
KubeCon
CloudNativeCon
Europe 2025
LONDON BUS

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Europe 2025

C.A.L.L.I.N.G. now I'm calling you, calling you now

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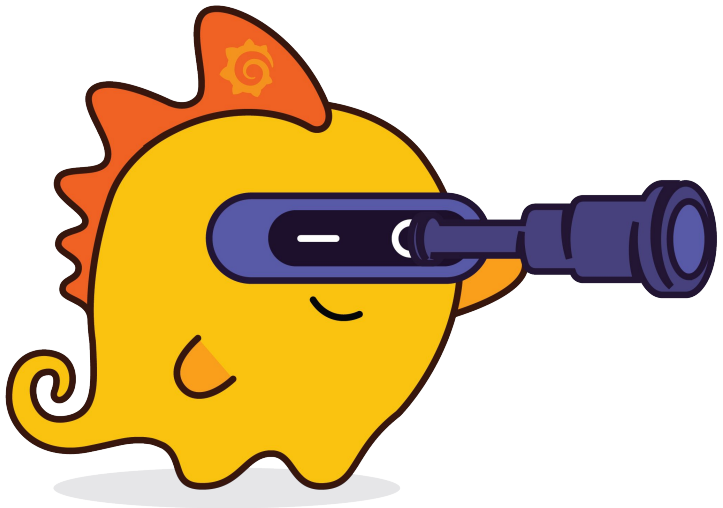
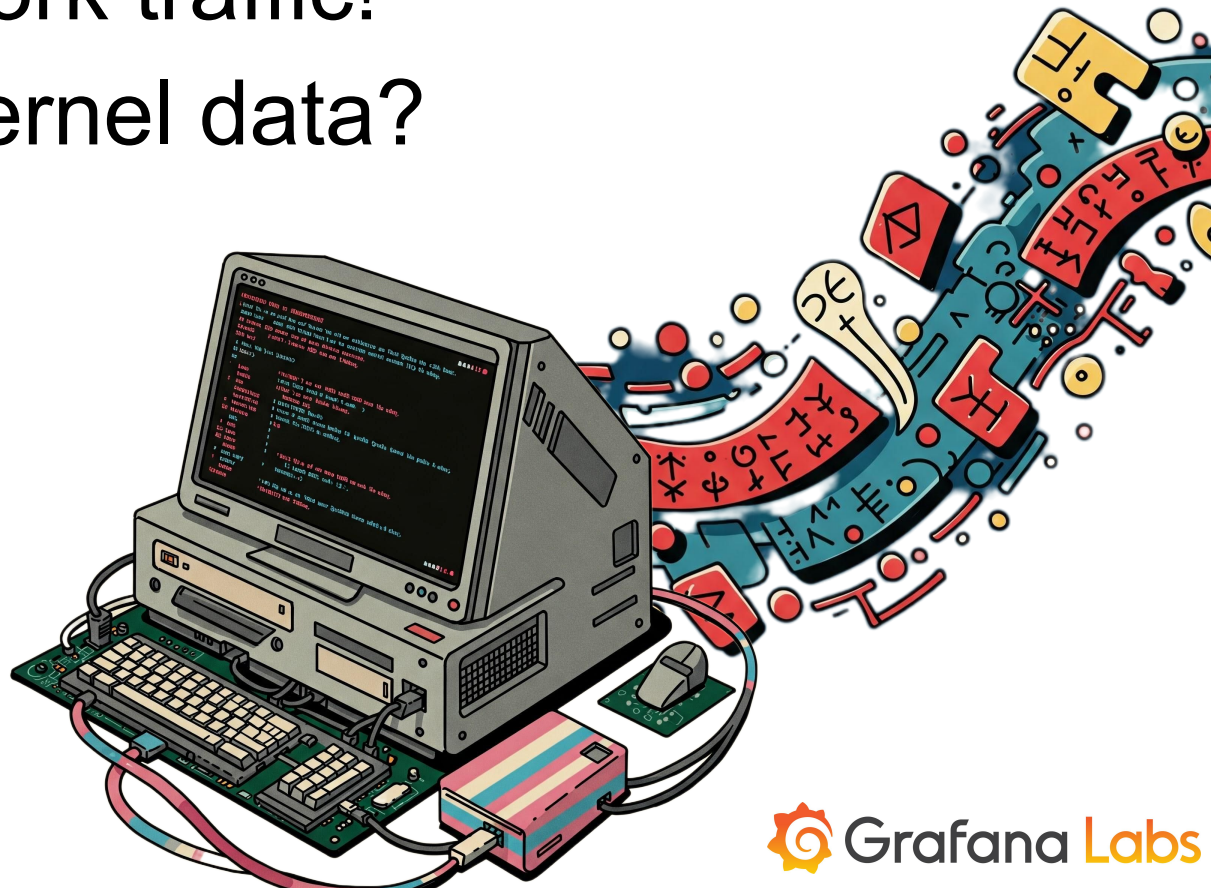
Today You'll Learn About

- eBPF
- Breaking Kubernetes API
- How Beyla enriches kernel data
- Scaling eBPF enrichment

eBPF: overview

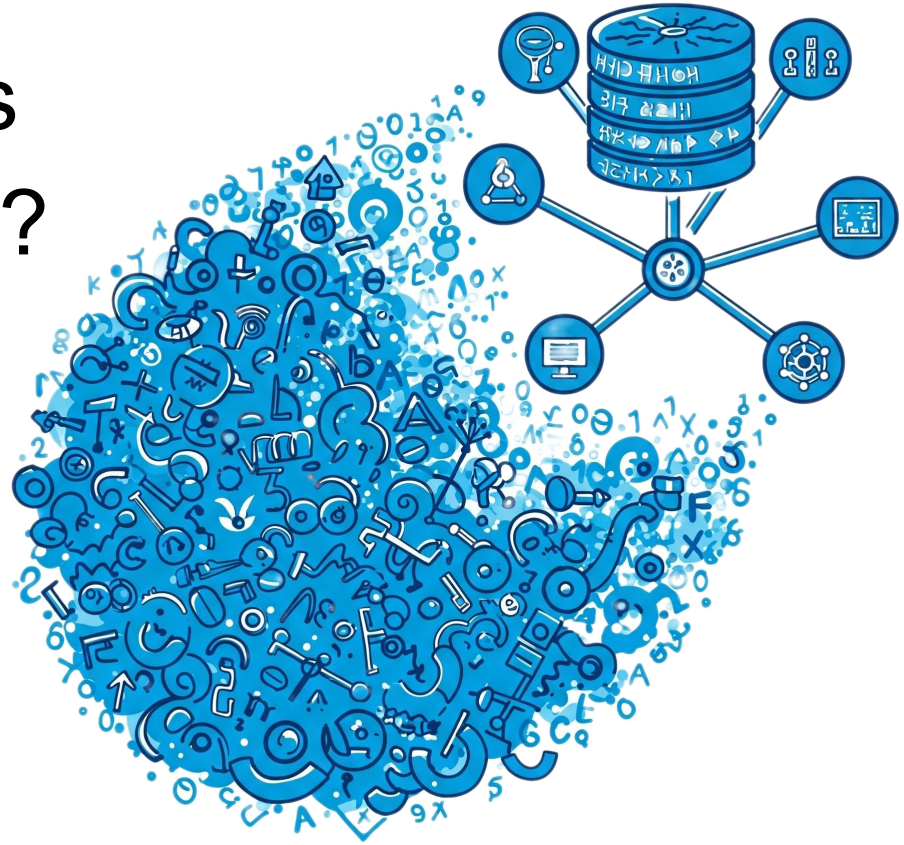
- Enables safe and efficient extension of the kernel
- For performance, We use hooks into `tc`
- Allows us to snoop on network traffic!
- - … but how useful is raw kernel data?





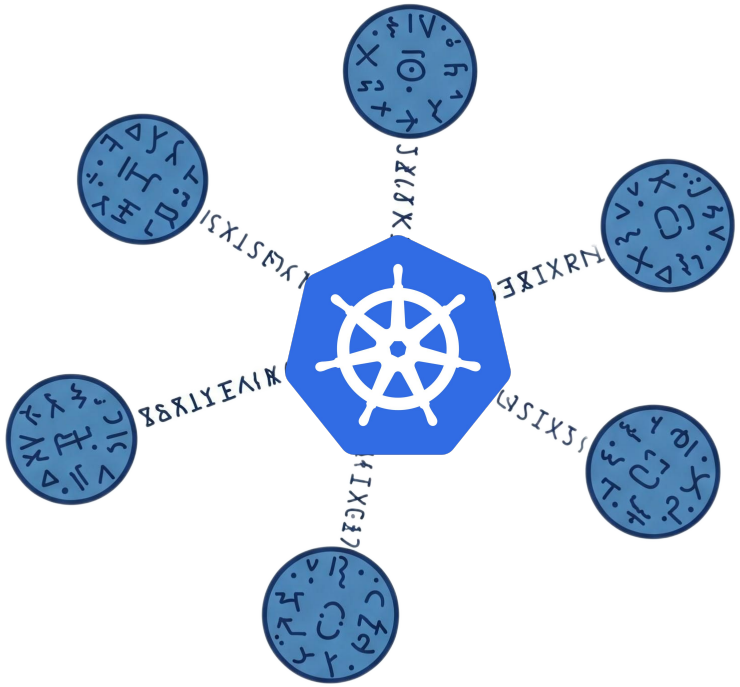
Kernel Data is Raw

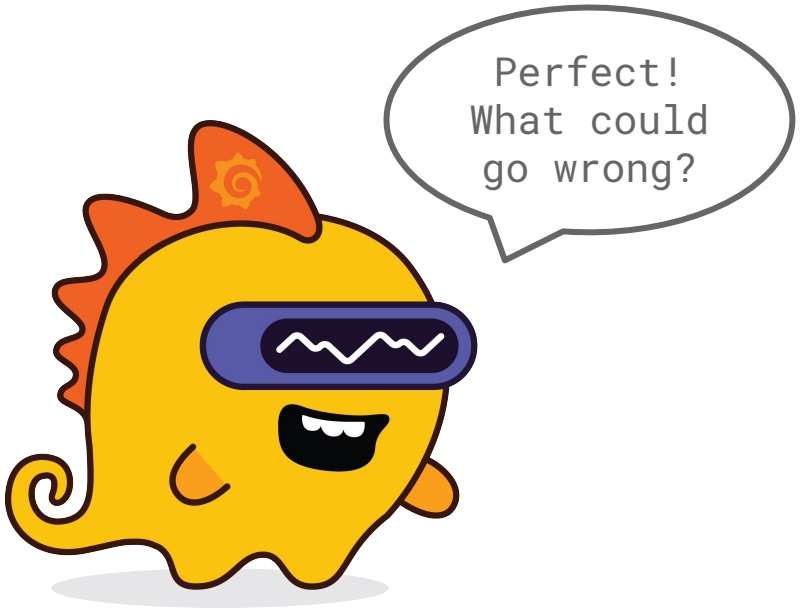
- Each Node has a kernel
- Kernel data gives IP addresses
- In Kubernetes, we care about Pods
- How can we enrich our kernel data?



eBPF on Kubernetes

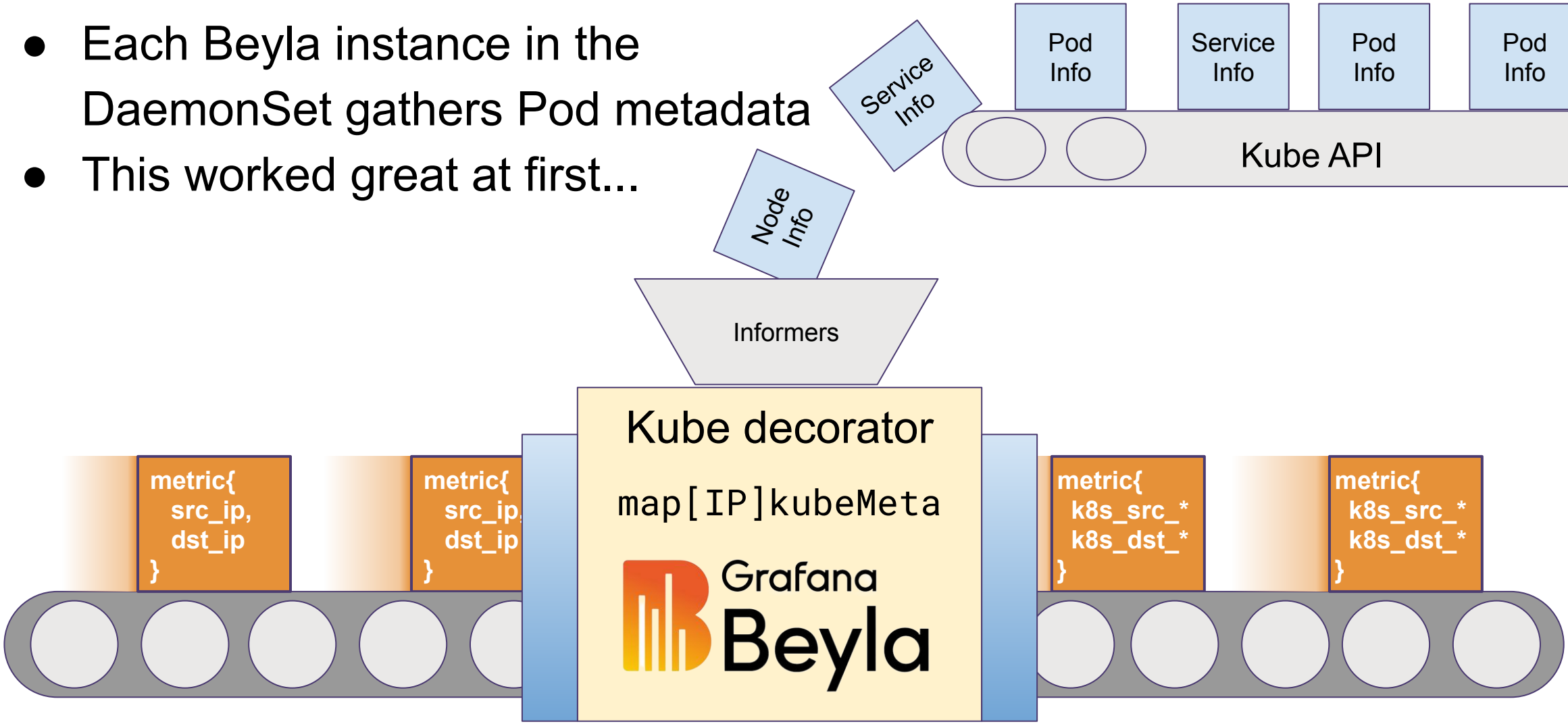
- DaemonSet = 1 pod per kernel
- We have this very tempting API
- It knows everything about the cluster





Our first attempt

- Each Beyla instance in the DaemonSet gathers Pod metadata
- This worked great at first...



The moment we realised…

- We deployed to a large cluster

Users also reported it

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grafana / bey

Code Issues 112

Limit impact

Closed

dashpole opened

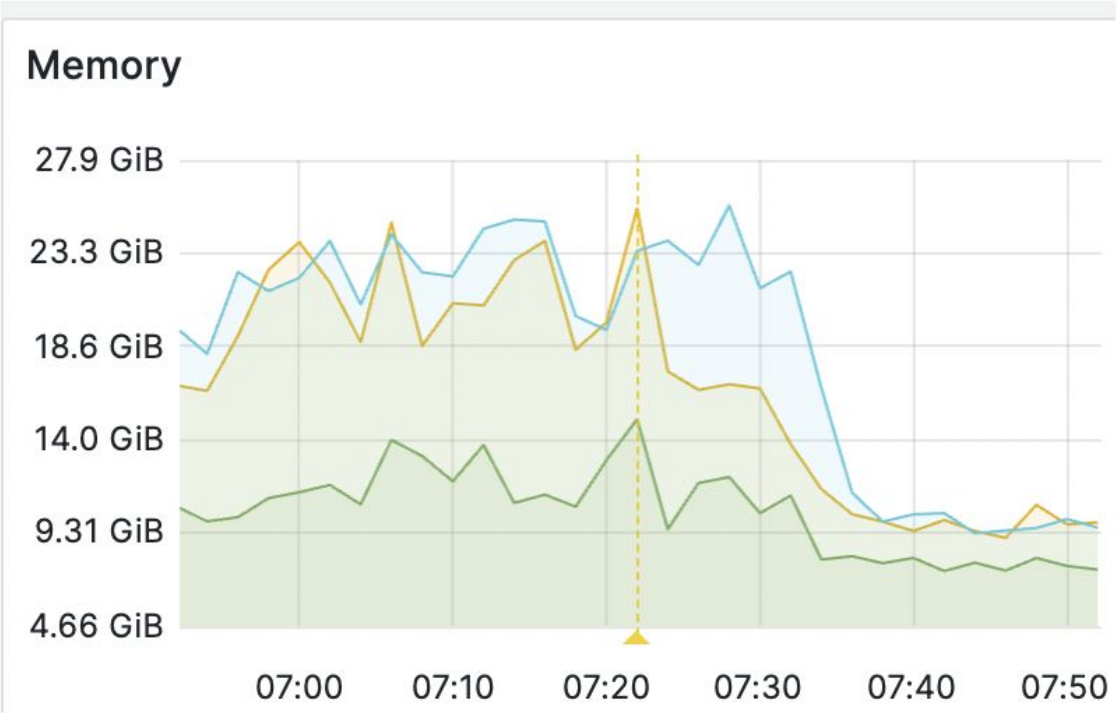
What I would lik

I mentioned this

As a general bes
replicasets, all se
to watch pods as
apiserver than a
the deployment.

dimunech on May 31, 2024

To expand on this - Kubernetes metadata decorator adds considerable load to Kubernetes API servers. Here's a graph of master nodes memory usage before and after disabling the decorator (yellow annotation on the graph).



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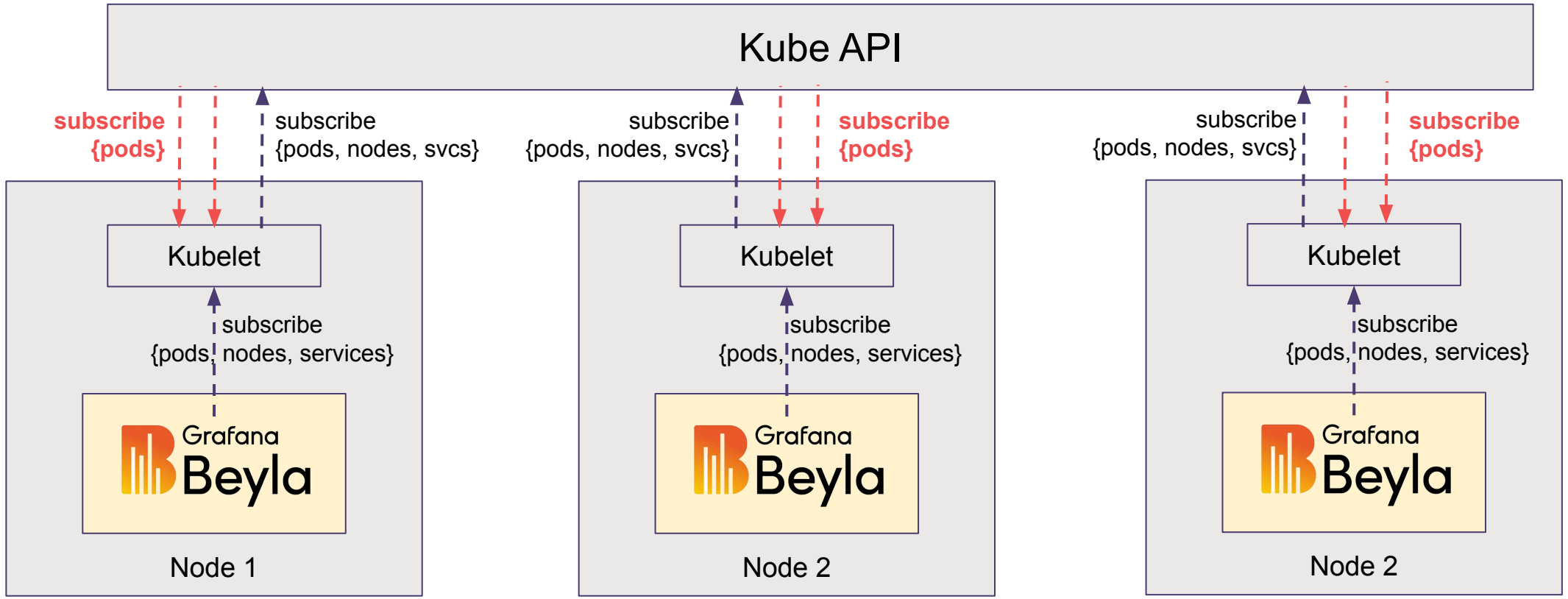
DDoS'ing Big Clusters

Kube API handling ~O(N^2) subscriptions



How Can We Fix This?

- Replace subscription model by individual requests
- Kubelet API
- Clustered
- Centralized Cache

Replacing subscription model by “get”

- Won’t work
  - Need to query information by IP address
- Stampede of requests during deployments

Kubelet API

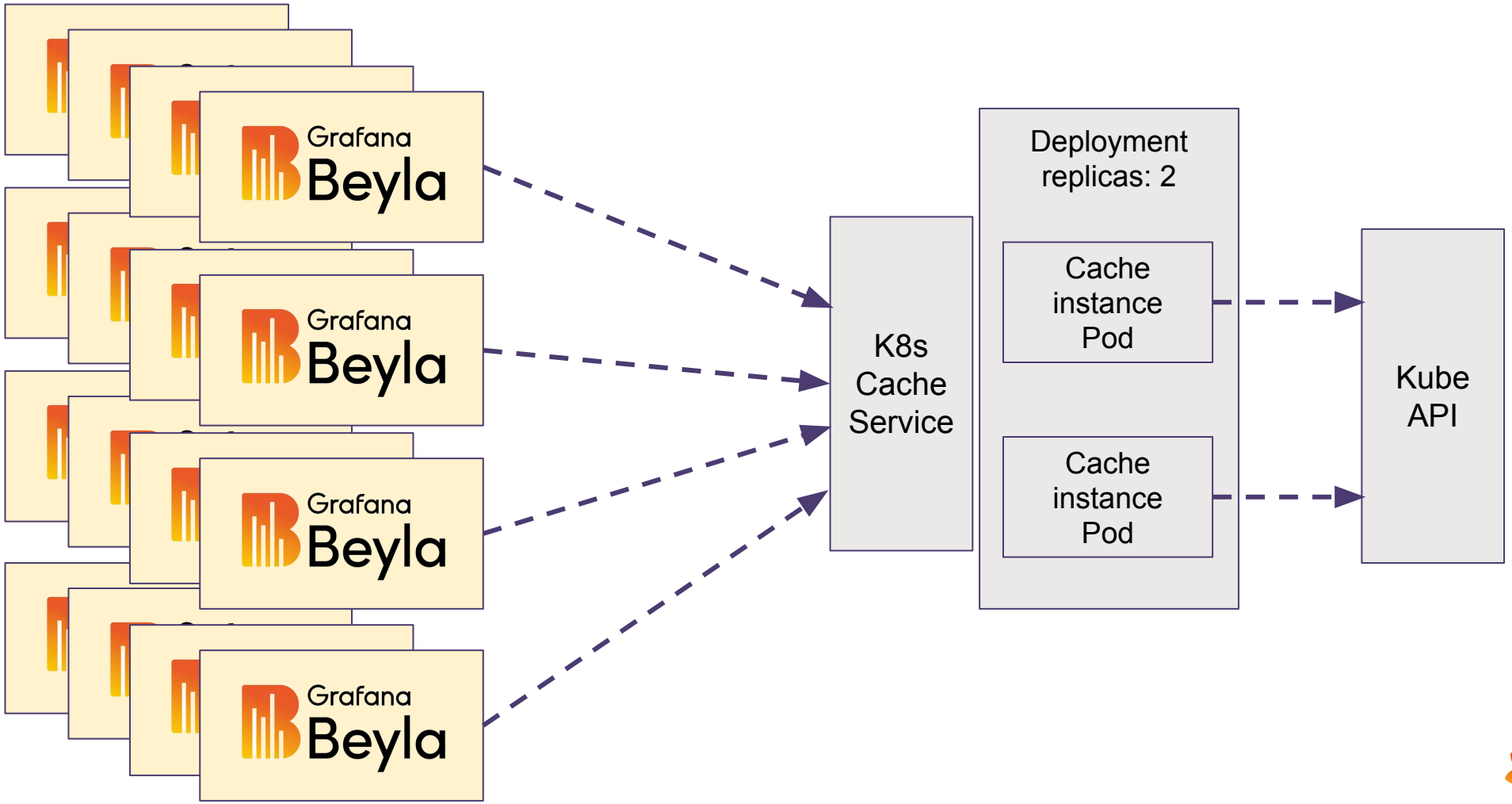
- The kubelet has an undocumented API
- It runs on every node and maintains its own state
- No access to global objects (e.g. services or Pods from other nodes)

Clustered Cache

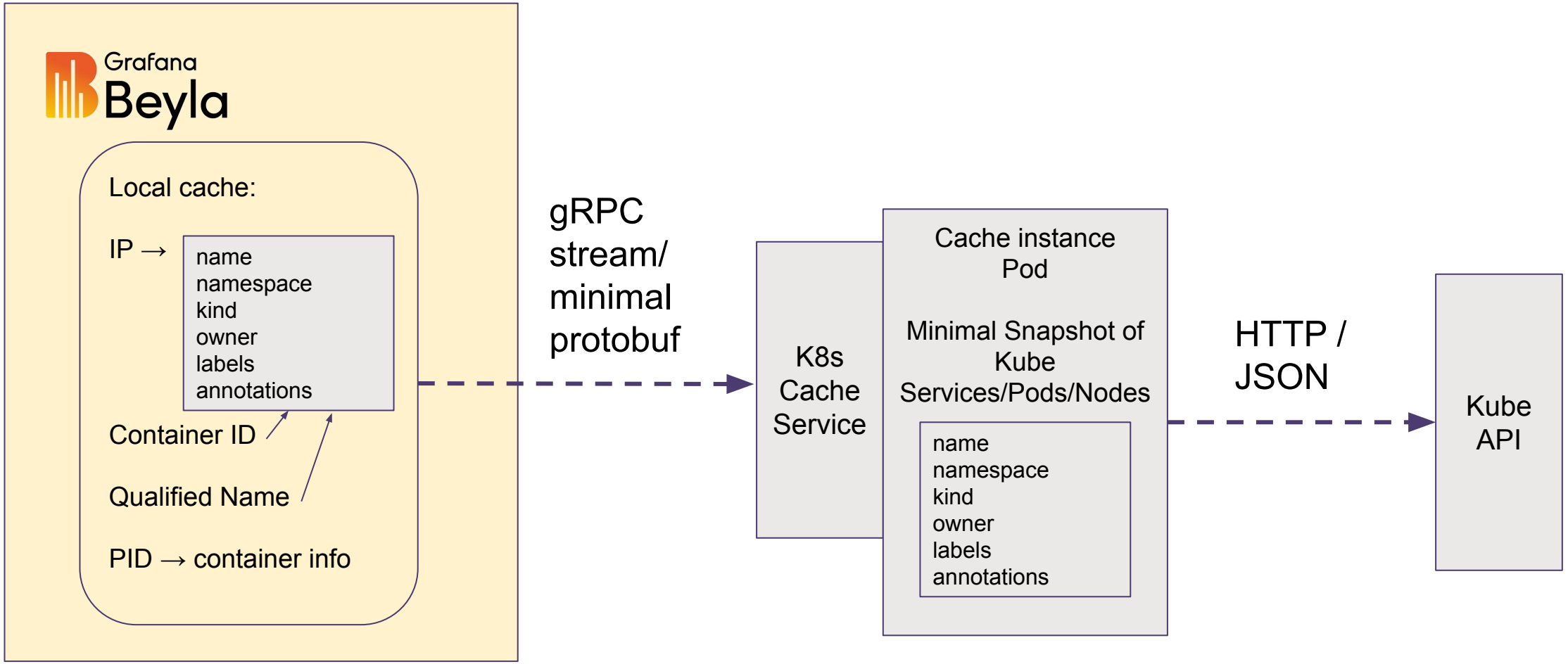
- Using a gossip protocol to share metadata
- Triggered when nodes learn about a new pod <-> IP mappings
- Adds network traffic overhead, complexity

Centralized cache

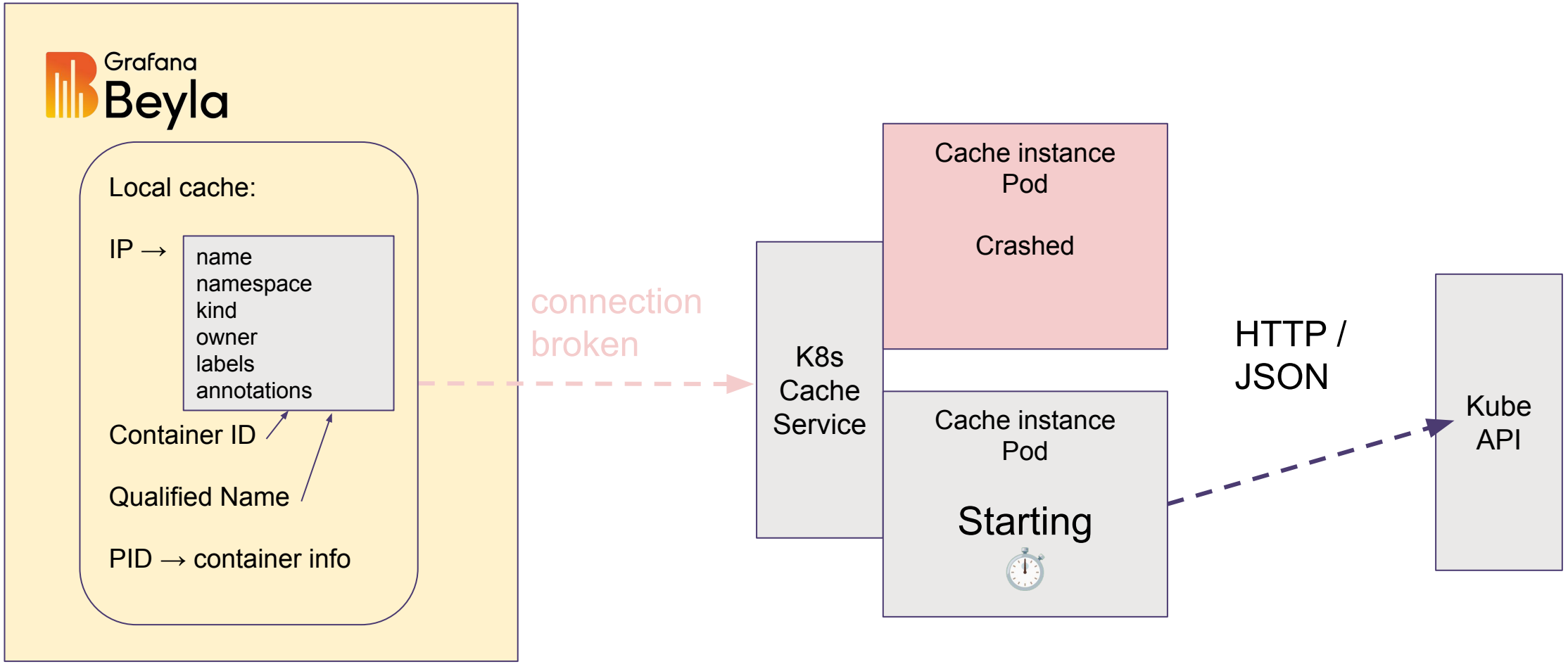
- Chosen approach, for simplicity and flexibility



Centralized cache

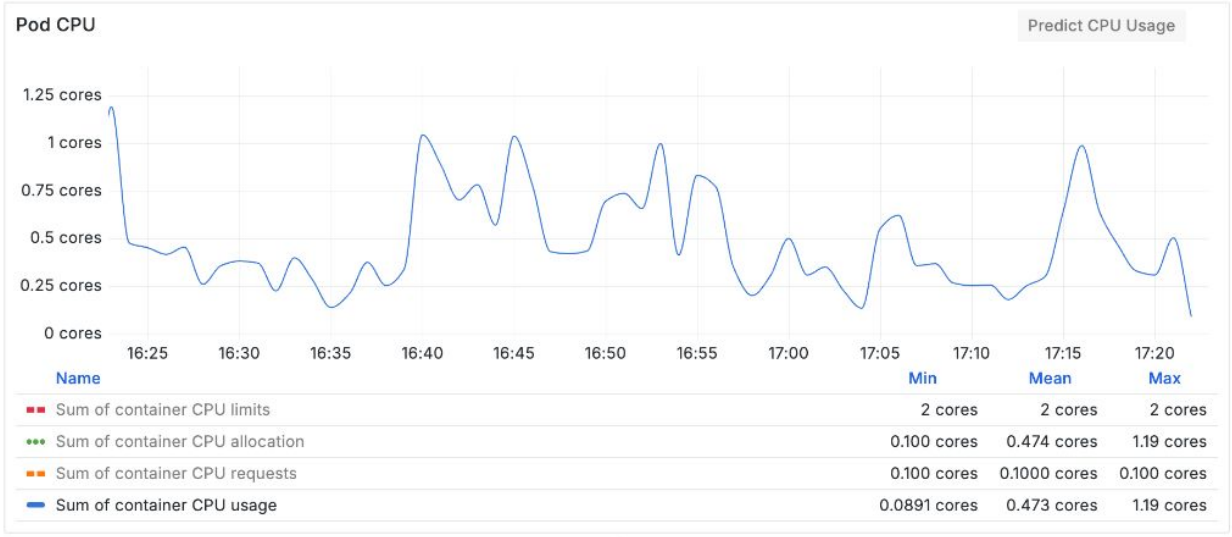


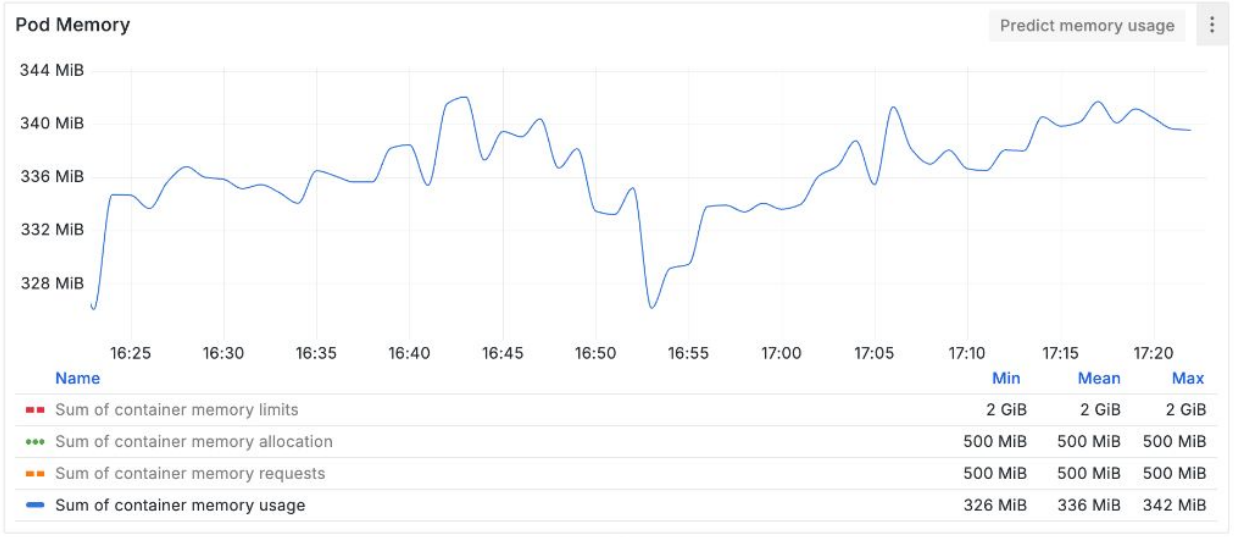
Centralized cache is storageless



Issues with a centralized cache

- Another component to manage
  - Avoid using external dependencies (DBs, MQs…)
- Resource utilization
  - Especially during startup
  - Use binary encodings
  - Remove unneeded fields





Cache resource utilization

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During cache deployment, instances are memory-hungry

Data source | Service: beyla/beyla-cache | Profile type: memory/alloc_space | Filters: pod = beyla-k8s-cache-d7ff998fc-6p9j4 | Filter by label values...

Symbol	Self ↓	Total
k8s.io/apimachinery/pkg/runtime.(*RawExtension).UnmarshalJSON	3.25 GiB	3.25 GiB
reflect.copyVal	2.68 GiB	2.68 GiB
reflect.unsafe_NewArray	2.11 GiB	2.11 GiB
github.com/google/go-cmp/cmp.(*state).compareMap	2.11 GiB	22.5 GiB
sigs.k8s.io/json/internal/golang/encoding/json.(*decodeState).liter...	1.67 GiB	3.07 GiB
reflect.Value.MapKeys	1.54 GiB	2.49 GiB
google.golang.org/protobuf/testing/protocmp.(*transformer).transf...	1.39 GiB	7.64 GiB
github.com/google/go-cmp/cmp.(*state).compareInterface	1.33 GiB	16.0 GiB
google.golang.org/protobuf/testing/protocmp.(*transformer).transf...	1.01 GiB	9.06 GiB
compress/flate.NewWriter	1.00 GiB	1.61 GiB

Sum of container CPU allocation	0.100 cores	0.163 cores	0.430 cores
Sum of container CPU requests	0.100 cores	0.100 cores	0.100 cores
Sum of container CPU usage	0.0214 cores	0.132 cores	0.430 cores

Sum of container memory allocation	500 MiB	767 MiB	1.29 GiB
Sum of container memory requests	500 MiB	500 MiB	500 MiB
Sum of container memory usage	315 MiB	650 MiB	1.29 GiB

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Summing Up

- The Kubernetes API can handle a lot, but it has limits
- Our solution was to use a centralized cache
- DaemonSet performance matters a lot

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Thank you for your attention!

¿Questions?

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