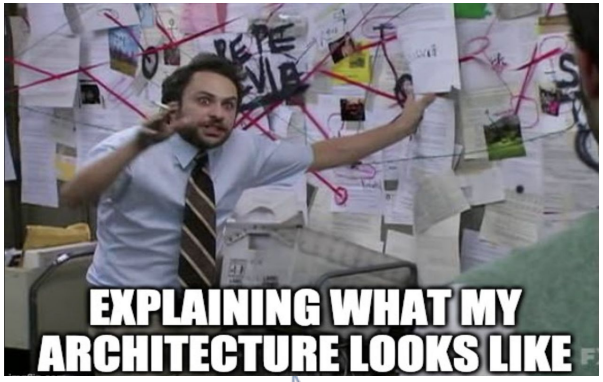

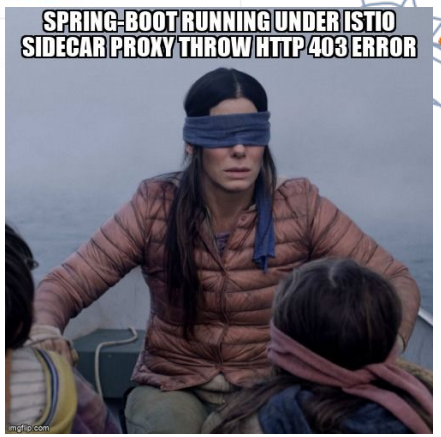

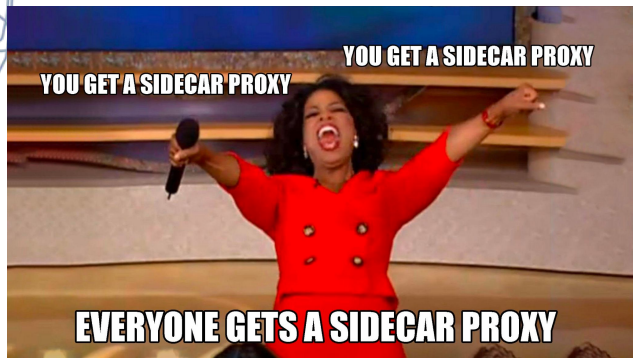

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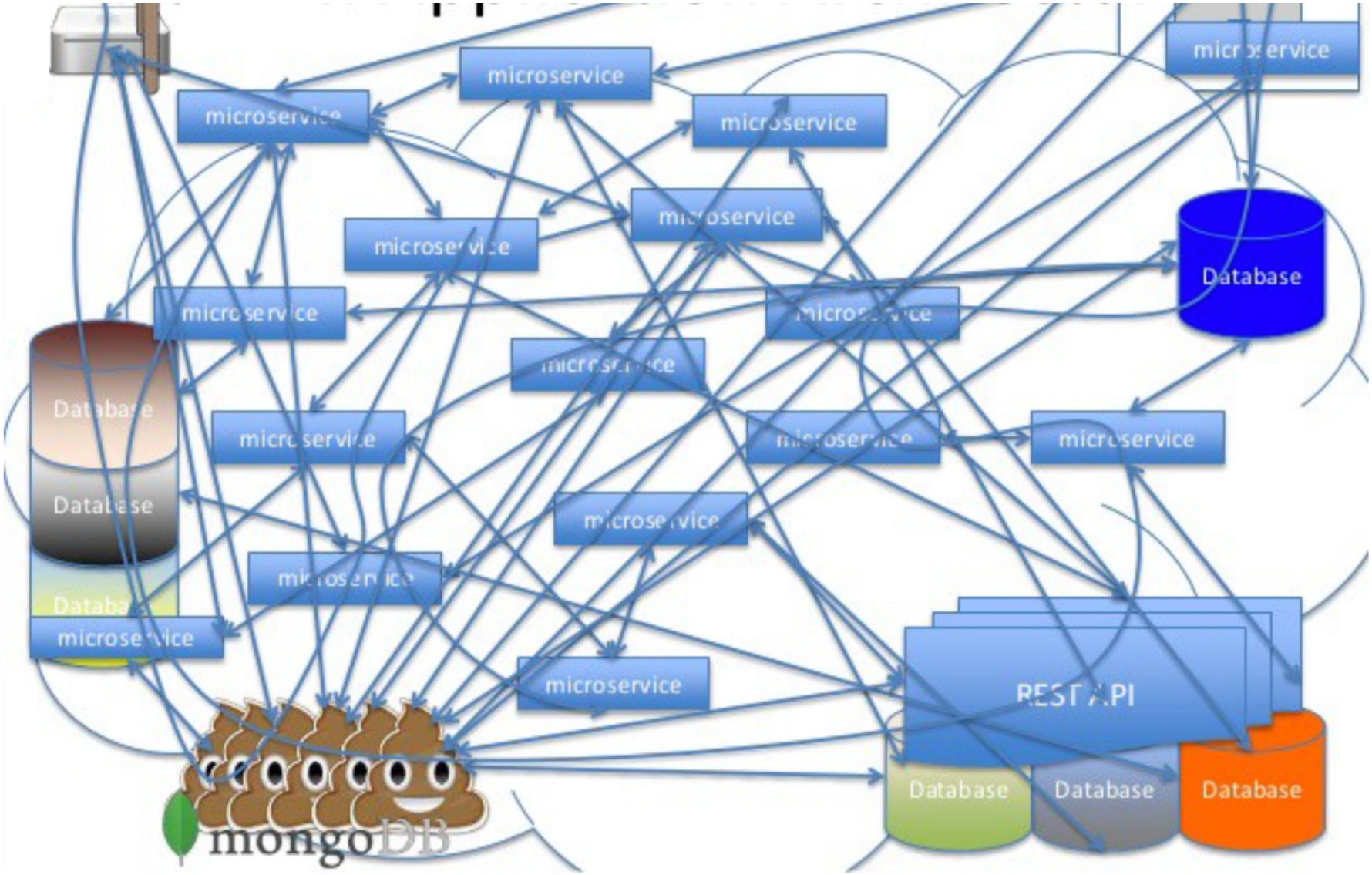
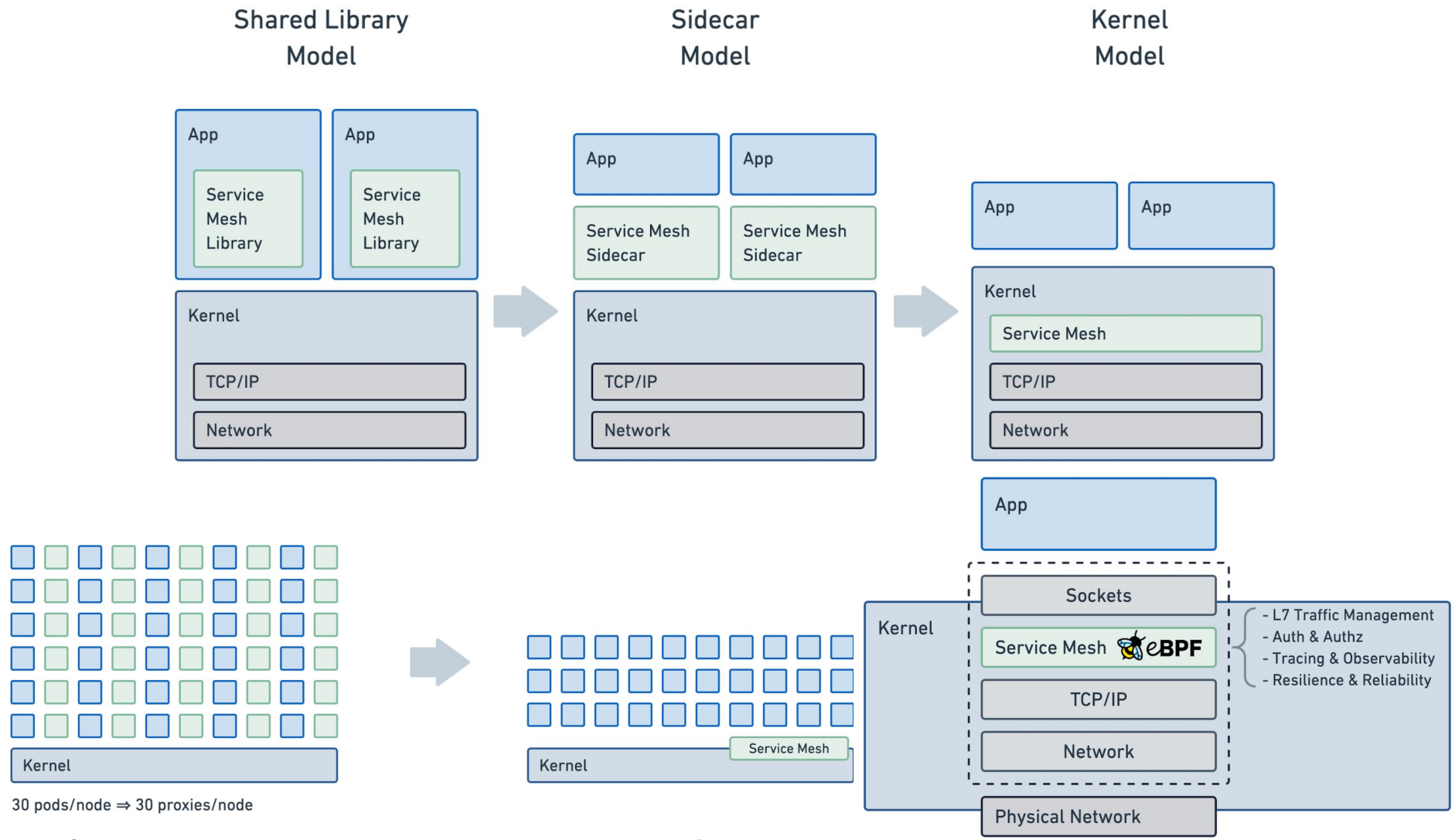
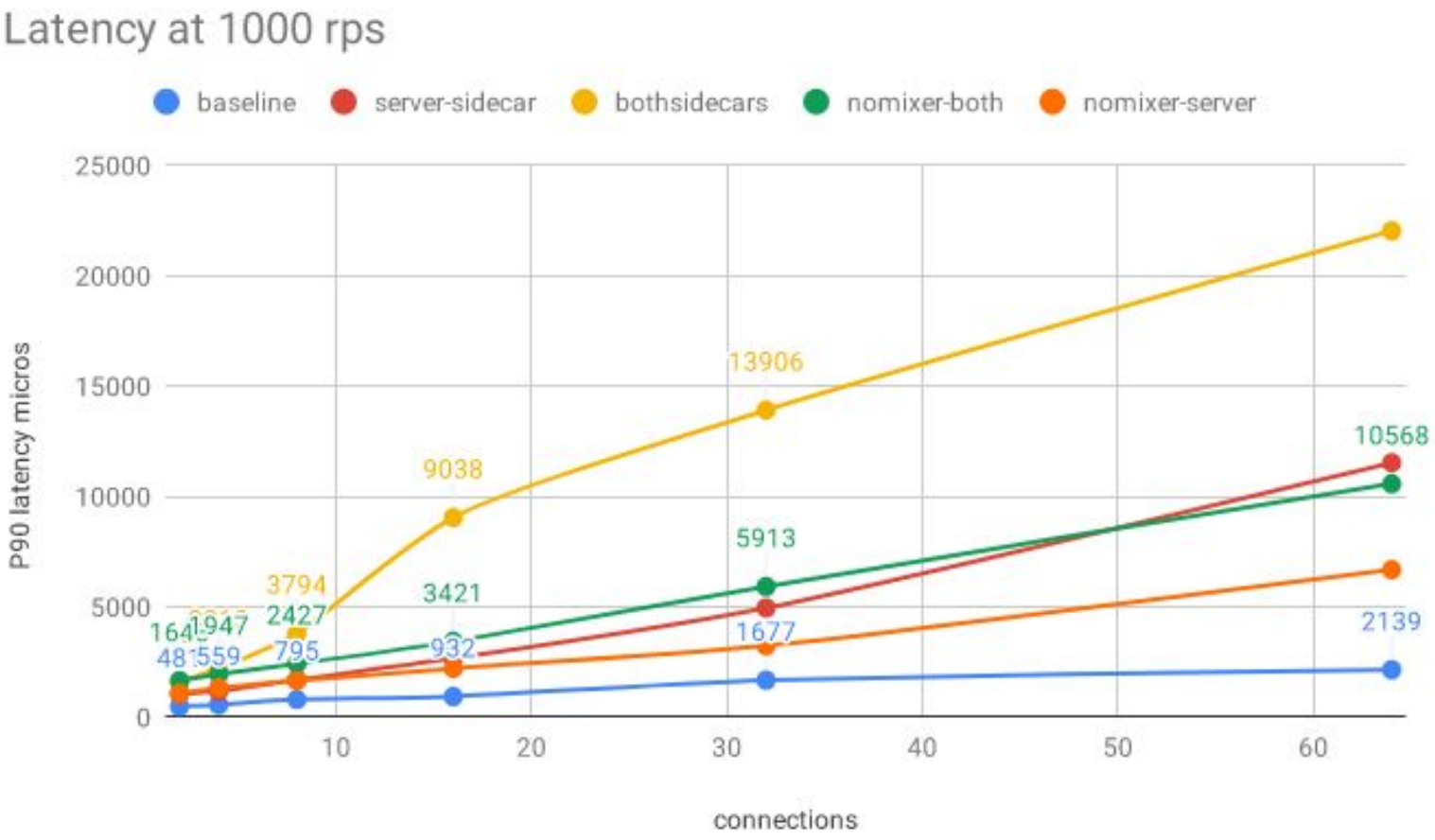


Why this matter ?



Ref: https://isovalent.com/blog/post/2021-12-08-ebpf-servicemesh

Why this matter ?



Ref:https://istio.io/v1.2/docs/concepts/performance-and-scalability/

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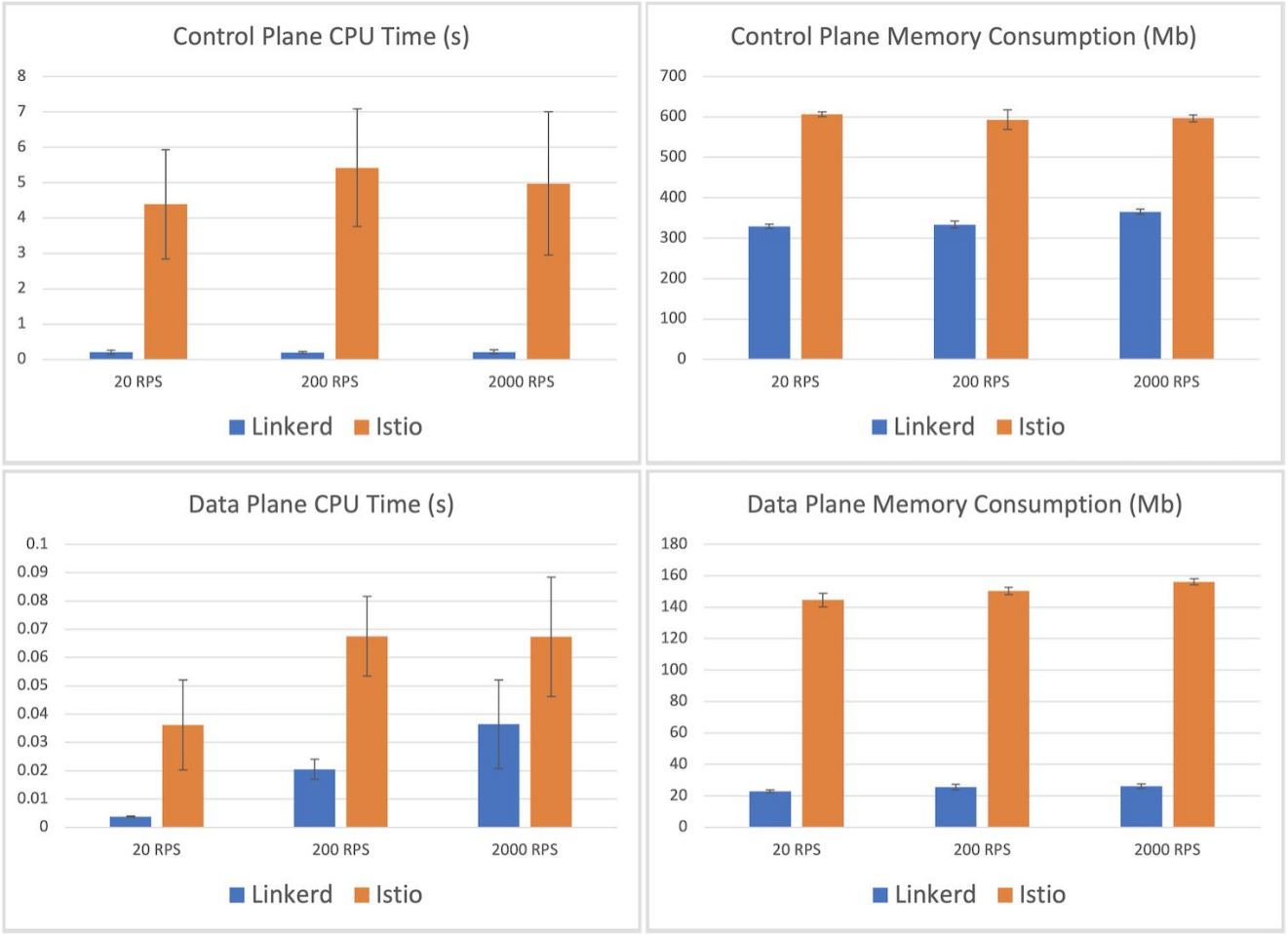
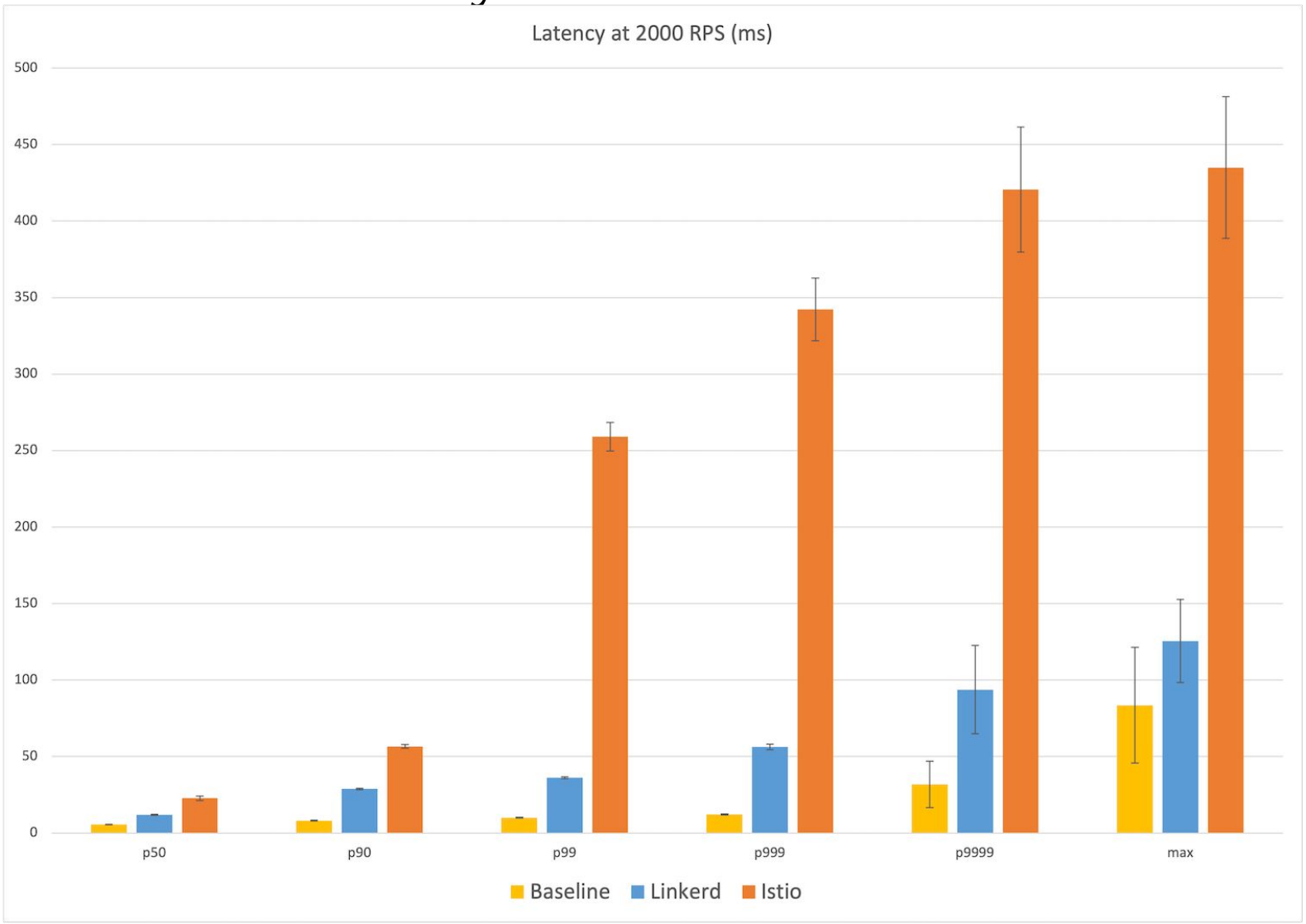


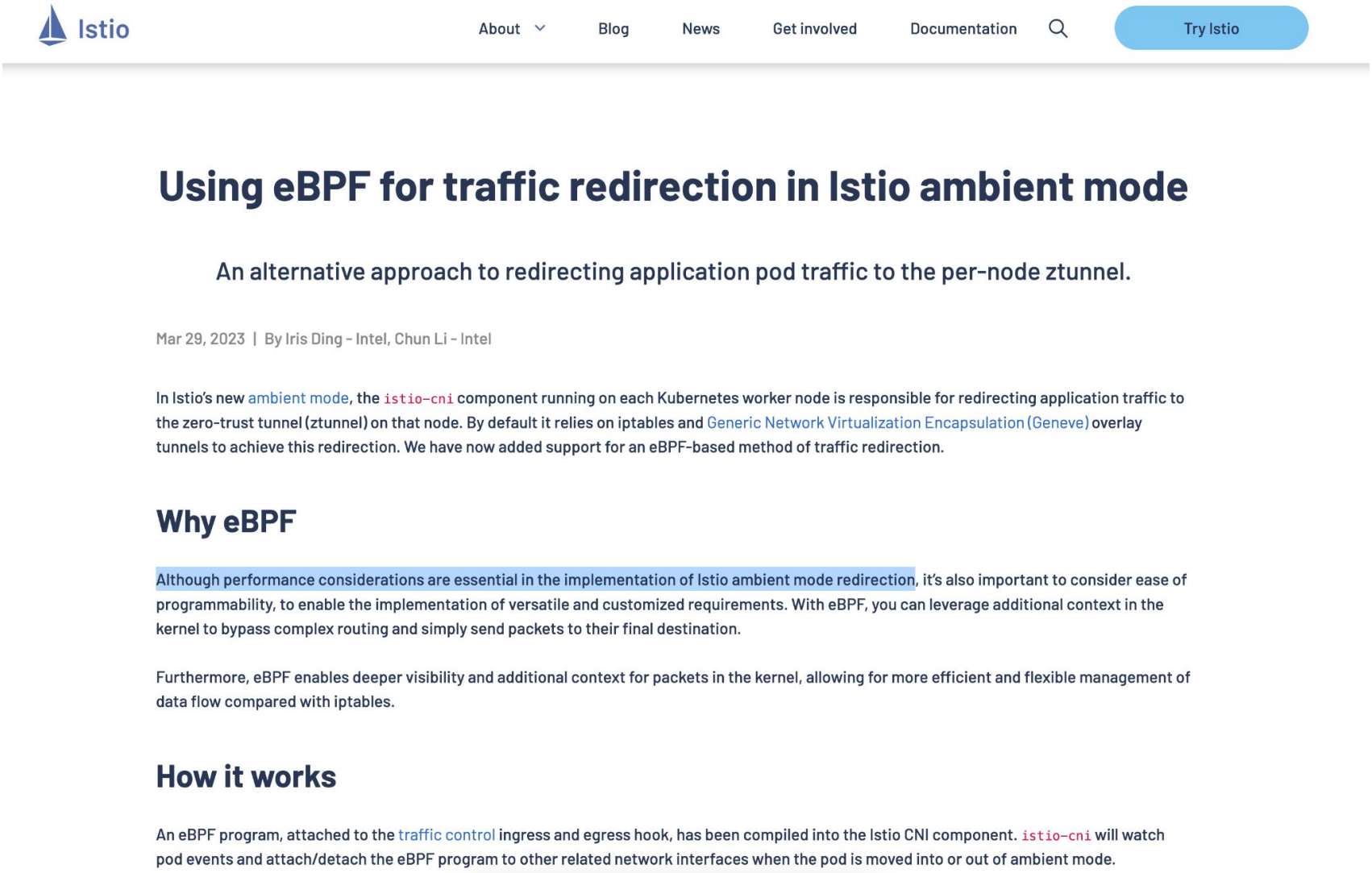
Ref:https://linkerd.io/2021/11/29/linkerd-vs-istio-benchmarks-2021/

Why this matter ?



https://linkerd.io/2021/11/29/linkerd-vs-istio-benchmarks-2021/

Why this matter ?



Istio

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Using eBPF for traffic redirection in Istio ambient mode

An alternative approach to redirecting application pod traffic to the per-node ztunnel.

Mar 29, 2023 | By Iris Ding - Intel, Chun Li - Intel

In Istio's new ambient mode, the `istio-cni` component running on each Kubernetes worker node is responsible for redirecting application traffic to the zero-trust tunnel (ztunnel) on that node. By default it relies on iptables and Generic Network Virtualization Encapsulation (Geneve) overlay tunnels to achieve this redirection. We have now added support for an eBPF-based method of traffic redirection.

Why eBPF

Although performance considerations are essential in the implementation of Istio ambient mode redirection, it's also important to consider ease of programmability, to enable the implementation of versatile and customized requirements. With eBPF, you can leverage additional context in the kernel to bypass complex routing and simply send packets to their final destination.

Furthermore, eBPF enables deeper visibility and additional context for packets in the kernel, allowing for more efficient and flexible management of data flow compared with iptables.

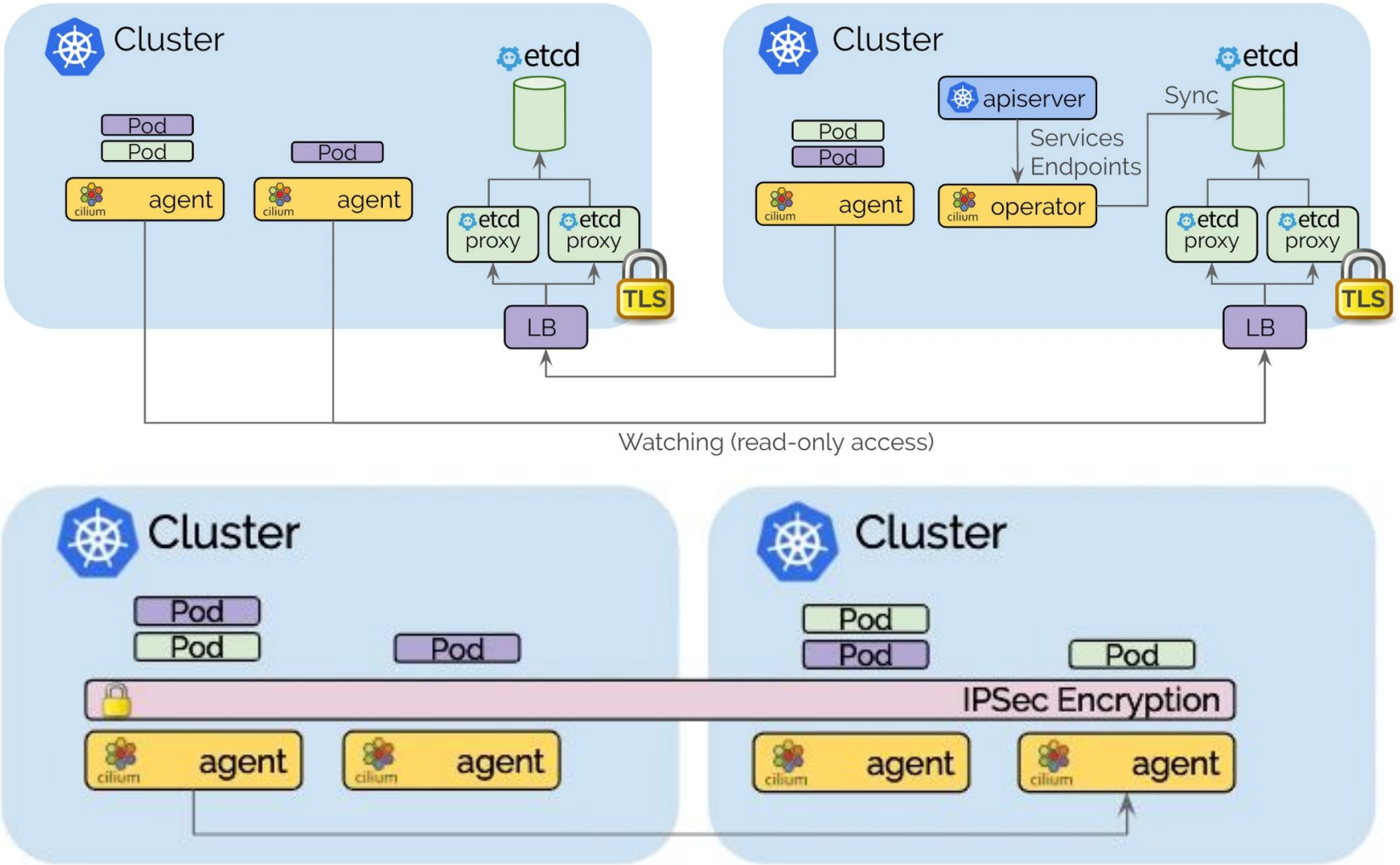
How it works

An eBPF program, attached to the traffic control ingress and egress hook, has been compiled into the Istio CNI component. `istio-cni` will watch pod events and attach/detach the eBPF program to other related network interfaces when the pod is moved into or out of ambient mode.

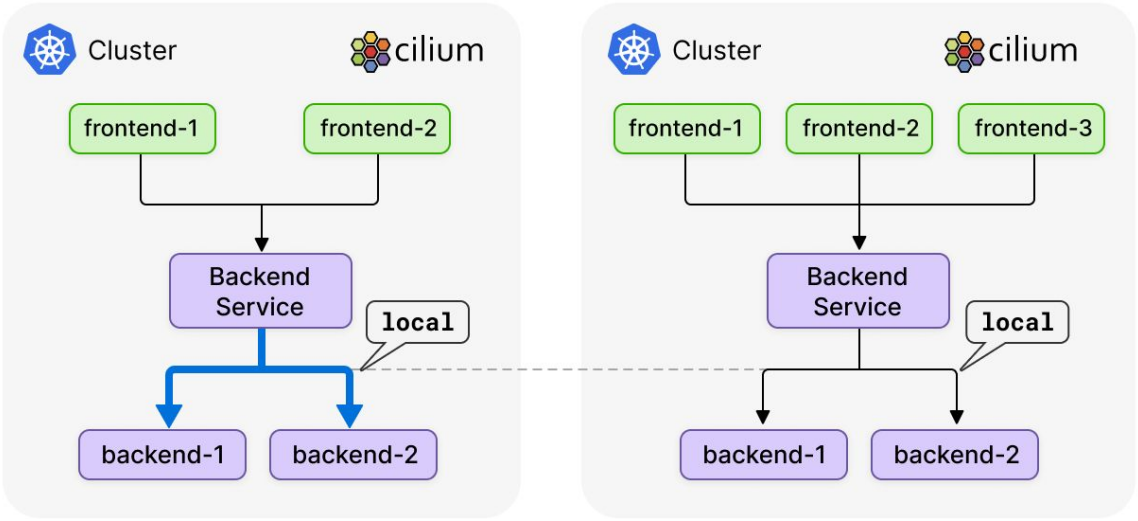
Ref: https://istio.io/latest/blog/2023/ambient-ebpf-redirection/

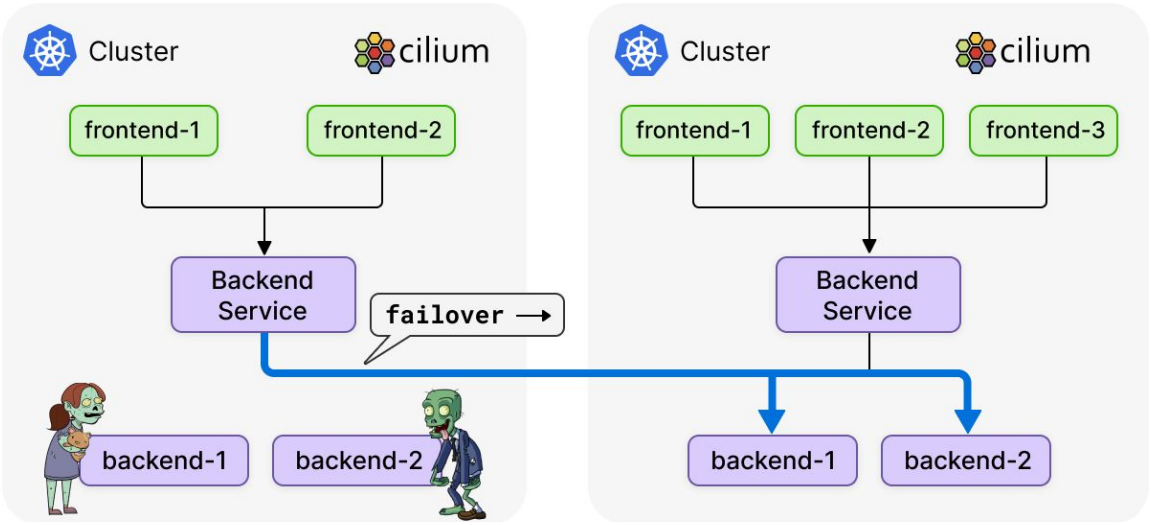
Why this matter ?

- **Case Study**: Cluster Mesh connection between Kubernetes cluster.

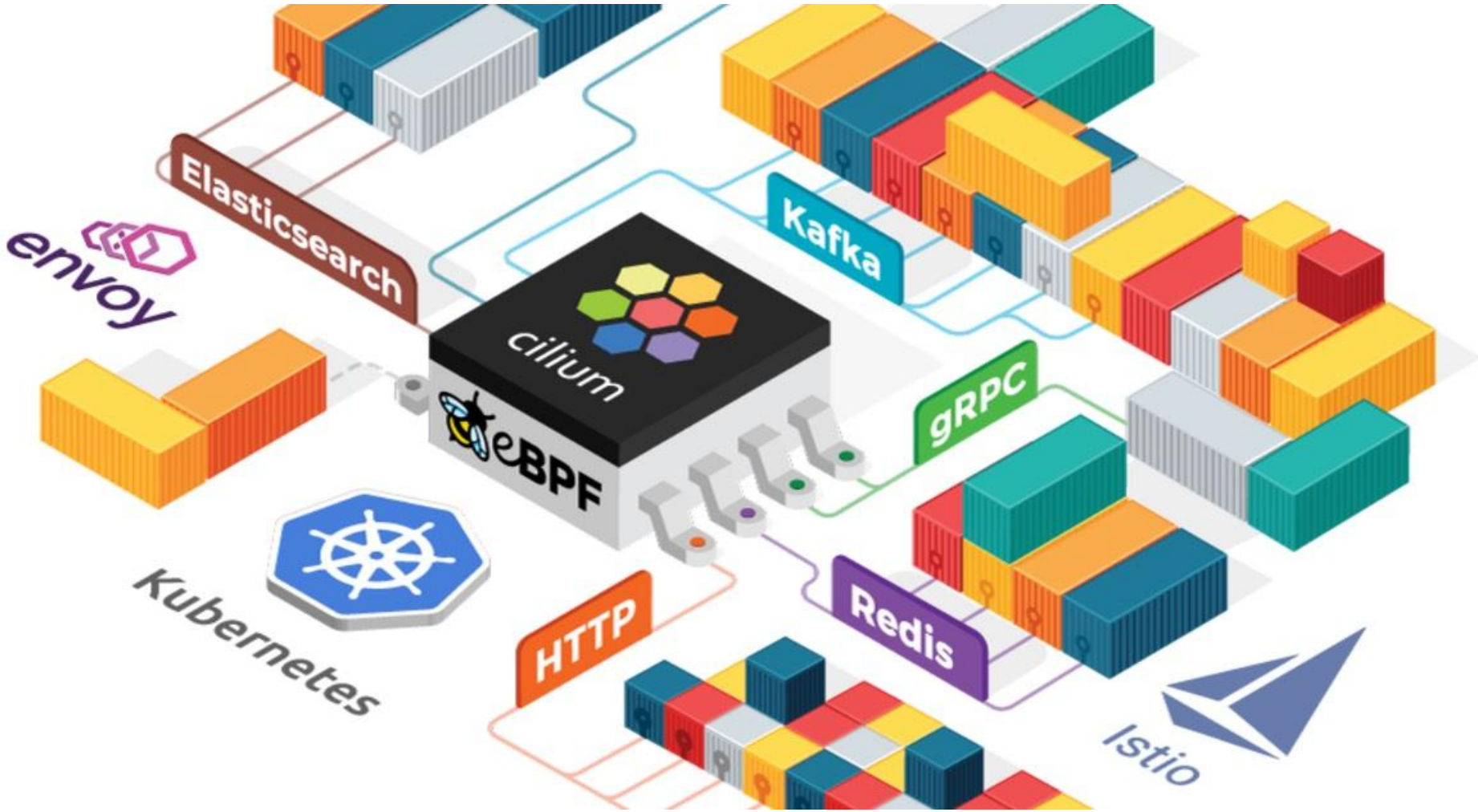


Why this matter ?





Demo Session



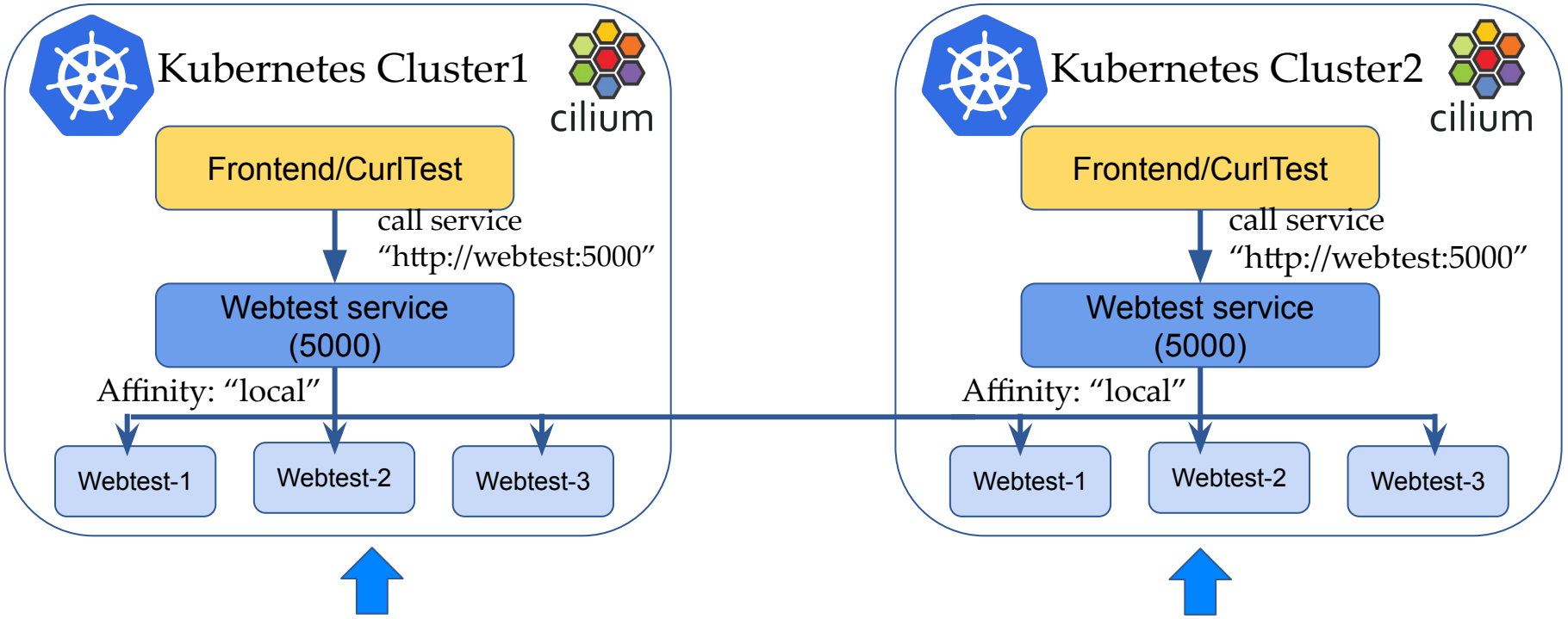
Demo Session

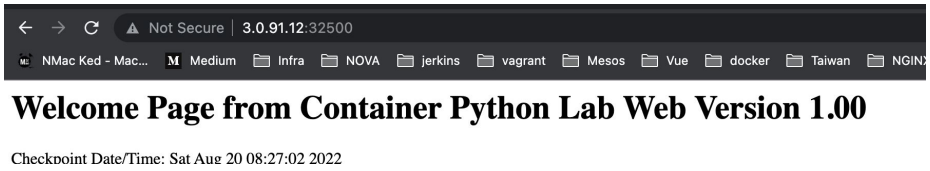
- In Demo session. We will provide 2 cluster (cluster1/cluster2) of Kubernetes with “Cluster Mesh” enable
- Each cluster will deploy application and service:
  - Cluster1: Deploy application **version 1.0**
  - Cluster2: Deploy application **version 1.51RC1**
- For make application extreme durability. We will enable “Cluster Mesh” with service affinity
- Normal condition:
  - Service will route traffic in local cluster for less latency
- Fail condition:
  - Service will kick traffic across cluster for HA and durability

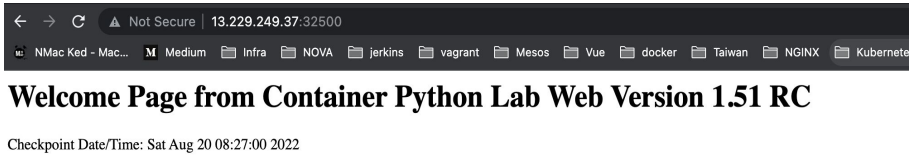
Demo Session

- Failover period:
  - Cilium take 30 second for failover traffic across cluster
- Fail back period:
  - Cilium will switch back when local resource available within 1 - 2 seconds

Demo Session

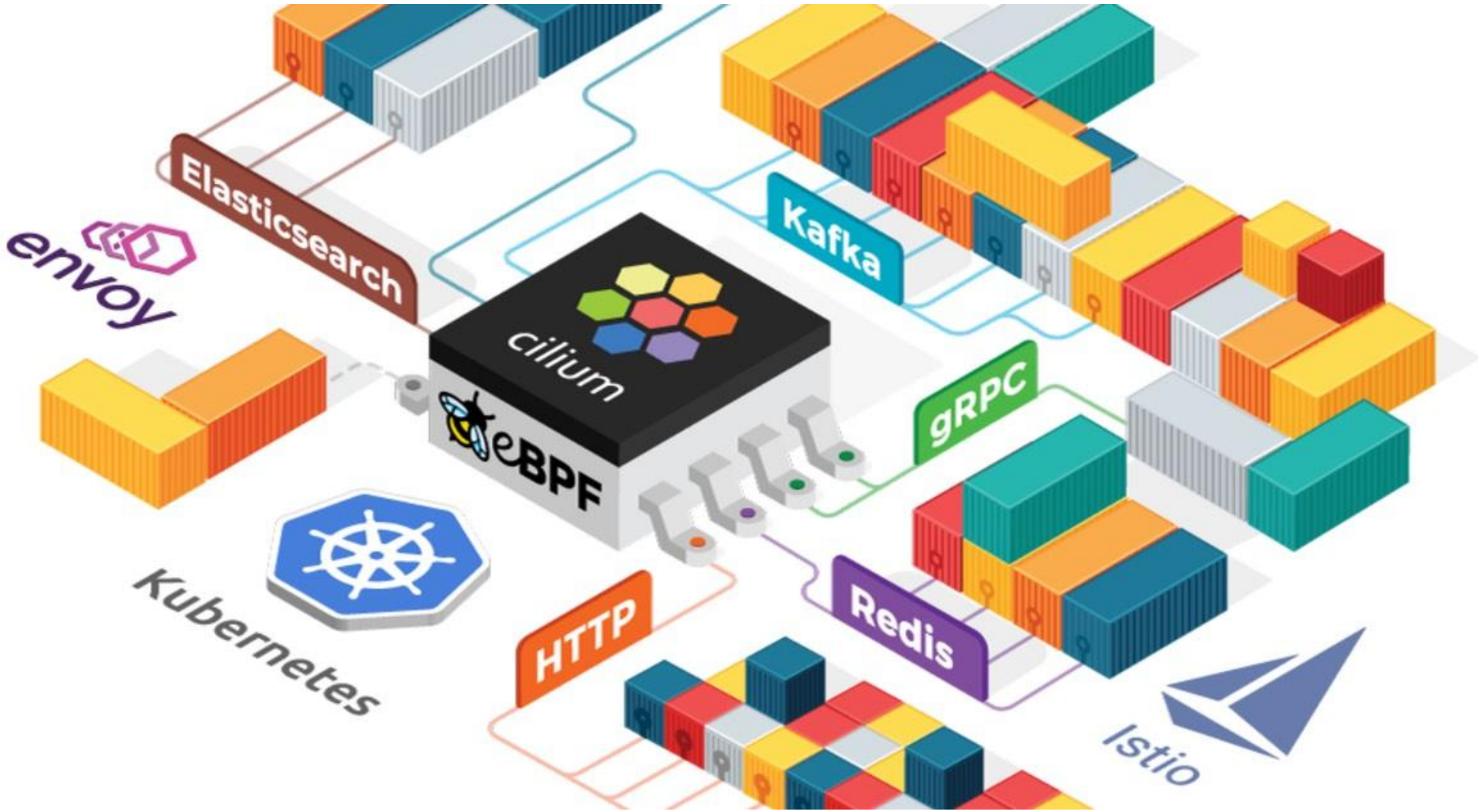






Demo 1: https://youtu.be/LSSNA-W2GWA?si=xKbq3Jr-BiJmXvuW
Demo 2: https://youtu.be/f84rzH8ERCs?si=RgJs5mlp5b8PCkY8

What Next ?


Elasticsearch
Kafka
envoy
cilium
eBPF
gRPC
Kubernetes
HTTP
Redis
Istio

What Next ?

- eBPF around the World ?
- User space vs Kernel space to make eBPF difference ?
- Step-by-Step Go programming with eBPF !!!
- “Maps” user application and kernel program ?
- Leverage ultimate capability of eBPF for our job ?