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The creators of LINKERD

Life Without Sidecars

Is eBPF's Promise Too Good to Be True?

@BuoyantIO

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Agenda

- What is Linkerd and why you need it
- The three pillars of a modern service mesh
- The basics of eBPF and how it relates to networking
- Can eBPF replace the proxy
- Sidecar proxies - should we get rid of them
- Q & A

What is Linkerd ?

Linkerd

- Simple and easy to use service mesh
- Uses a purpose-built micro proxy
- CNCF graduated project
- Thriving open source community
- Uses the sidecar model

Observability

- Golden metrics for HTTP and gRPC traffic
- TCP level metrics
- Topology graphing for insights into the runtime communication characteristics of your services
- Request sampling - on demand inspection of requests

Security

- Automatic mTLS for all meshed traffic without code changes
- Authorisation policies for fine grained traffic control at L7
- HTTP access logging audit
- Per pod isolation for security and operability reasons

Reliability

- Advanced retries and timeouts
- Traffic splitting and automatic canary deployments
- Multi-cluster connectivity and automated failover
- Intelligent latency aware load - balancing

High level architecture

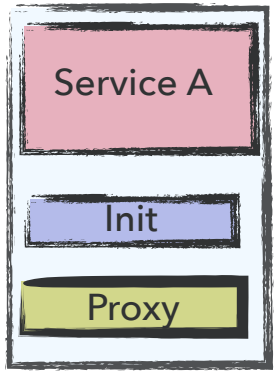
Control plane

- TLS certificates for the proxy
- Service Discovery
- Service profiles
- Dashboard + Metrics
- Identity aware policy
- API interface for CLI commands

Proxy (Data plane)

- Ultralight transparent proxy written in Rust
- Automatic Prometheus metrics export for HTTP and TCP traffic
- Latency-aware load balancing
- Automatic mTLS
- On-demand diagnostic tap API

Request path



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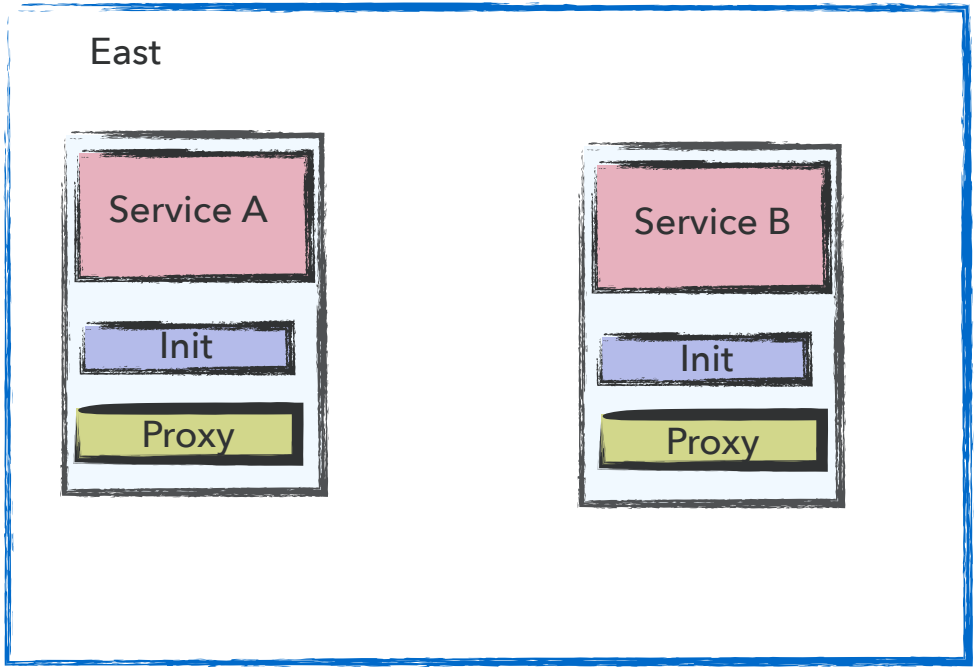

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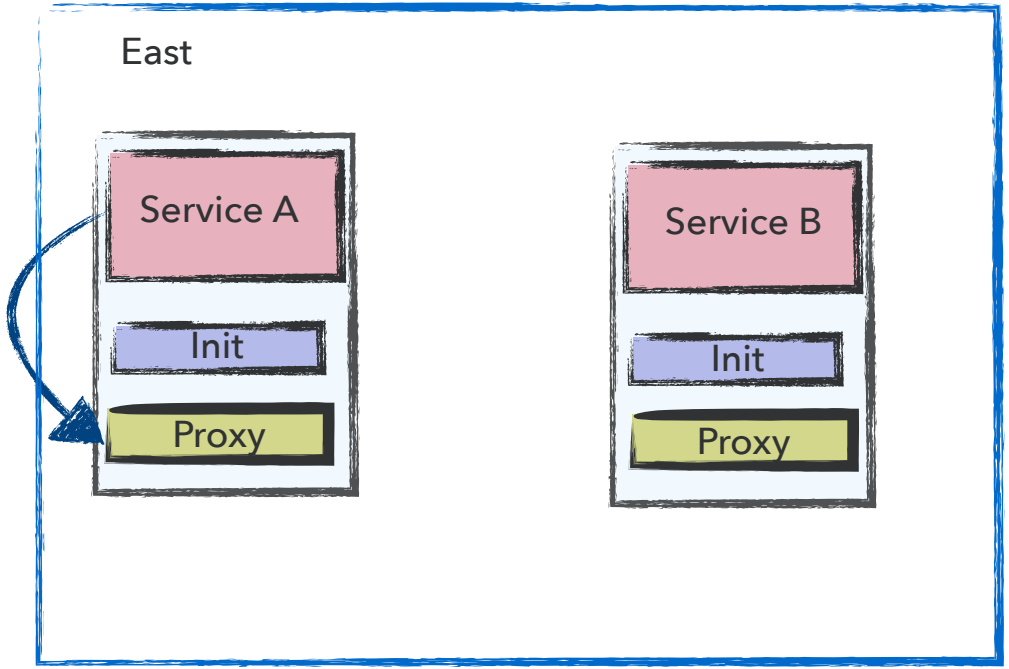

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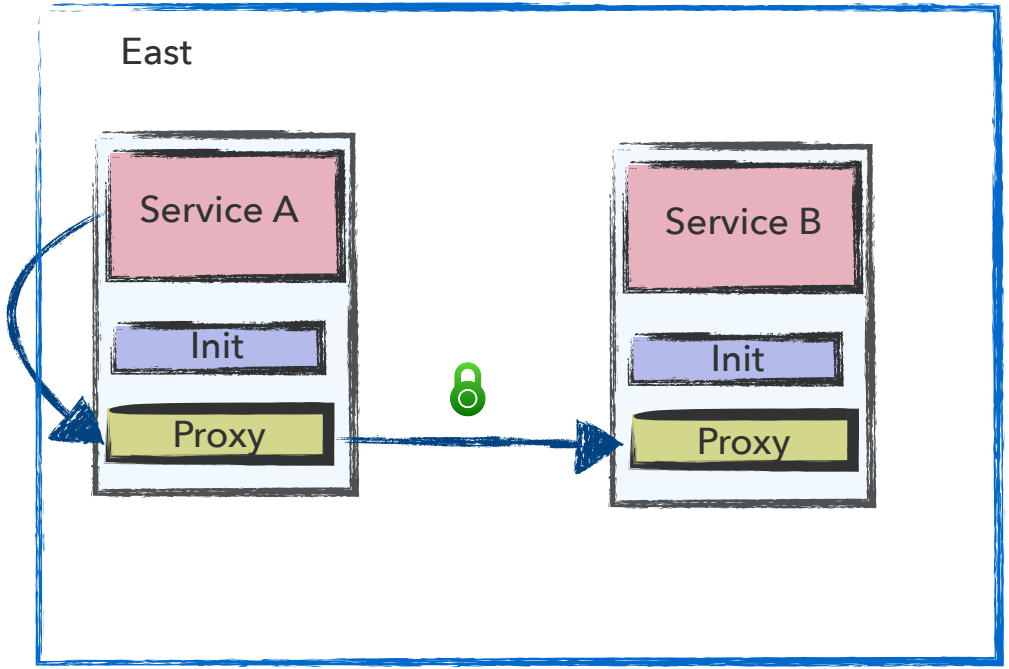

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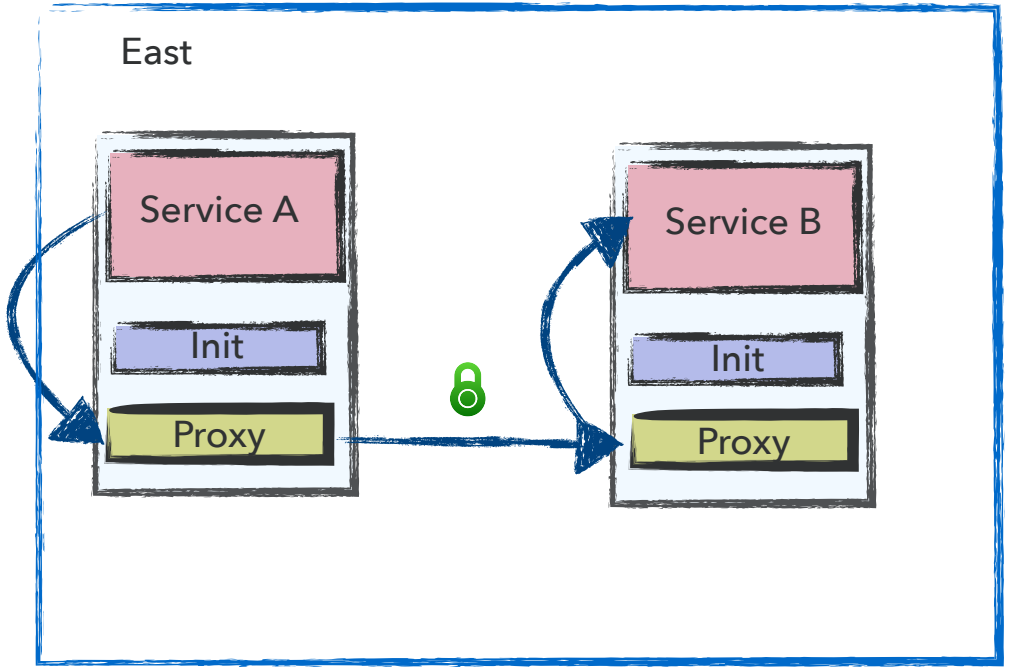

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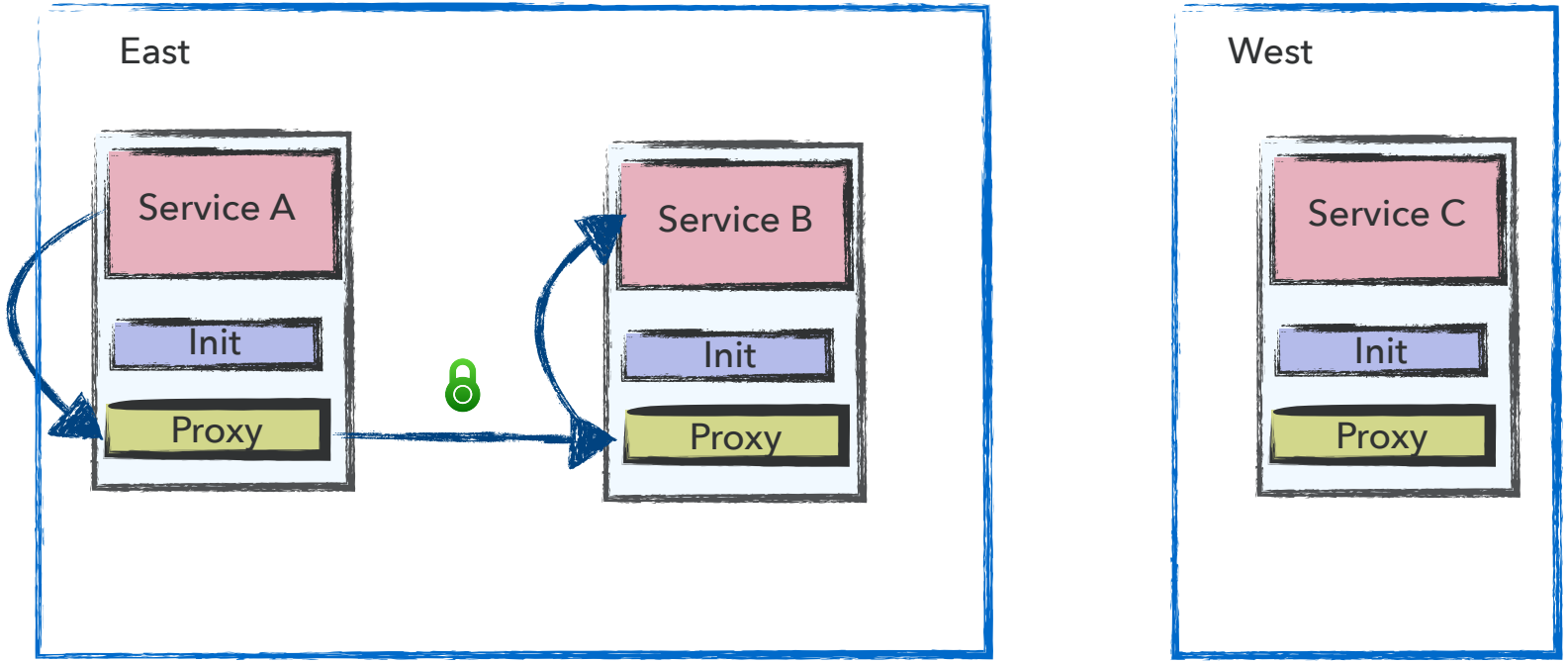

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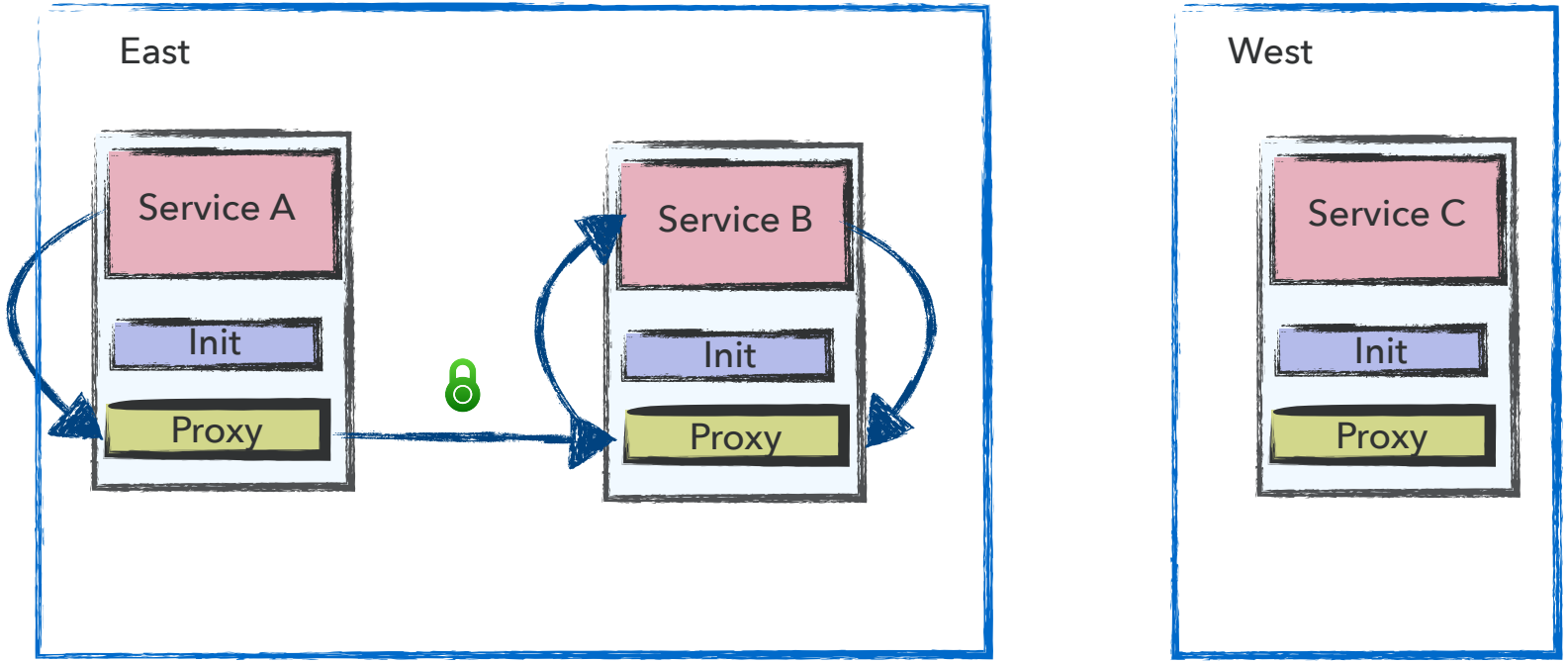

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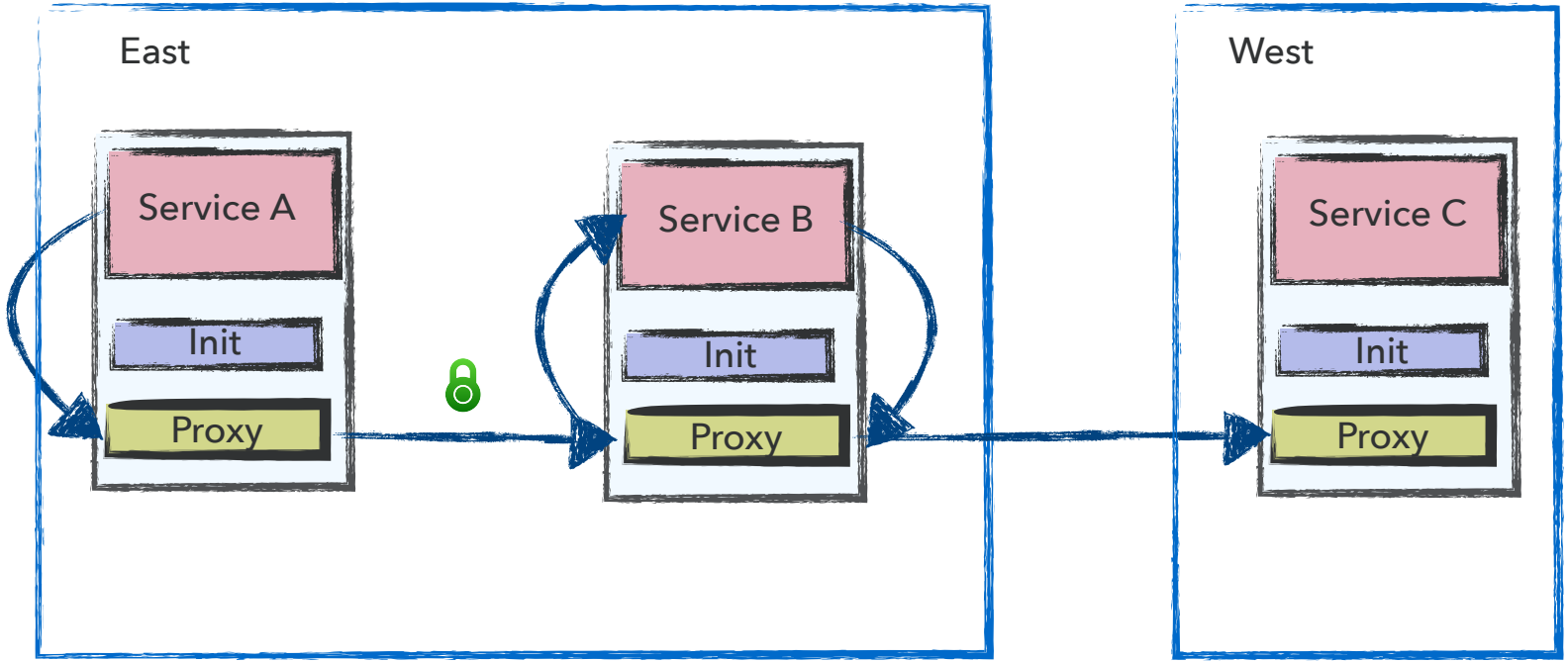

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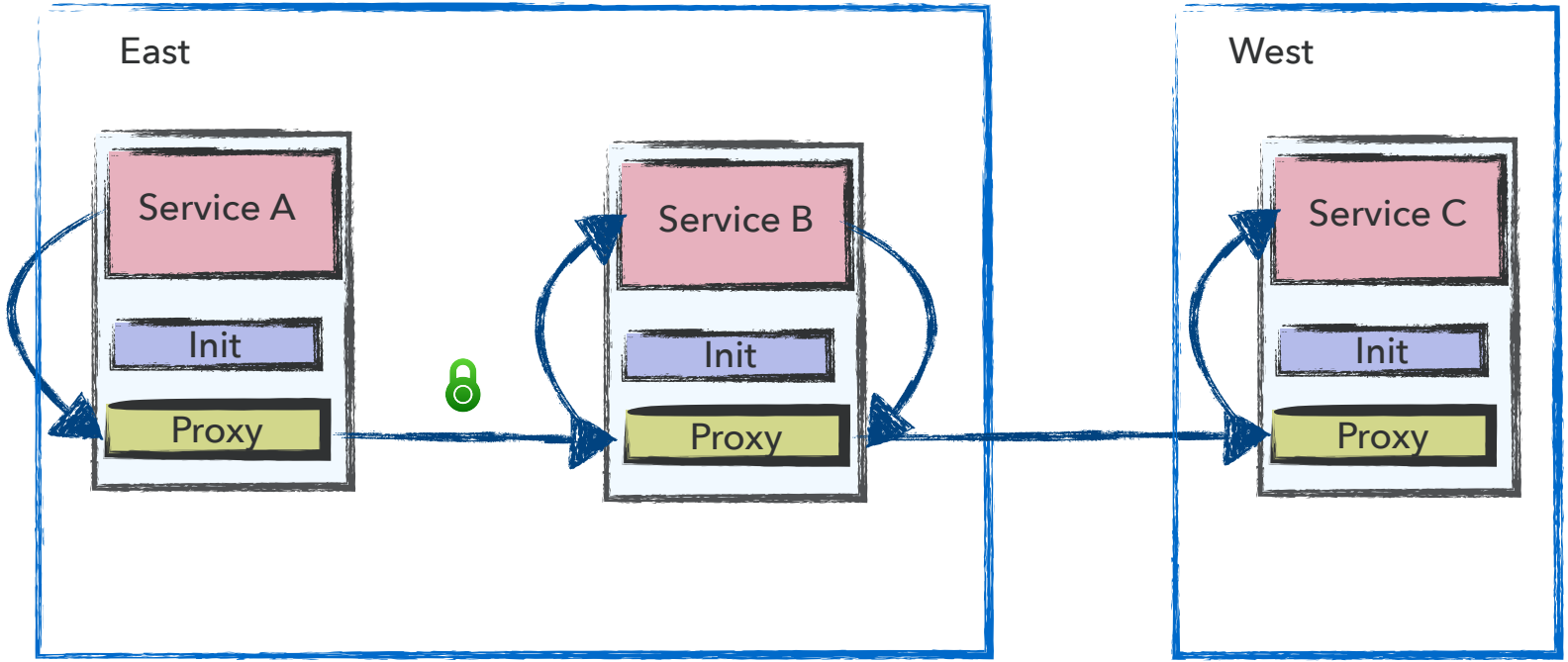


eBPF overview

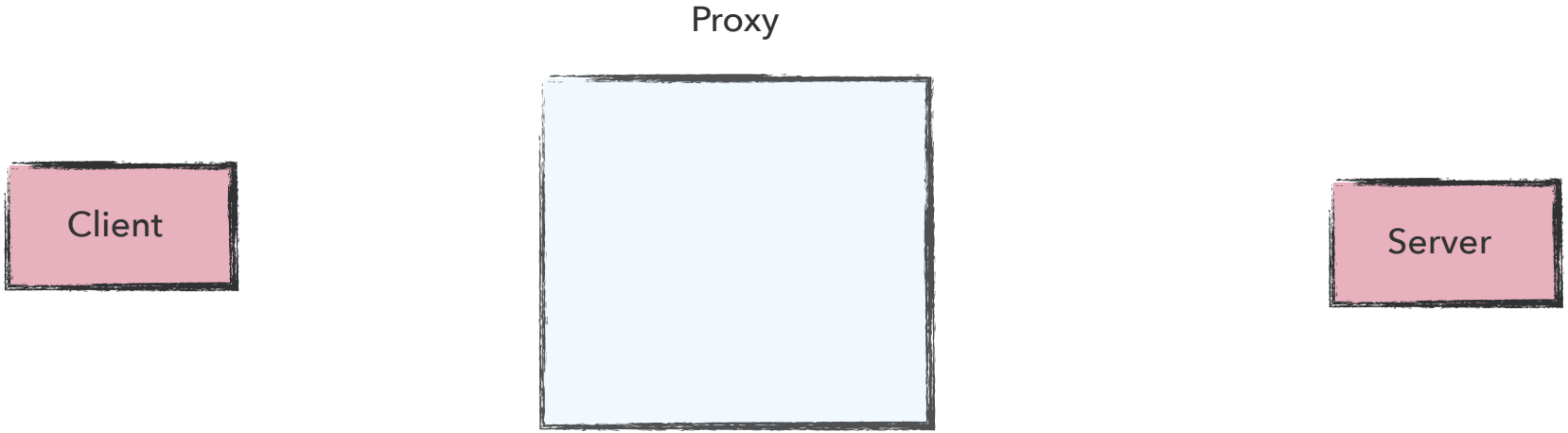
eBPF overview

- Interface to make the kernel programmable
- Event driven, runs in kernel space
- Efficient - allows developers to avoid data transfers to user space and minimises context switches
- Safe - programs are subject to strict requirements so halting the kernel is impossible

Traditional reverse proxy

Traditional reverse proxy

Traditional reverse proxy



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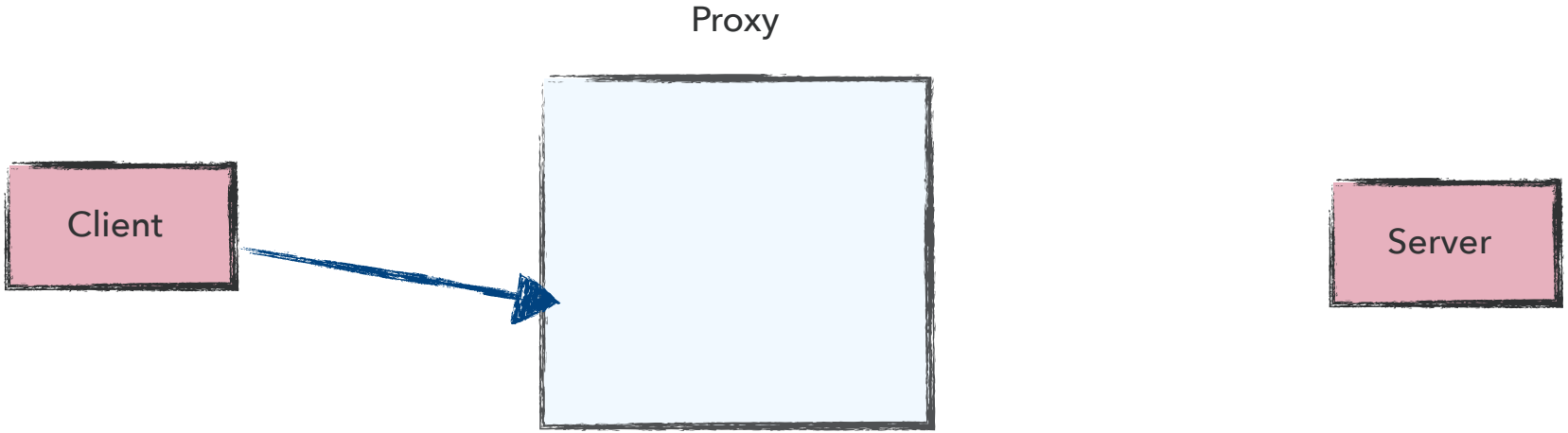

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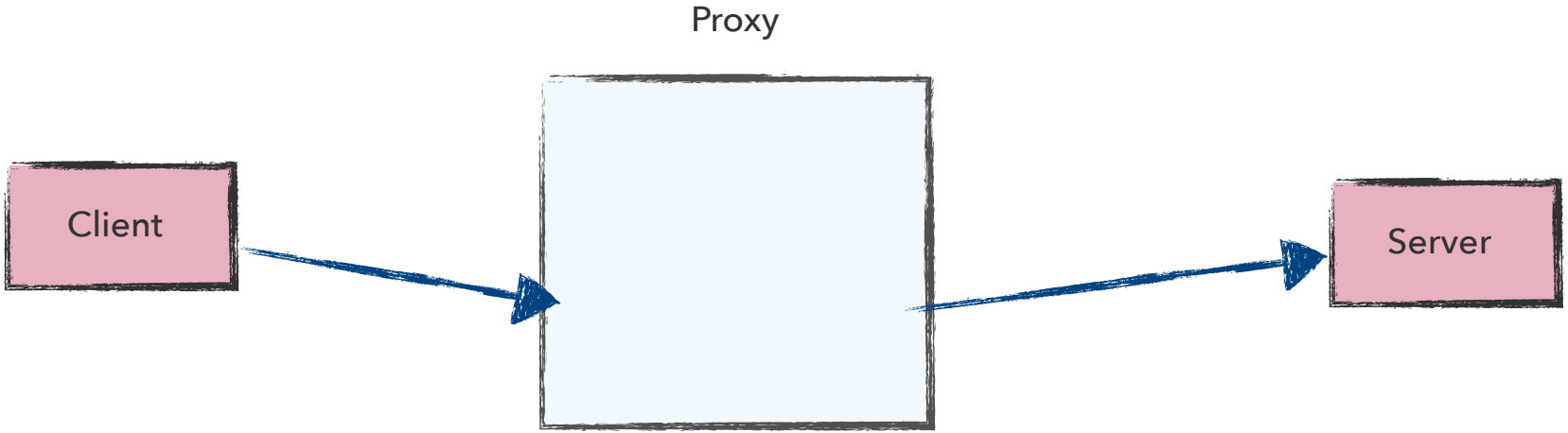

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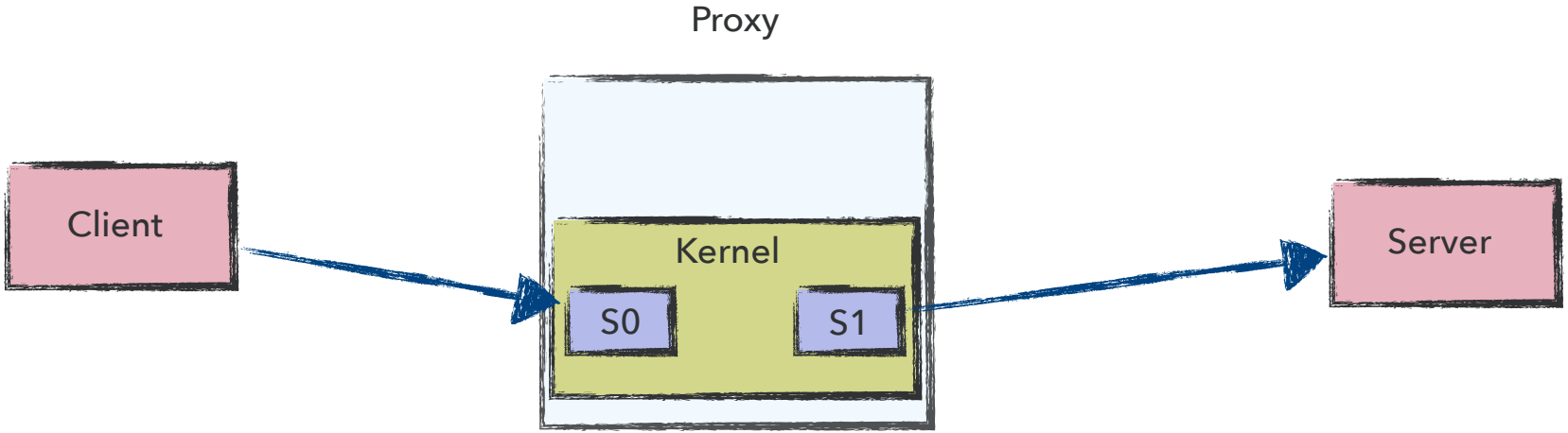

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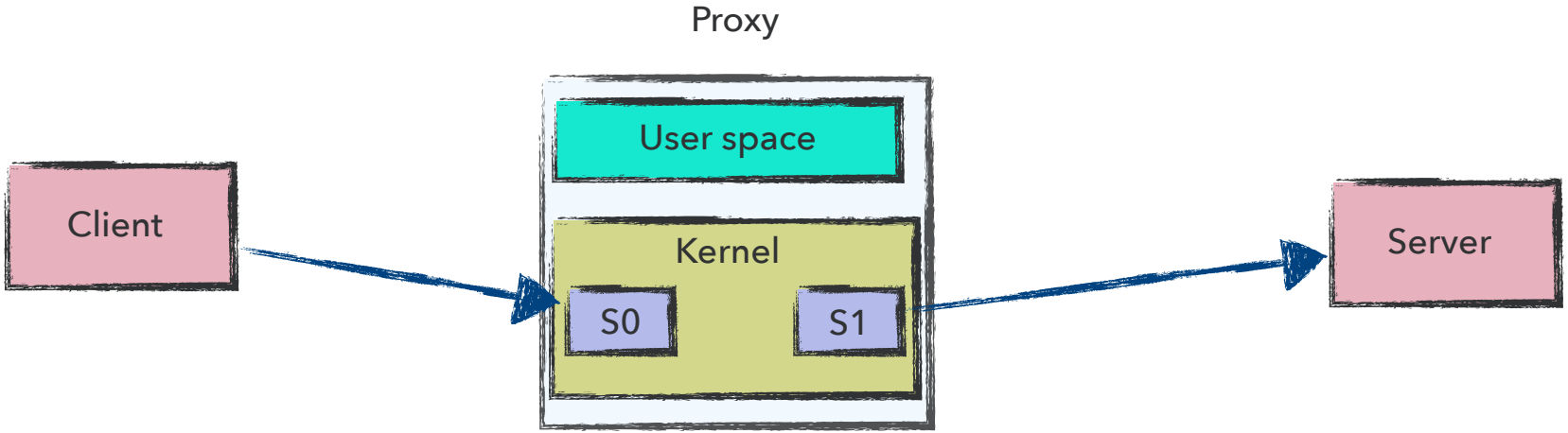

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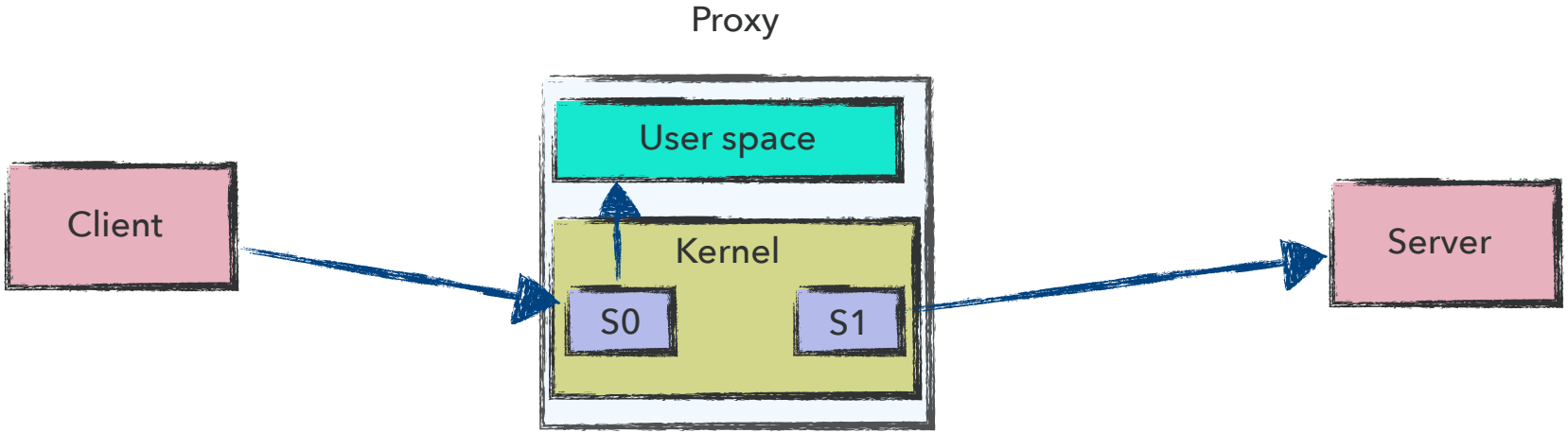

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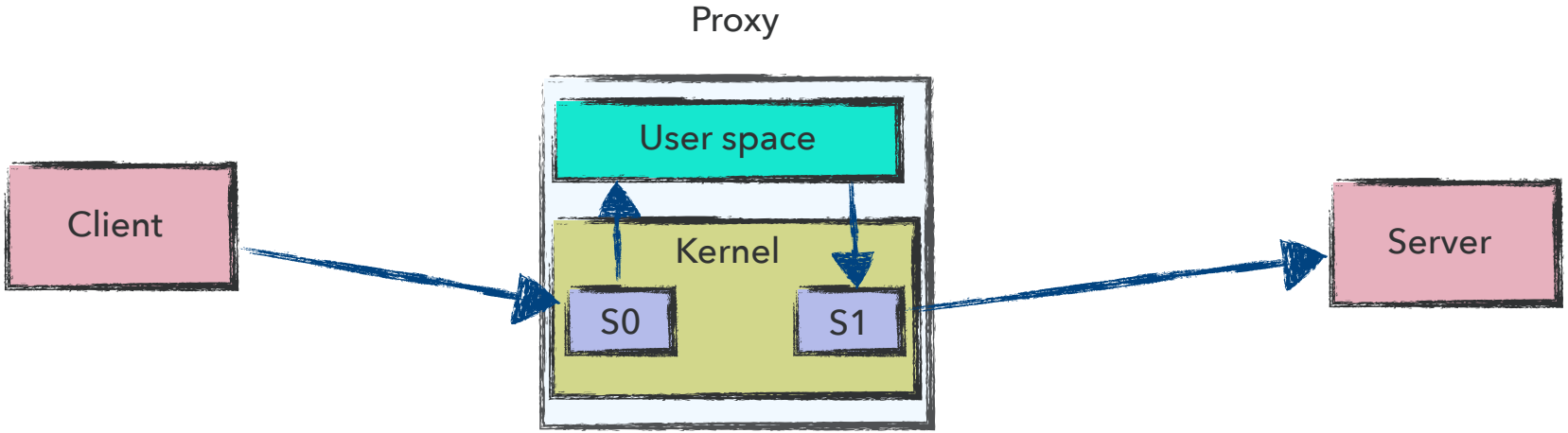


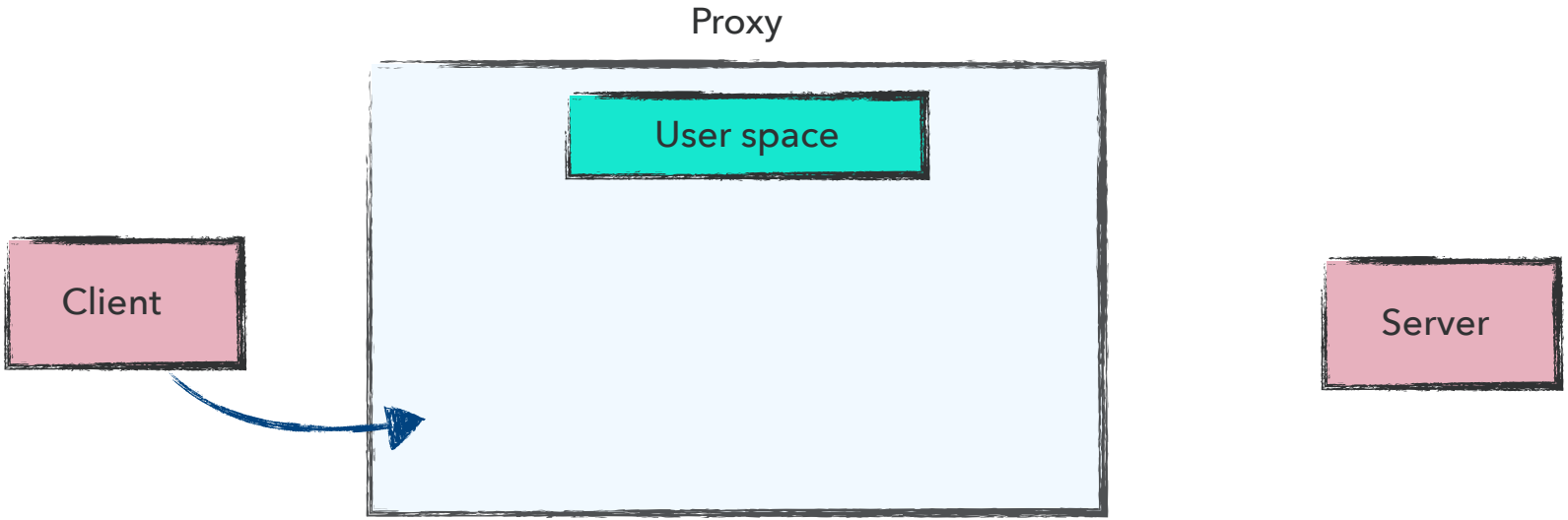
Drawbacks

- Syscall costs
- Wakeup latency
- Data copying costs

Sockmap

- eBPF's sock map is a data structure that can help in this scenario
- It stores references to sockets and allows eBPF programs to redirect TCP packets entirely in kernel space
- It can be used to accelerate reverse proxies and load balancers

Sockmap based proxy



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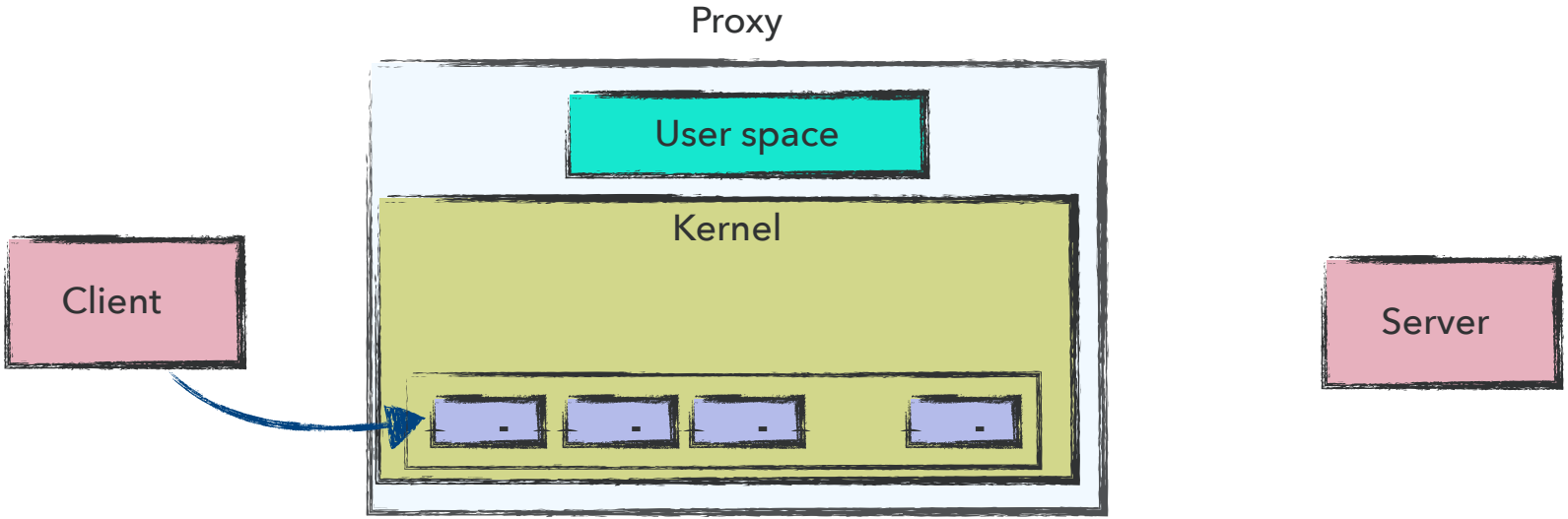

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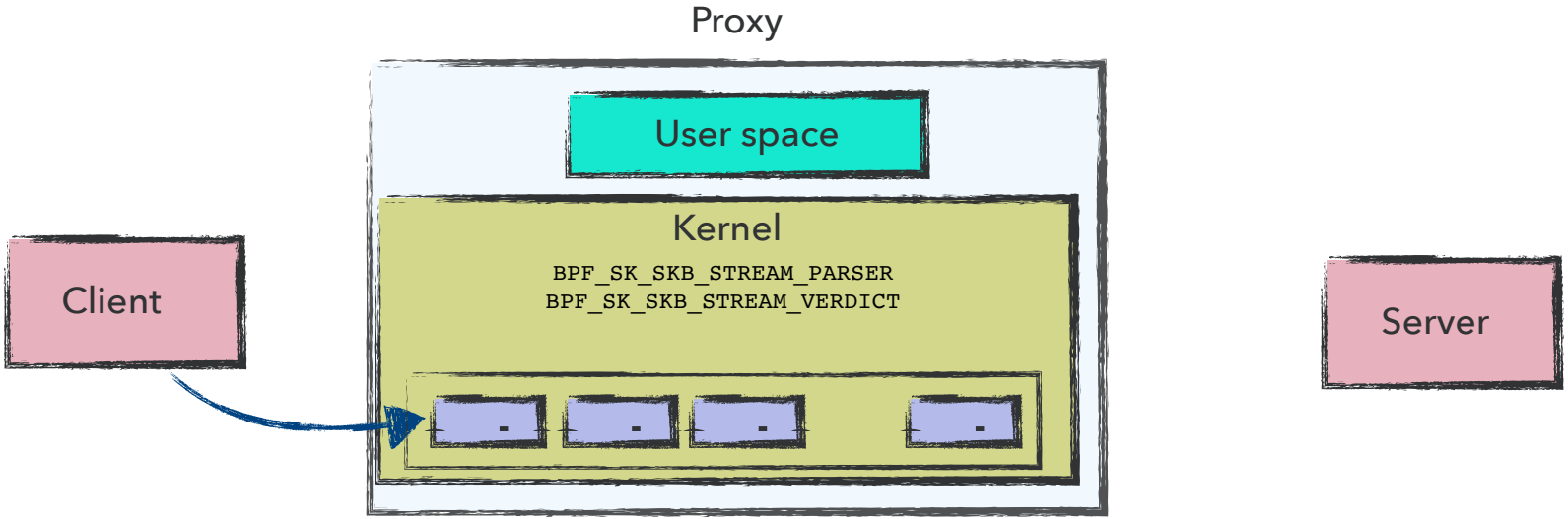

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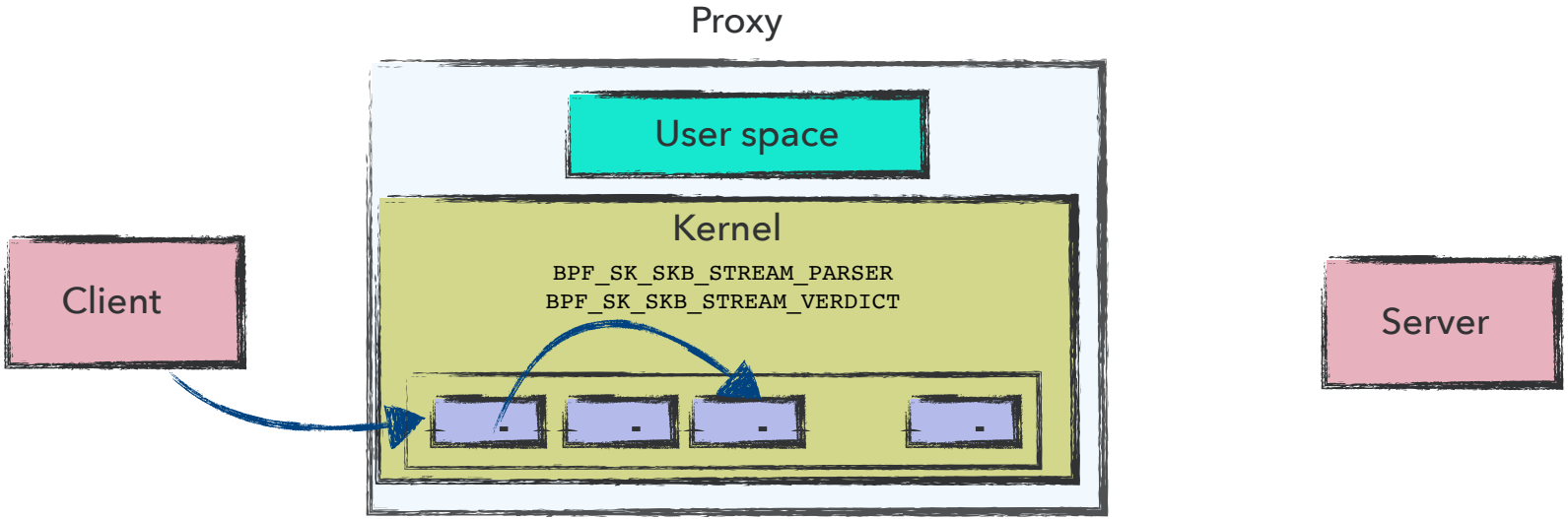

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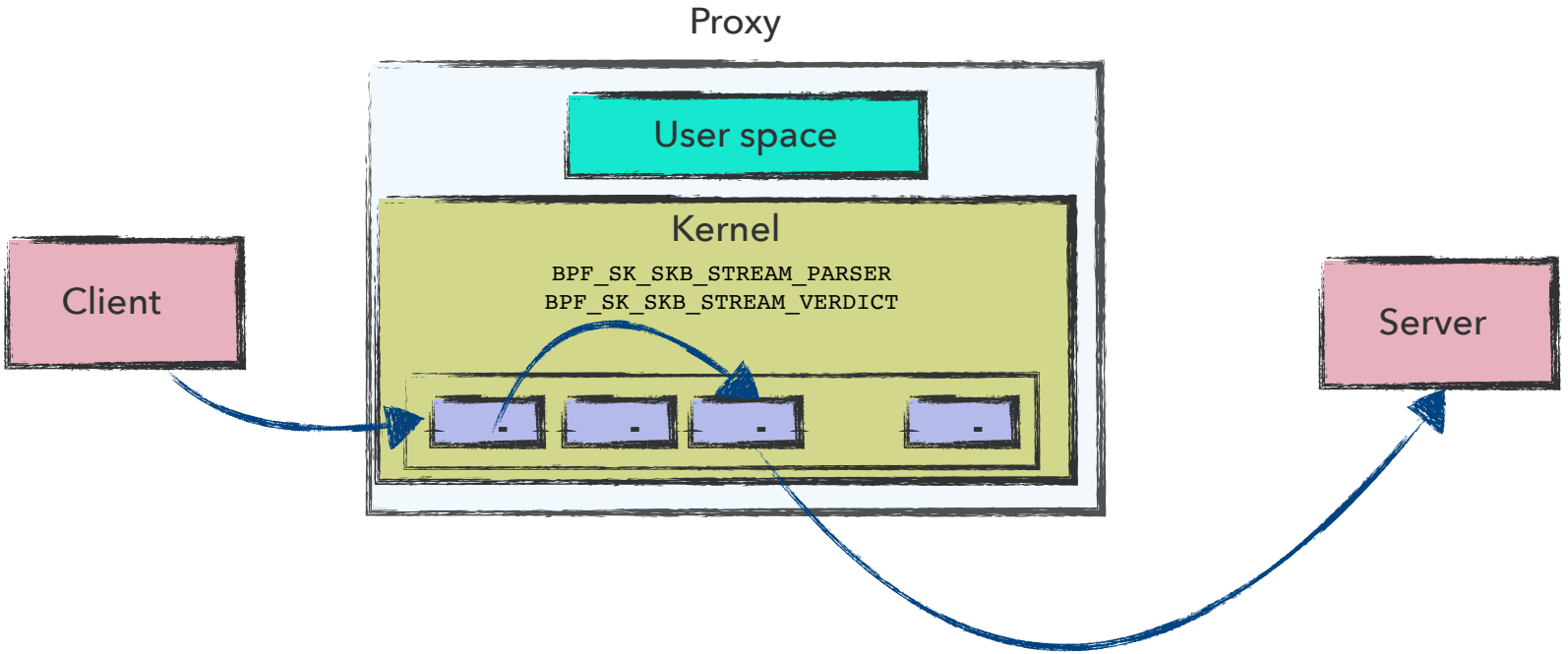

Advantages

- No copying of data from kernel to user space
- No context switching
- Flexibility

eBPF strengths

- Pod and container statistics
- Traffic metrics
- Syscall interception and audit
- Layer 4 routing

The sidecar is going away !!!

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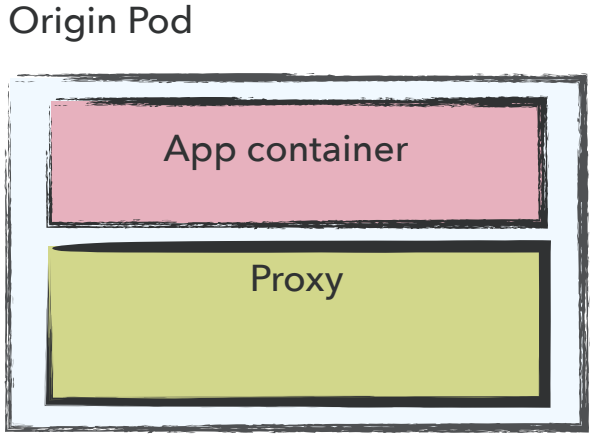
Could it all be true ?

eBPF use cases

- Observability - container level statistics, continue profiling of applications
- Security - syscall interception and audit
- Reliability - load balancing, reverse proxies

Latency aware load balancing



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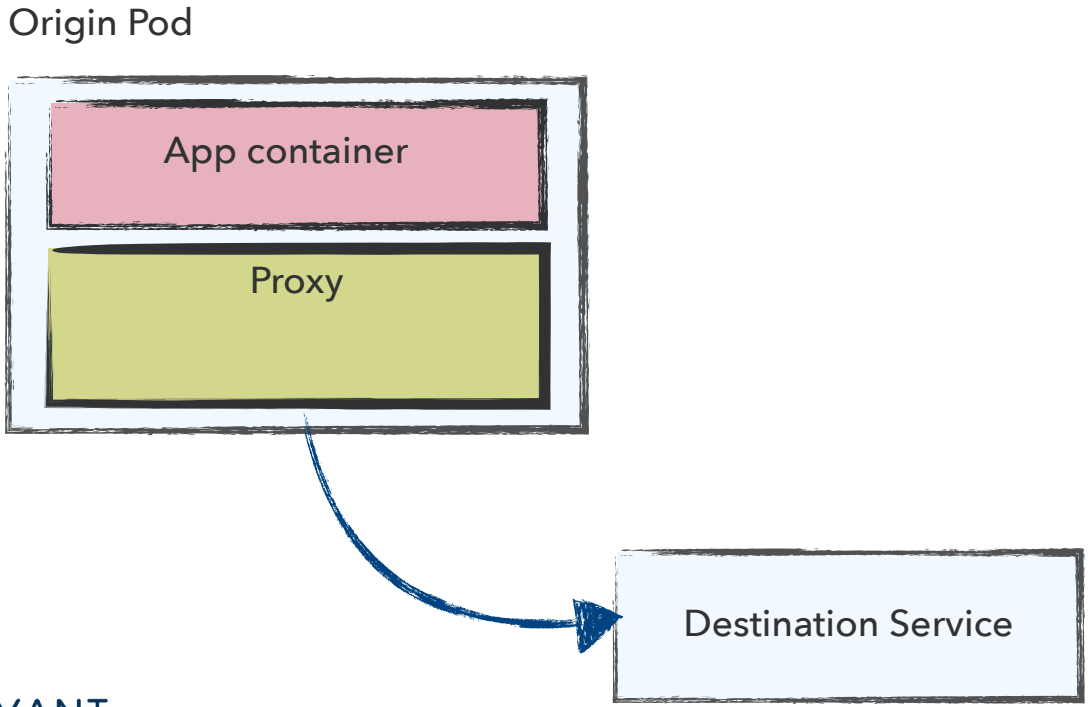

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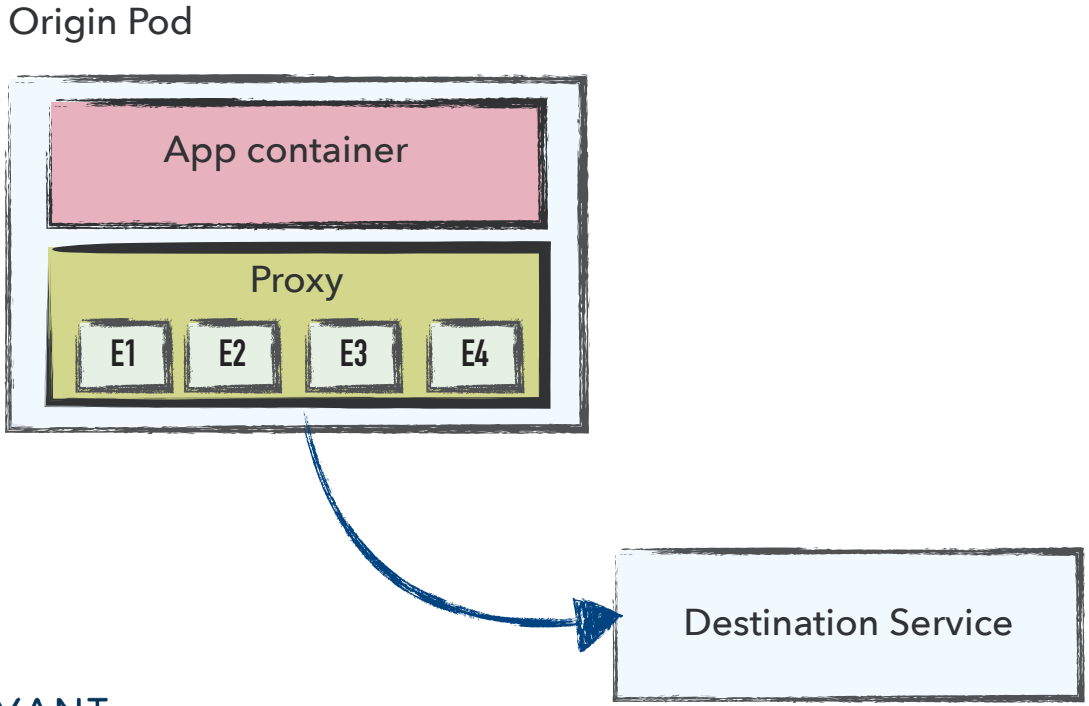

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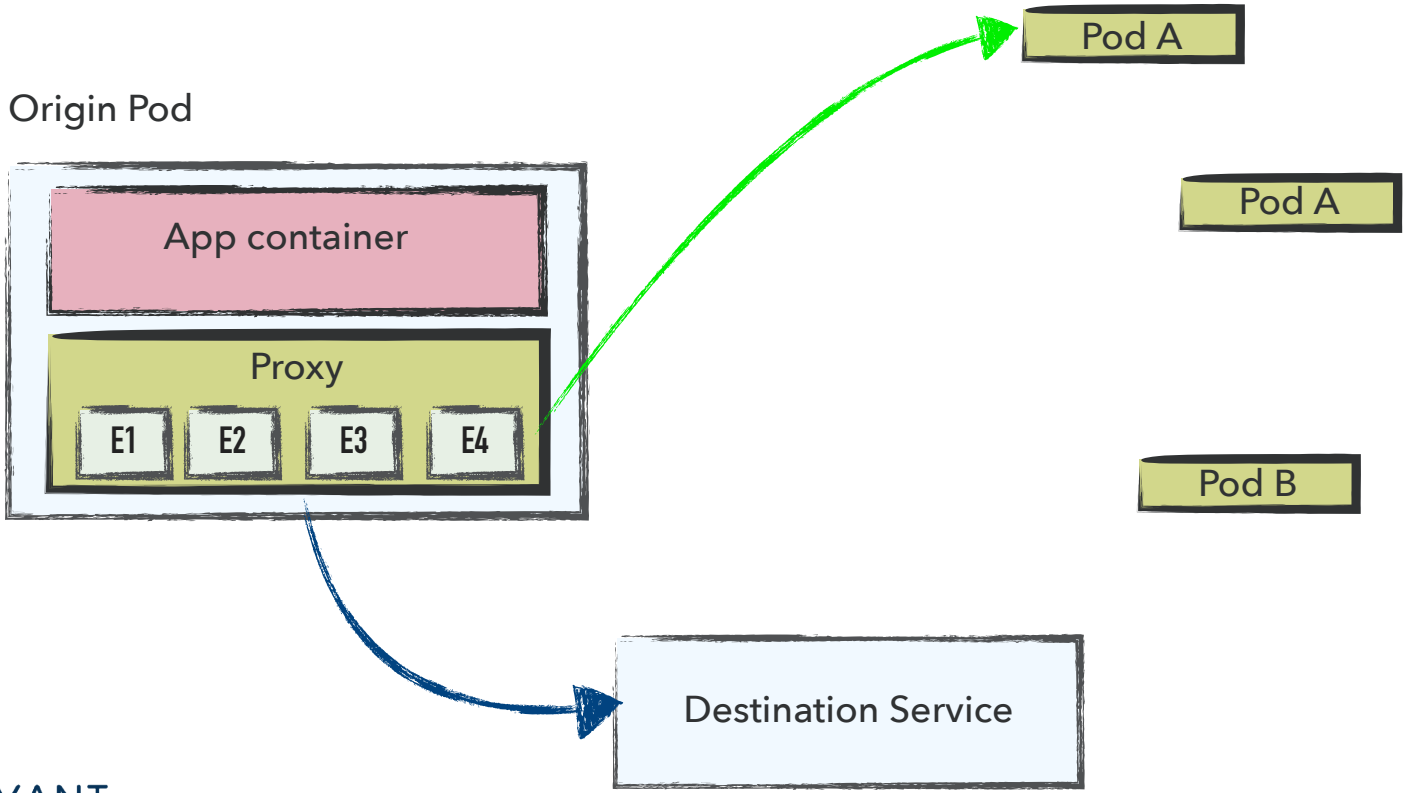

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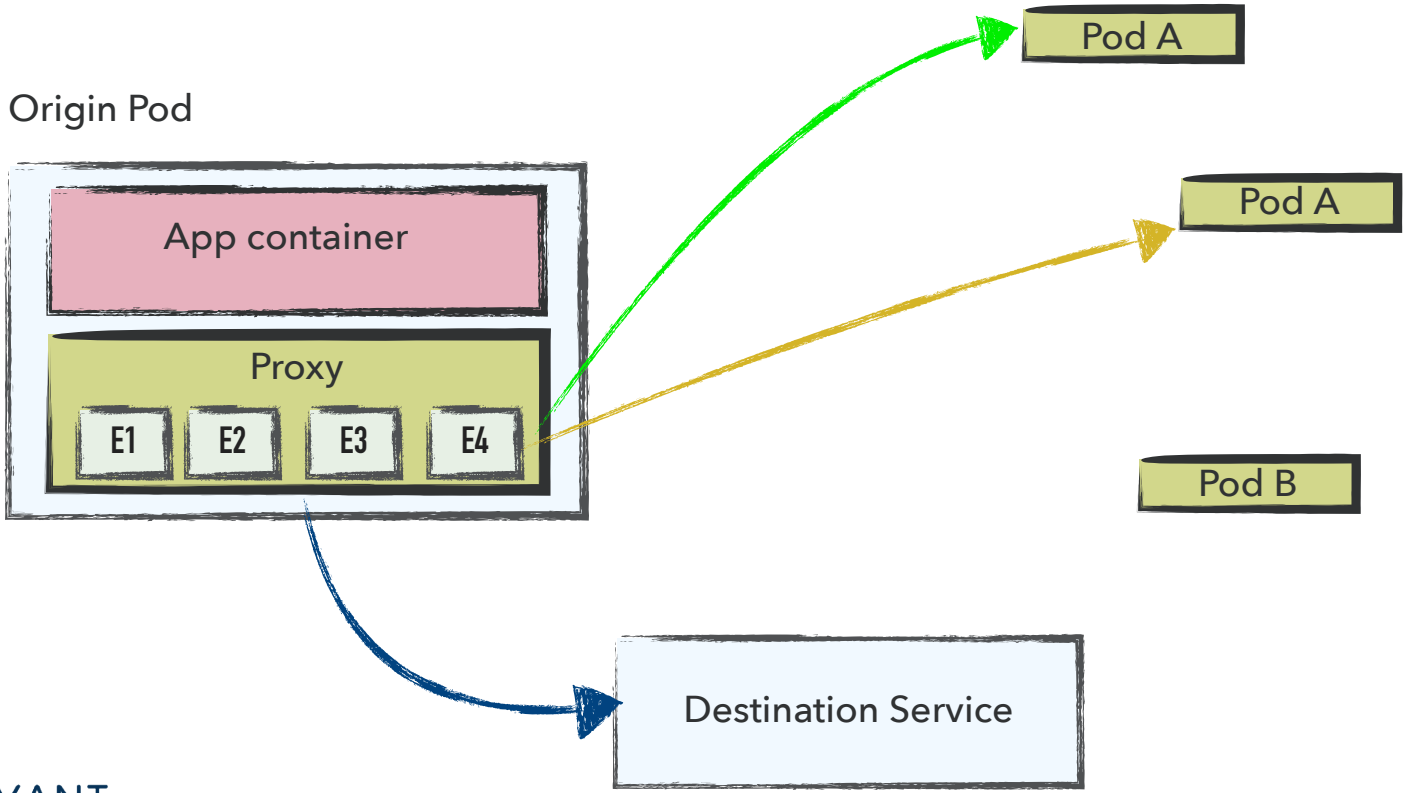

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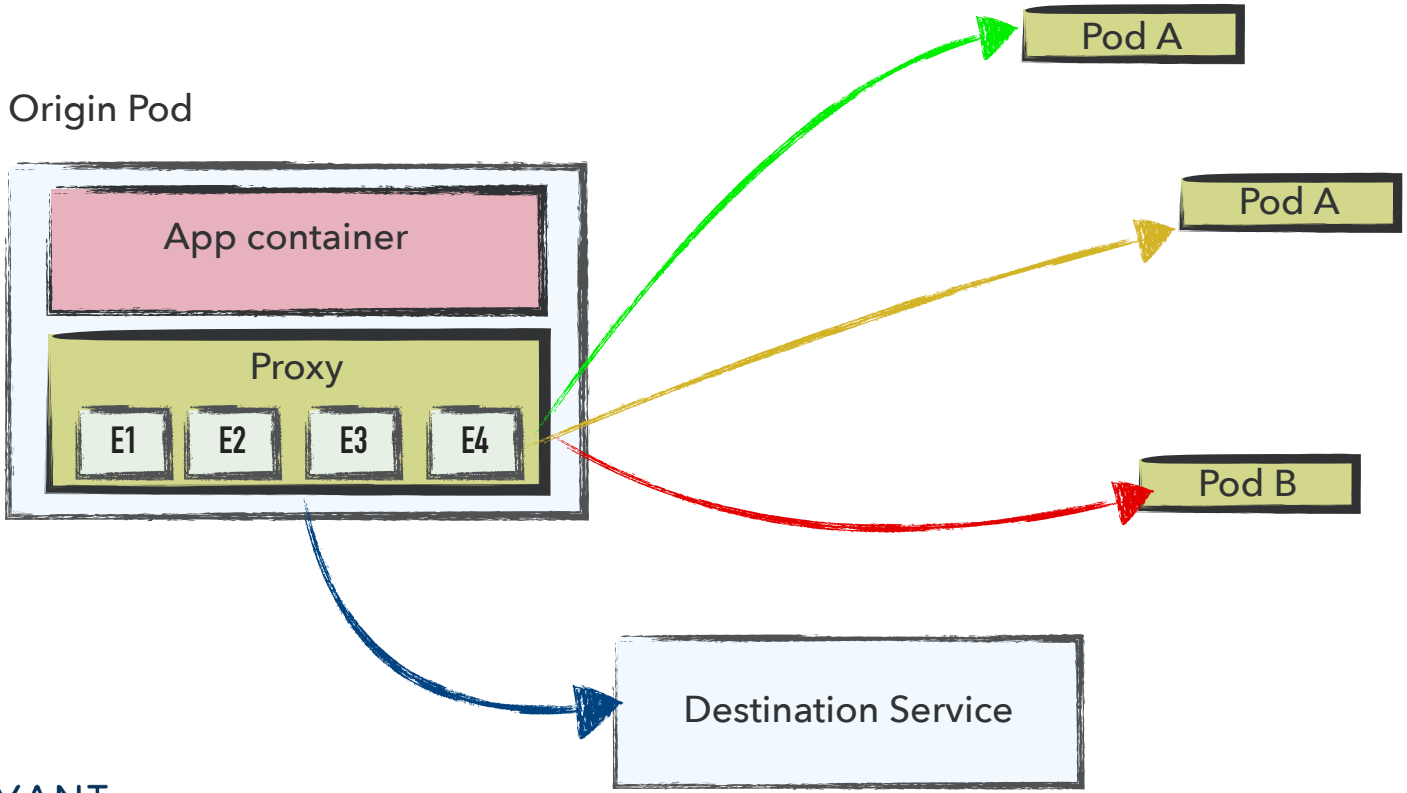
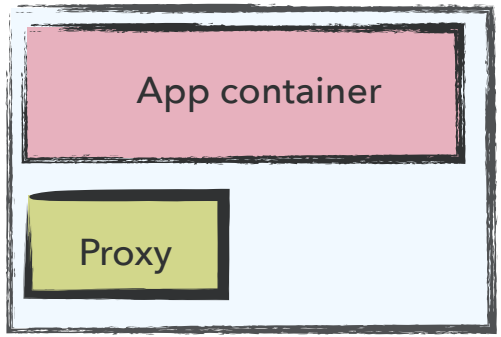


Identity based policy



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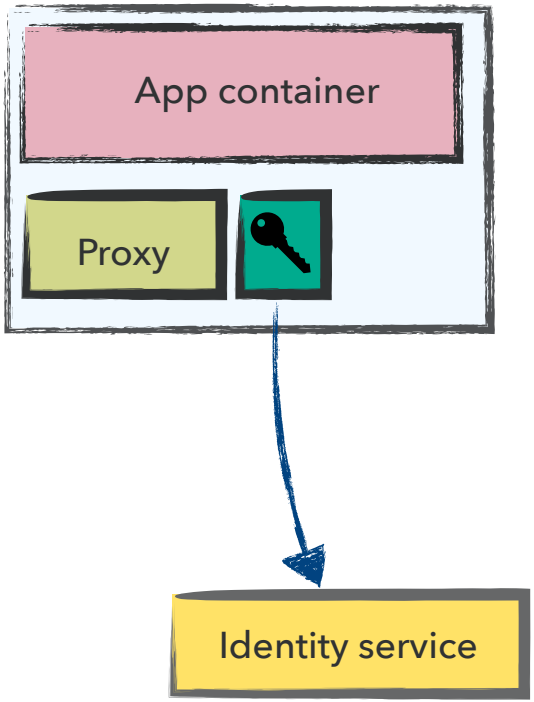

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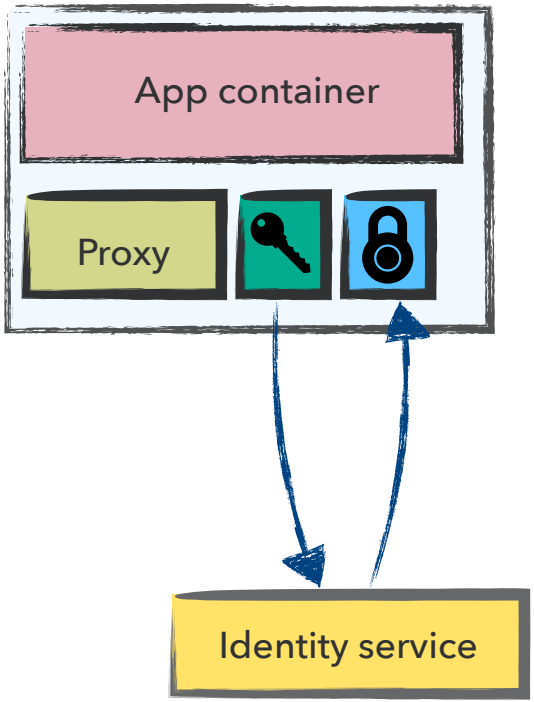

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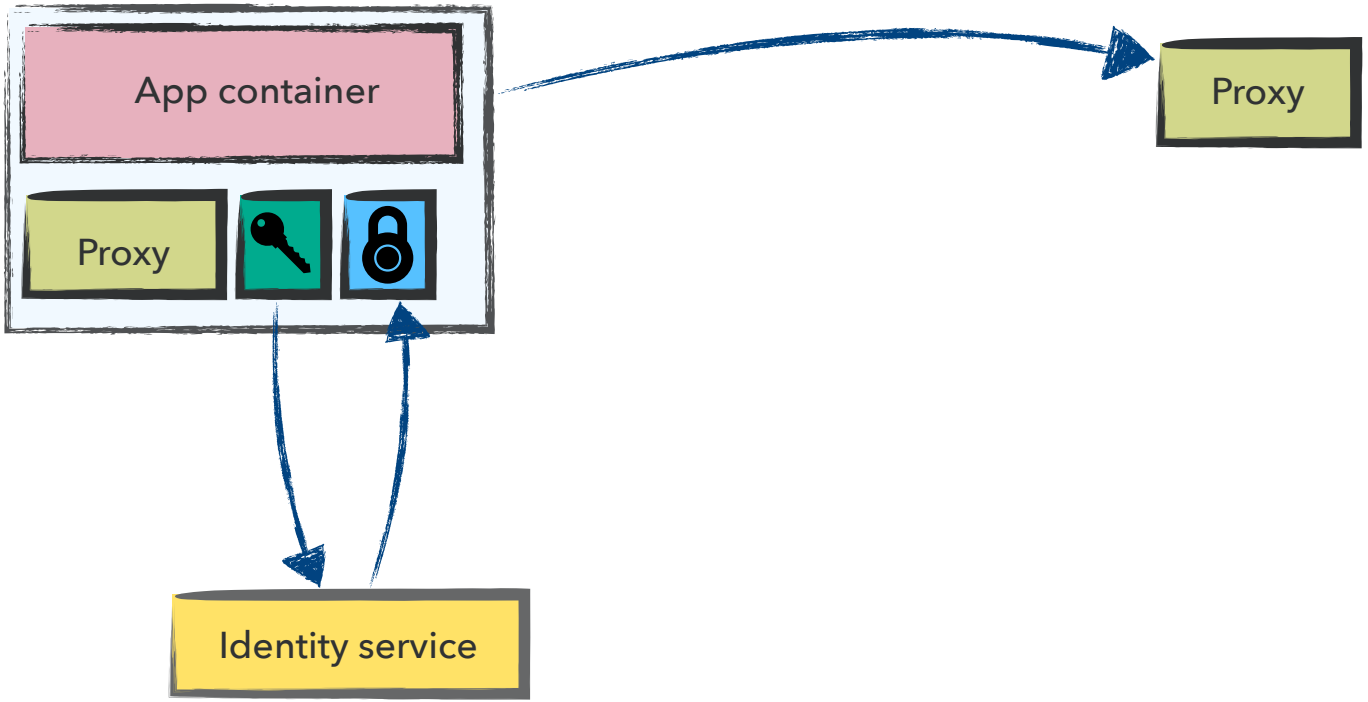

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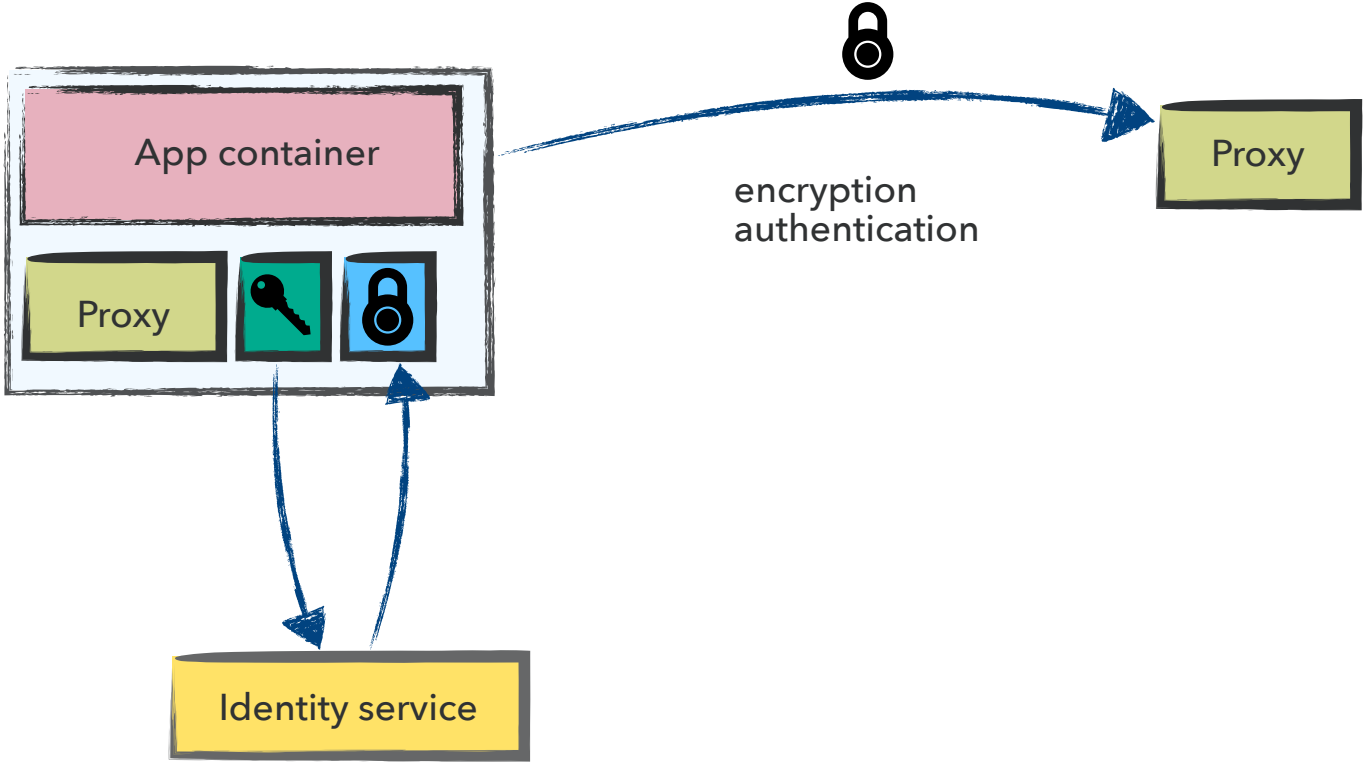

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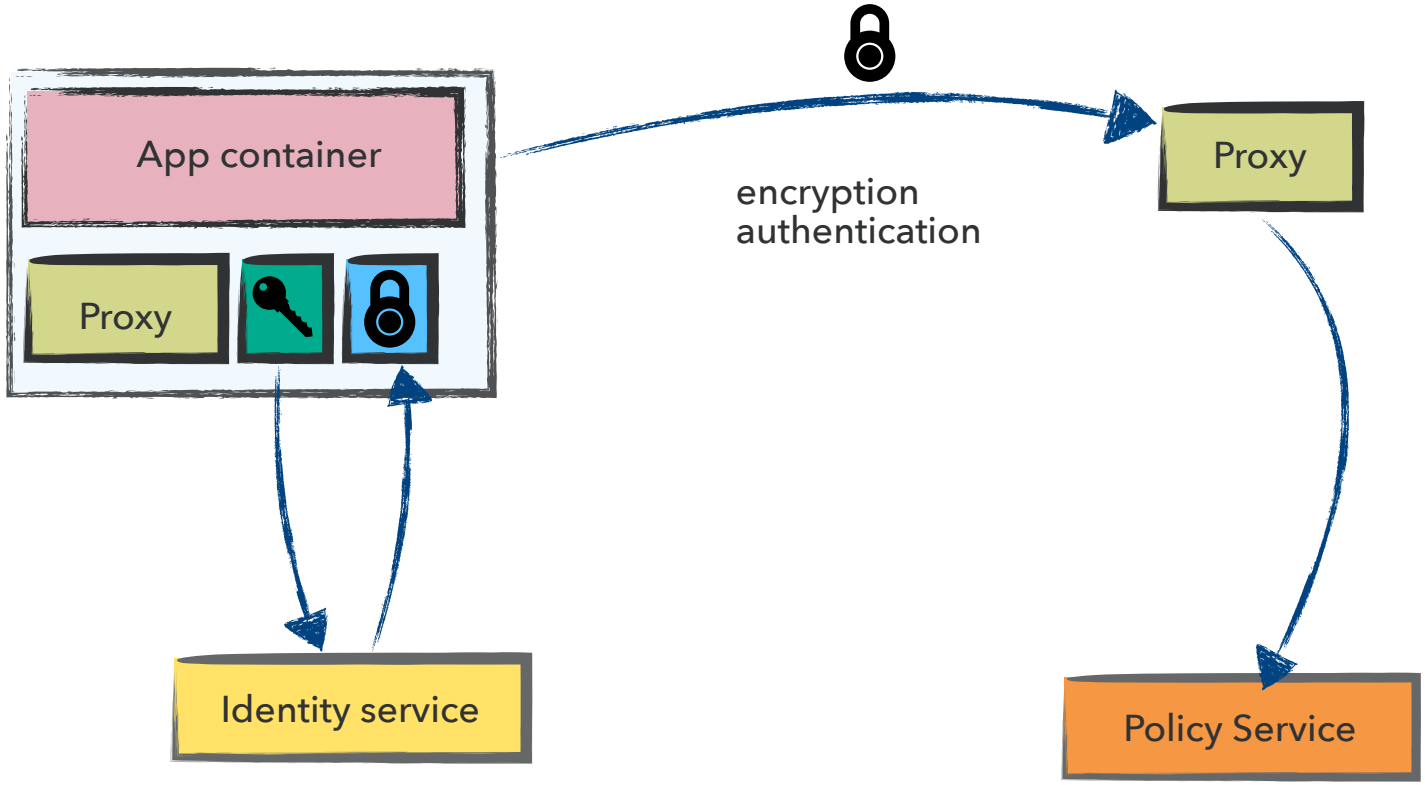

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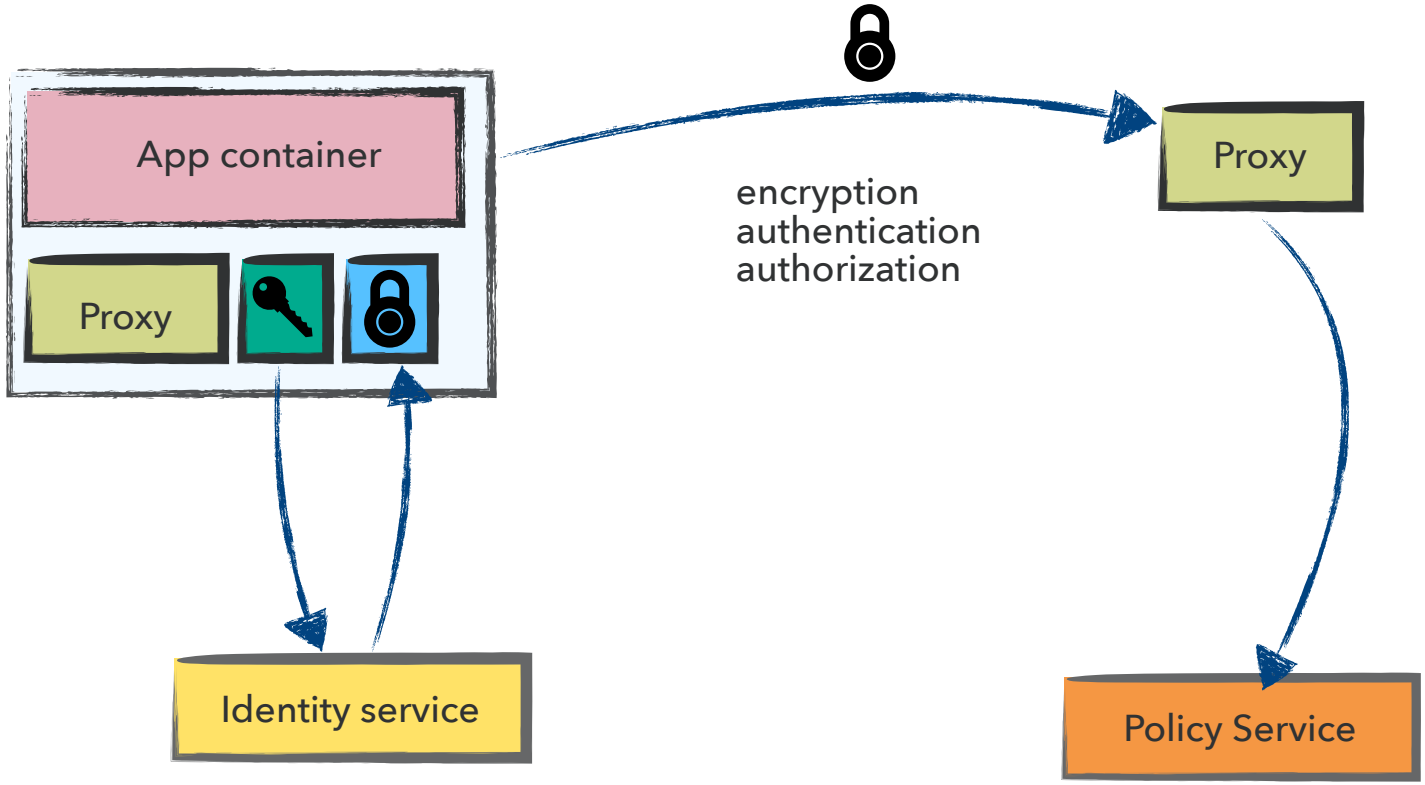
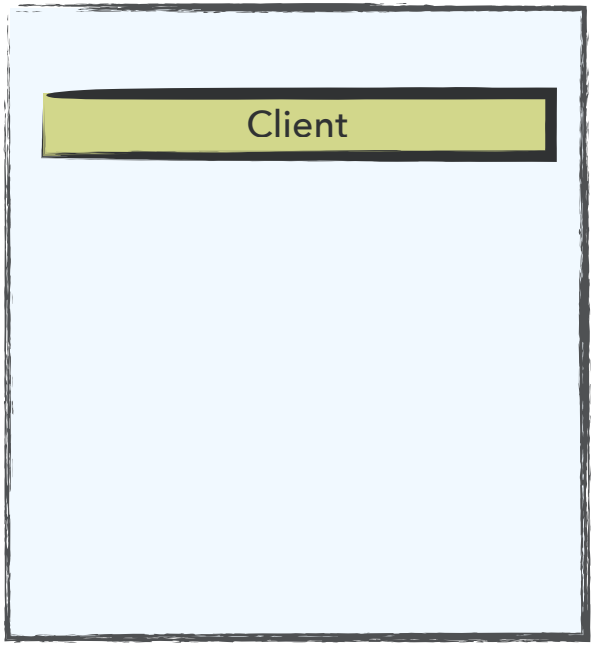


Identity based policy

9090 / admin-http
✓ Any traffic is allowed if: • mTLS'd from the `metrics-api` ServiceAccount
✓ Any traffic is allowed if: • mTLS'd from the `dive-viz` ServiceAccount in the `dive-viz` namespace
✓ Configured Kubernetes probes are allowed ⊘ Otherwise, traffic is denied
All other ports
✓ All traffic is allowed

Retries



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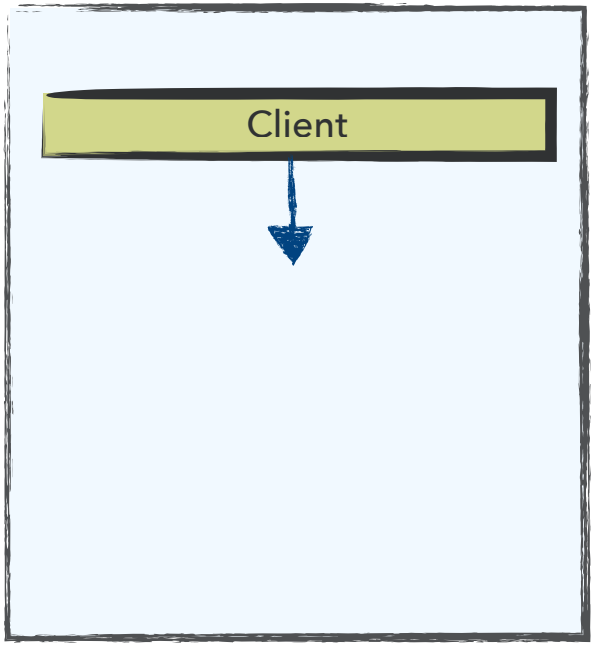

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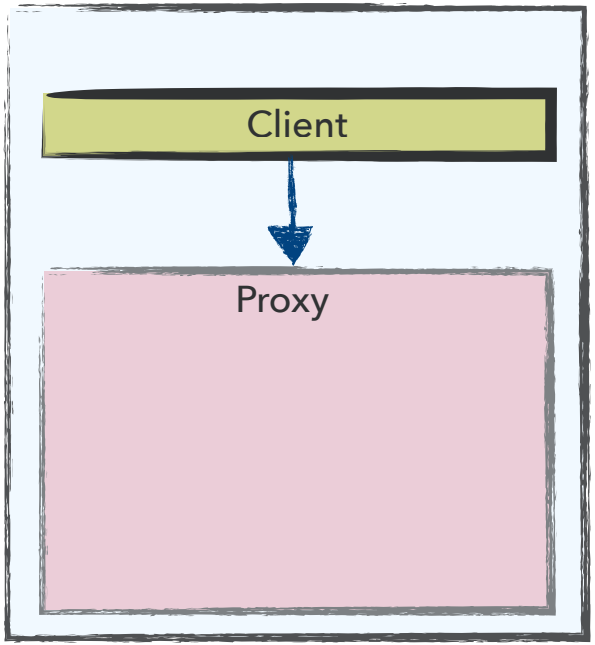

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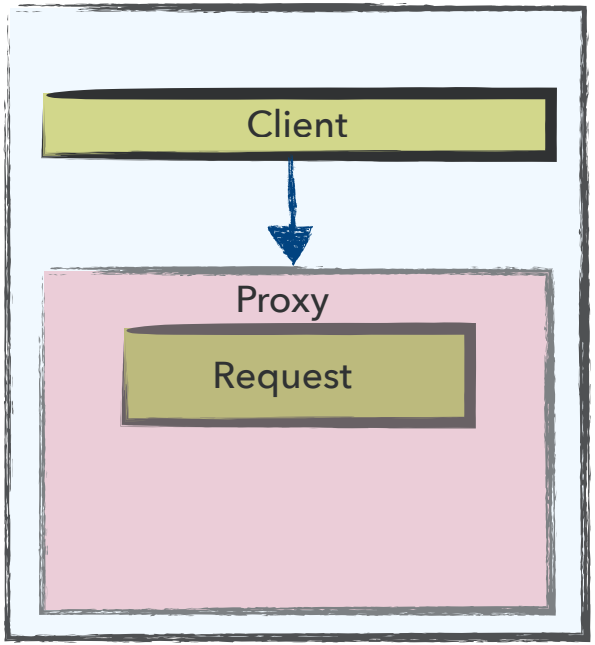

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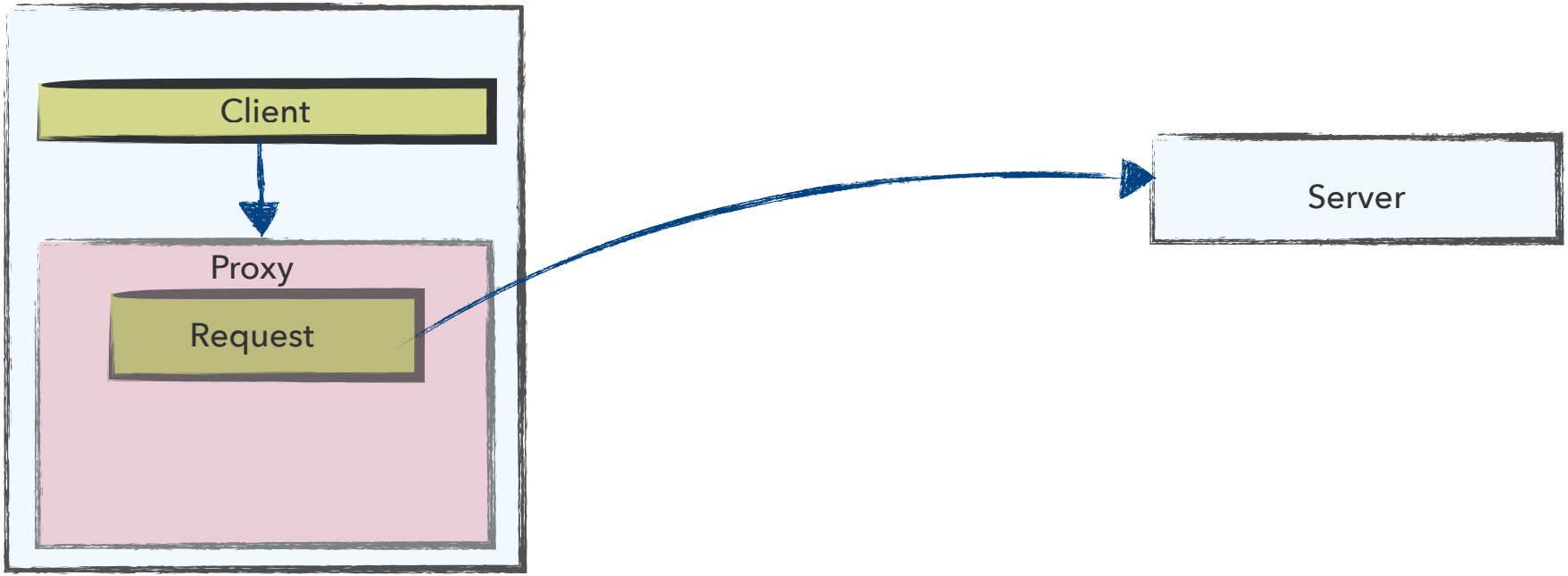

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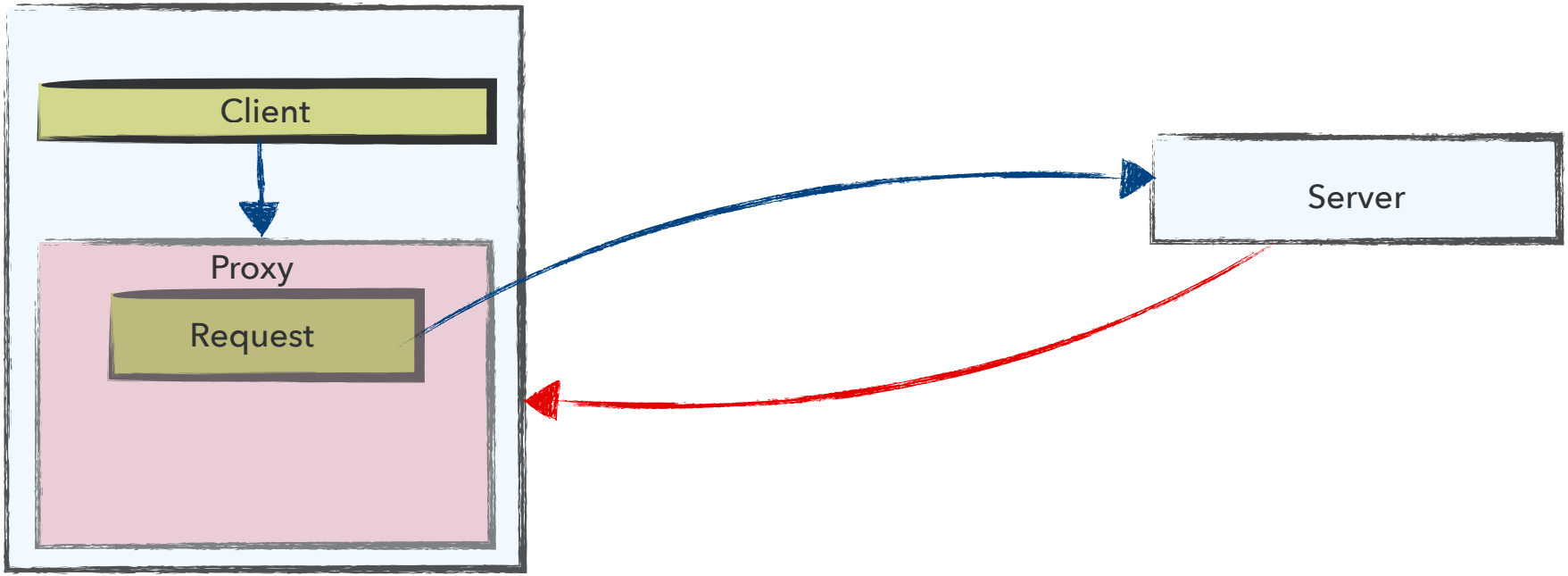

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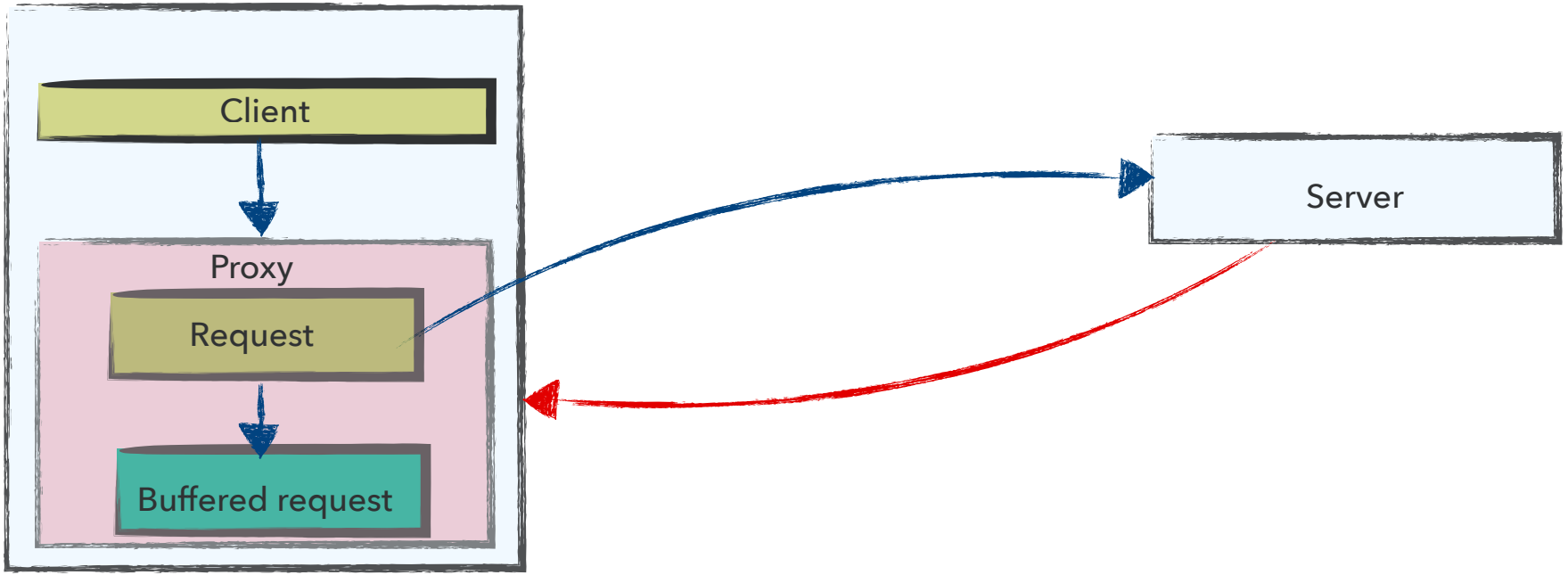

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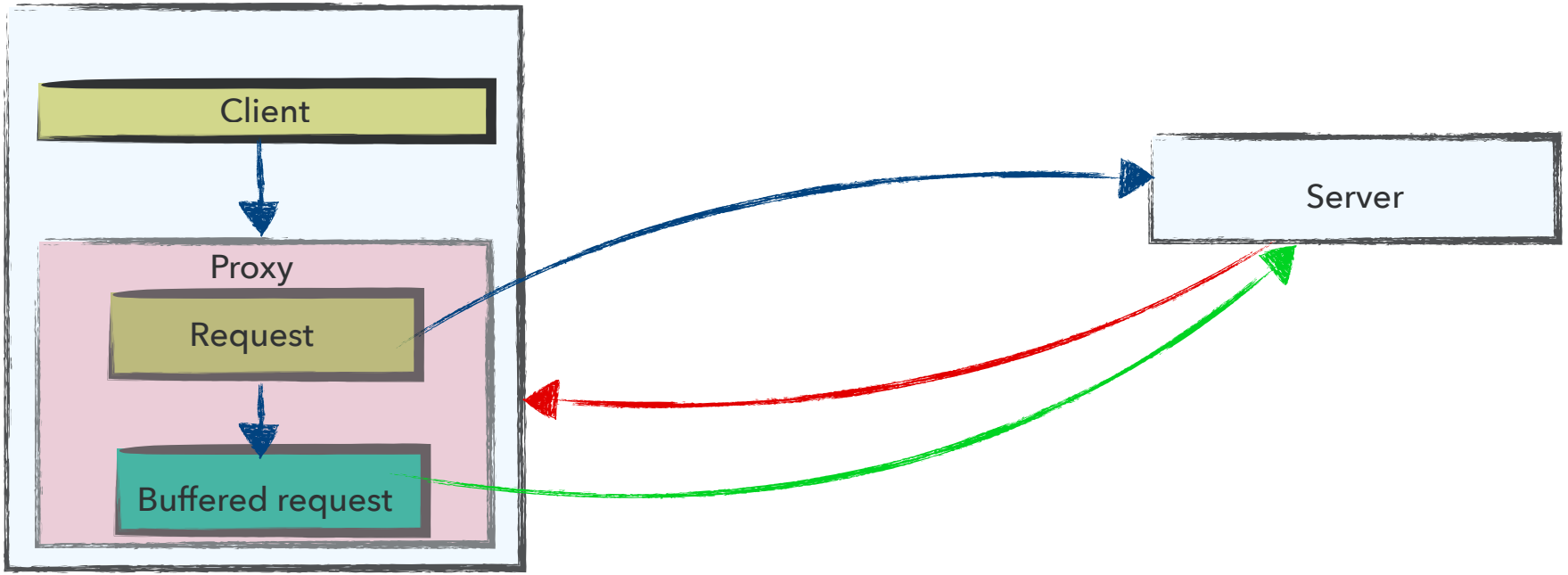


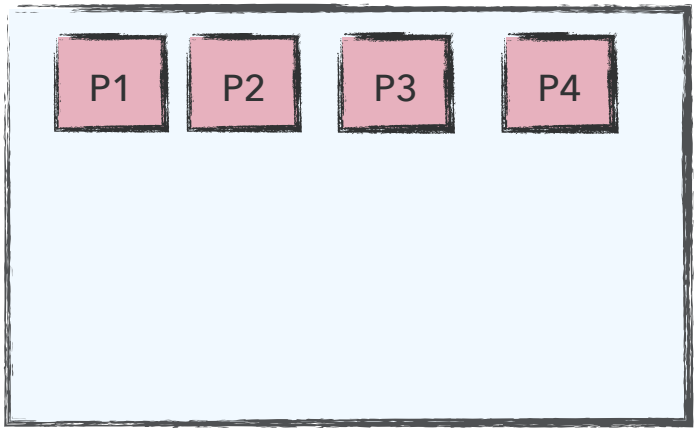
eBPF programs

- Not allowed to block
- No unbounded loops
- Limited in size
- All possible paths of execution need to be known
- Limited state management

What else could we do ?

Shared proxy per node

Node 1



Shared proxy per node

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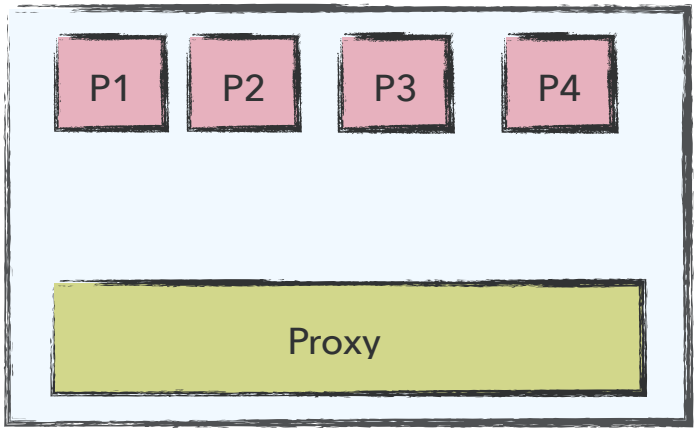

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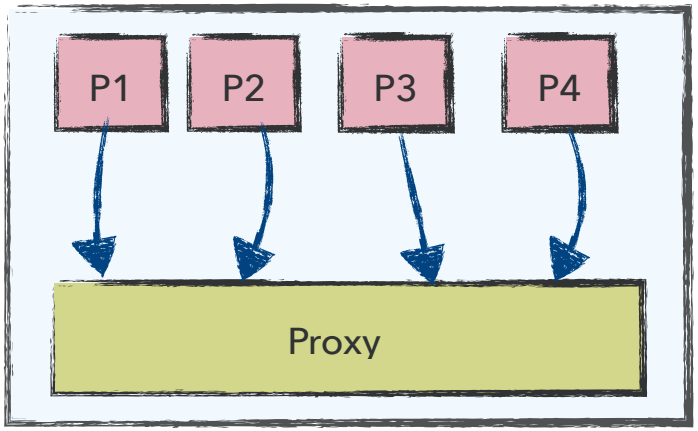

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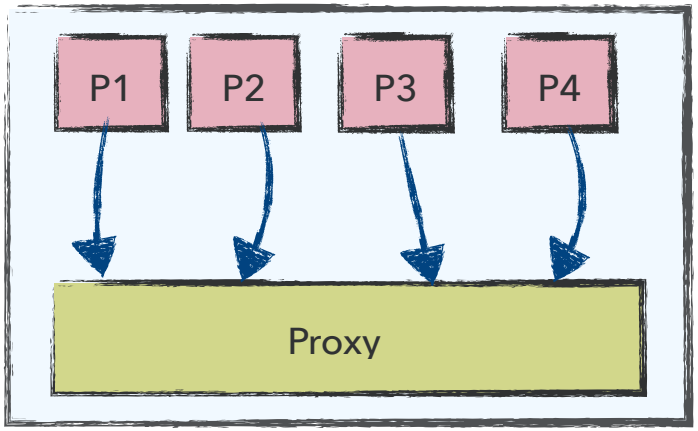
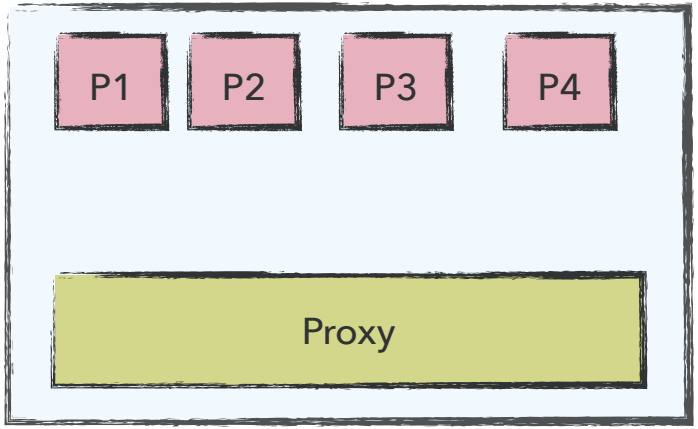
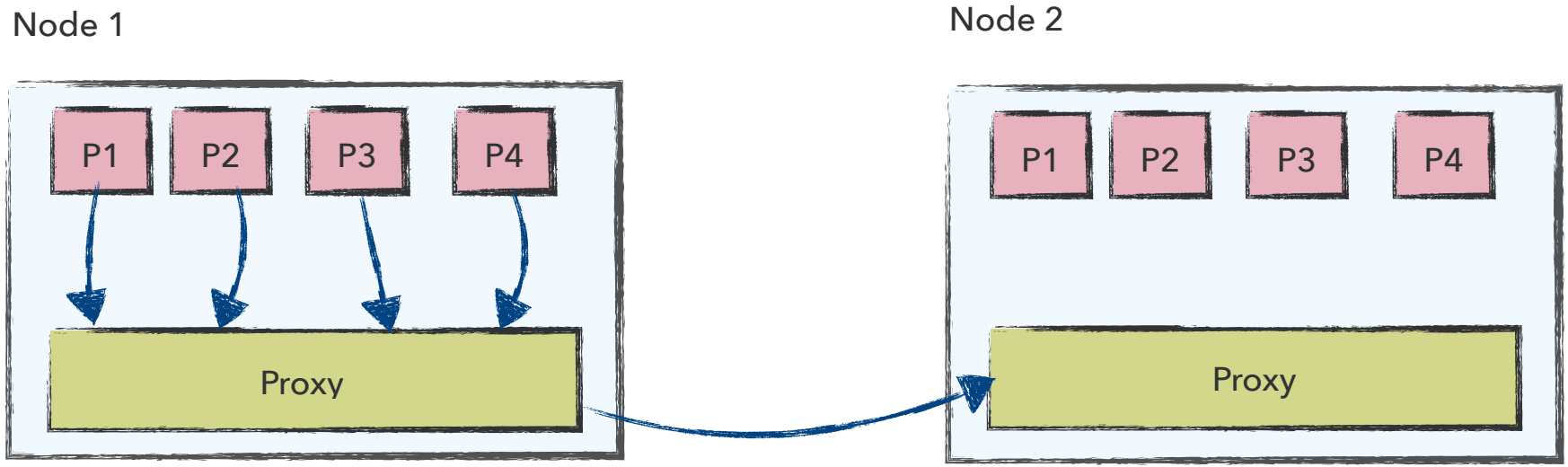


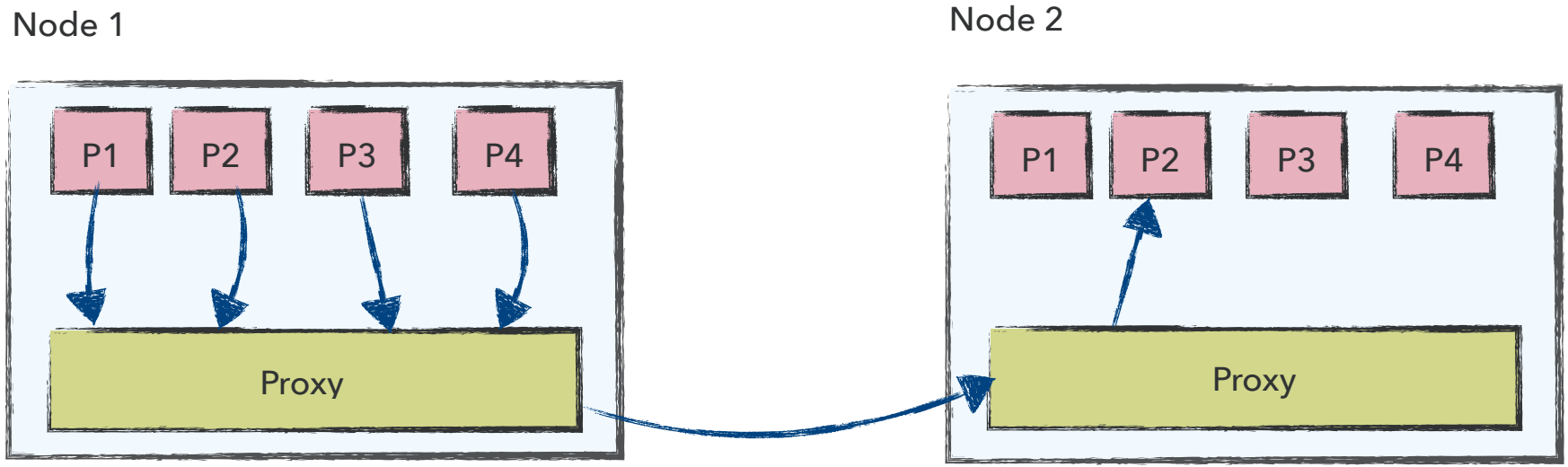
Node 2



Shared proxy per node



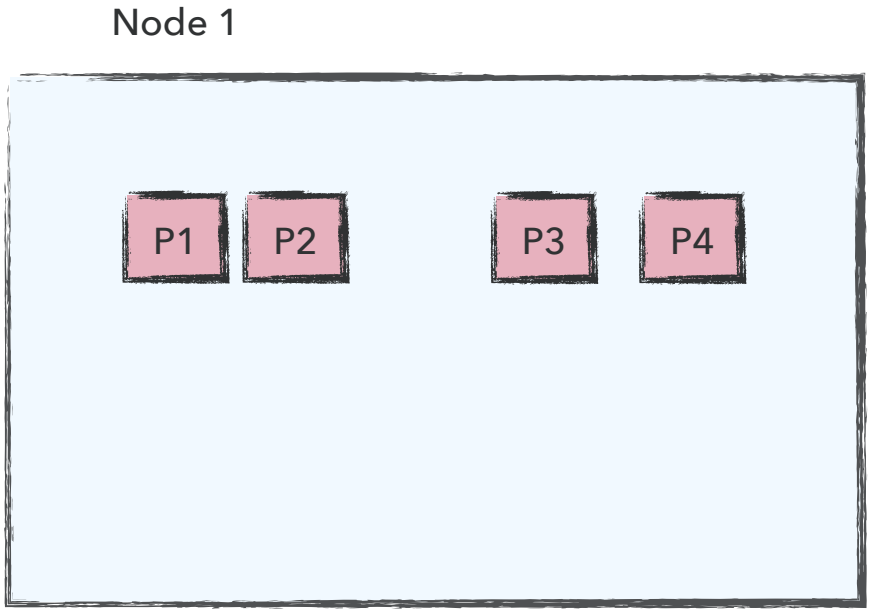
Shared proxy per node



Shared proxy per node

- Resource starvation and fairness concerns
- Lack of resource optimisation granularity
- No isolation of secret material
- Increased blast radius when things go wrong

Shared proxy per service account



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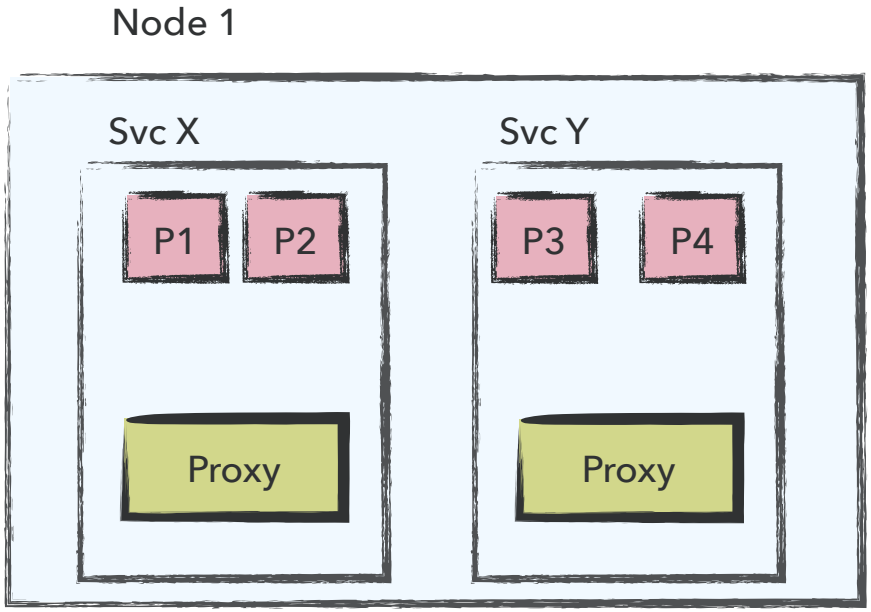
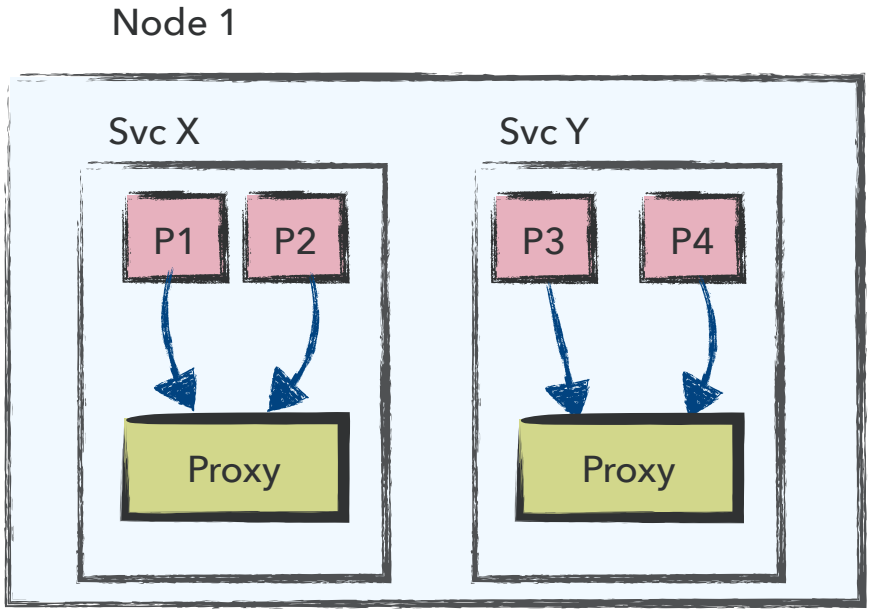


Shared proxy per service account



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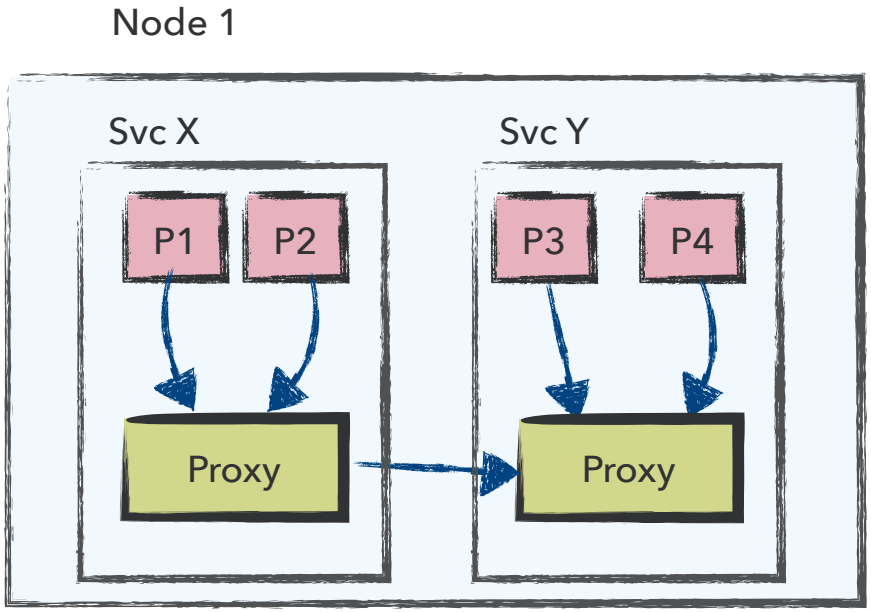
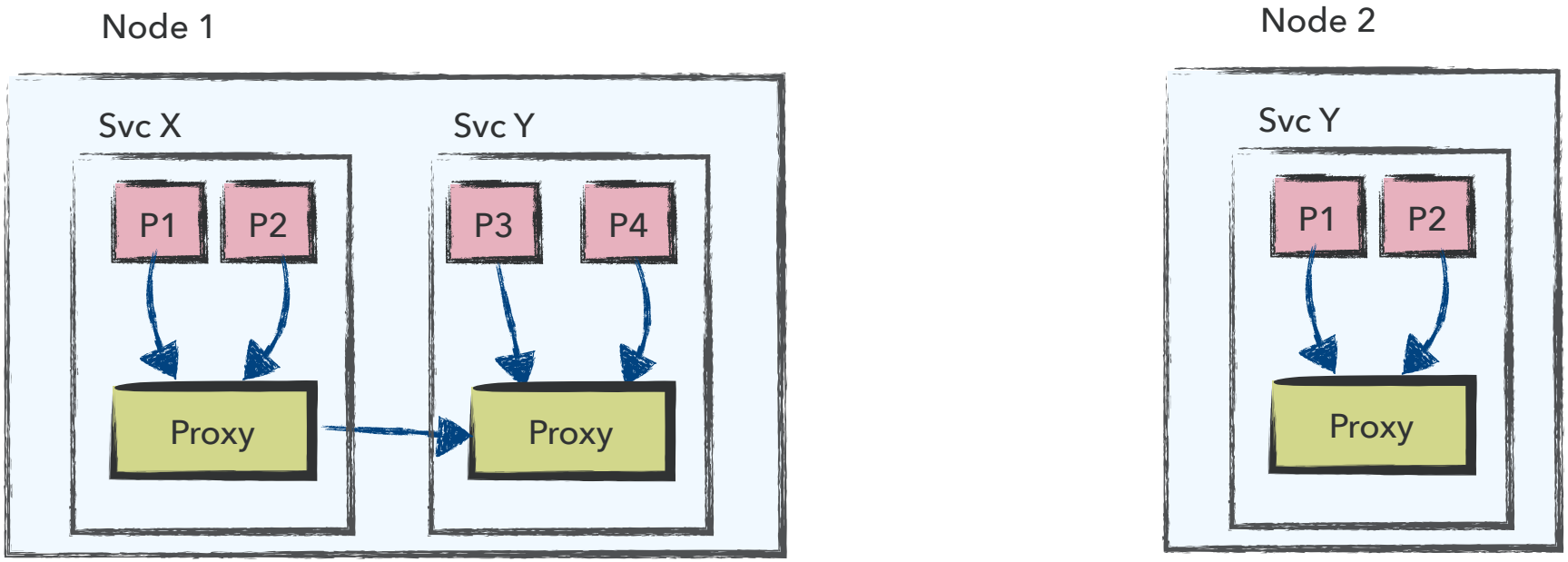
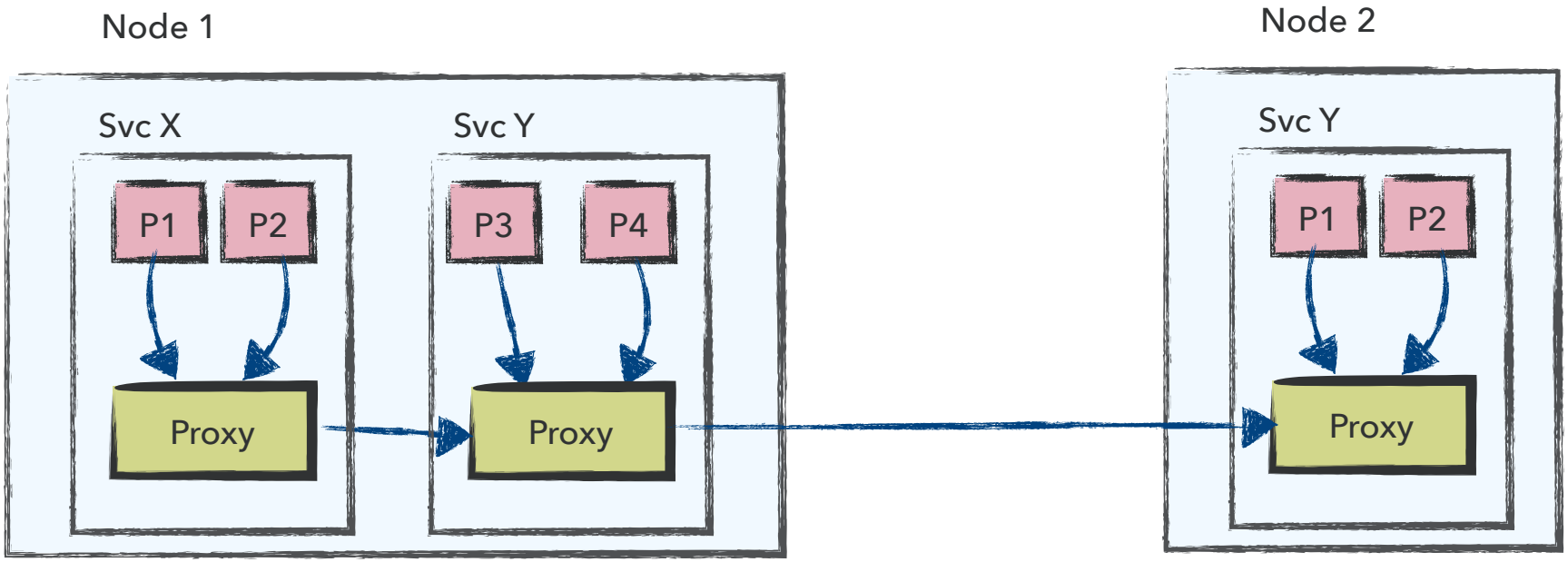


Shared proxy per service account



Shared proxy per service account



Shared proxy per service account

- Better resource isolation
- Still suffers from security concerns
- Presents increased operational risk
- Does not bring a lot more advantages

Sidecar advantages

- Resource consumption scale with the application
- Proxy failure is limited to a particular instance
- Maintenance is easier and less risky
- The security boundary is very clear and benefits from the very isolation principles that containers are here to bring

Popular folklore

Popular folklore

- Sidecars are slow, bulky and waste resources
- Introduce extra latency
- The service mesh will soon live in the kernel
- Multi-tenant proxy are the way forward
- You are speaking you own book here

Q&A