Resiliency Superpowers with eBPF

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Emeritus chair, CNCF Technical Oversight Committee

@lizrice

ISOVALENT

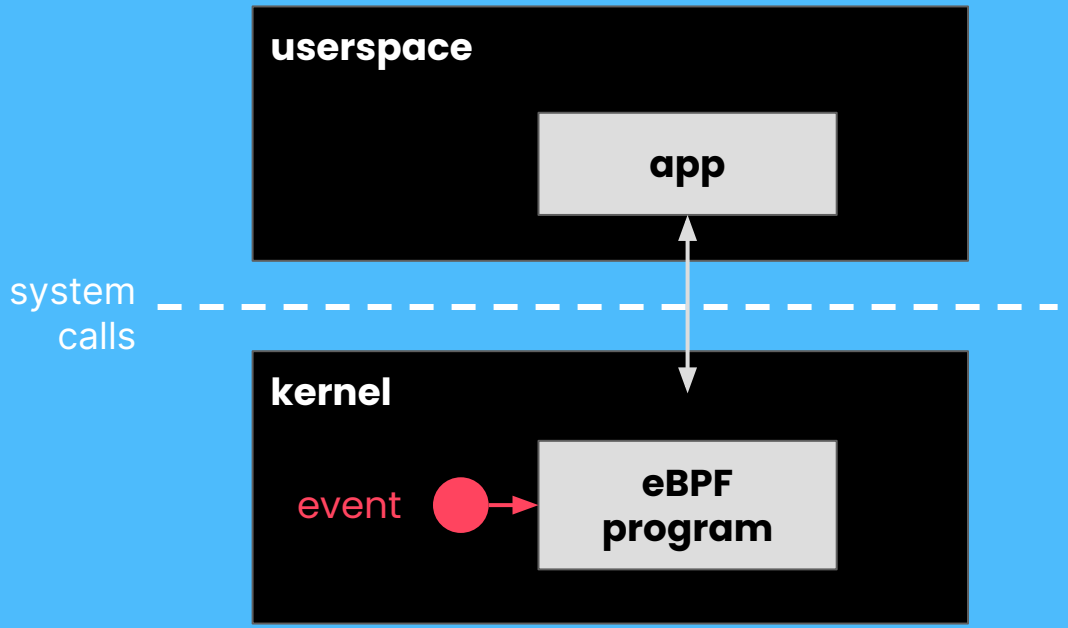
What is eBPF?

extended
Berkeley
Packet
Filter

What is eBPF?

Makes the kernel programmable

Run custom code in the kernel



eBPF Hello World

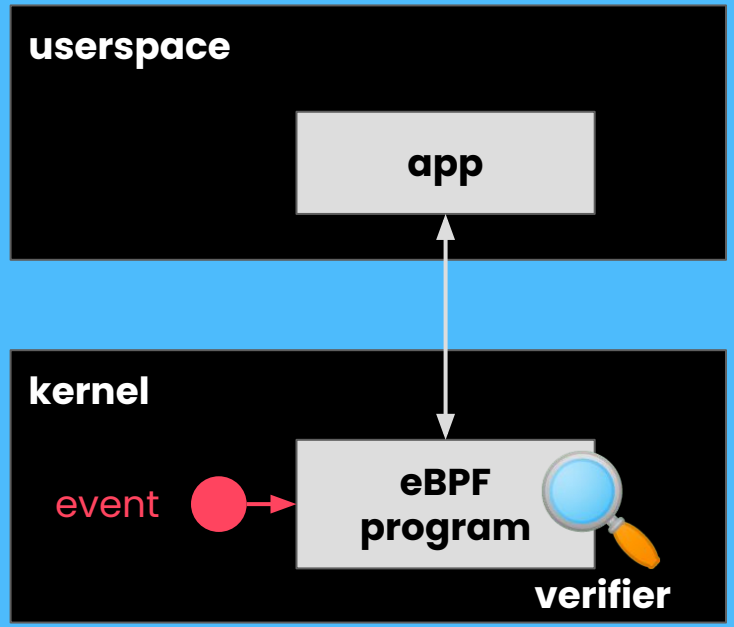
```c
SEC("kprobe/sys_execve")
int hello(void *ctx)
{
    bpf_printk("I'm alive!");
    return 0;
}
```

\+ userspace code to load eBPF program & attach to event

Info about process that called execve syscall

```
$ sudo ./hello
   bash-20241   [004] d... 84210.752785: 0: I'm alive!
   bash-20242   [004] d... 84216.321993: 0: I'm alive!
   bash-20243   [004] d... 84225.858880: 0: I'm alive!
```

eBPF code has to be safe



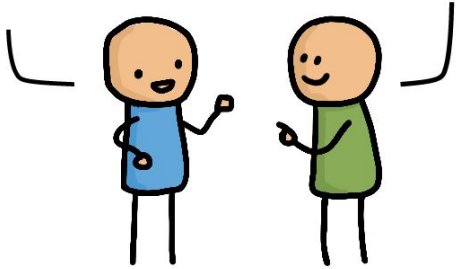
Dynamically change kernel behavior

Application Developer:

i want this new feature to observe my app

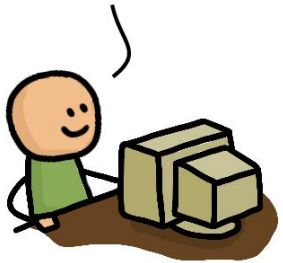
Hey kernel developer! Please add this new feature to the Linux kernel

OK! Just give me a year to convince the entire community that this is good for everyone.

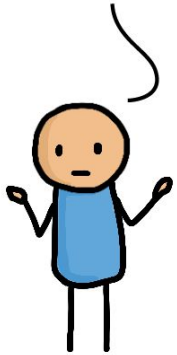


1 year later...

i'm done. The upstream kernel now supports this.

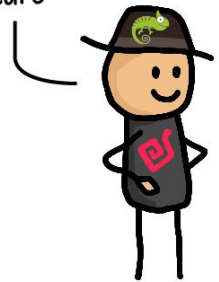


But i need this in my Linux distro

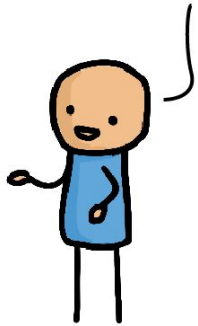


5 years later...

Good news. Our Linux distribution now ships a kernel with your required feature



OK but my requirements have changed since...

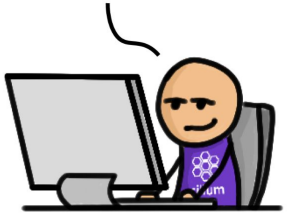


Application Developer:

i want this new feature to observe my app

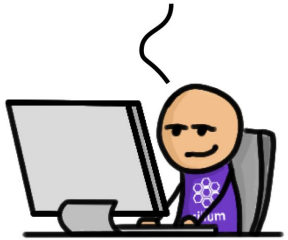
eBPF Developer:

OK! The kernel can't do this so let me quickly solve this with eBPF.



A couple of days later...

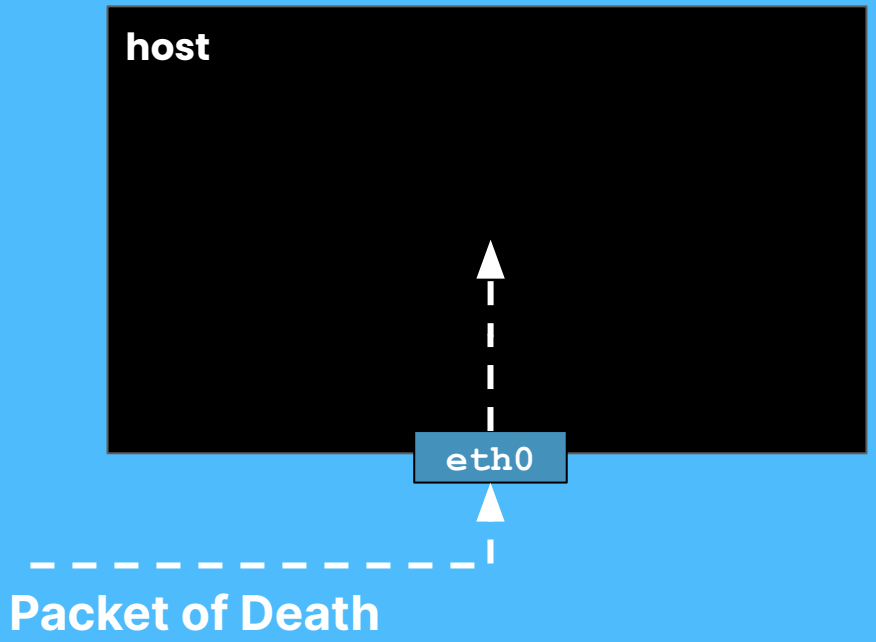
Here is a release of our eBPF project that has this feature now. BTW, you don't have to reboot your machine.



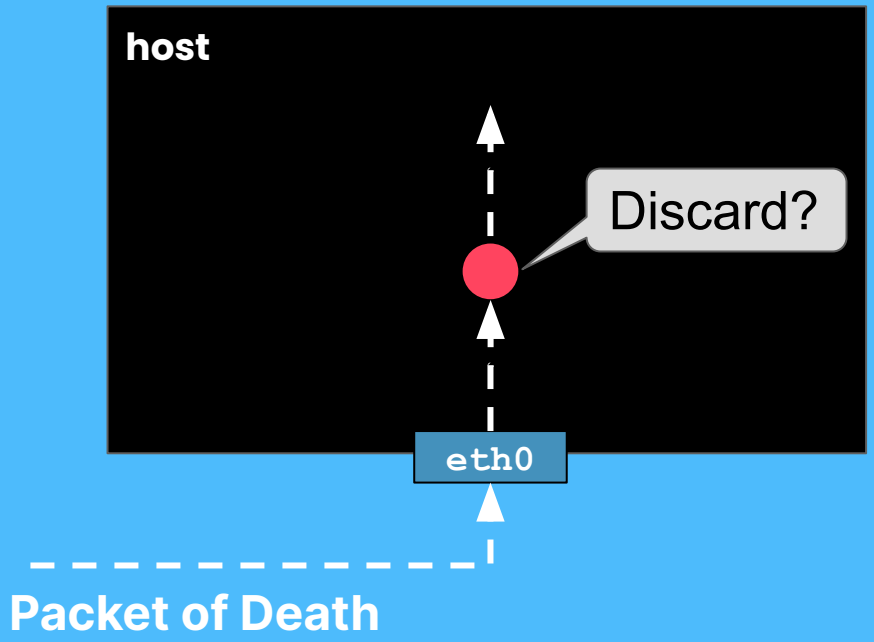
Resilience to exploits

Dynamic vulnerability patching

Packet of Death



Packet of Death



eBPF Packet Drop

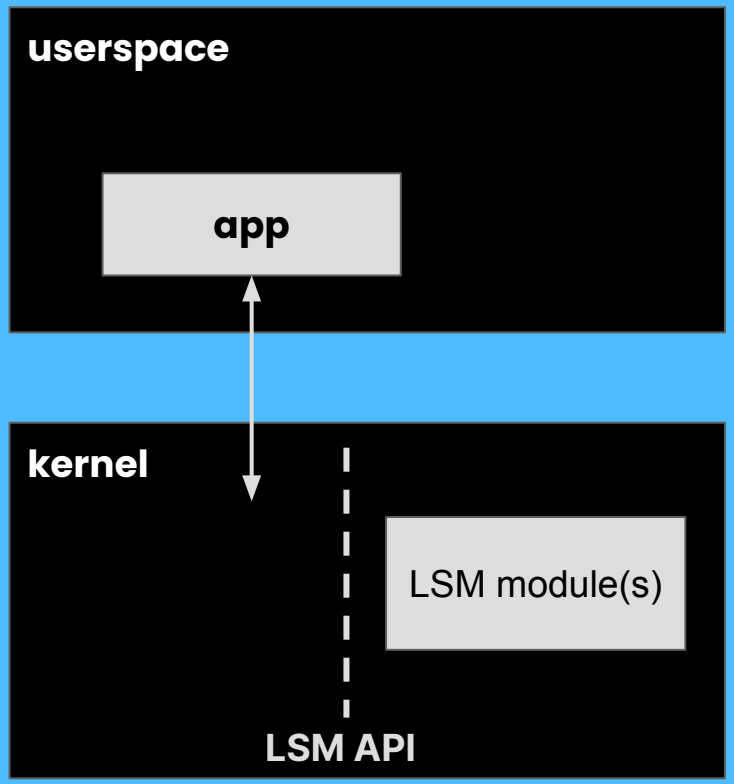
```
SEC("xdp/bye")
int goodbye_ping(struct xdp_md *ctx)
{
    ...
    if (iph->protocol == IPPROTO_ICMP)
       return XDP_DROP;

    return XDP_PASS;
}
```

Resilience to exploits

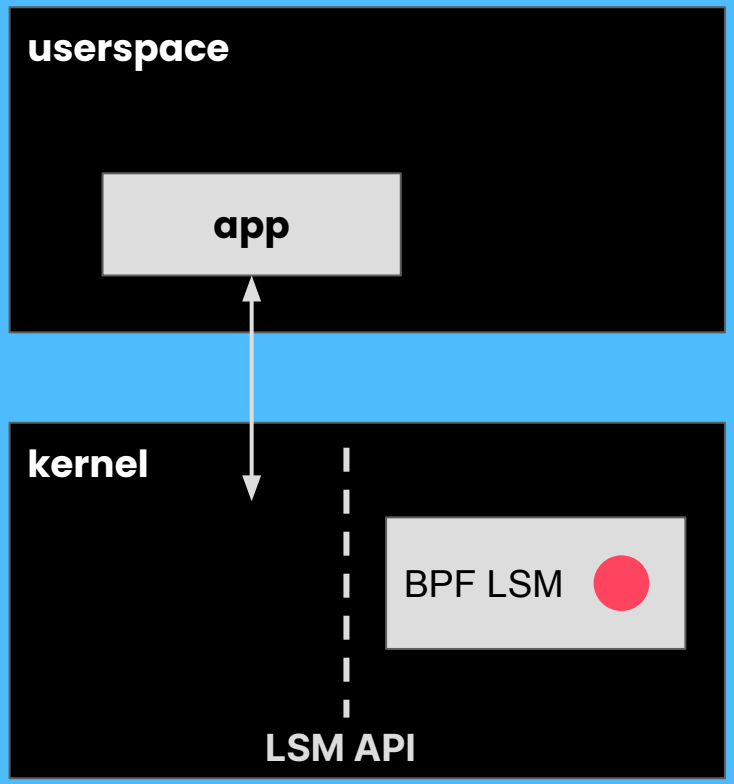
BPF Linux Security Module

LSM

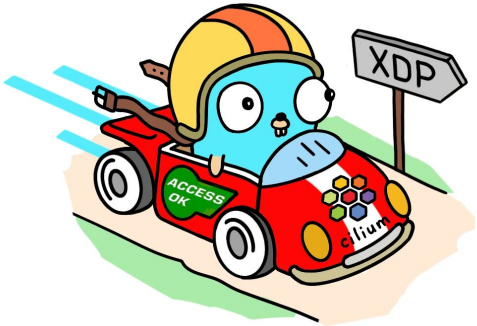


Inflexible security policies

BPF LSM



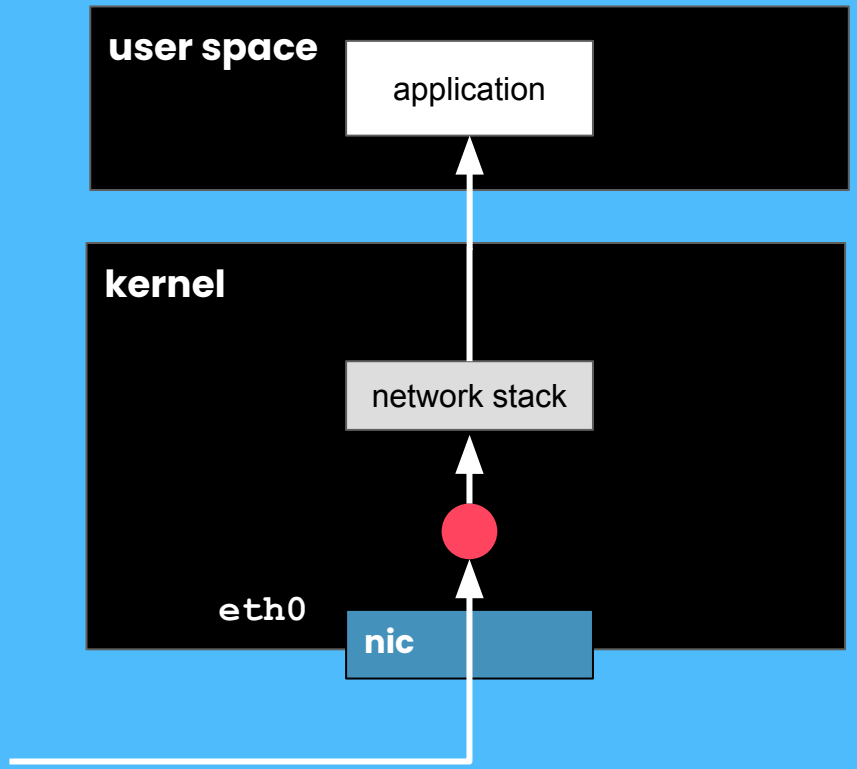
Dynamic, custom security policies



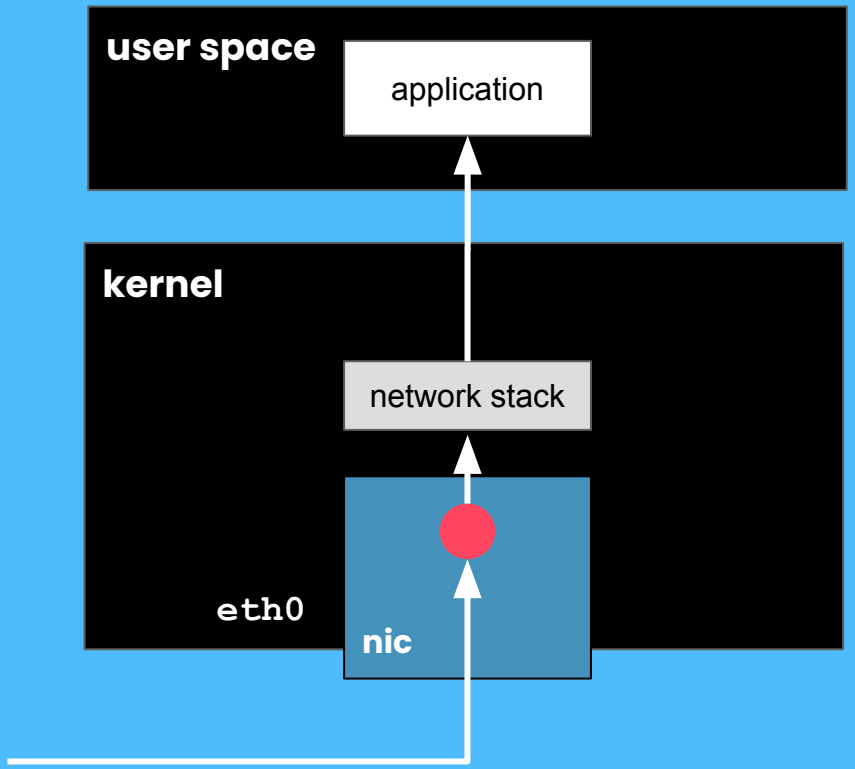
Resilience to failure

Super-fast load balancing

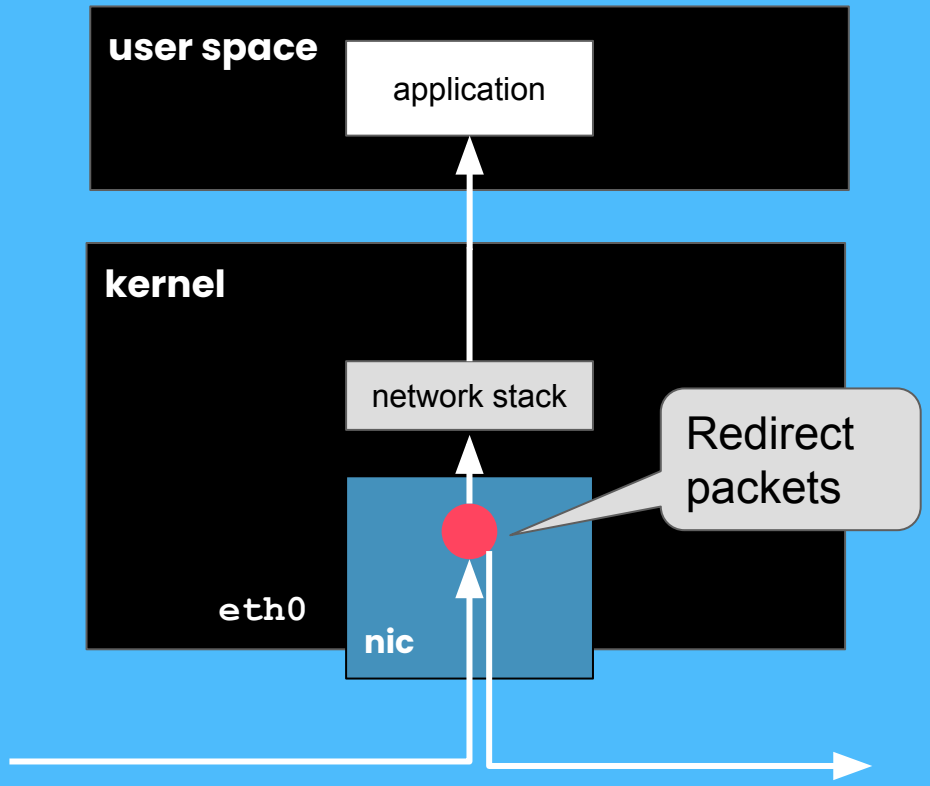
eXpress Data Path



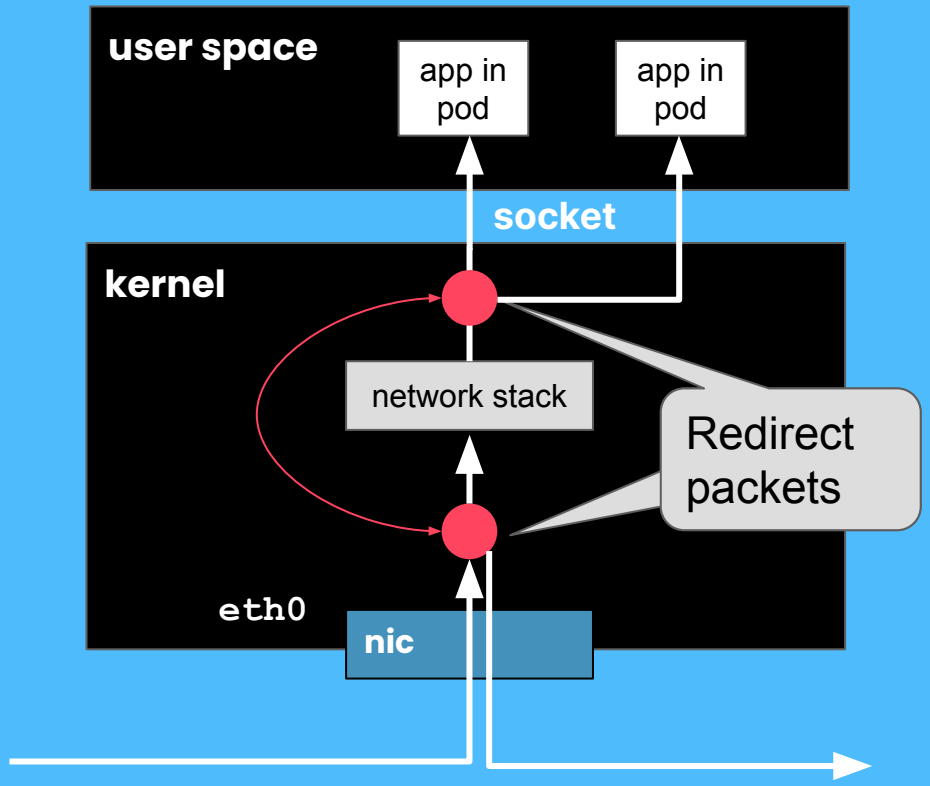
eXpress Data Path



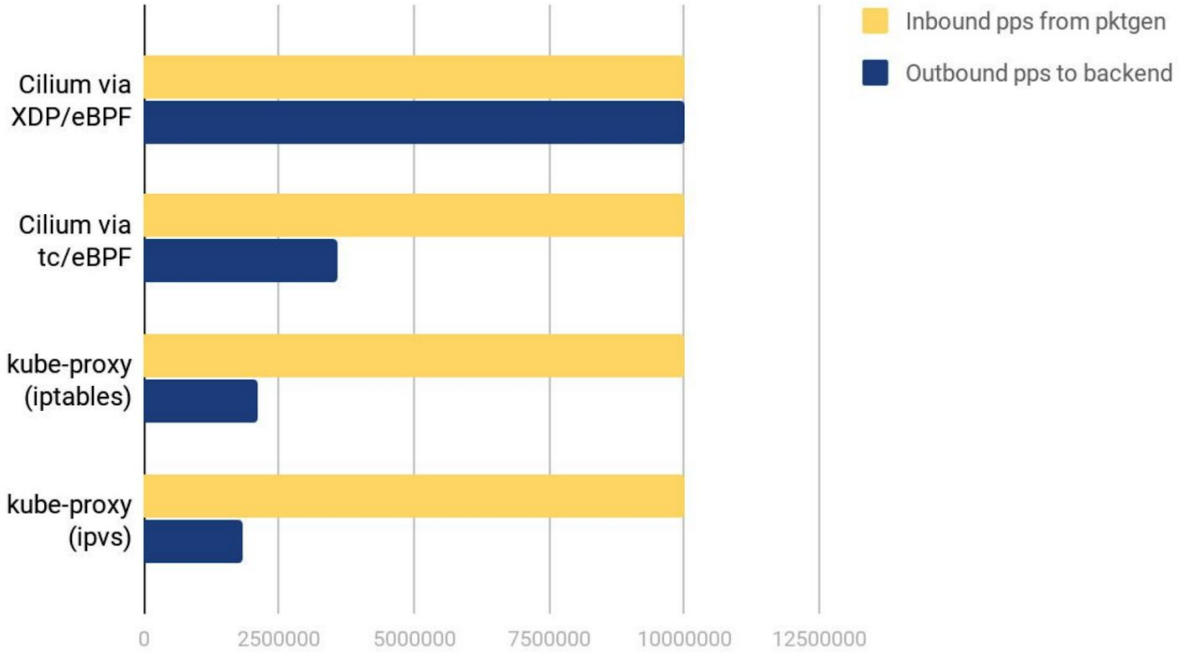
L3/4 load balancing



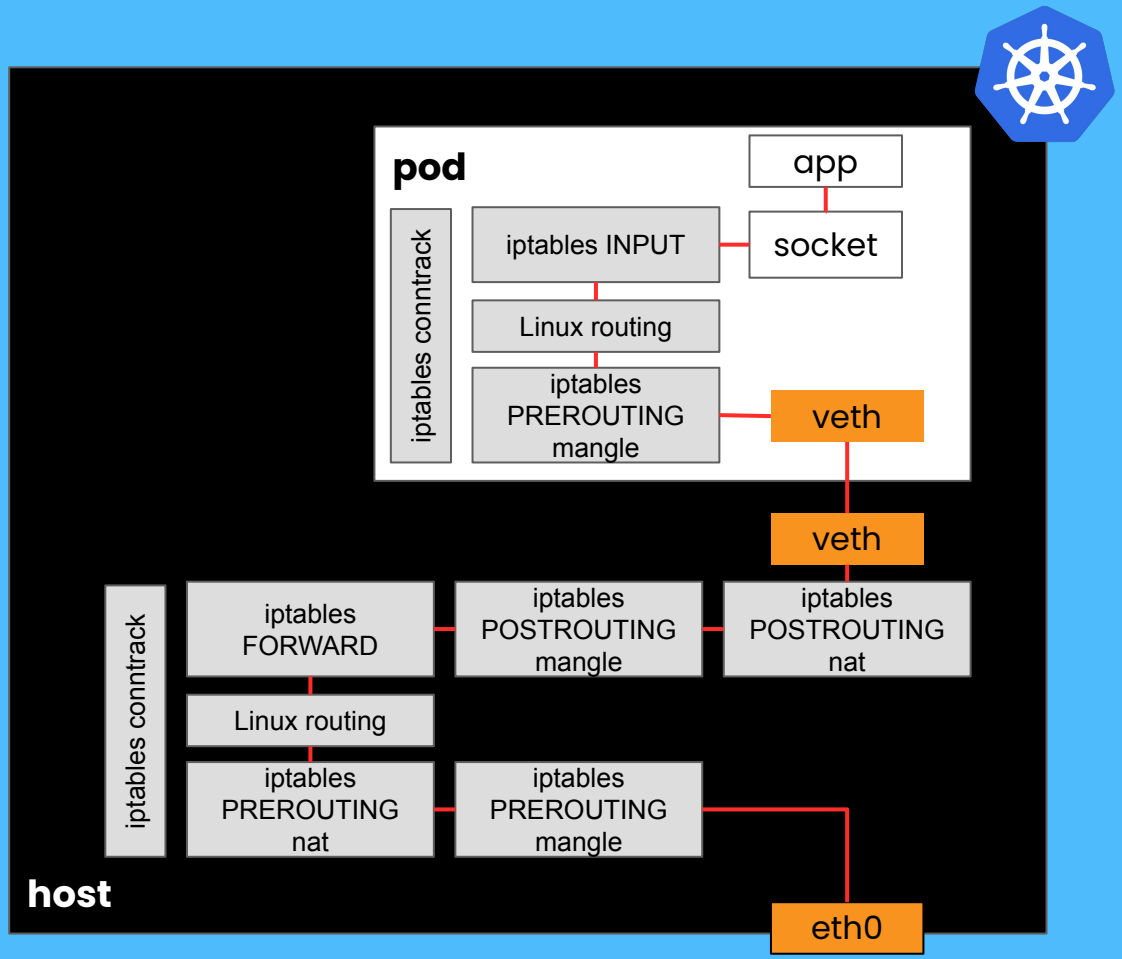
kube-proxy replacement

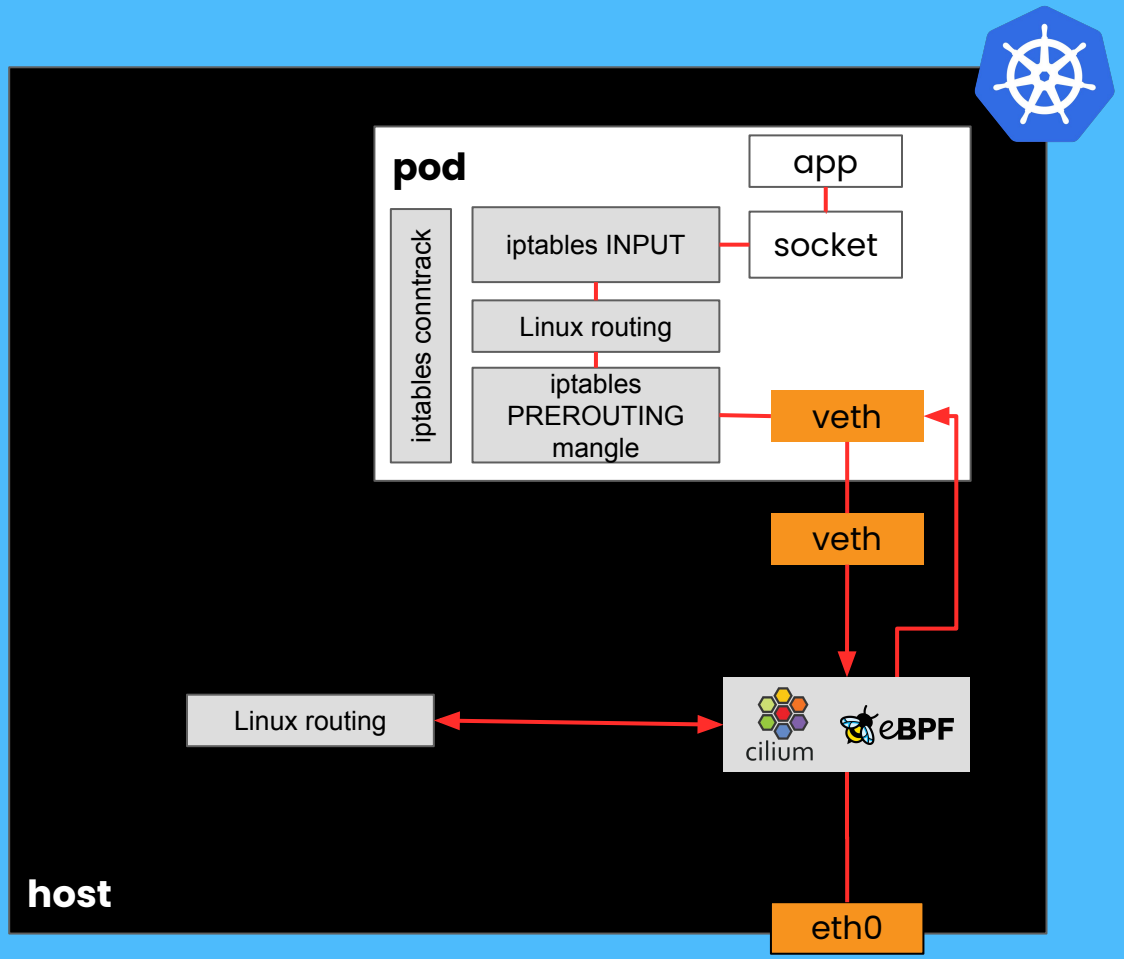


kube-proxy replacement performance



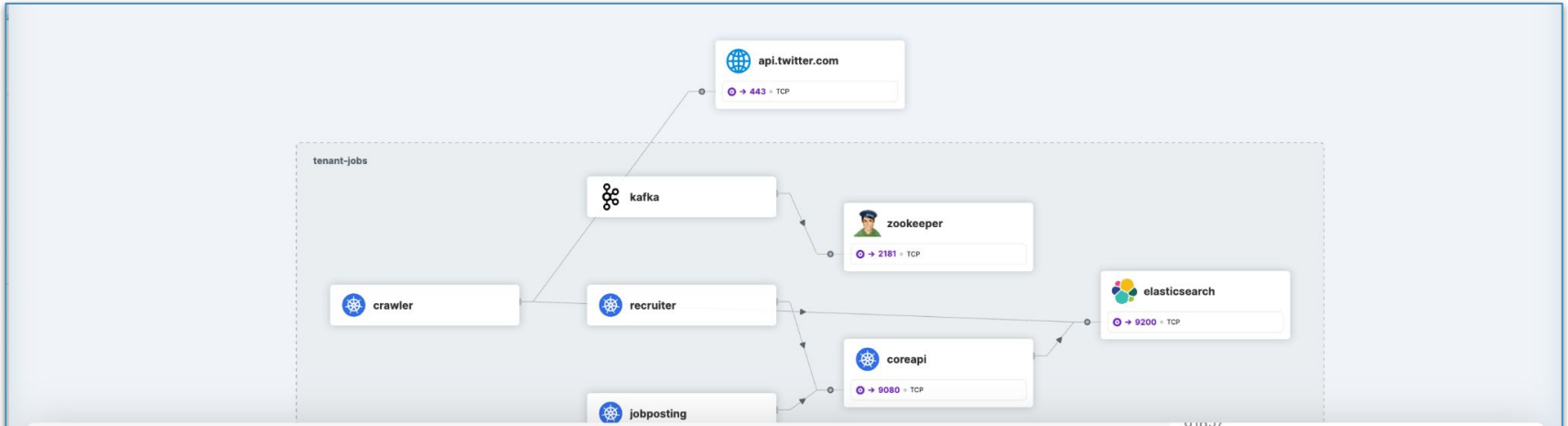
eBPF enables efficient Kubernetes-aware networking


pod
app
socket
iptables INPUT
Linux routing
iptables PREROUTING mangle
iptables conntrack
veth
veth
iptables FORWARD
iptables POSTROUTING mangle
iptables POSTROUTING nat
Linux routing
iptables PREROUTING nat
iptables PREROUTING mangle
iptables conntrack
host
eth0


pod
app
socket
iptables INPUT
Linux routing
iptables PREROUTING mangle
iptables conntrack
veth
veth
Linux routing
cilium
eBPF
host
eth0

for example

Kubernetes-aware network flows



Columns

Source Pod	Source Service	Destination Service	Destinatio
kafka-0	kafka *tenant-jobs*	zookeeper *tenant-jobs*	
kafka-0	kafka *tenant-jobs*	zookeeper *tenant-jobs*	
—	coreapi *tenant-jobs*	elasticsearch *tenant-jobs*	
—	coreapi *tenant-jobs*	elasticsearch *tenant-jobs*	
recruiter-f44d5f778-86qkv	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
recruiter-f44d5f778-86qkv	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
—	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
—	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
coreapi-79568ff848-k98zq	coreapi *tenant-jobs*	elasticsearch *tenant-jobs*	
recruiter-f44d5f778-86qkv	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
—	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
—	recruiter *tenant-jobs*	coreapi *tenant-jobs*	
—	recruiter *tenant-jobs*	coreapi *tenant-jobs*	

Destination labels
app=elasticsearch
io.cilium.k8s.policy.cluster=default
io.cilium.k8s.policy.serviceaccount=default
namespace=tenant-jobs

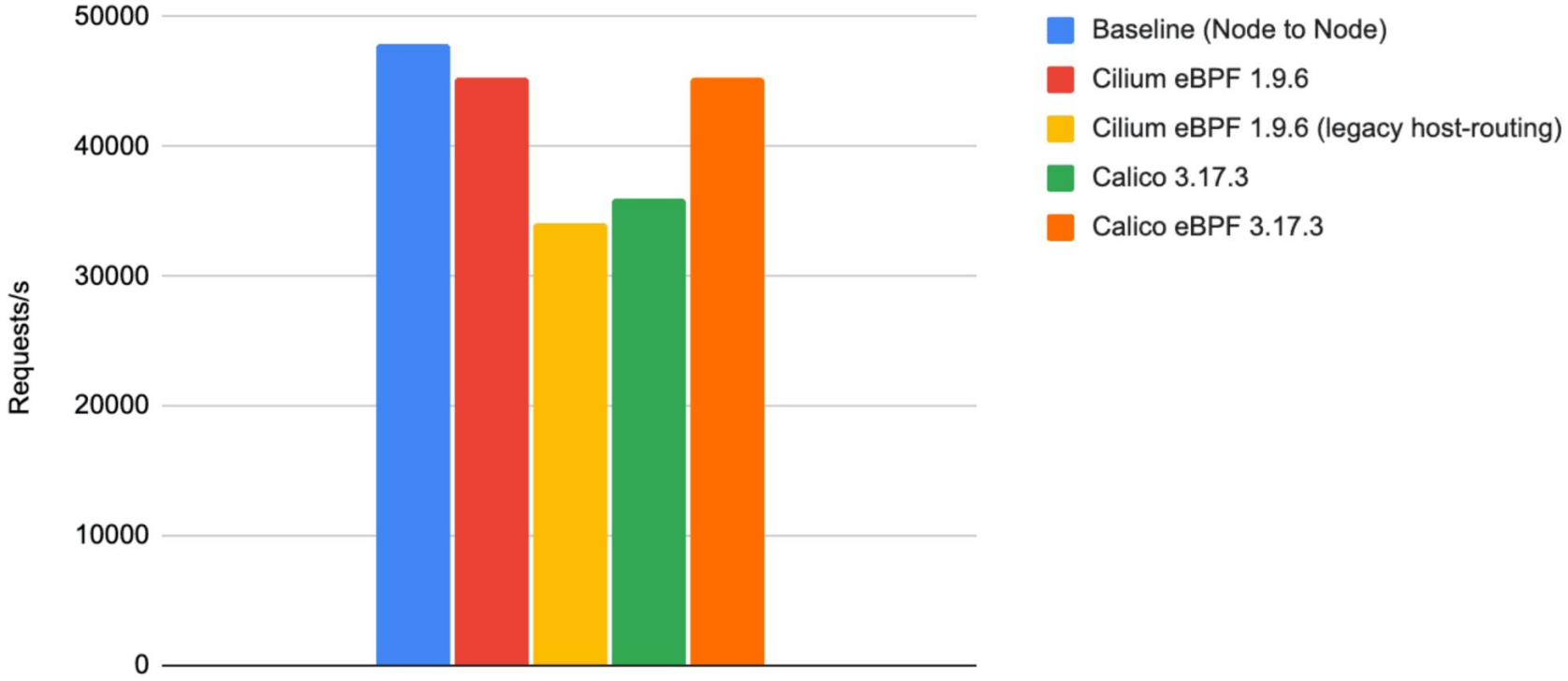
Destination IP
192.168.60.86

Destination port
9200

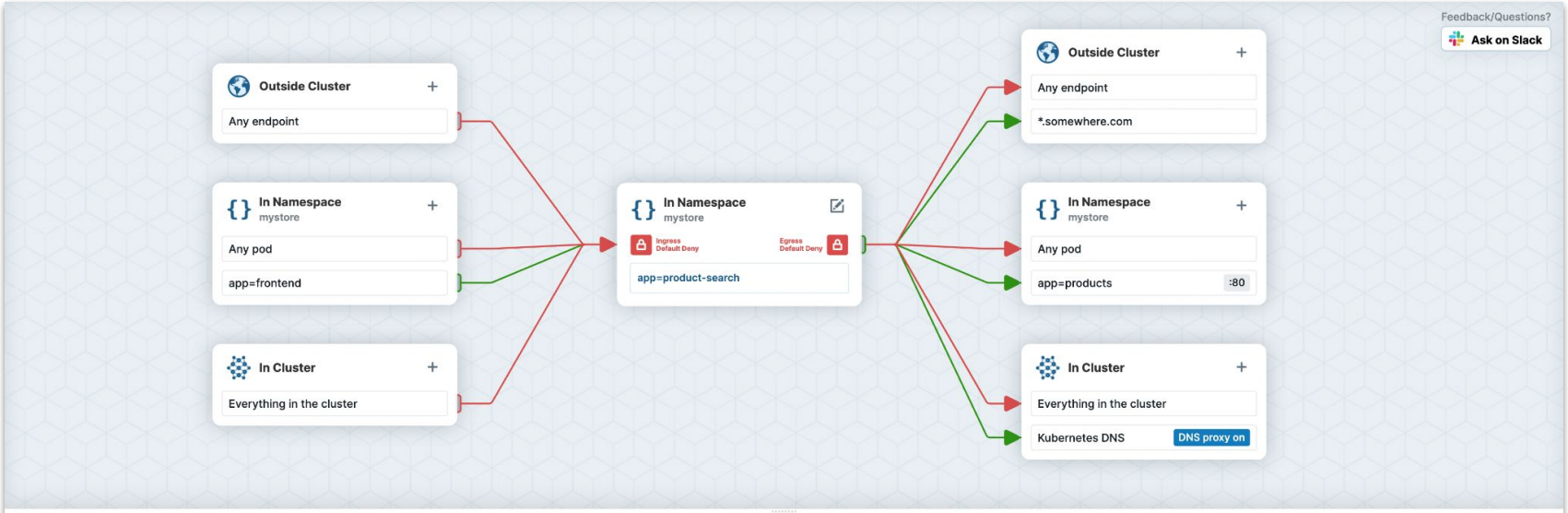
HTTP Request Method
GET

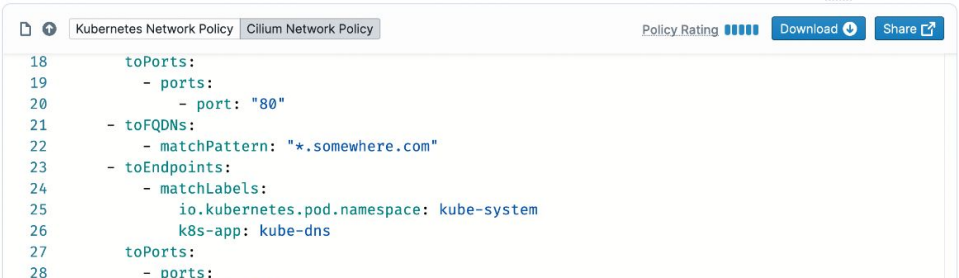
HTTP Request Protocol

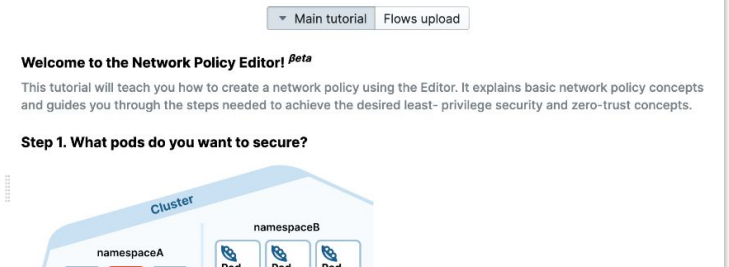
TCP RR - higher is better



eBPF network policy decisions



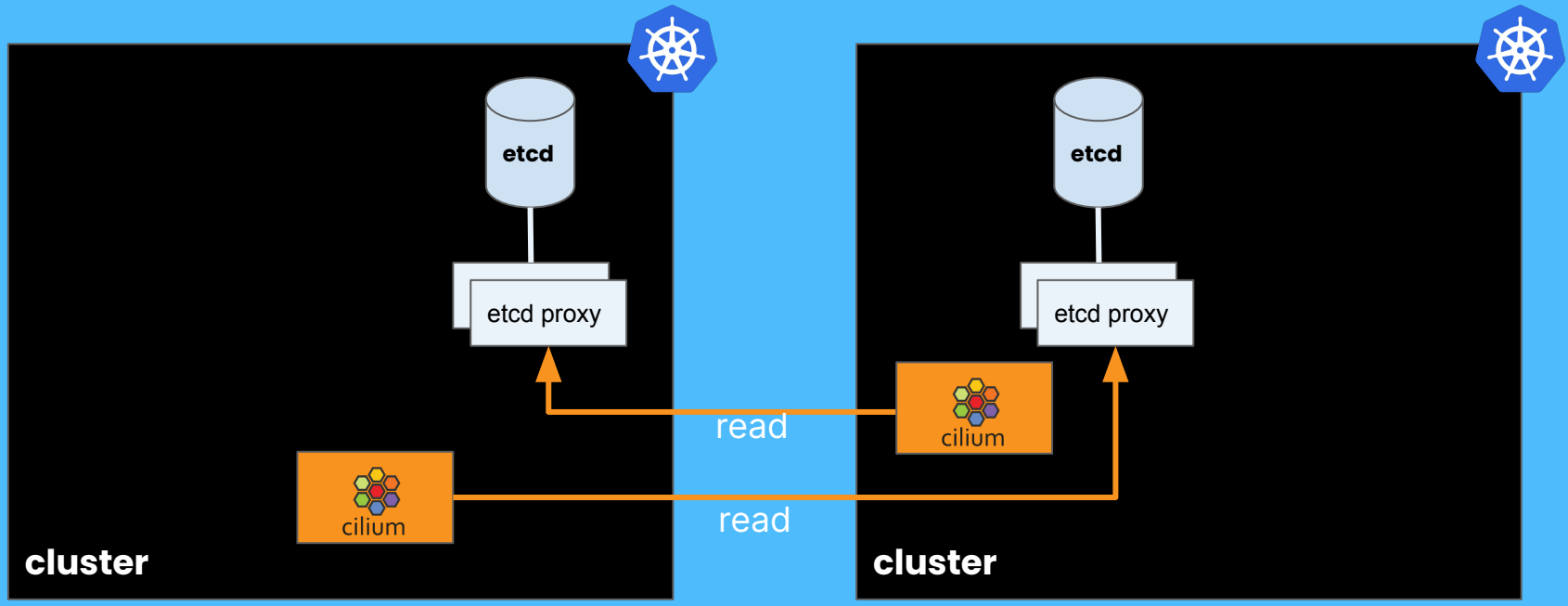




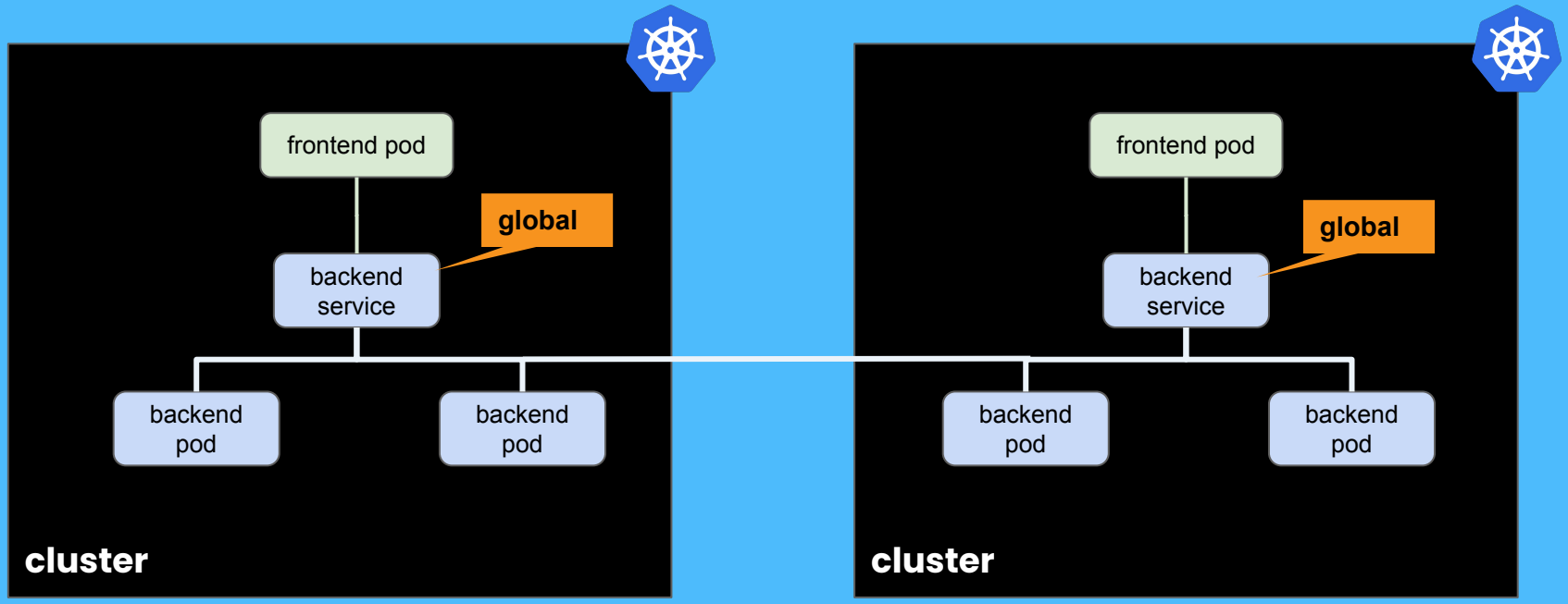
Resilience to failure

Clustermesh

Share multi-cluster state

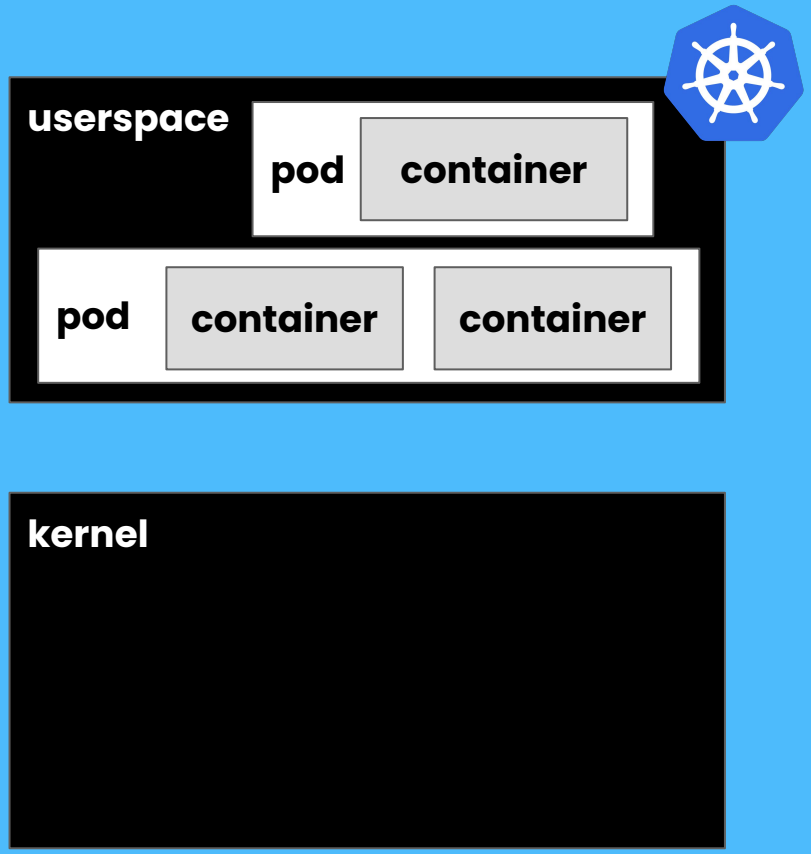


Highly available services



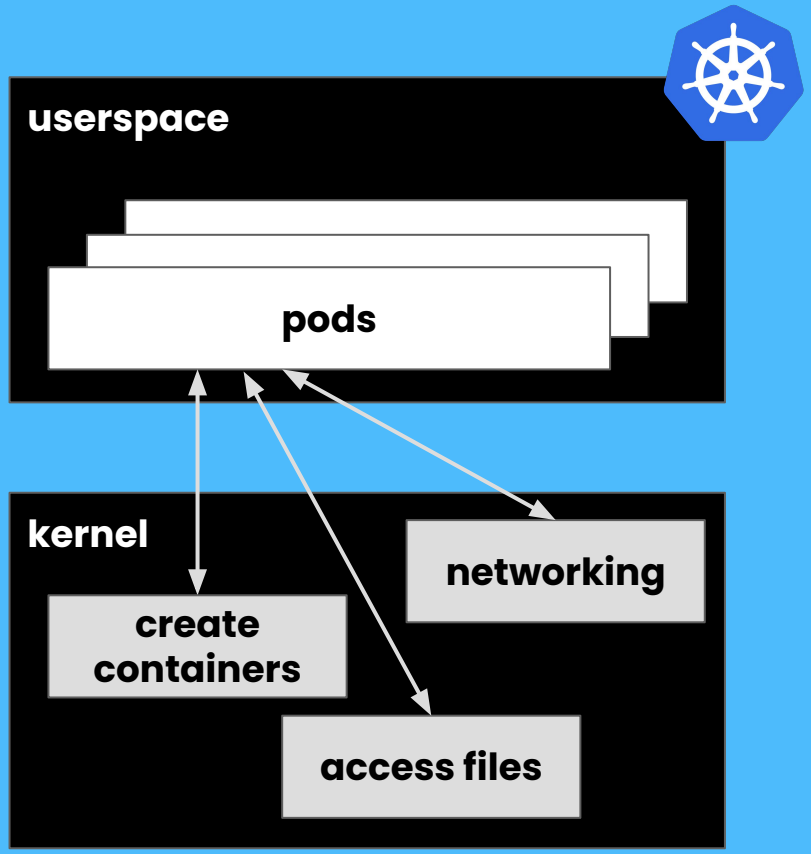
Visibility into failures

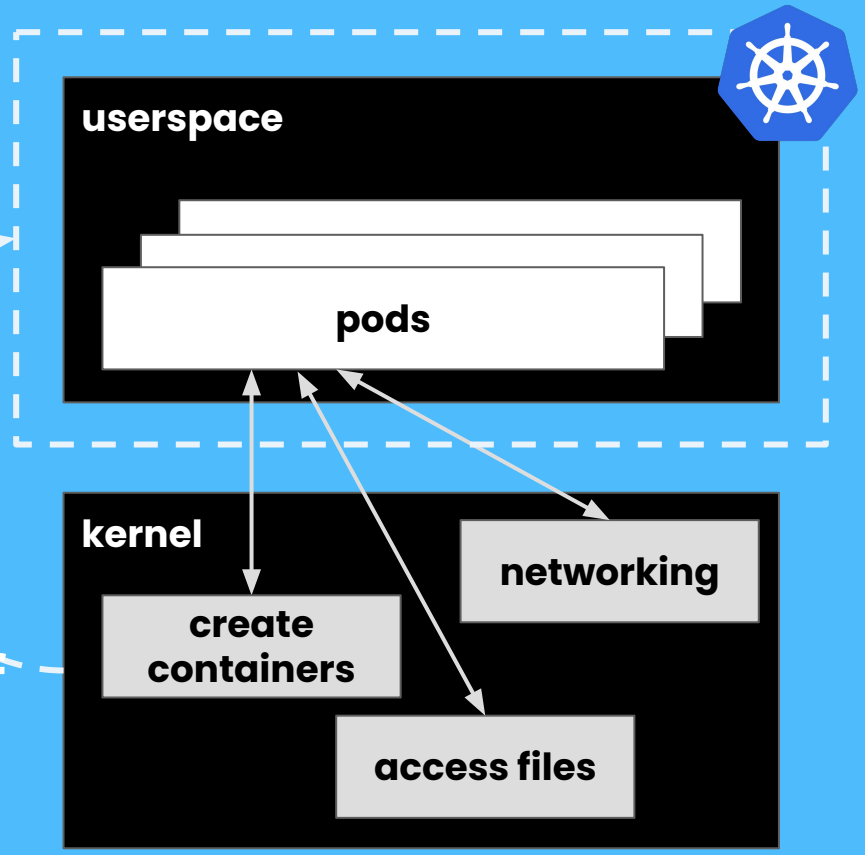
eBPF observability instrumentation



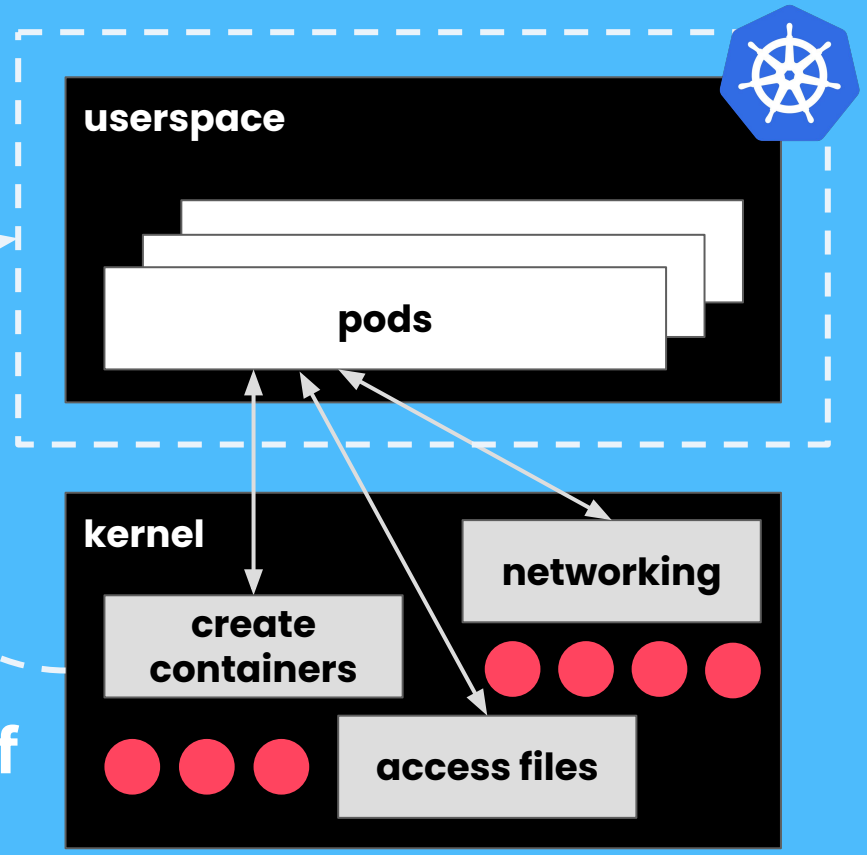
One kernel per host

One kernel per host





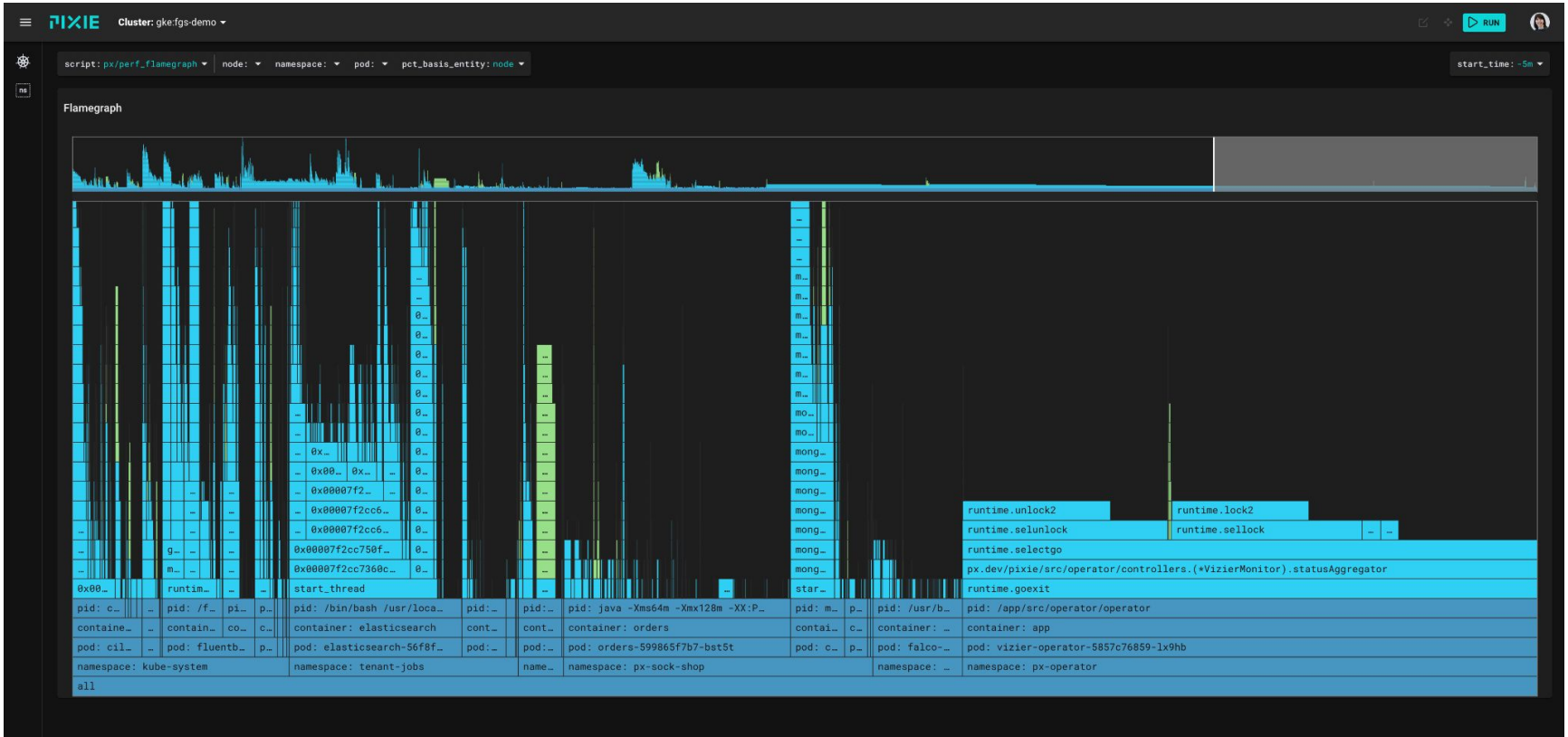
Kernel aware of everything on the host



eBPF programs can be aware of everything

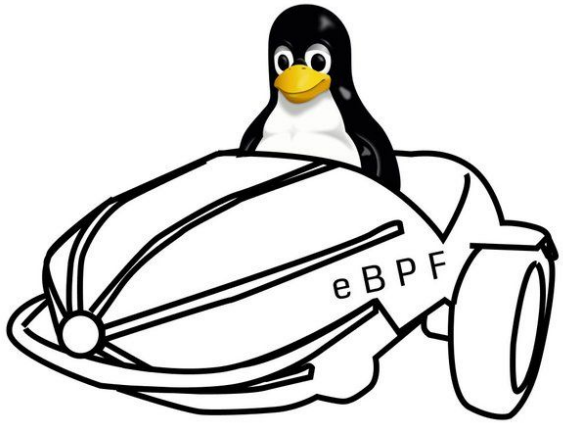
for example

Pixie flamegraph



eBPF programs have a view across the entire node without any app or config changes

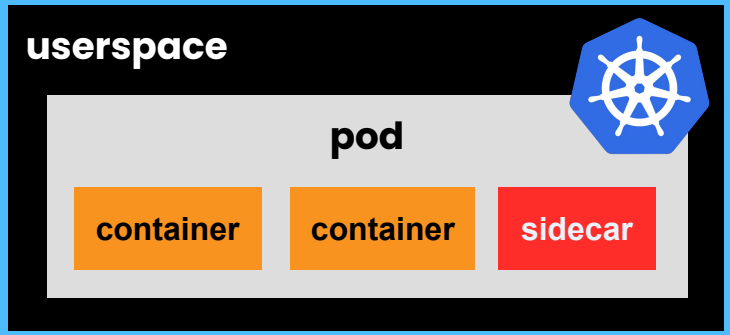
My other sidecar is a **kernel**



"Get in loser. We're going tracing"

- **Nathan LeClaire @dotpem**

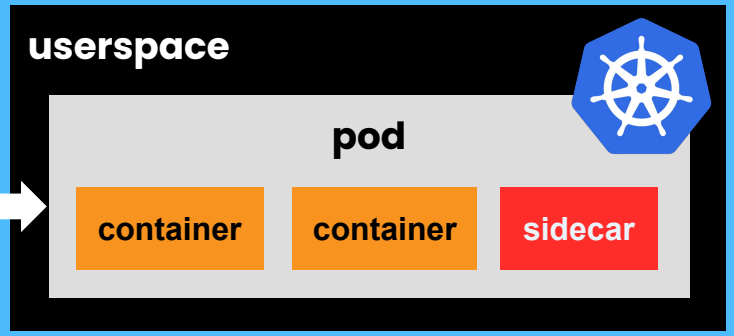
A sidecar has a view across one pod



Sidecars need YAML

my-app.yaml

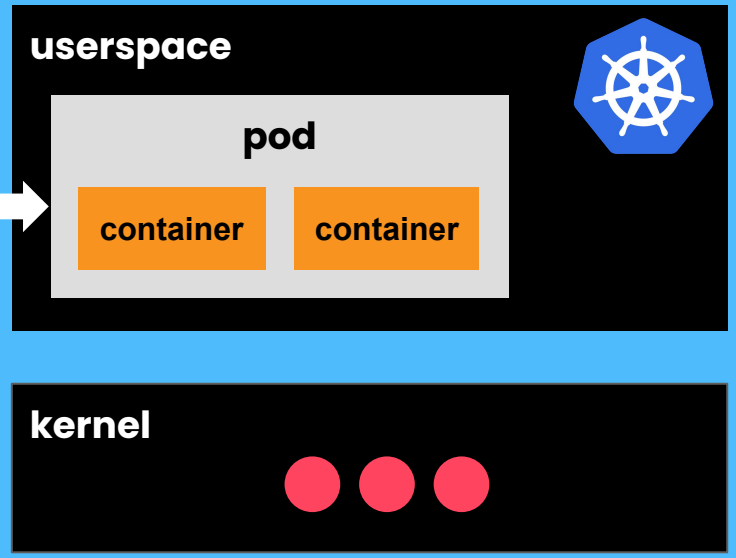
```
containers:
  -   name: my-app
      ...
  -   name: my-app-init
      …
  -   name: my-sidecar
      ...
```



eBPF does not need any app changes

my-app.yaml

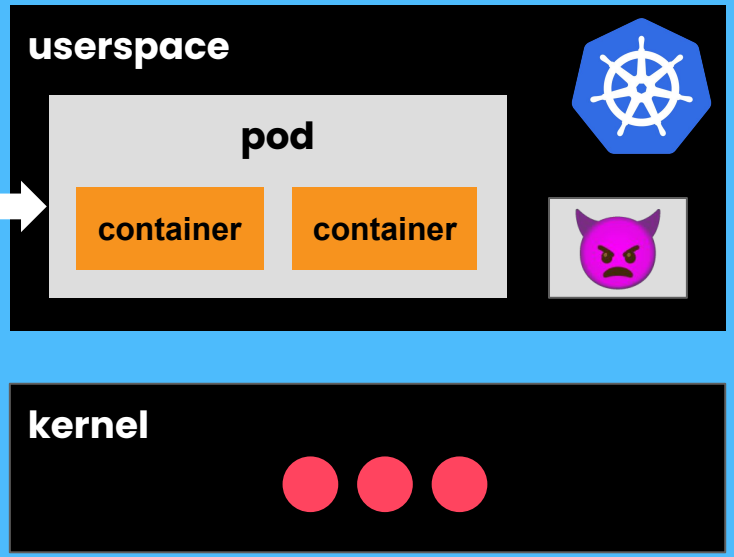
```
containers:
  -   name: my-app
      ...
  -   name: my-app-init
      …
```



eBPF can see ALL activity on the node

my-app.yaml

```
containers:
  -   name: my-app
      ...
  -   name: my-app-init
      …
```

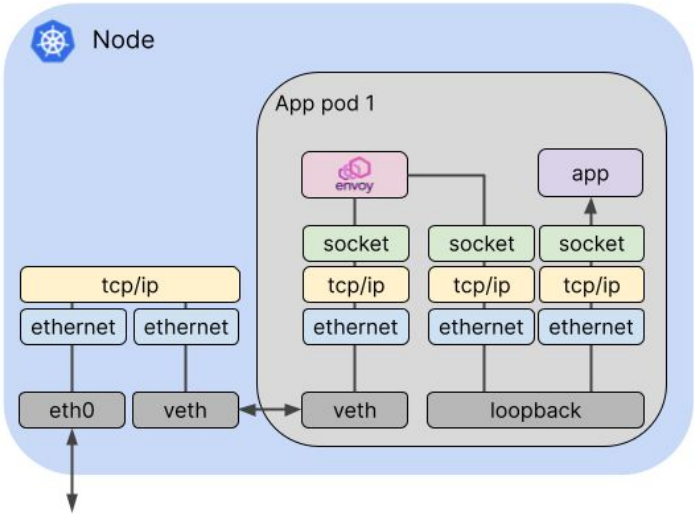


Resilient, observable, secure deployments

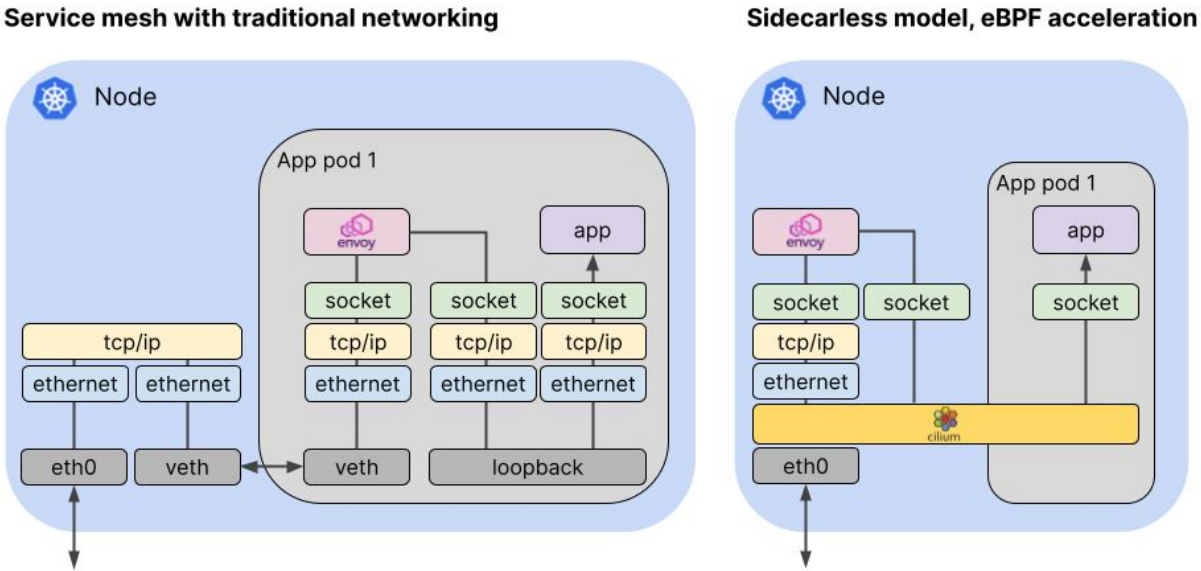
Sidecarless service mesh

Service mesh

Service mesh with traditional networking



eBPF-accelerated service mesh



eBPF makes the kernel programmable enabling networking, observability & security tools for resilient deployment

Not just for Linux...

README.md

eBPF on Windows

eBPF is a well-known technology for providing programmability and agility, especially for extending an OS kernel, for use cases such as DoS protection and observability. This project is a work-in-progress that allows using existing eBPF toolchains and APIs familiar in the Linux ecosystem to be used on top of Windows. That is, this project takes existing eBPF projects as submodules and adds the layer in between to make them run on top of Windows.

eBPF Foundation

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