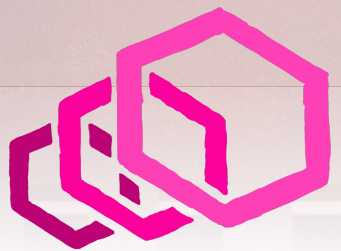
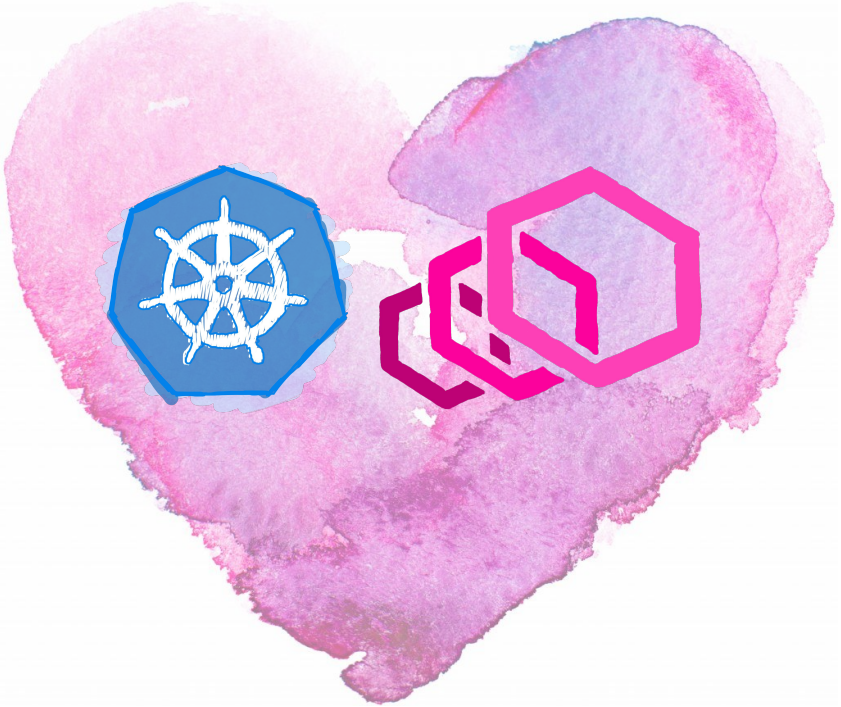
LITA CHO & TOM WANIELISTA

Service Mesh in Kubernetes: It's not that Easy



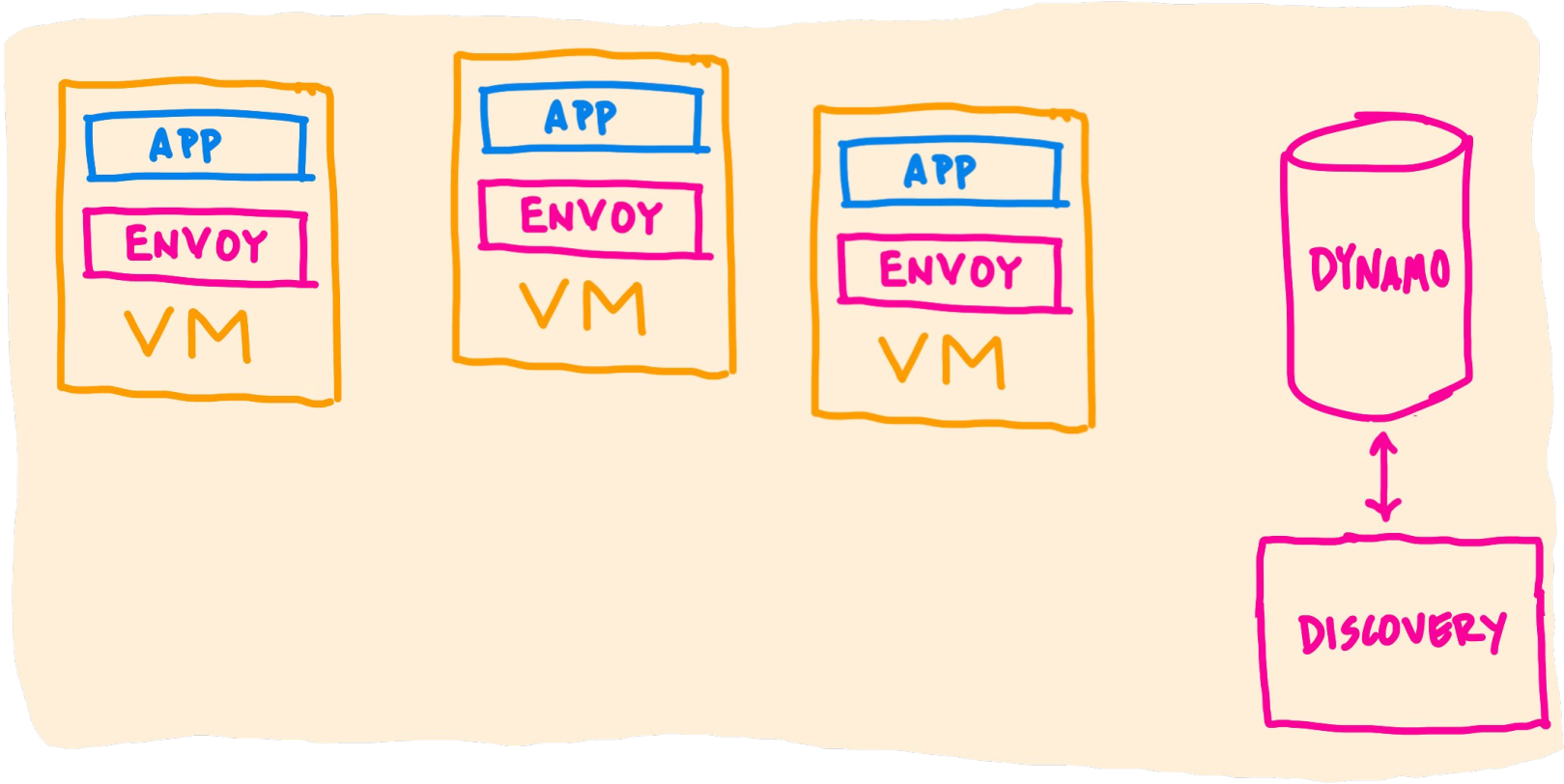
lyft

Agenda



- Service Discovery
  - Legacy vs. Kubernetes
- Issues
  - Scale up
  - Scale down
- Future Work

Pre-Kubernetes Service Discovery



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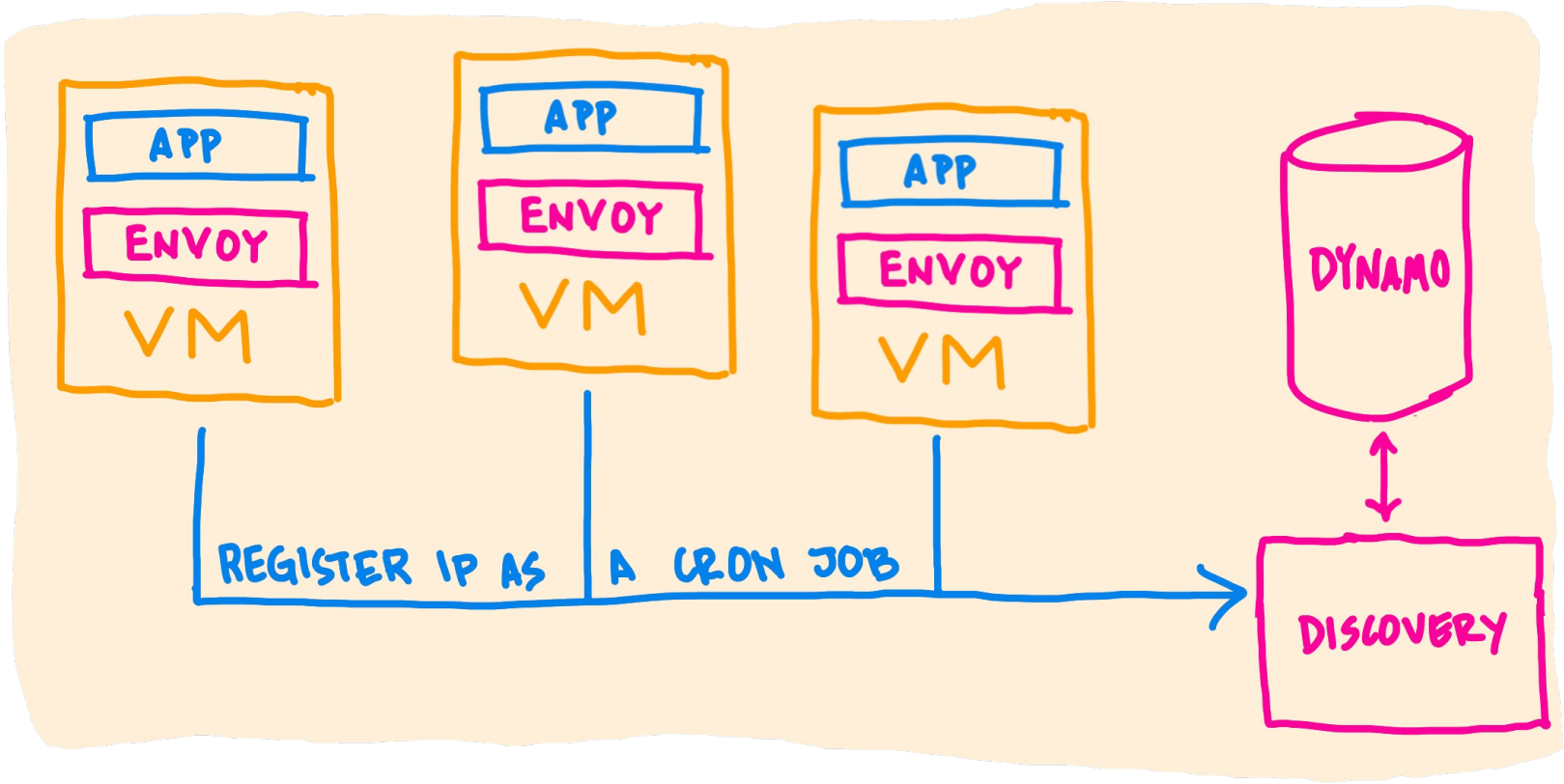

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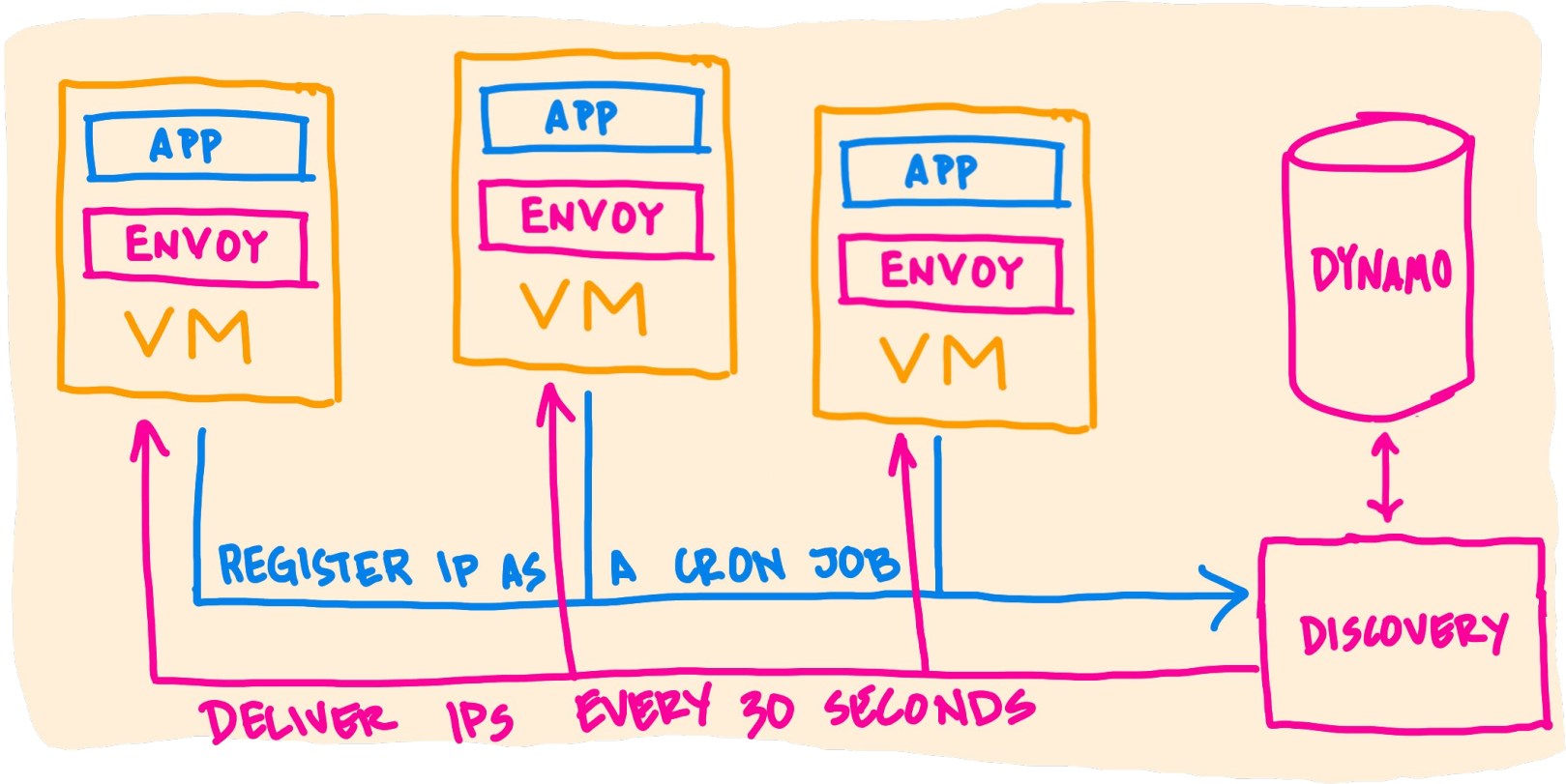
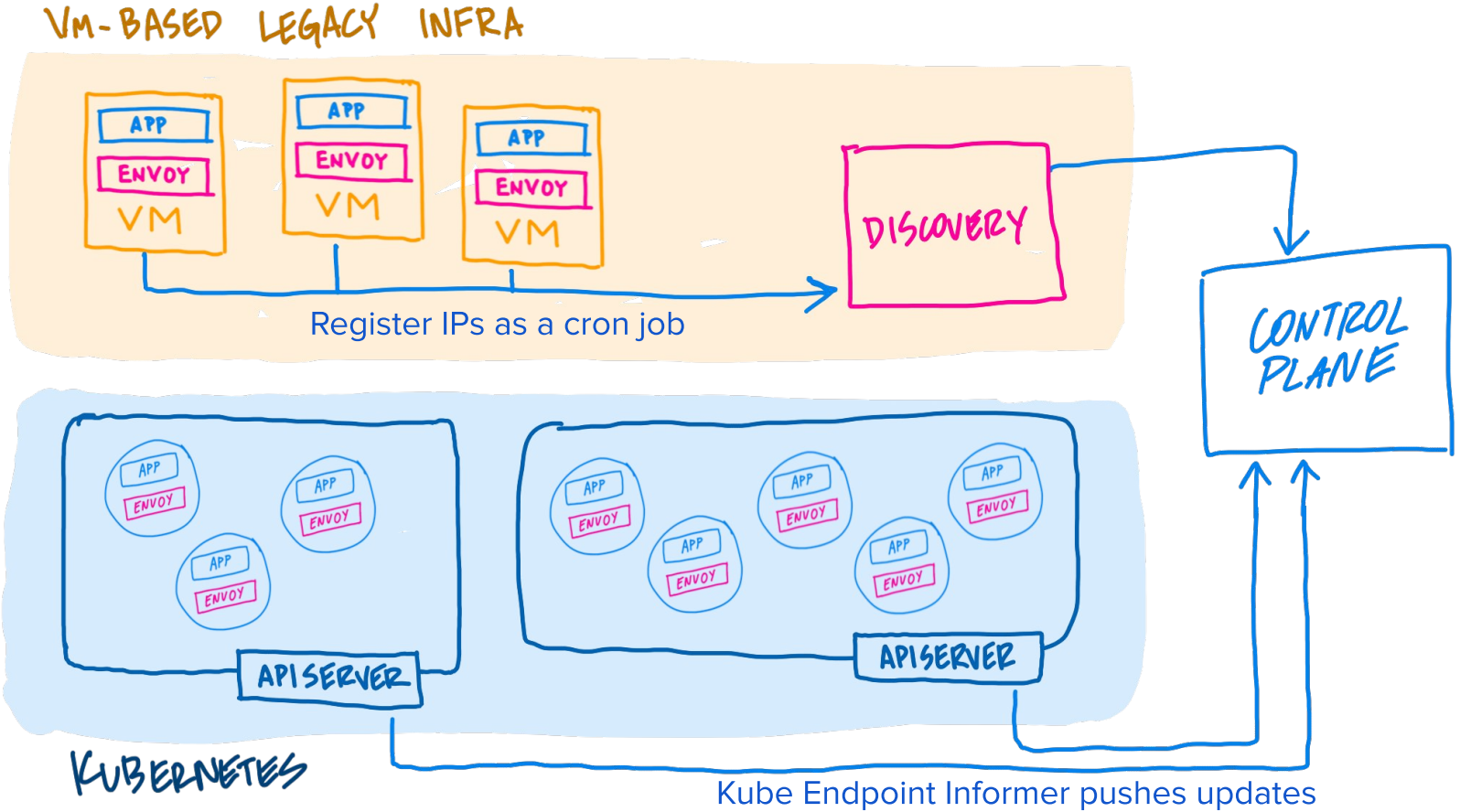


Hybrid Service Discovery



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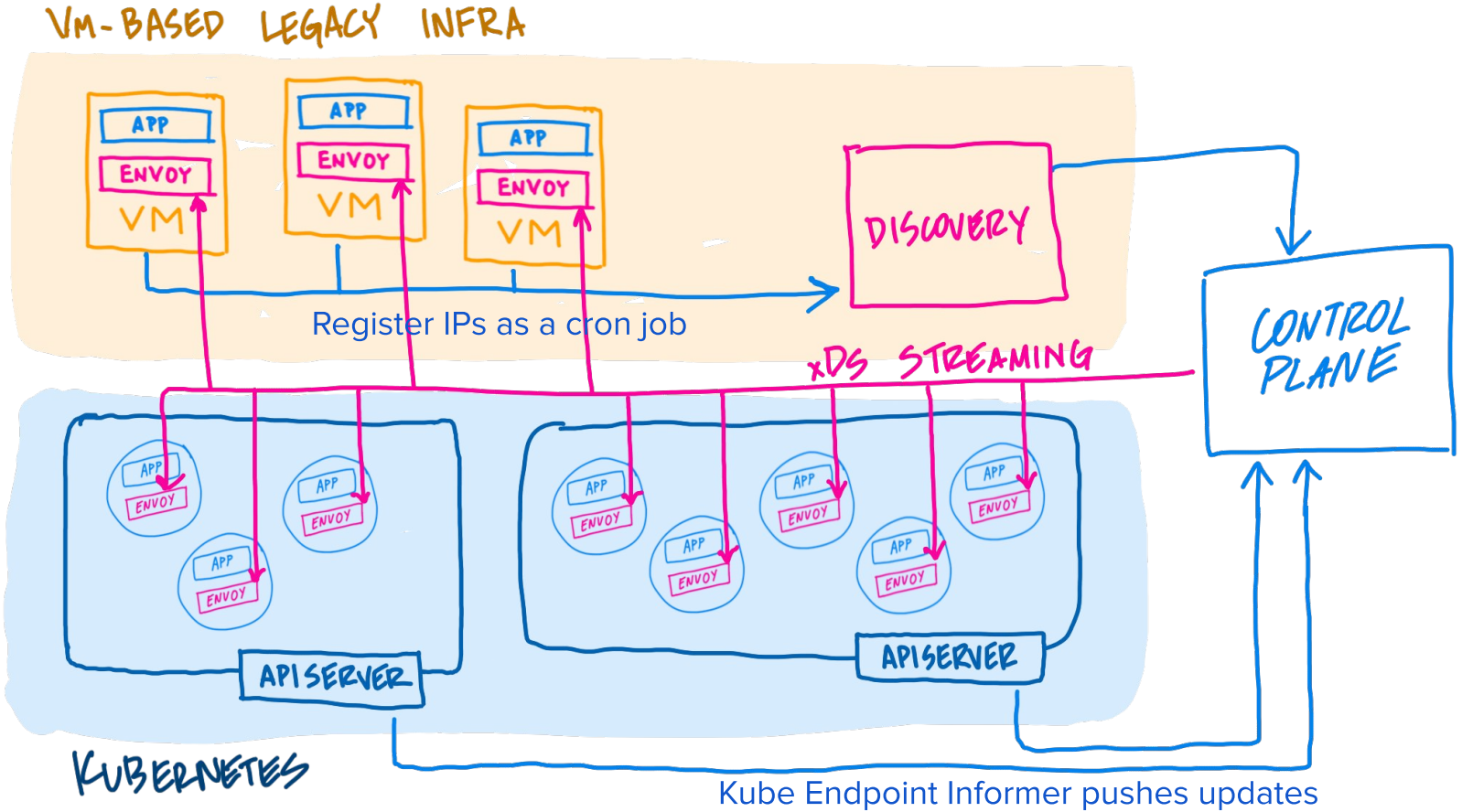
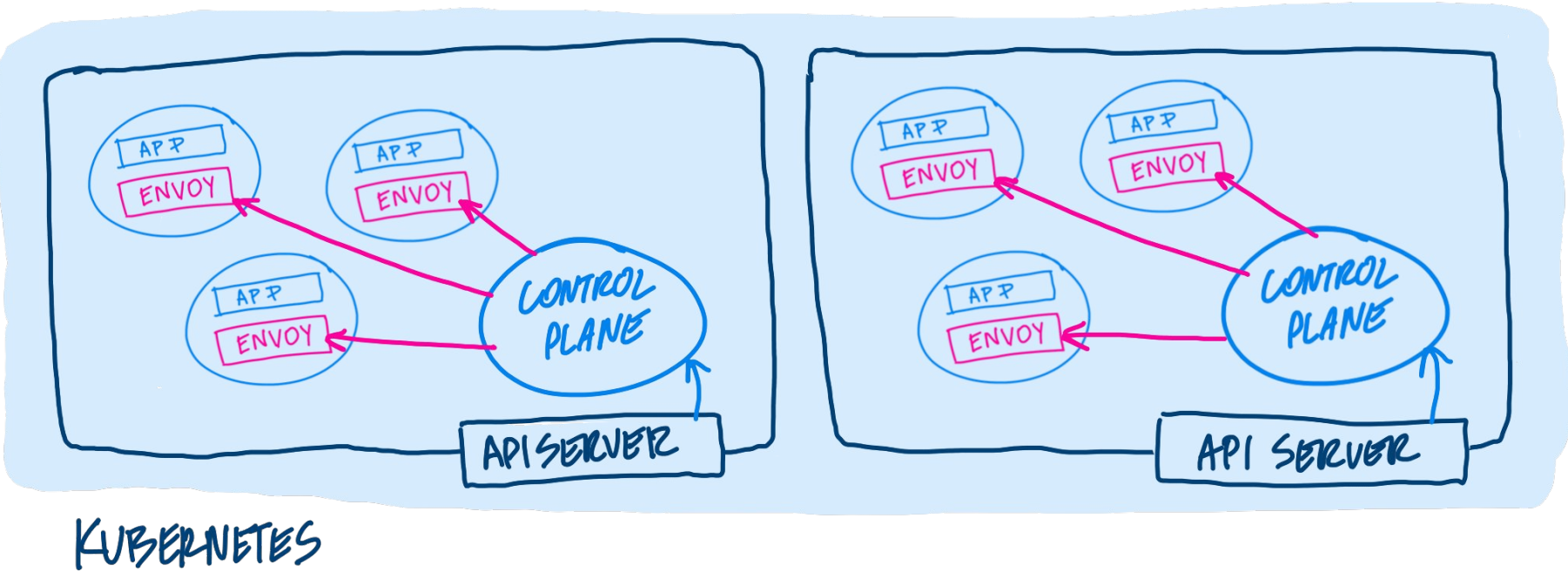


Final State


APP
ENVOY
APP
ENVOY
APP
ENVOY
CONTROL PLANE
API SERVER
APP
ENVOY
APP
ENVOY
APP
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CONTROL PLANE
API SERVER
KUBERNETES

KEEPING IT SIMPLE

Initial Design

- Control Plane leverages Informers.
  - Uses WATCH APIs
- Kubernetes Endpoints object provide all IPs for a particular Service.
  - Provides old state and the new state. Either you can generate the diff, or in our case, just overwrite with the new state.
- Control Plane includes data from legacy Discovery API
- Moving to Streaming xDS APIs
  - Important since K8s changes very fast with immutable infrastructure.

Envoy CDS

Active Health Checking	<pre>"health_checks": [
	  {
	  "timeout": "2s",
	  "interval": "15s"
	  }
	…</pre>

Outlier Detection	<pre>"outlier_detection": {
	  "consecutive_5xx": 3,
	  "max_ejection_percent": 5,
	  "success_rate_minimum_hosts": 20,
	  "success_rate_request_volume": 50,
	  "success_rate_stdev_factor": 1900
	}</pre>

Panic Routing	Turned on by default. Enabled after 50% of hosts fail healthcheck

Issues

Every deployment is a scale up and scale down

We need to propagate this information across the mesh in time

Let’s explore each separately

Let’s explore each separately

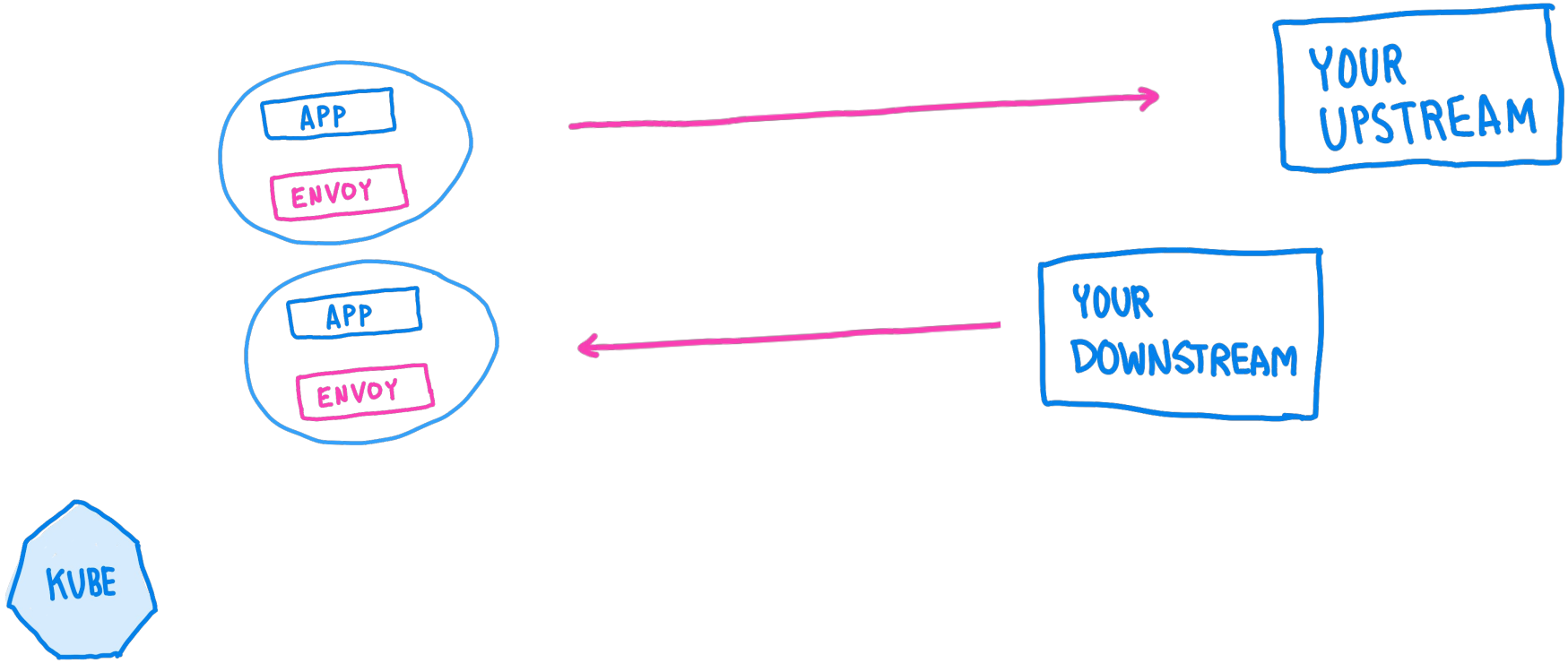
with an invitation to a party 

Scale Up

Scale Up: be polite and introduce yourself to everyone

BE POLITE: SAY HELLO TO EVERYONE

Scale Up



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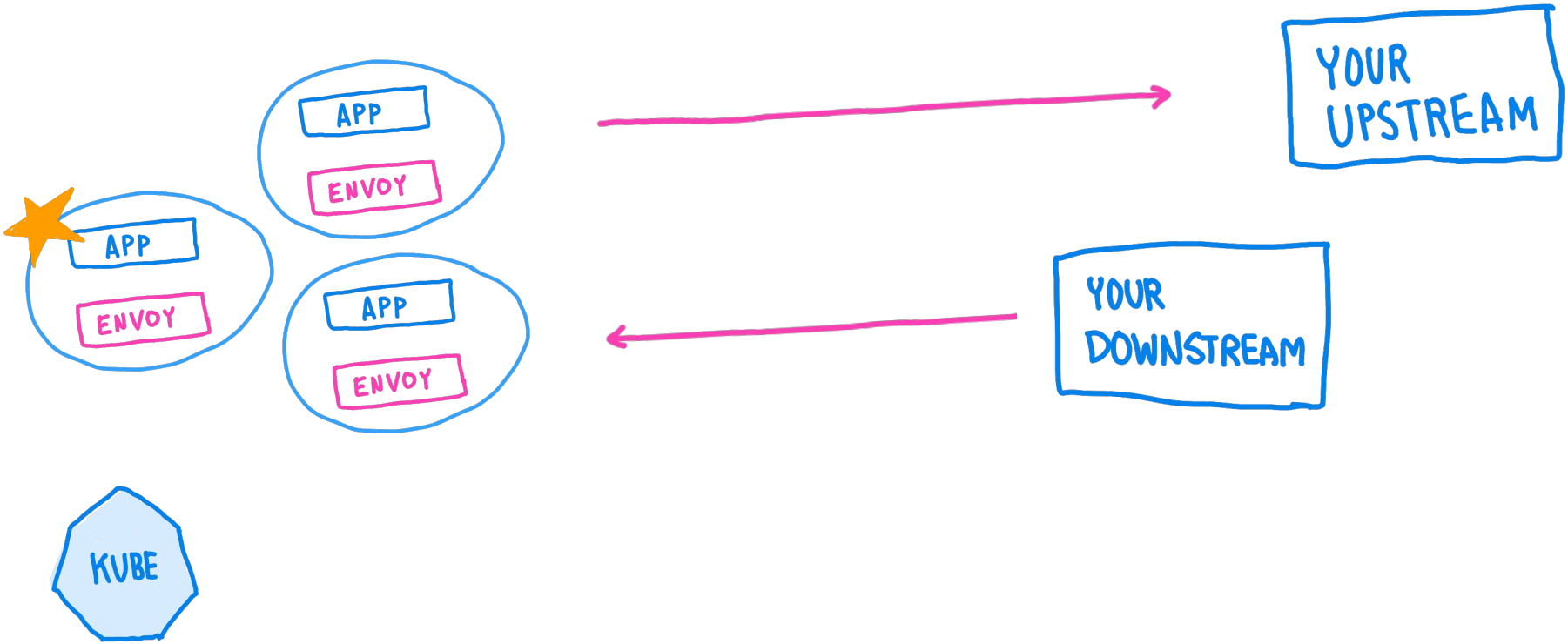

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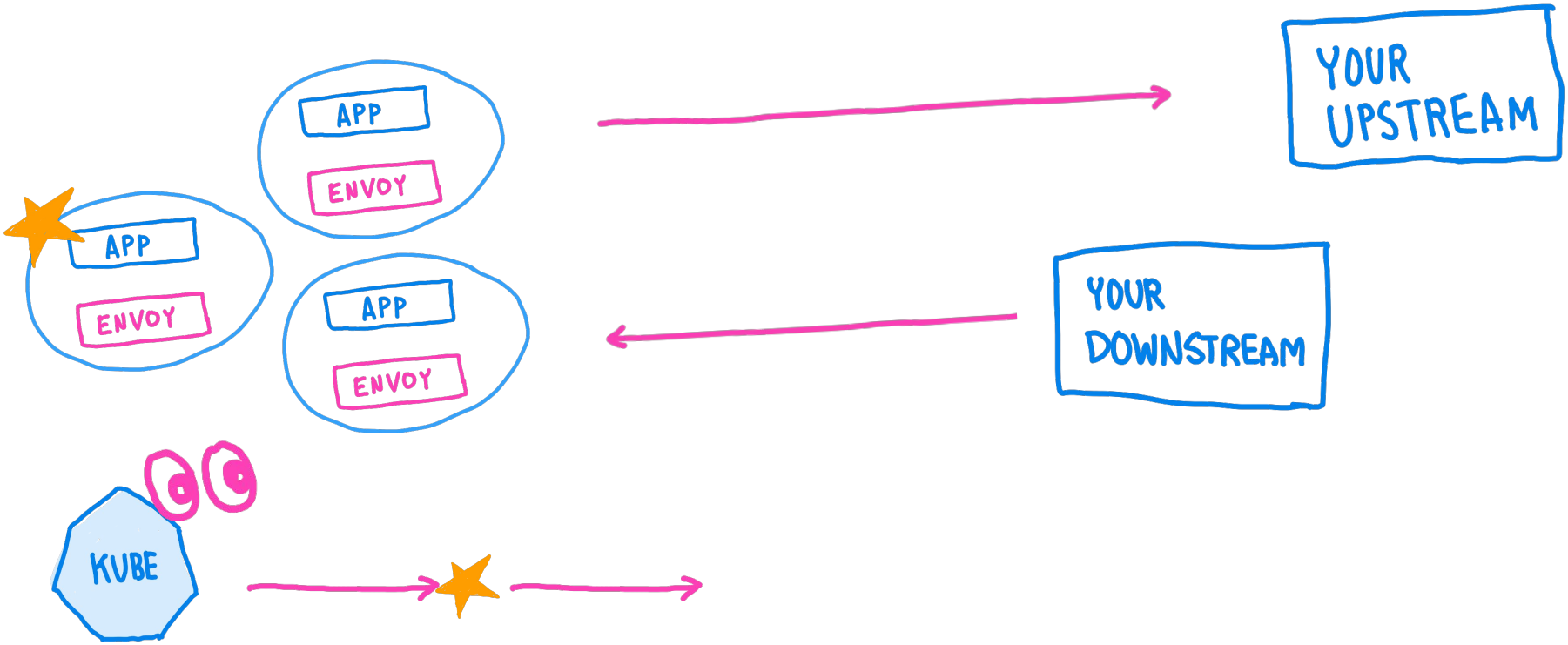

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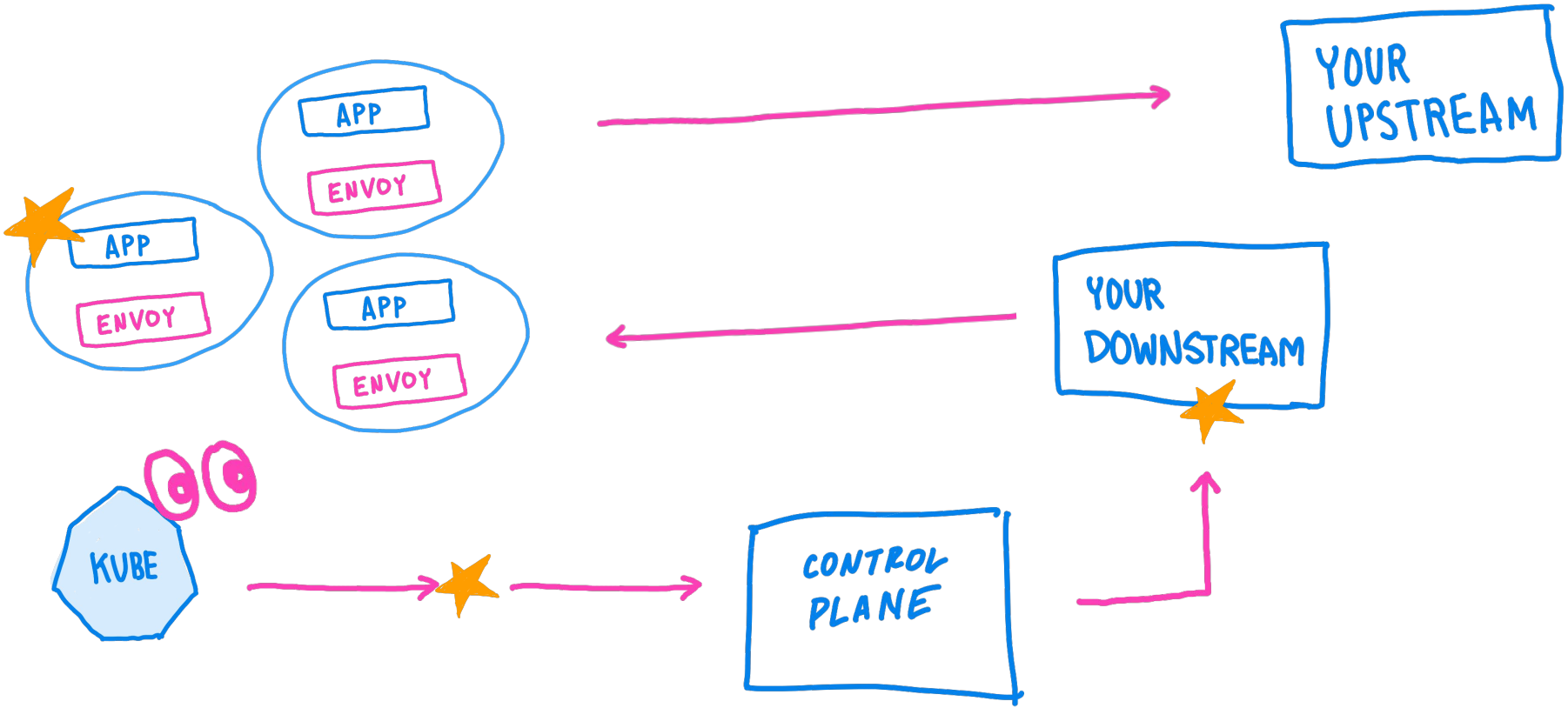

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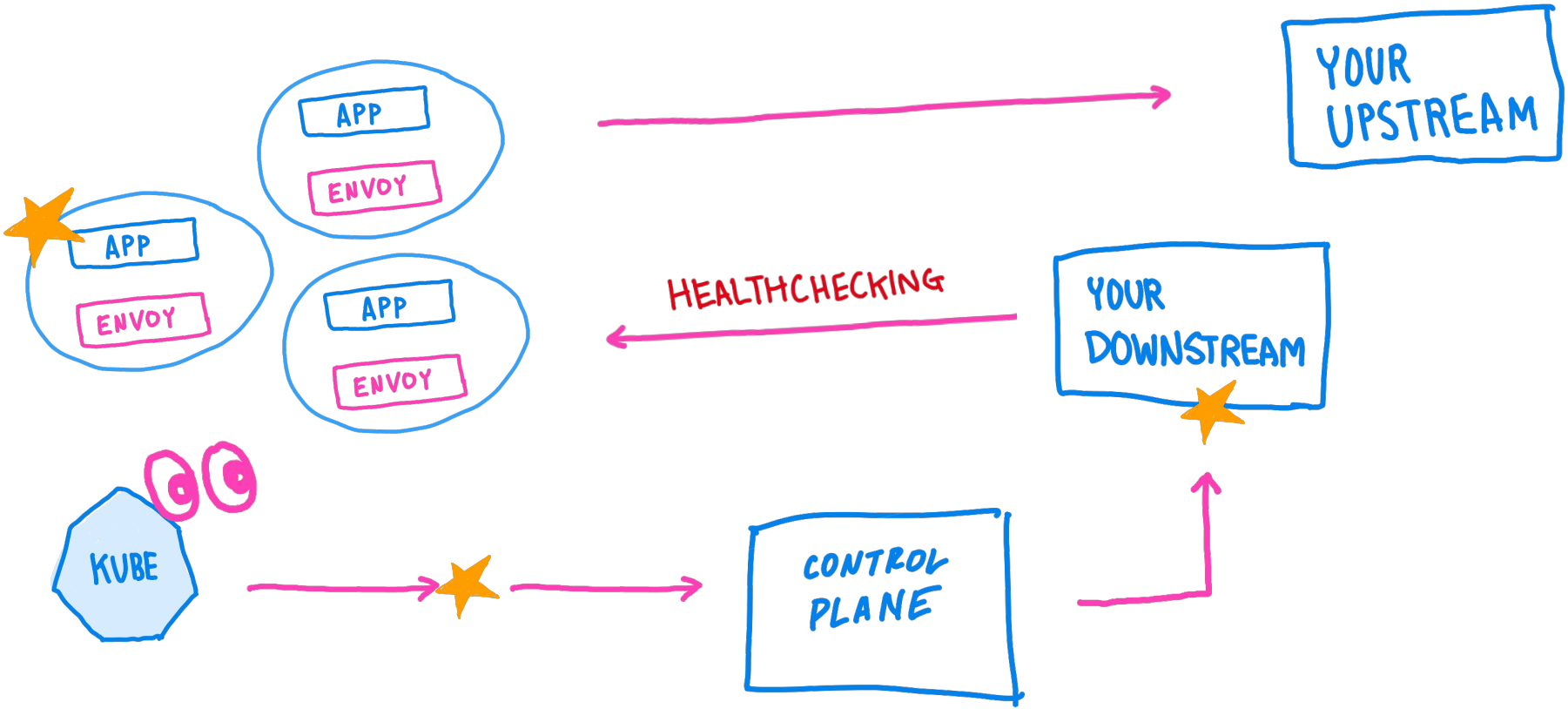

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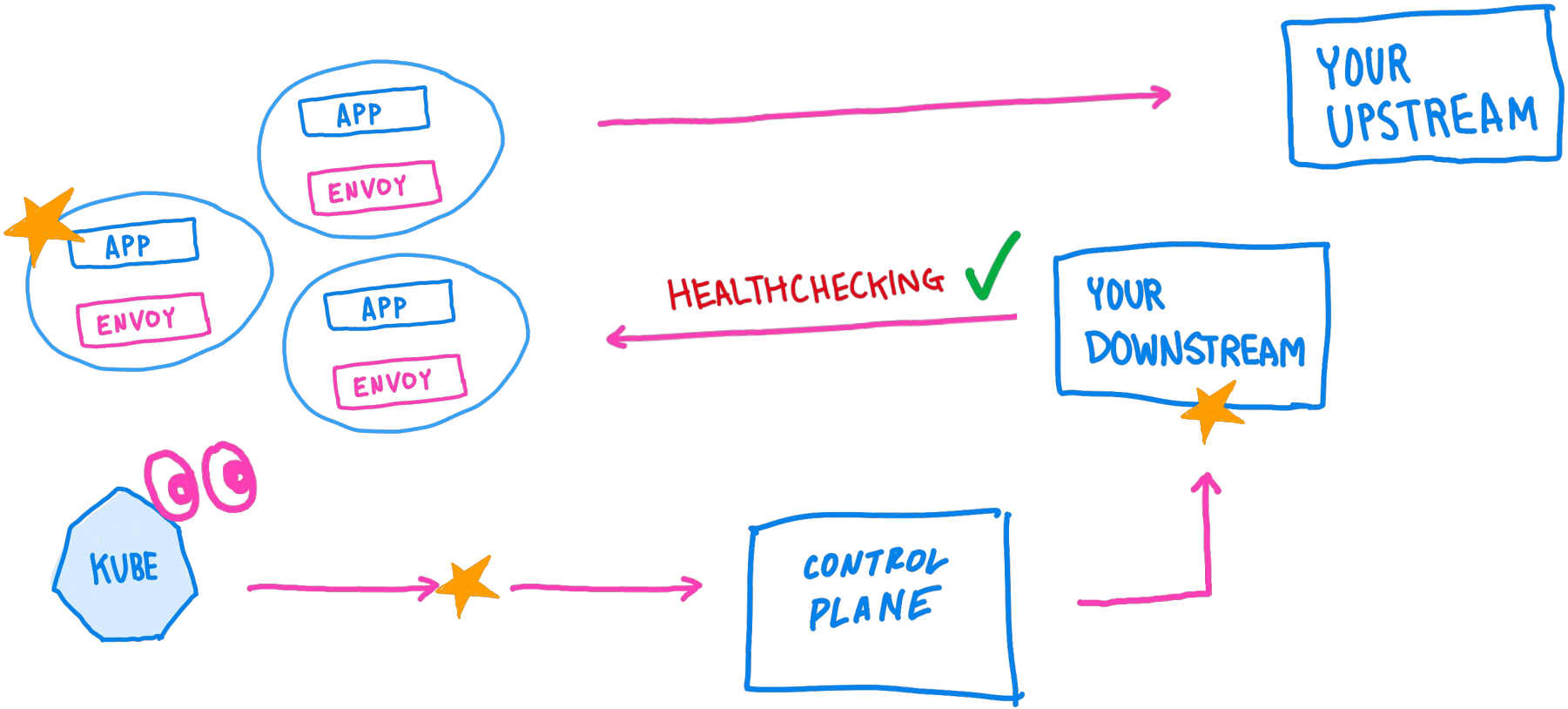

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Panic Routing

- Intended to prevent “thundering herd” effect.
- We have this turned on at 50%.
  - If 50% of the fleet is unhealthy, we will route requests to all hosts.
- **Issue:** A scale up >50% could cause unintentional panic routing.
  - New pods enter the mesh “unhealthy”, skewing the calculation.
  - Prevents us from taking advantage of Kubernetes’ faster scale-up.

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Scale Up Fix: Envoy Upstream

- Upstream: allow excluding hosts from load balancing calculations until initial health check (#6794) Thanks SnowP!
  - This works for both panic routing and priority spillover.
  - Has to be enabled via CDS

```
// CDS Configuration
bool ignore_new_hosts_until_first_hc = 5;
```

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Application & Envoy Startup

- Most applications at Lyft expect Envoy to be ready to serve traffic right away
- With our previous VM-based solution, Envoy was a long-lived process that was effectively always running.
  - Envoy is deployed in-place via hot-restarter
- In Kube, each new Pod means new Envoy
- **Issue:** New Envoy may have not connected to the Control Plane yet!
  - Applications experience Envoy failures when making outbound requests.

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Kubernetes & Sidecars

- In Kube, all containers in a Pod are started together.
- We could have applications wait for Envoy but would require widespread code changes
  - As the infra group, we intended for the migration to Kubernetes to migrate applications unchanged.

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Kubernetes & Sidecars

- Envoy
  - /ready admin endpoint serves as readiness
  - Be careful with initialization timeout
- We maintain a fork of Kubernetes with some patches:
  - At start, sidecars must be ready first before applications
  - At termination, applications exit first before sidecars
- Mostly follows KEP: sig-apps/sidecarcontainers.md
  - Working with Pinterest & the community to figure out a possible upstream solution.
  - https://github.com/lyft/kubernetes - branch: release-1.14.7-lyft

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Summary - Scale Up

- **Panic Routing**
  - Upstream Envoy fix prevents large scale-ups triggering unintentional panic routing.
- **Kubernetes' Sidecar Support**
  - Readiness means "I've connected to the control plane"
  - Our forked Kubernetes ensures Envoy is ready before the application starts.

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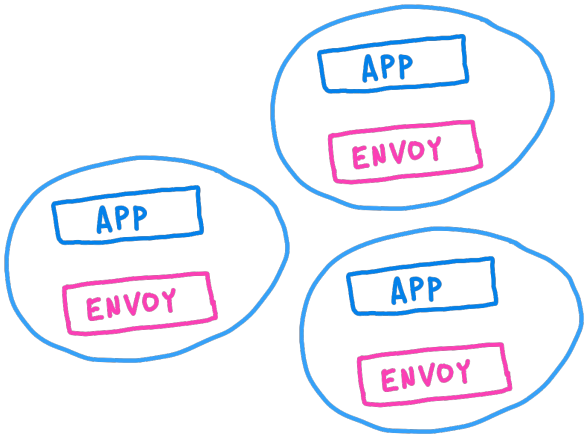
Scale Down

Scale Down: Say bye to everyone before you leave

SAY BYE TO EVERYONE BEFORE YOU LEAVE

Scale Down



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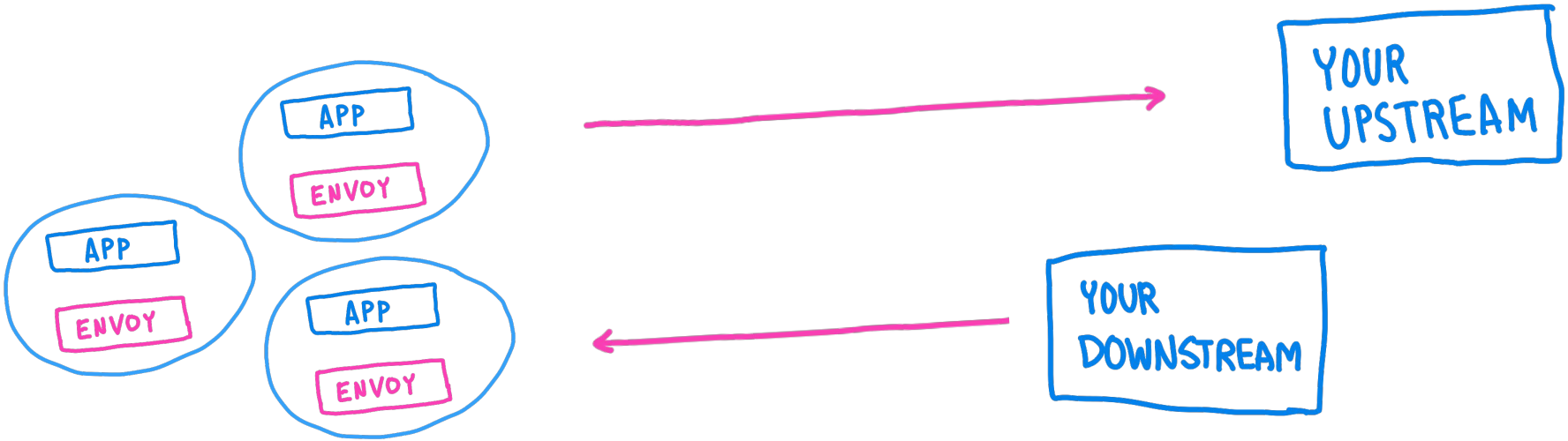

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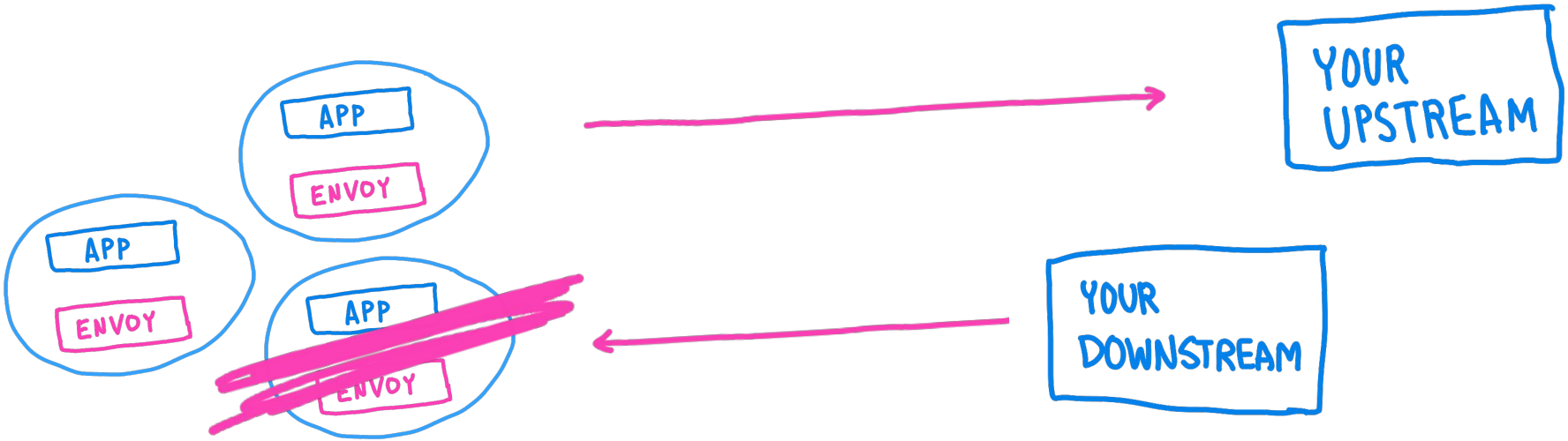

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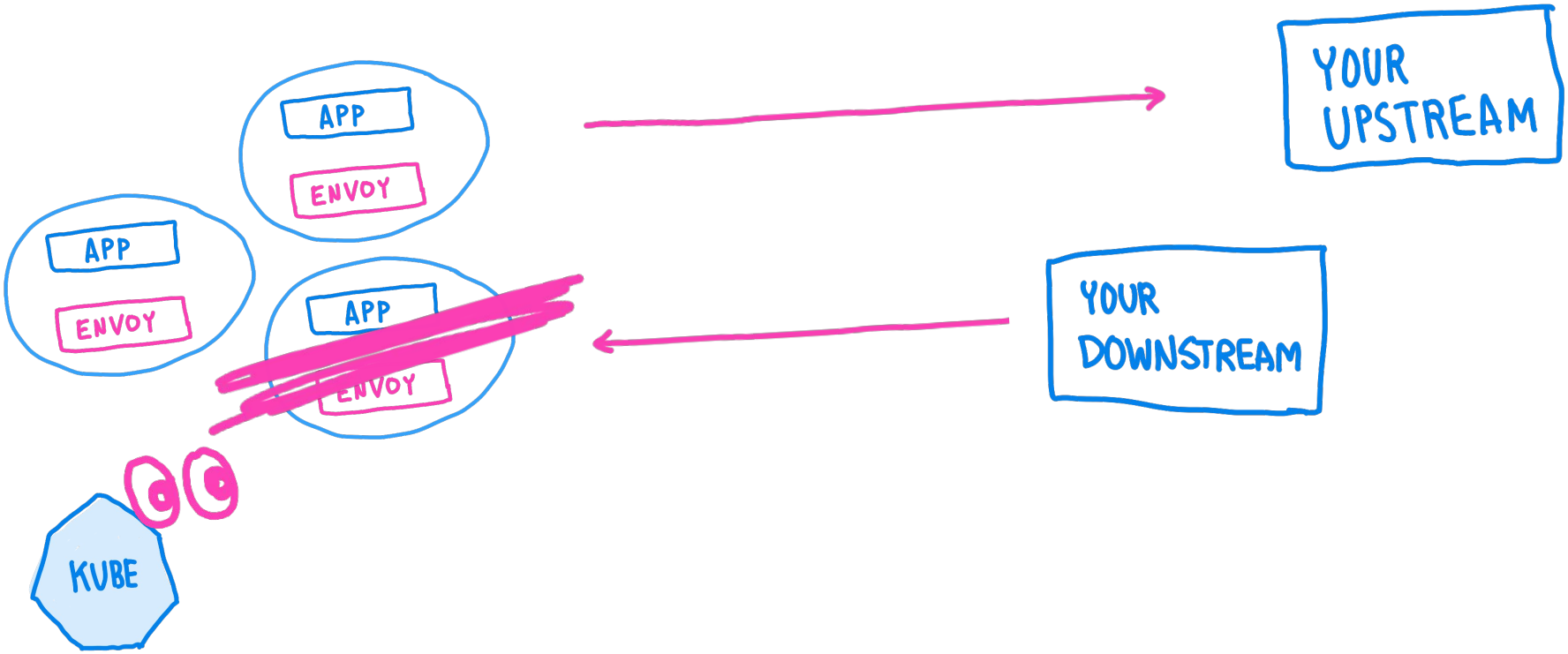

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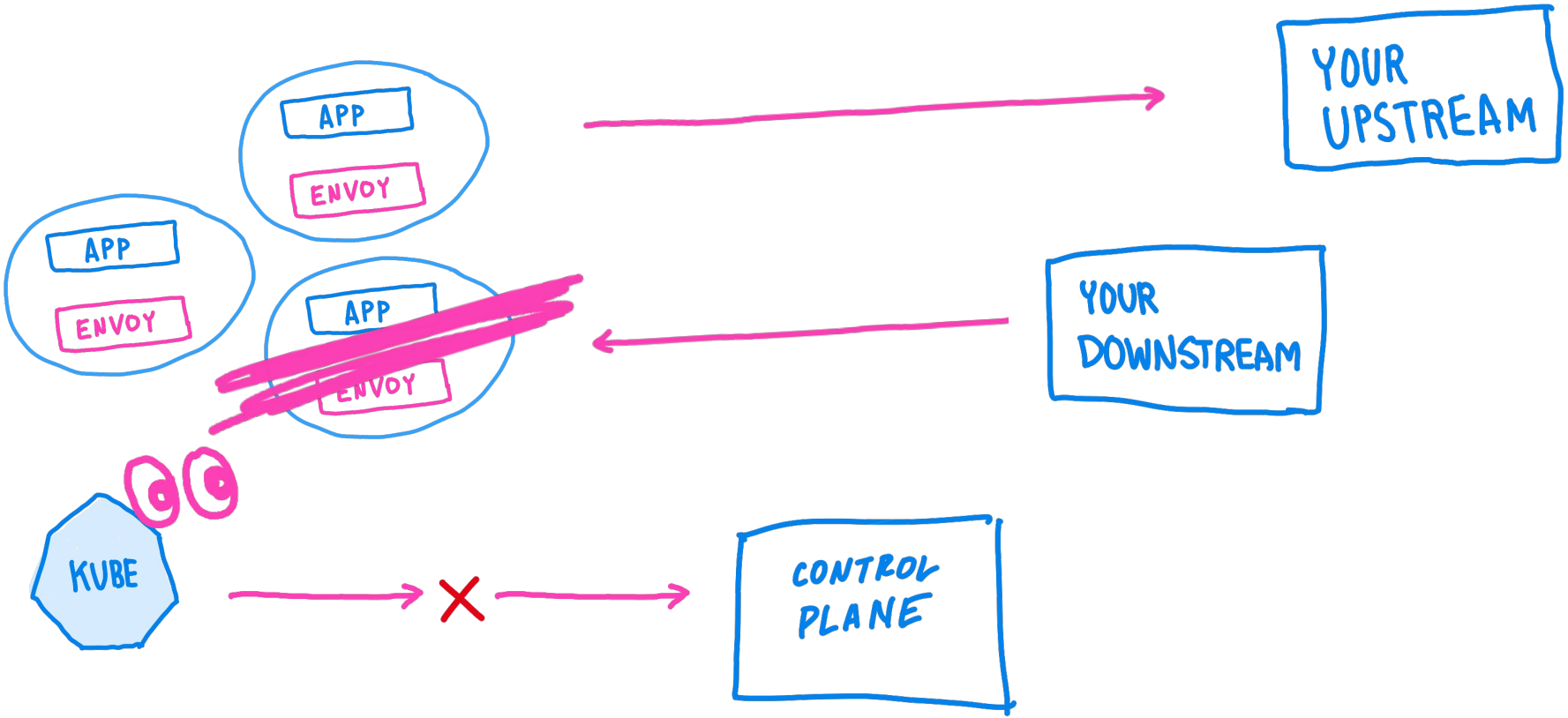

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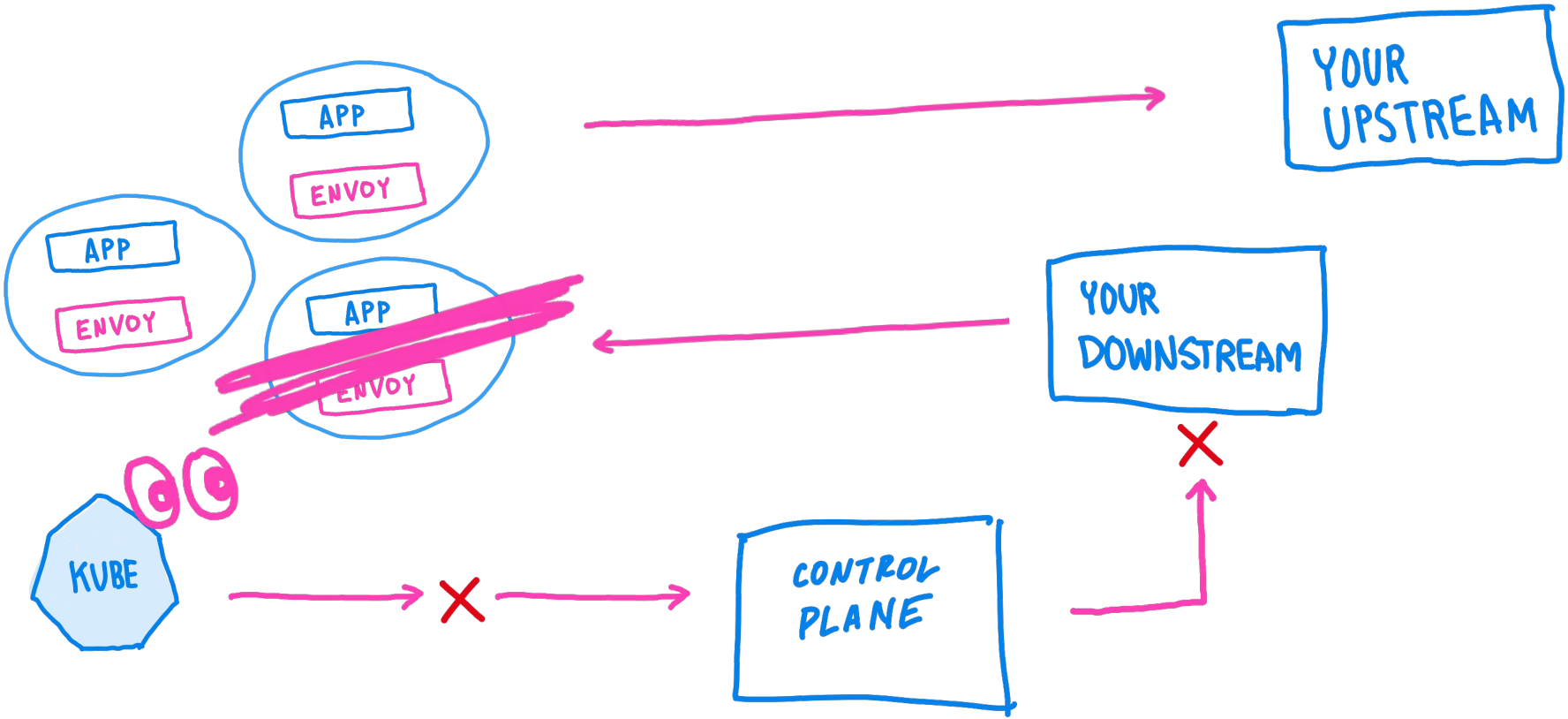

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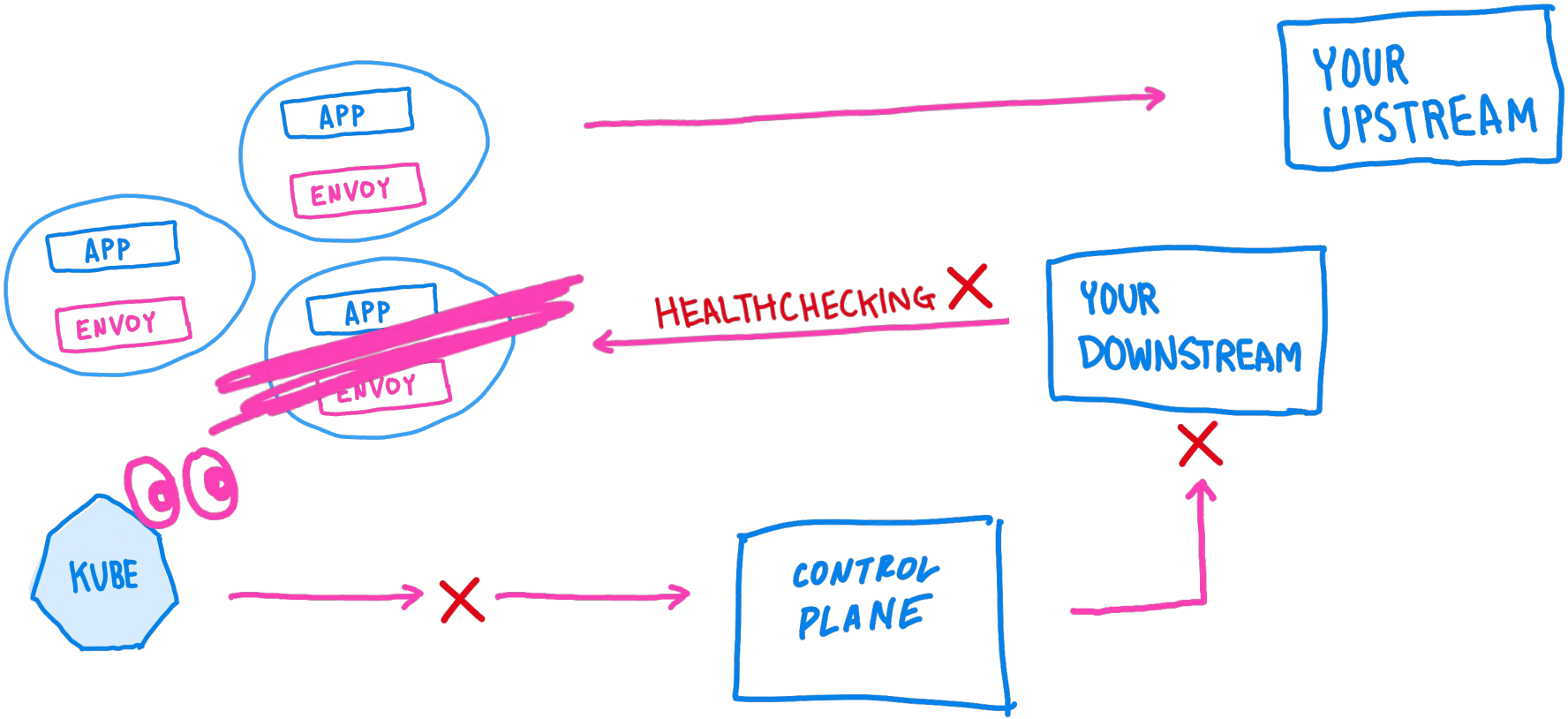

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Undead Hosts

- Pods would be terminated, but their downstreams would keep these “undead” hosts in local discovery.
  - This caused service owners to be paged for having too many unhealthy hosts.
  - **The mesh was not converging correctly.**

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Scale Down Issues

- Envoy protects from byzantine failures against the xDS Control Plane
  - Doesn't remove hosts from "local discovery" until they:
    - Fail healthchecks
    - Are absent from the Control Plane's EDS response
- ***In order!***
- We had this happen out of order, **accumulating stale entries until another update.**
- With xDS streaming, **you could have garbage IP addresses depending on update timing.**

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Scale Down Issues

Discovery Status	Health Check OK	Health Check Failed
Discovered	Route	Don’t Route
Absent	Route	Don’t Route / Delete

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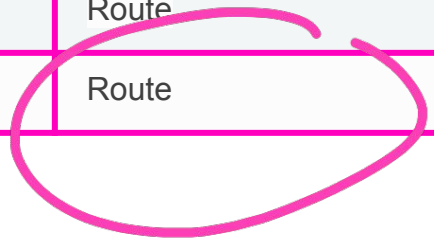

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Envoy Upstream

- Upstream: do not stabilize host when failed by EDS (#6714)
  - Allows control plane to forcibly remove host from mesh
    - Control Plane can send DRAINING state first to forcibly remove host from mesh
- Upstream: handle health check fail after removal (#6765)
  - Removes ordering requirement for health checking
  - This change makes envoy store the state of the last discovery update

**Thanks mklein for implementing both of these code changes!

SAY BYE TO EVERYONE BEFORE YOU LEAVE

Scale Down Issues

Discovery Status	Health Check OK	Health Check Failed
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Even removing ordering, still seeing 503s

- Even though Envoy can handle out of order healthchecks, we still saw 503s.
  - We can rely on retries, but, we wanted to do better!
- This is because Endpoints are deleted at the same time the healthcheck fails.
- **Issue: How do we notify the mesh that a host is is going away to avoid unnecessary 503s?**

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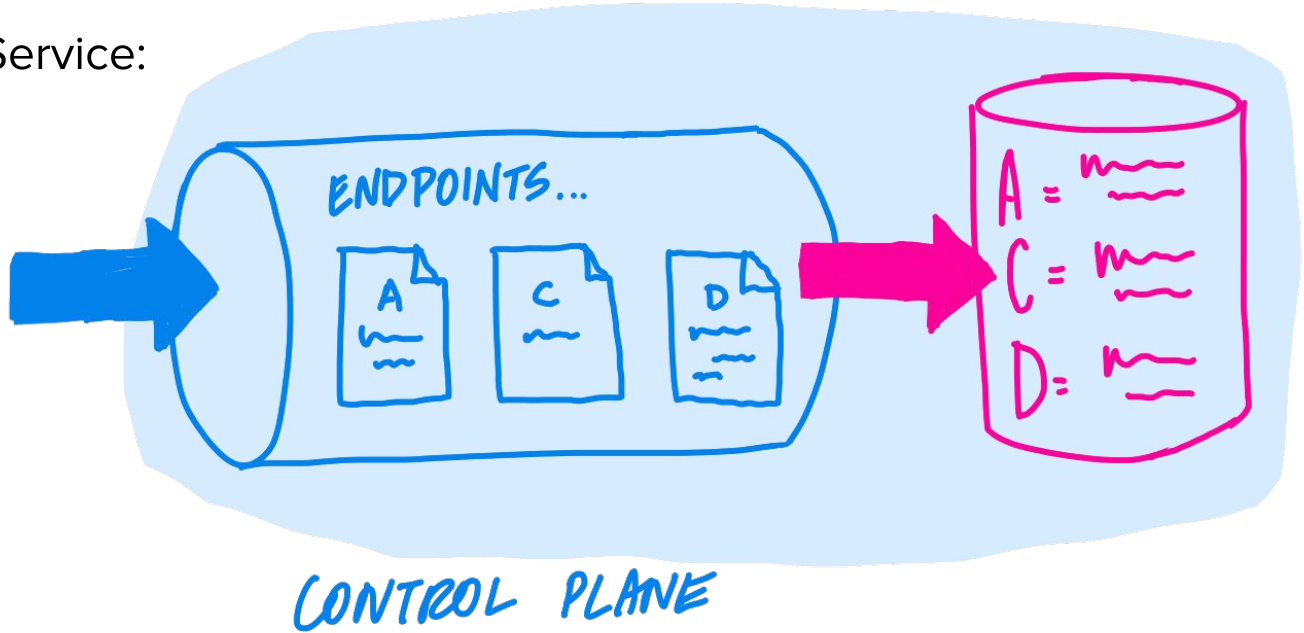
Kubernetes Endpoints

- Kubernetes Endpoints object tracks IPs in a Service.
- Informer is pretty easy to set up, every update contains all IPs for a given Service:



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Kubernetes Endpoints

- Endpoints they are **immediately** removed once readiness fails.
  - Not much time to send a DRAINING update.
  - There could be a race**, causing small amount of 503s** when a pod is terminated ***before*** **the EDS removal** makes it to downstreams, but before active health check.

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Kubernetes Endpoints

- Pods are the next logical alternative:
  - **A Pod's Termination Grace Period provides the window to send a DRAINING update.**
  - **Pod updates are not Service-level, they are individual updates. Yuck!**

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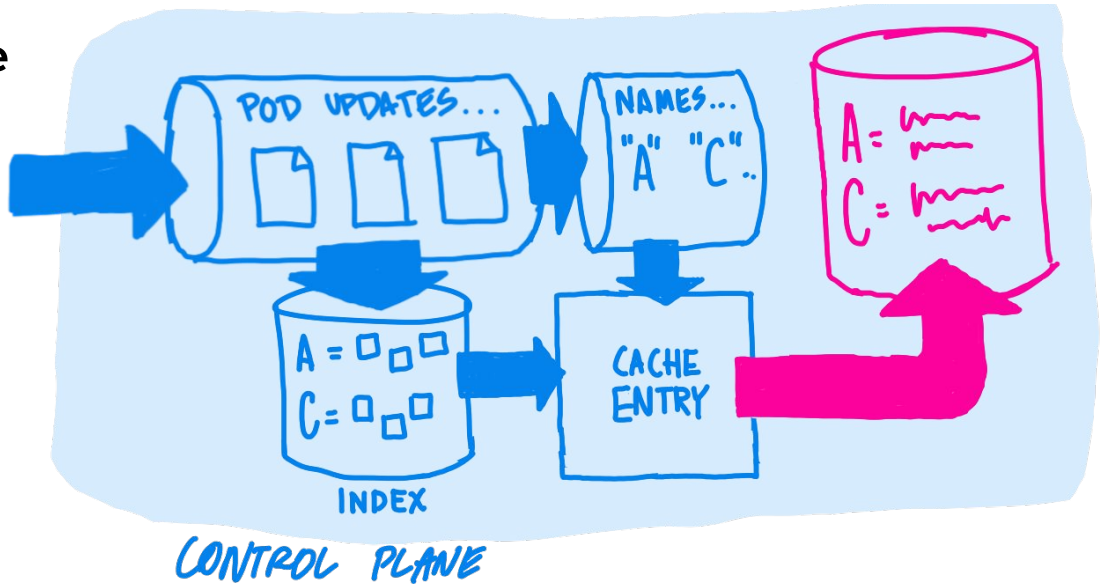
Kubernetes Indexer for Pods

- Indexers allow you to bucket the watched objects in arbitrary ways.
- All of our Pods are labeled by service name, therefore:
- **We index by service name: get all pods for a given service in one update!**



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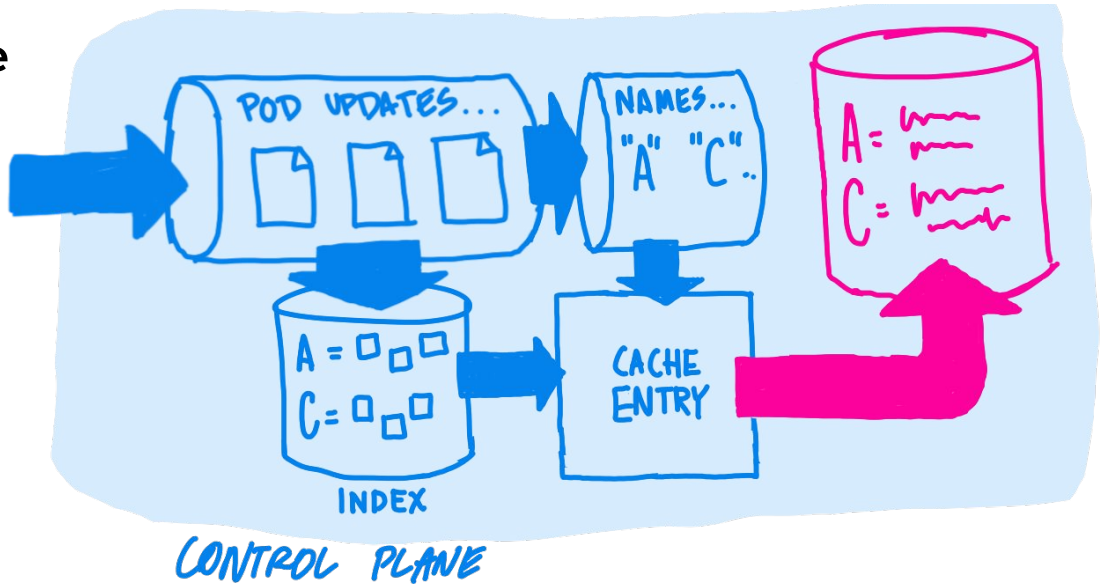

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Summary - Scale Down

- **Envoy can handle out-of-order discovery and healthcheck data**
  - Control plane can force host removal by sending a DRAINING update.
  - Envoy can resolve local discovery without healthcheck failing first
- **Control Plane monitors Pods**
  - Control Plane updates downstreams the moment a Pod is scheduled to be terminated.
  - Pods can safely drain requests before they exit.

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In Summary

PARADIGM SHIFT

Summary

- Paradigm shift moves most changes from Node-level to the mesh topography.
  - Take advantage of Kubernetes: quick scale up/down
- Few things needed tweaking:
  - Envoy upstream improvements to work with streaming
  - Kubernetes' Sidecar Ordering
  - Monitoring Pods, not Endpoints

THE FINAL FRONTIER?

Future Work

- Envoy runs as a sidecar on every Pod — Expensive!
  - Envoy as DaemonSet seems very interesting to us. But complex!
- Right now we have one big mesh, we’re looking into splitting them up
  - AWS Availability Zone
- Batch updates with big scaling up and down events in our control plane.
- Splitting envoy control plane / mesh
  - Envoy OSS moving to federation

Thank You!

Thank You!

Now we’re inviting you to a party  ...

Join us for some local beer, wine, and tacos!

Lyft Happy Hour

Date: Tuesday, Nov 19
Time: 7pm-10pm
Where: Thorn Barrio Logan (1745 National Avenue, San Diego, CA 92113)

RSVP: https://lyft-kubecon.splashthat.com/ (you can also register at the door)