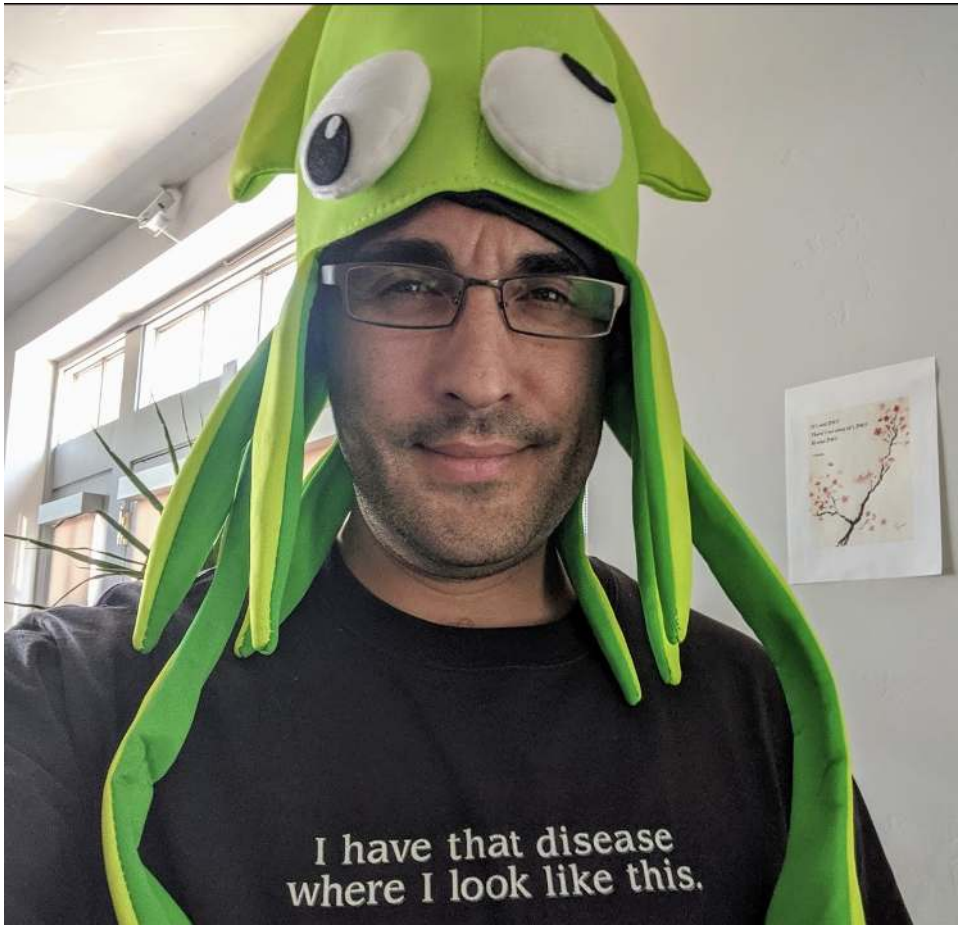
Descartes Labs

Understanding The Data Plane

What Envoy Hears When Istio Speaks



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Rob Salmond

SRE Here

Istio in Prod for >2yrs

@phro

Map of These Territories

Descartes Labs

Istiod

WTF is an Envoy

Envoy Operation

Envoy Configuration

istiod

An Envoy “management server”

You had ~~one~~ three jobs!

Descartes Labs

Galley

Understand
Kubernetes

Pilot

Program
Sidecars

Citadel

Autograph
Certificates

You had ~~one~~ ~~three~~ many jobs!

Descartes Labs

Galley

Understand
Kubernetes

Pilot

Program
Sidecars

Citadel

Autograph
Certificates

sidecar injection
webhook handler!

cinnamon flavor
crystals!

CRD validation!

Several jobs are typing ...

Descartes Labs

Galley

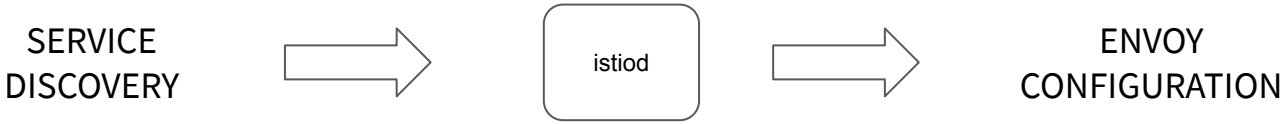
Understand Kubernetes

Pilot

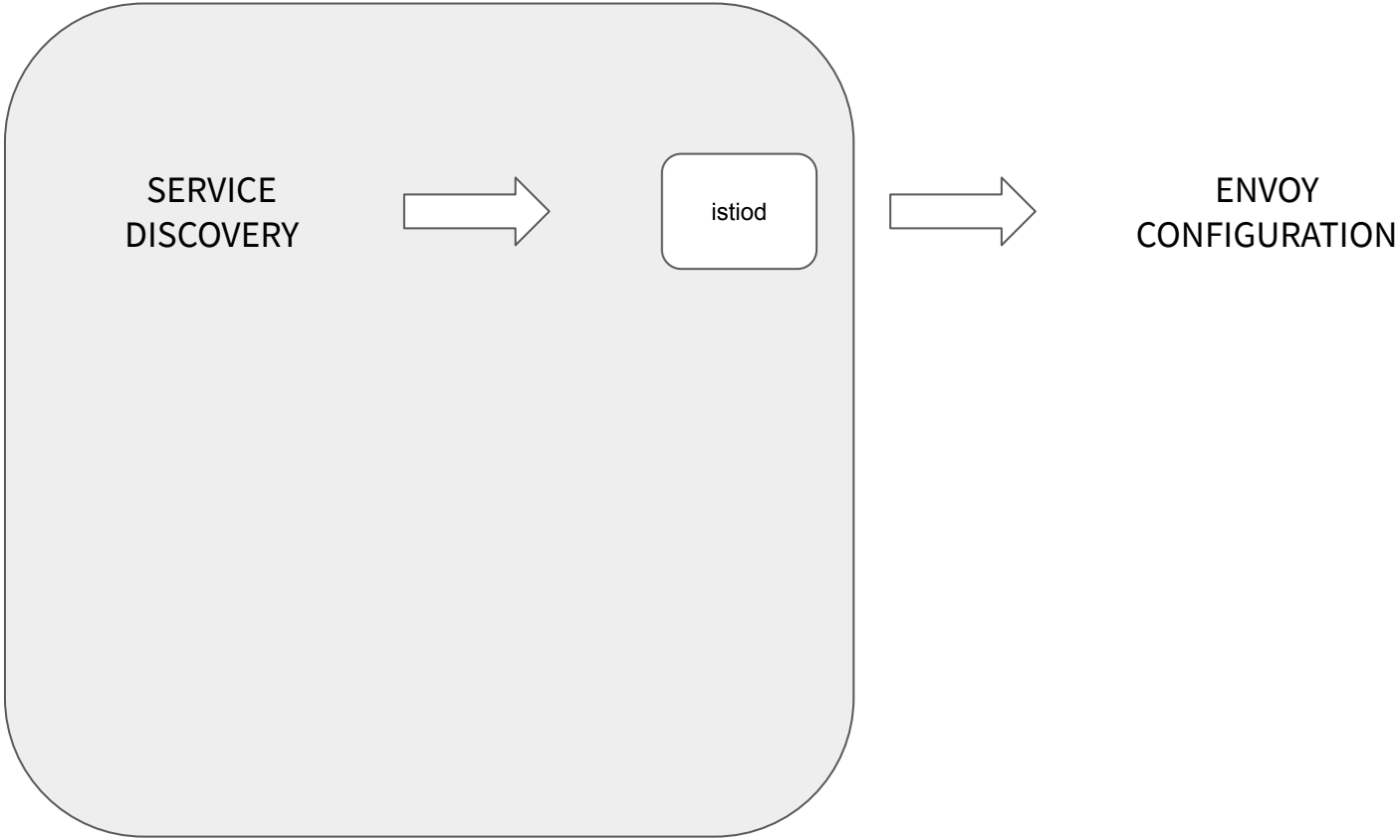
Program Sidecars

Citadel

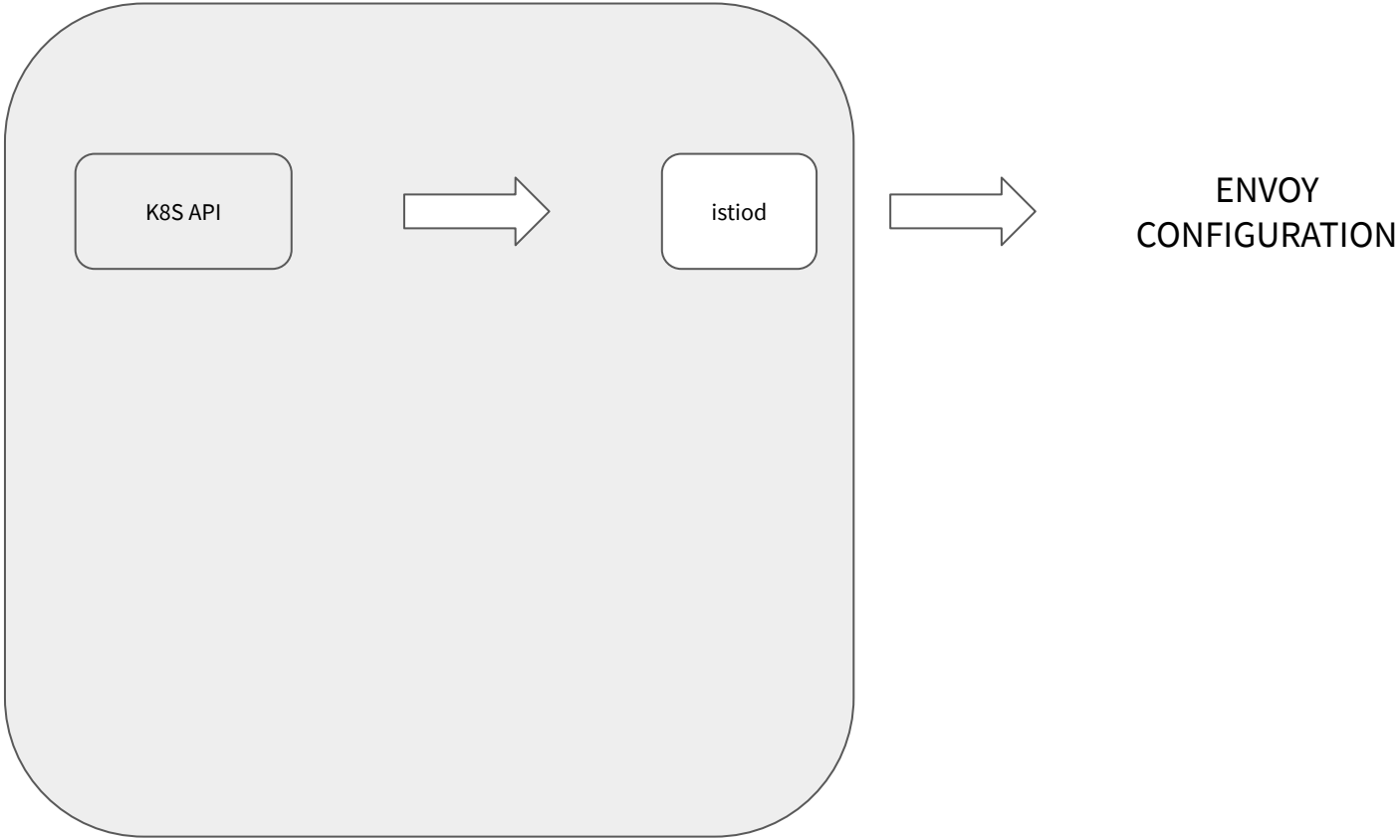
istiod



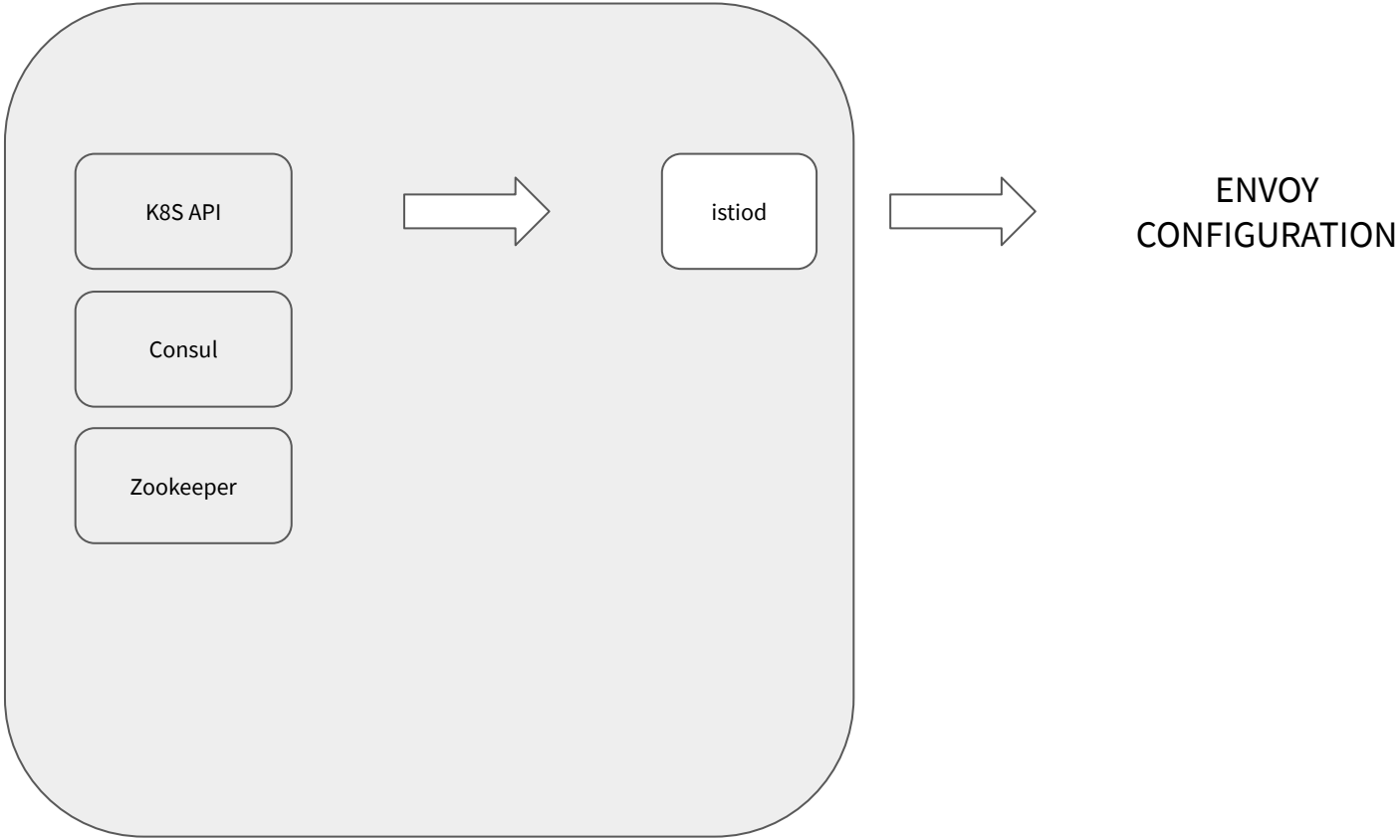
istiod - galley



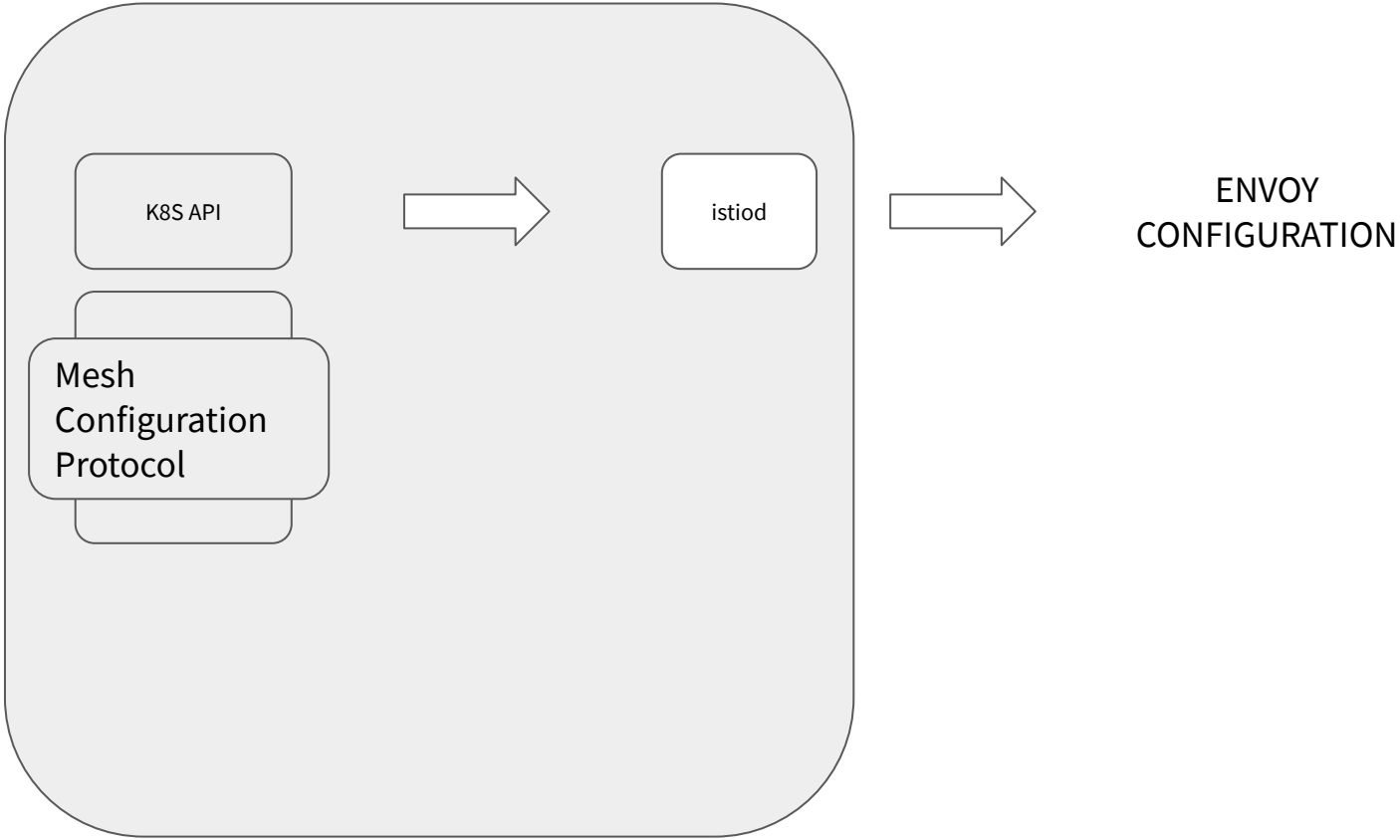
istiod - galley



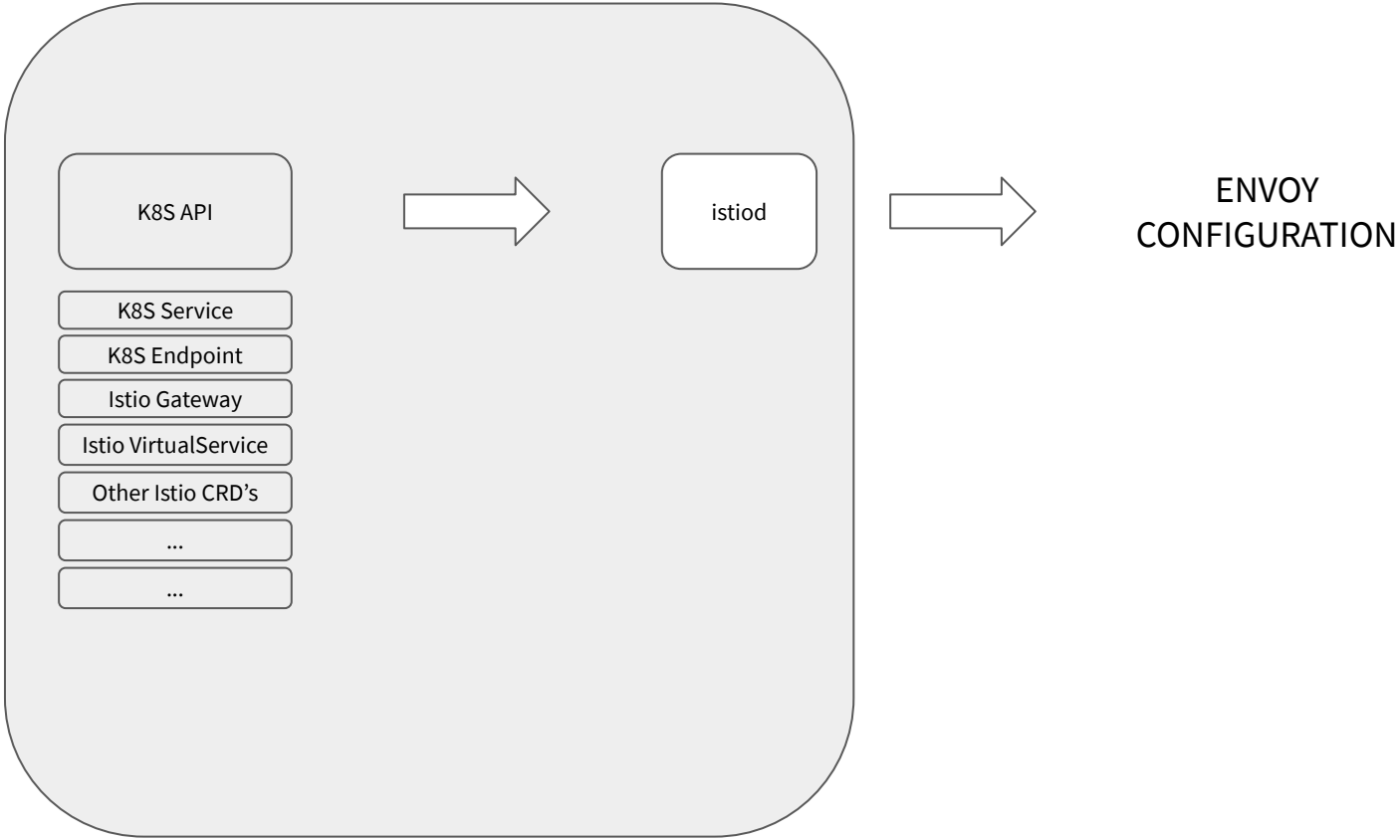
istiod - galley



istiod - galley



istiod - galley



istiod - galley

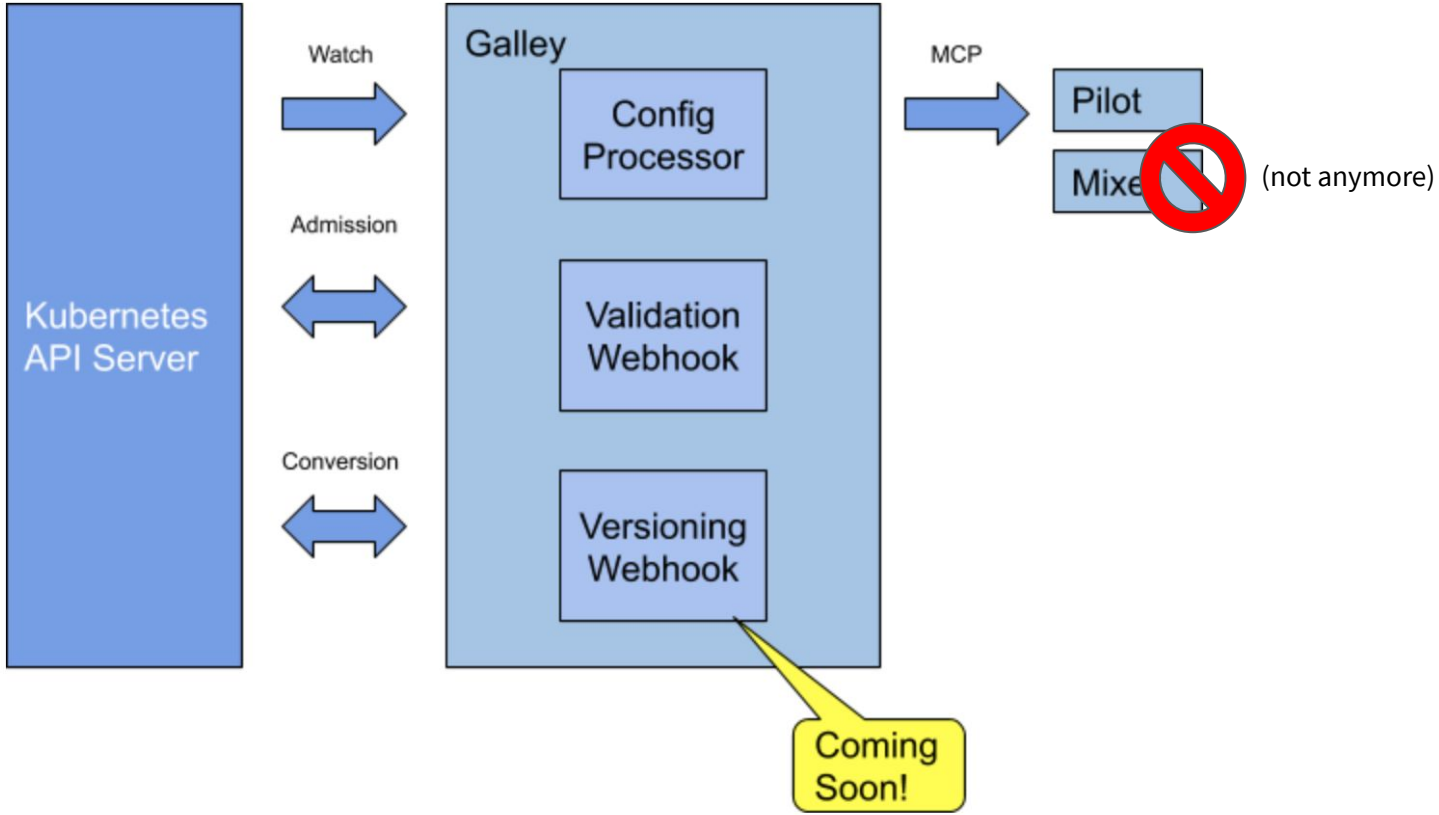
```
rob@ayyyyyylmao:~ kubectl port-forward po/istiod-58f84ffddc-r8nqf 8080
Forwarding from 127.0.0.1:8080 -> 8080
Forwarding from [::1]:8080 -> 8080
```

istiod - galley

localhost:8080/debug/registryz


```
[
  {
    "Attributes": {
        "ServiceRegistry": "Kubernetes",
        "Name": "api",
        "Namespace": "master",
        "UID": "istio://master/services/api",
        "ExportTo": null,
        "ClusterExternalAddresses": null,
        "ClusterExternalPorts": {
            "Kubernetes": {
                "8000": 30731
            }
        }
    },
    "ports": [
        {
            "name": "grpc-web-port",
            "port": 8000,
            "protocol": "GRPC-Web"
        }
    ],
    "creationTime": "2021-01-28T20:46:33Z",
    "hostname": "api.master.svc.cluster.local",
    "address": "10.56.3.75",
    "Mutex": {},
    "cluster-vips": {
        "Kubernetes": "10.56.3.75"
    },
    "Resolution": 0,
    "MeshExternal": false
  },
```

istiod - galley



istiod - galley - validation

```yaml
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
metadata:
  name: istiod-istio-system
webhooks:
- admissionReviewVersions:
  - v1beta1
  clientConfig:
    service:
      name: istiod
      namespace: istio-system
      path: /validate
      port: 443
  failurePolicy: Fail
  matchPolicy: Exact
  name: validation.istio.io
  namespaceSelector: {}
  objectSelector: {}
  rules:
  - apiGroups:
    - config.istio.io
    - rbac.istio.io
    - security.istio.io
    - authentication.istio.io
    - networking.istio.io
    apiVersions:
    - '*'
    operations:
    - CREATE
    - UPDATE
    resources:
    - '*'
    scope: '*'
  sideEffects: None
  timeoutSeconds: 30
```

istiod - galley - sidecar injection

```yaml
apiVersion: admissionregistration.k8s.io/v1
kind: MutatingWebhookConfiguration
metadata:
  name: istio-sidecar-injector
webhooks:
- admissionReviewVersions:
  - v1beta1
  clientConfig:
    service:
      name: istiod
      namespace: istio-system
      path: /inject
      port: 443
  failurePolicy: Fail
  matchPolicy: Exact
  name: sidecar-injector.istio.io
  namespaceSelector:
    matchLabels:
      istio-injection: enabled
  objectSelector: {}
  reinvocationPolicy: Never
  rules:
  - apiGroups:
    - ""
    apiVersions:
    - v1
    operations:
    - CREATE
    resources:
    - pods
    scope: '*'
  sideEffects: None
  timeoutSeconds: 30
```

sidecar injection sidebar

```
$ istioctl kube-inject -f mypod.yaml -o sidecarpod.yaml
```

You had ~~one~~ three jobs!

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Galley

✔

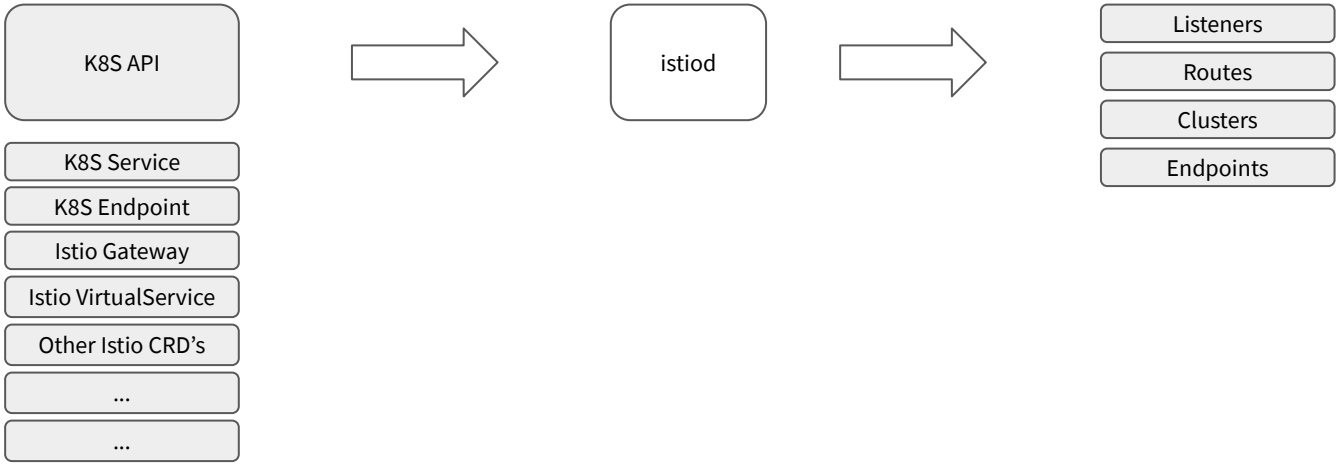
Understand Kubernetes

Pilot

Program Sidecars

Citadel

istiod - pilot



istiod - pilot

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Mapping Resources to Envoy Configuration

Resource Type	Envoy Configuration	Notes
Kubernetes Services	Listeners Routes Clusters	New listeners if port/protocol combo is unique Add virtual hosts for existing routes One cluster per Service/Port/Subset
Kubernetes Endpoints	Endpoints	
Istio Gateway	Listeners	Apply to Ingress/Egress Gateways
Istio VirtualService	Listeners Routes	Client side proxies TLS/TCP affect listeners HTTP match blocks affect routes
Istio DestinationRule	Clusters Endpoints	Client side proxies Connection/HTTP/TLS settings
Istio ServiceEntry	Clusters Endpoints	Client side proxies
Istio PeerAuthentication	Listeners Clusters	Server side proxies
Istio RequestAuthentication	Listeners	Server side proxies
Istio Authorization Policies	Listeners	Server side proxies
Istio EnvoyFilter	All	Break glass API to directly manipulate Envoy
Istio Sidecar	All	Client or server side proxies Sidecar scope sets config visibility

You had ~~one~~ three jobs!

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Galley ✔

Understand Kubernetes

Pilot ✔

Program Sidecars

Citadel

WTF Is An Envoy?

Isn’t that the dude who pissed off king Leonidas and got kicked down a well?

envoy - was ist das?

envoyproxy.io/docs/envoy/latest/intro/what_is_envoy

envoy

1.17.0-dev-3736b5

Search docs

About the documentation

⊟ Introduction

What is Envoy

» Introduction » What is Envoy

View page source

What is Envoy

Envoy is an L7 proxy and communication bus designed for large modern service oriented architectures. The project was born out of the belief that:

> *The network should be transparent to applications. When network and application problems do occur it should be easy to determine the source of the problem.*

envoy - was ist das?

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Envoy refresher

- **Out of process architecture**: Let's do a lot of really hard stuff in one place and allow application developers to focus on business logic.
- **Modern C++11 code base**: Fast and productive.
- **L3/L4 filter architecture**: A byte proxy at its core. Can be used for things other than HTTP (e.g., MongoDB, redis, stunnel replacement, TCP rate limiter, etc.).
- **HTTP L7 filter architecture**: Make it easy to plug in different functionality.
- **HTTP/2** first! (Including **gRPC** and a nifty gRPC HTTP/1.1 bridge).
- **Service discovery** and **active/passive health checking.**
- **Advanced load balancing**: Retry, timeouts, circuit breaking, rate limiting, shadowing, outlier detection, etc.
- Best in class **observability**: stats, logging, and tracing.
- **Edge proxy**: routing and TLS.

envoy - was ist das?

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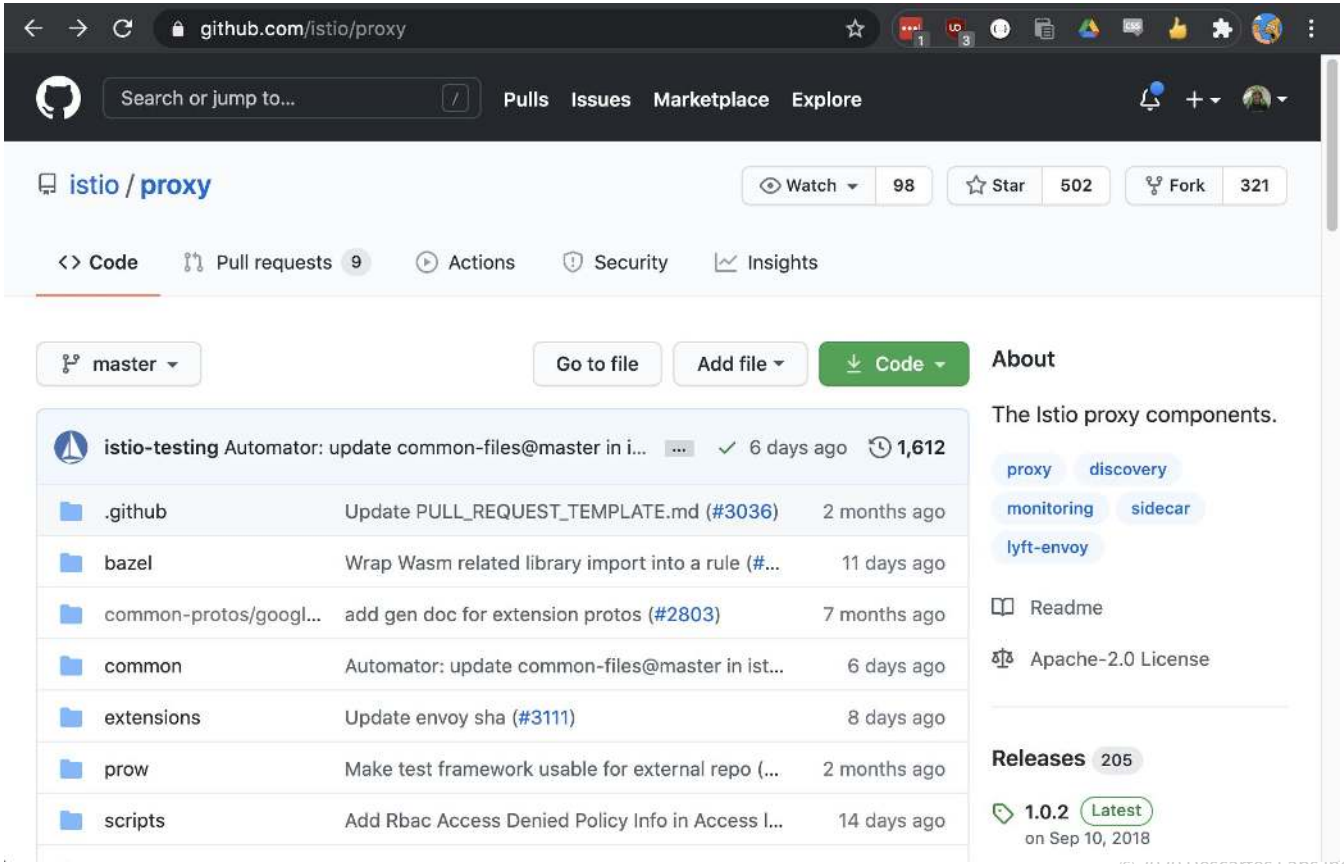

envoy - was ist das?

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Fraser Today at 1:30 AM

Whats the plan for the istio fork of envoy, once envoy-wasm is merged into upstream envoy will istio fork the main envoy? or will it use the upstream envoy?

2 replies

John Howard 1 hour ago

Still fork main envoy until we have no more custom filters

John Howard 1 hour ago

Which will happen eventually once they move to wasm

envoy - terminology

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Upstream

Downstream

envoy - terminology

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Where Envoy connections come from

Downstream

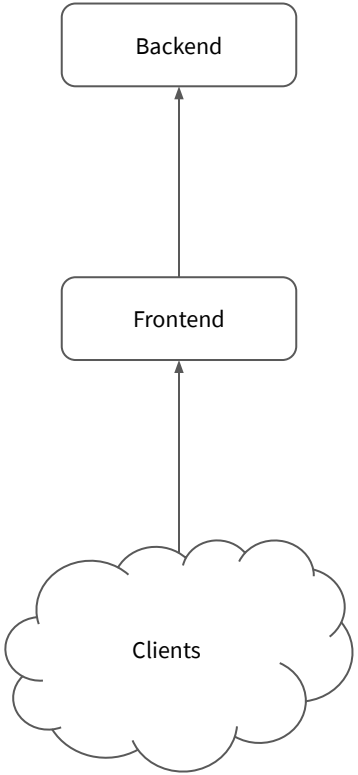
envoy - terminology

Descartes Labs

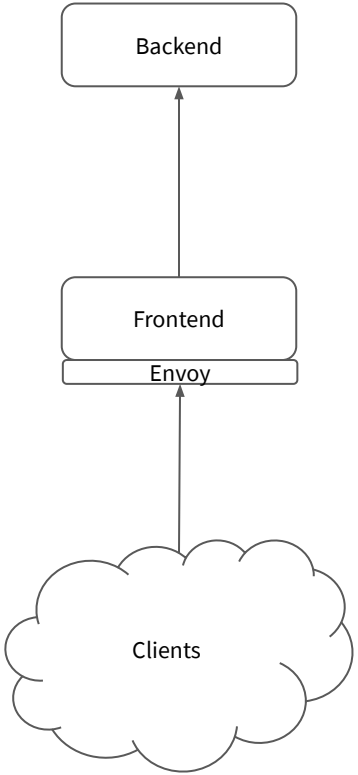
Upstream

Where Envoy connections go to

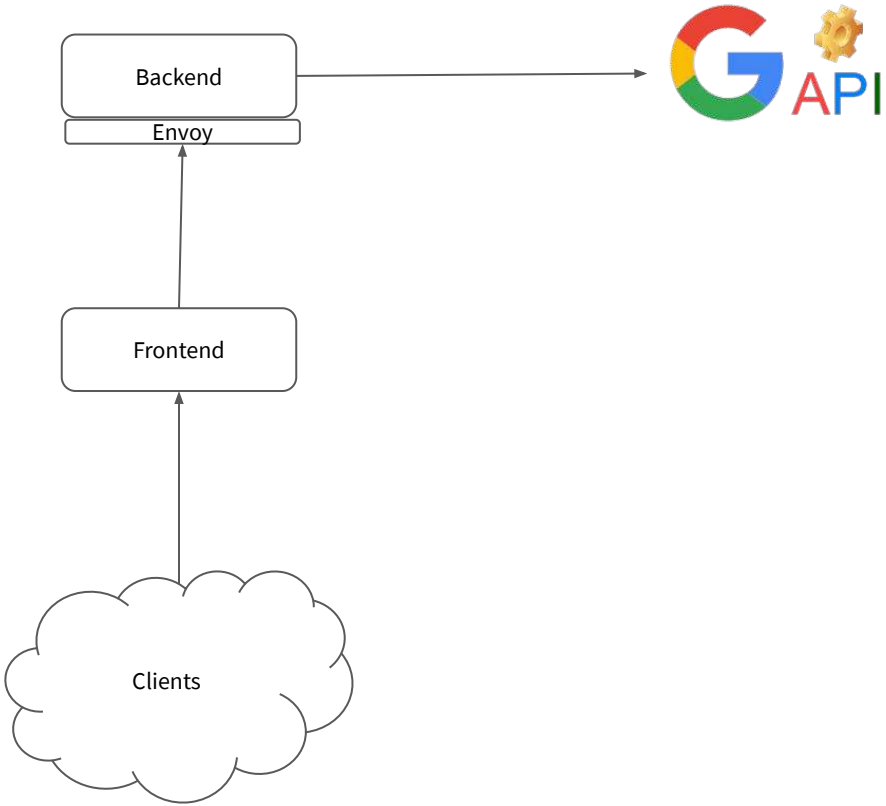
“North-South” Traffic



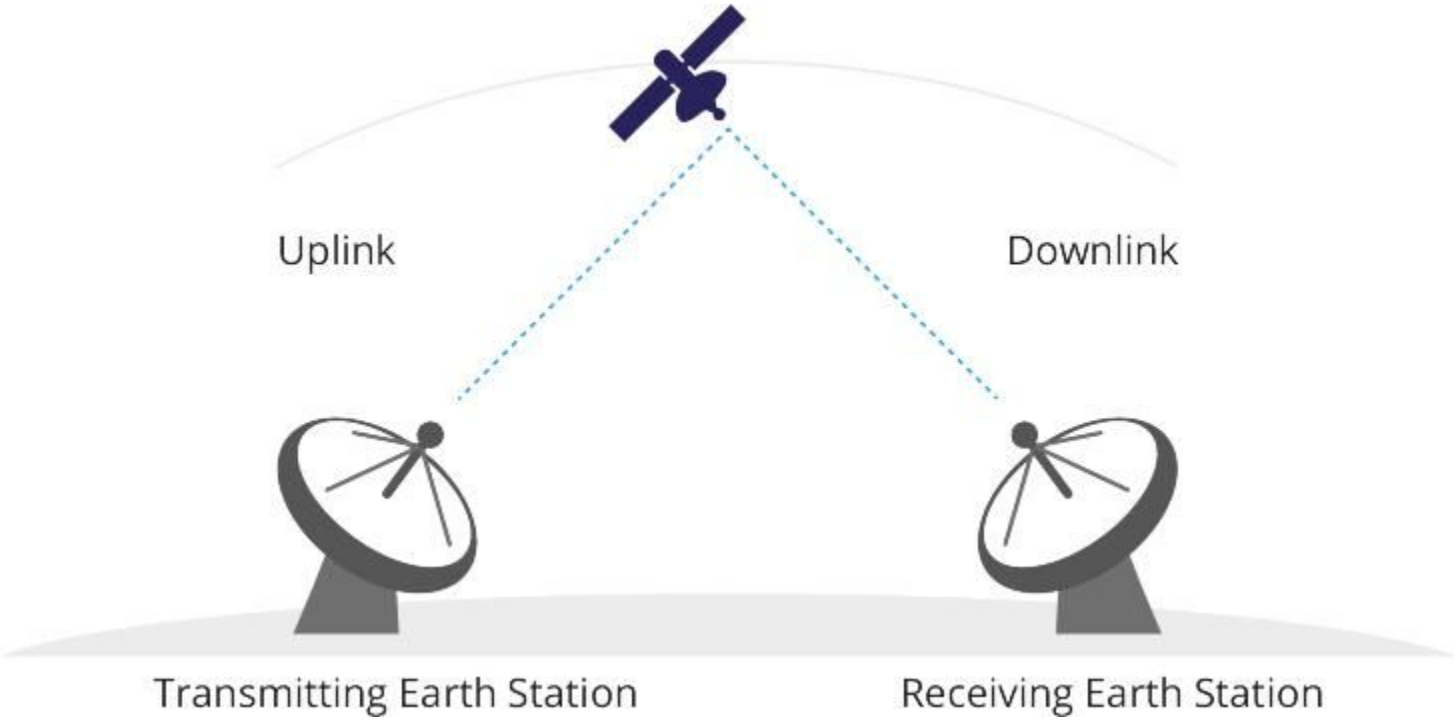
envoy - upstream and downstream



envoy - upstream and downstream



envoy - upstream and downstream



envoy - terminology

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Clusters
&
Endpoints

Listeners
&
Routes

envoy - terminology

Descartes Labs

Clusters
&
Endpoints

≈

Hostnames
&
IP Addresses

envoy - terminology

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Clusters
&
Endpoints

outbound|443||kubernetes.default.svc.cluster.local

10.4.0.10_53

xds-grpc

envoy - terminology

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What to accept
How to process it
&
Where to send it

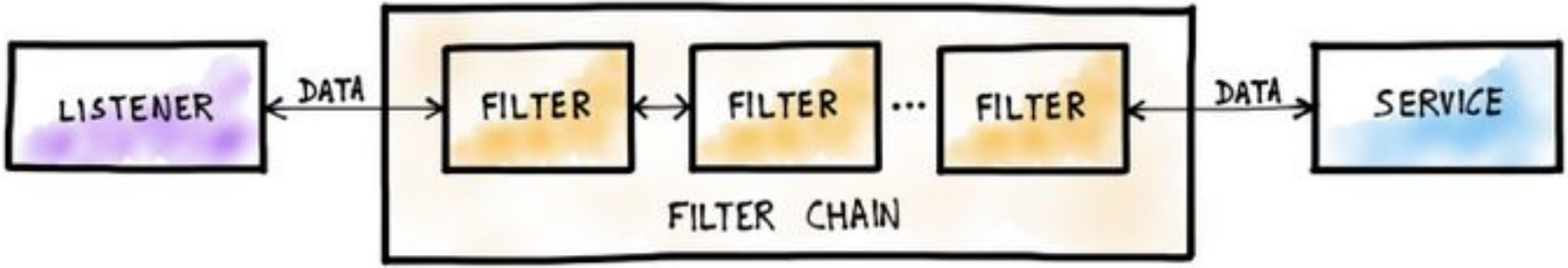
Listeners
&
Routes

Envoy: Operation

*professional SRE

Sidecars and lions and bears!

envoy - operation



envoy - operation

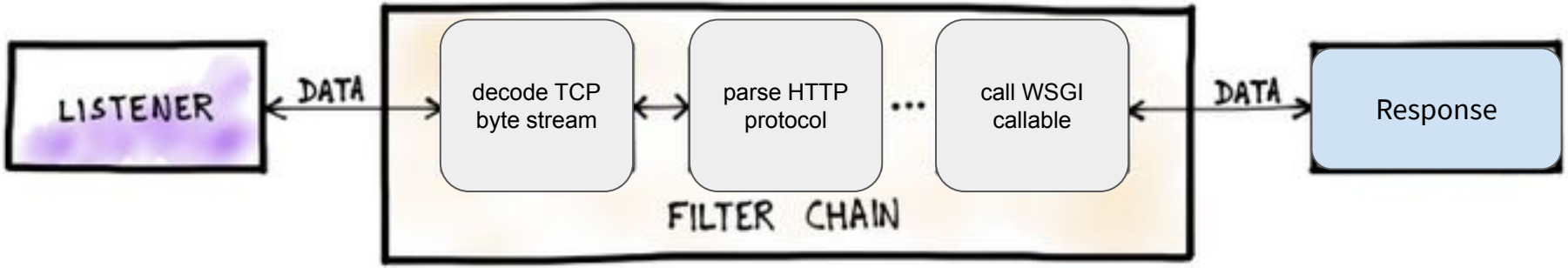
```
from wsgiref.simple_server import make_server
from cgi import parse_qs

def application (environ, start_response):

    query = parse_qs(environ['QUERY_STRING'])
    foo_val = query.get('foo')

    print "lol, this guy wants his foo like {}".format(foo_val)

    start_response('200 OK', [])
    return ['cool query bro']

httpd = make_server ('localhost', 8051, application)
httpd.handle_request()
```

envoy - operation

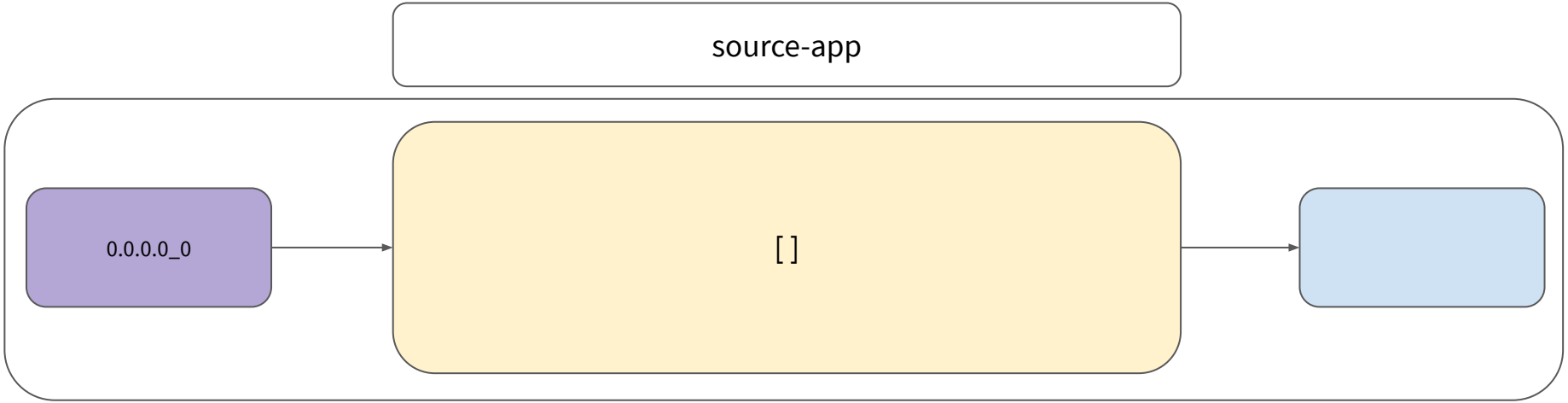
```
$ echo -e "GET /?foo=bar HTTP/1.1\r\n" | nc localhost 8051
HTTP/1.0 200 OK
Date: Sat, 05 Dec 2020 22:28:28 GMT
Server: WSGIServer/0.1 Python/2.7.18rc1
Content-Length: 14

cool query bro
```

```
$ python web.py
lol, this guy wants his foo like ['bar']
127.0.0.1 - - [05/Dec/2020 15:28:28] "GET /?foo=bar HTTP/1.1" 200 14
```

envoy - operation



envoy - operation

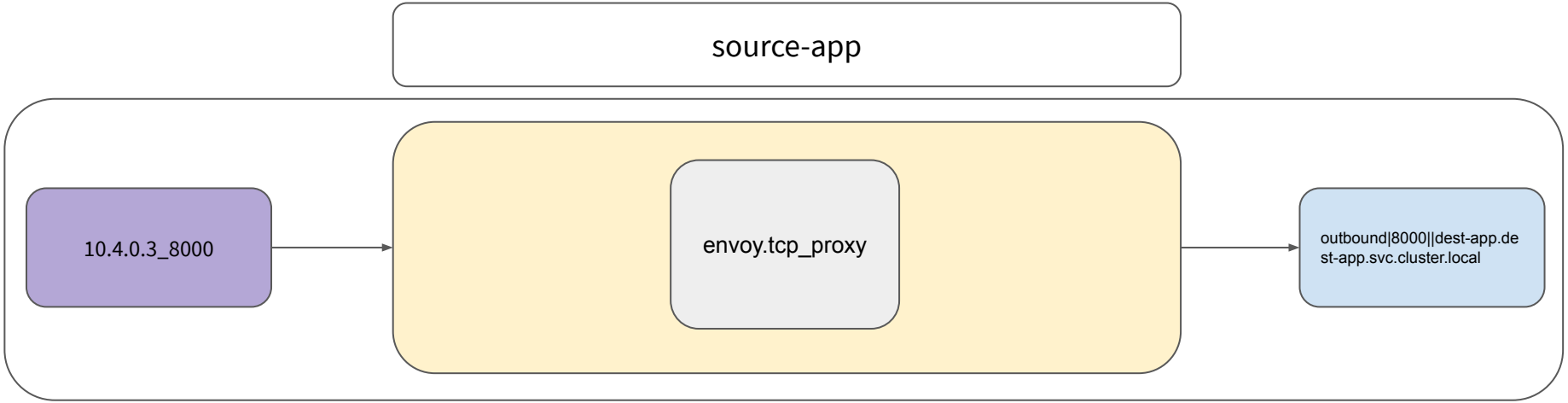


k8s networking - classic

envoy - operation

```yaml
apiVersion: v1
kind: Service
metadata:
  labels:
    app: dest-app
  name: dest-app
  namespace: dest-app
spec:
  clusterIP: 10.4.0.3
  ports:
  - name: tcp-sweetport
    port: 8888
    protocol: TCP
    targetPort: 8888
  selector:
    app: dest-app
  sessionAffinity: None
  type: ClusterIP
```

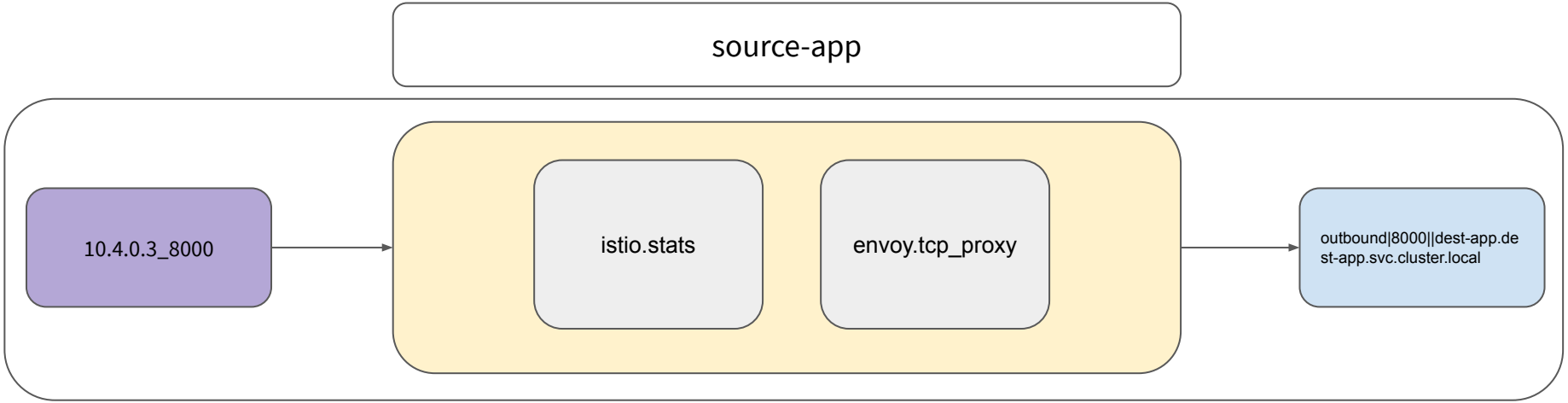
envoy - operation



envoy - operation


```
[
  {
    "name": "10.4.0.3_8000",
    "address": {
      "socketAddress": {
        "address": "10.4.0.3",
        "portValue": 8000
      }
    },
    "filterChains": [
      {
        "filters": [
          {
            "name": "envoy.tcp_proxy",
            "typedConfig": {
              "@type": "type.googleapis.com/envoy.config.filter.network.tcp_proxy.v2.TcpProxy",
              "statPrefix": "outbound|8000||dest-app.dest-app.svc.cluster.local",
              "cluster": "outbound|8000||dest-app.dest-app.svc.cluster.local"
            }
          }
        ]
      }
    ],
    "deprecatedV1": {
      "bindToPort": false
    },
    "trafficDirection": "OUTBOUND"
  }
]
```

envoy - operation



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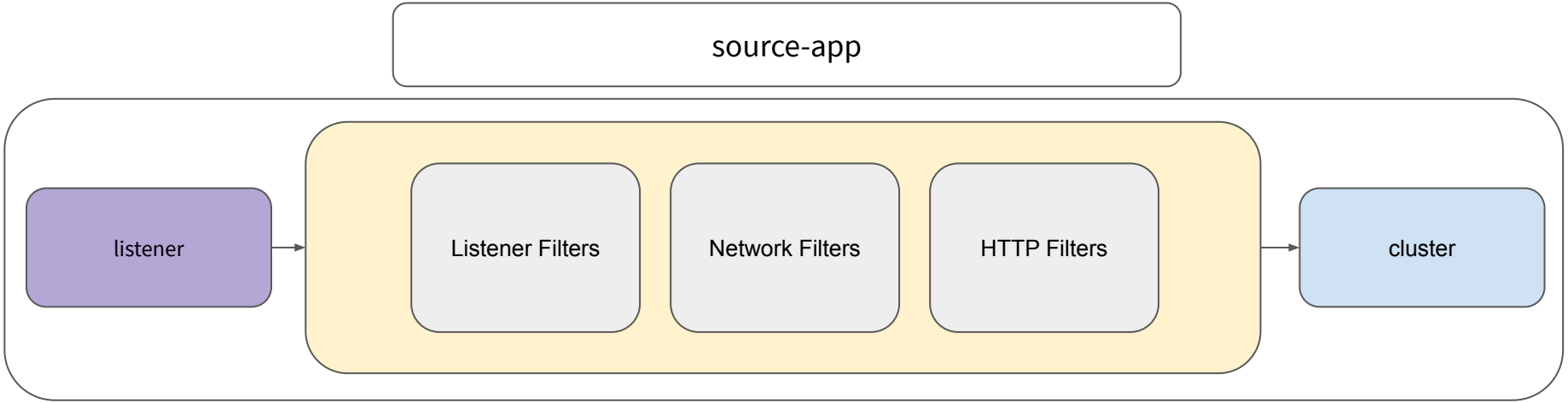
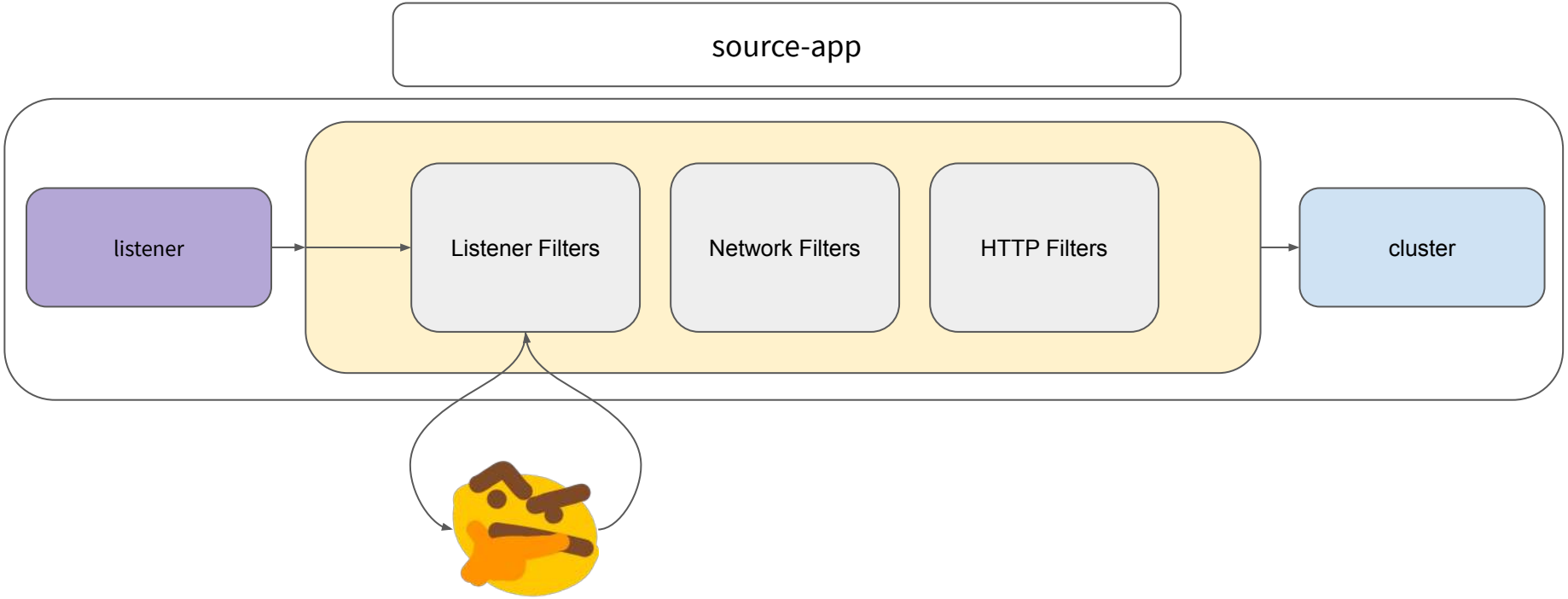
Extensions & Plugins

- Access loggers
- Retry implementations
- Tracers
- Resource Monitors
- Credential Providers

envoy - operation - filters

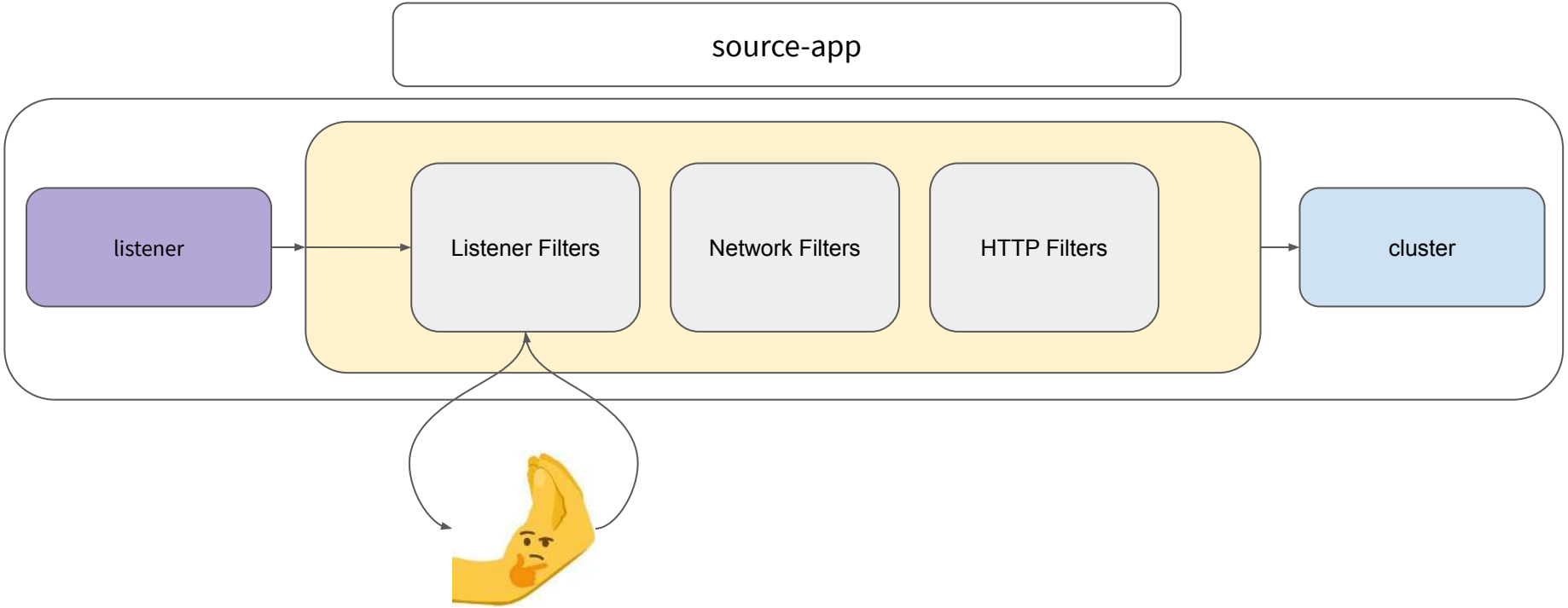


envoy - operation - filter chains



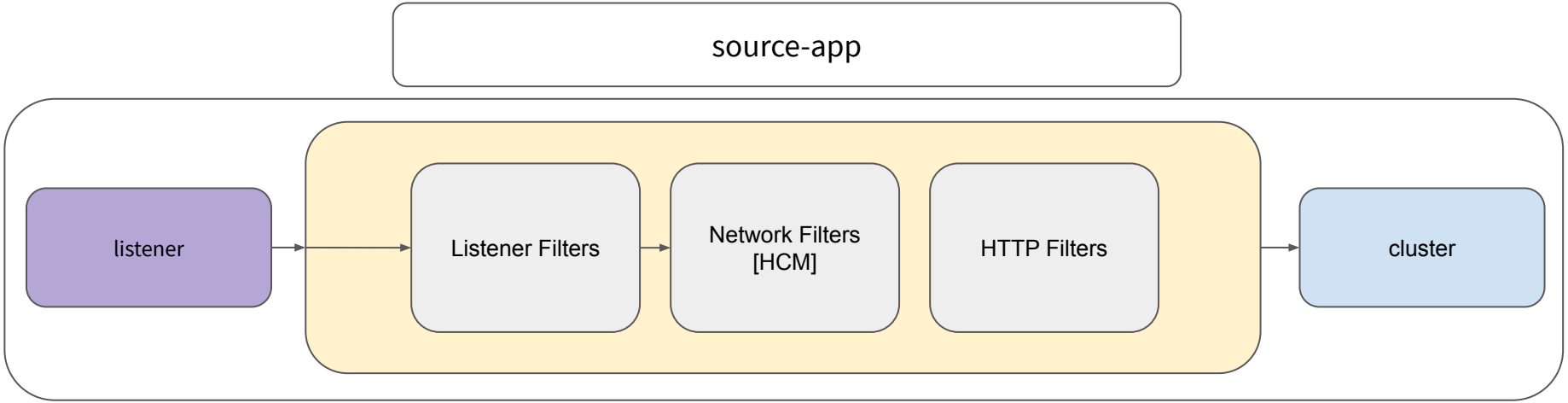
Is TLS?

envoy - operation - filter chains

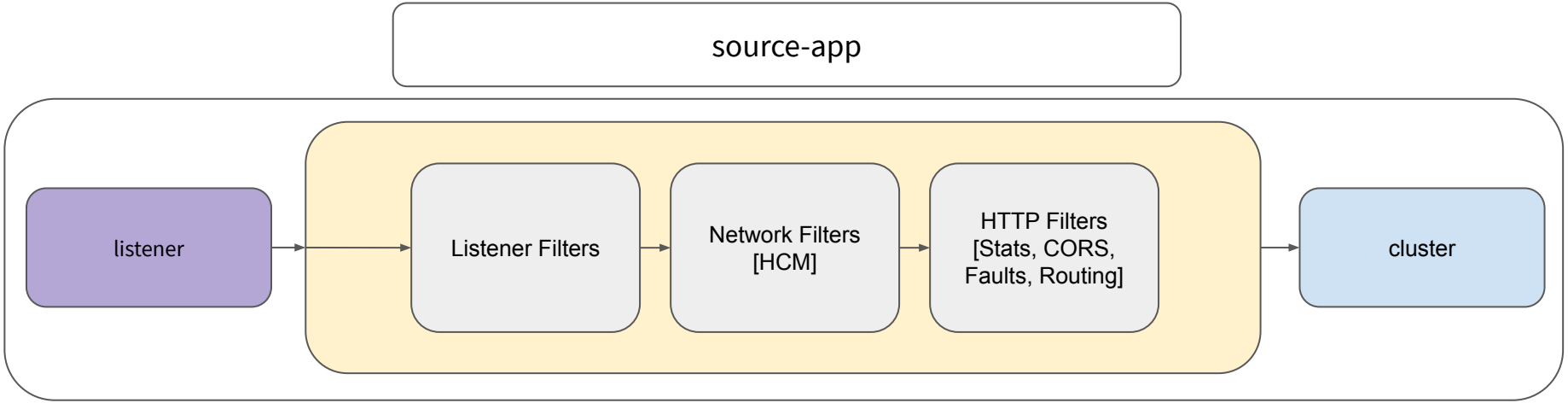


Is HTTP?

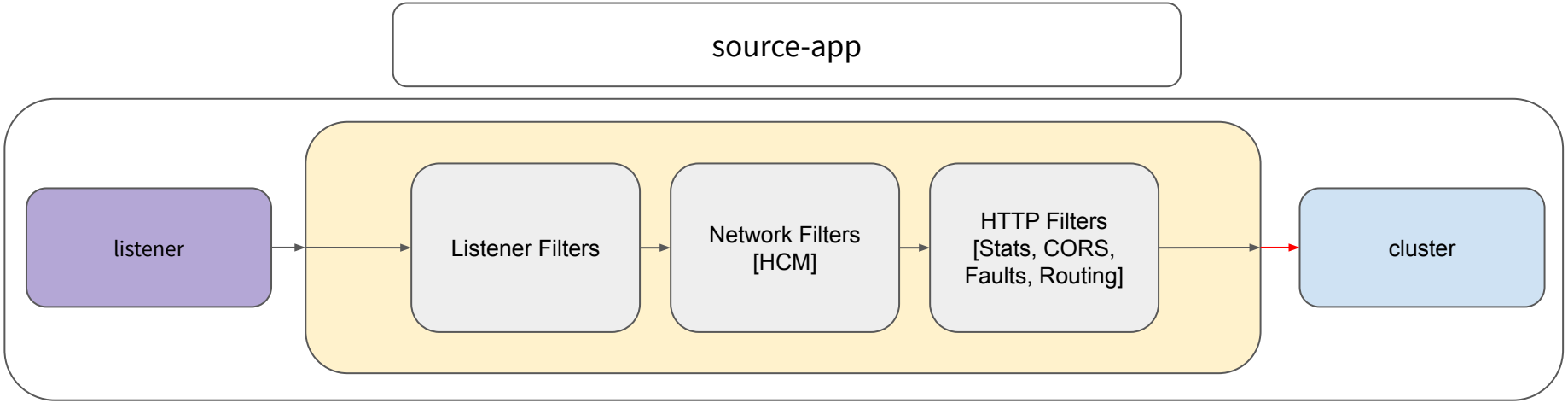
envoy - operation - filter chains



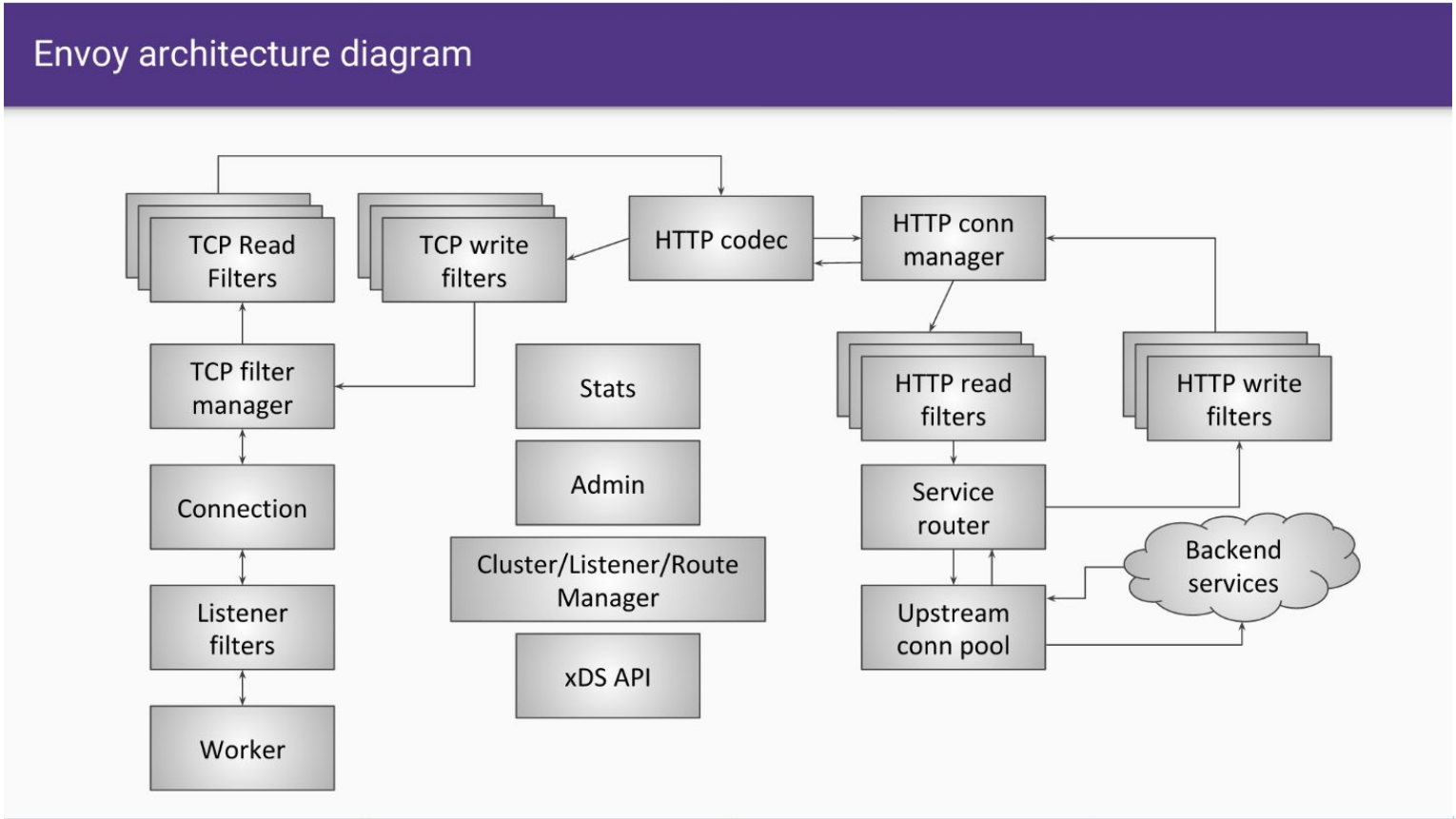
envoy - operation - filter chains



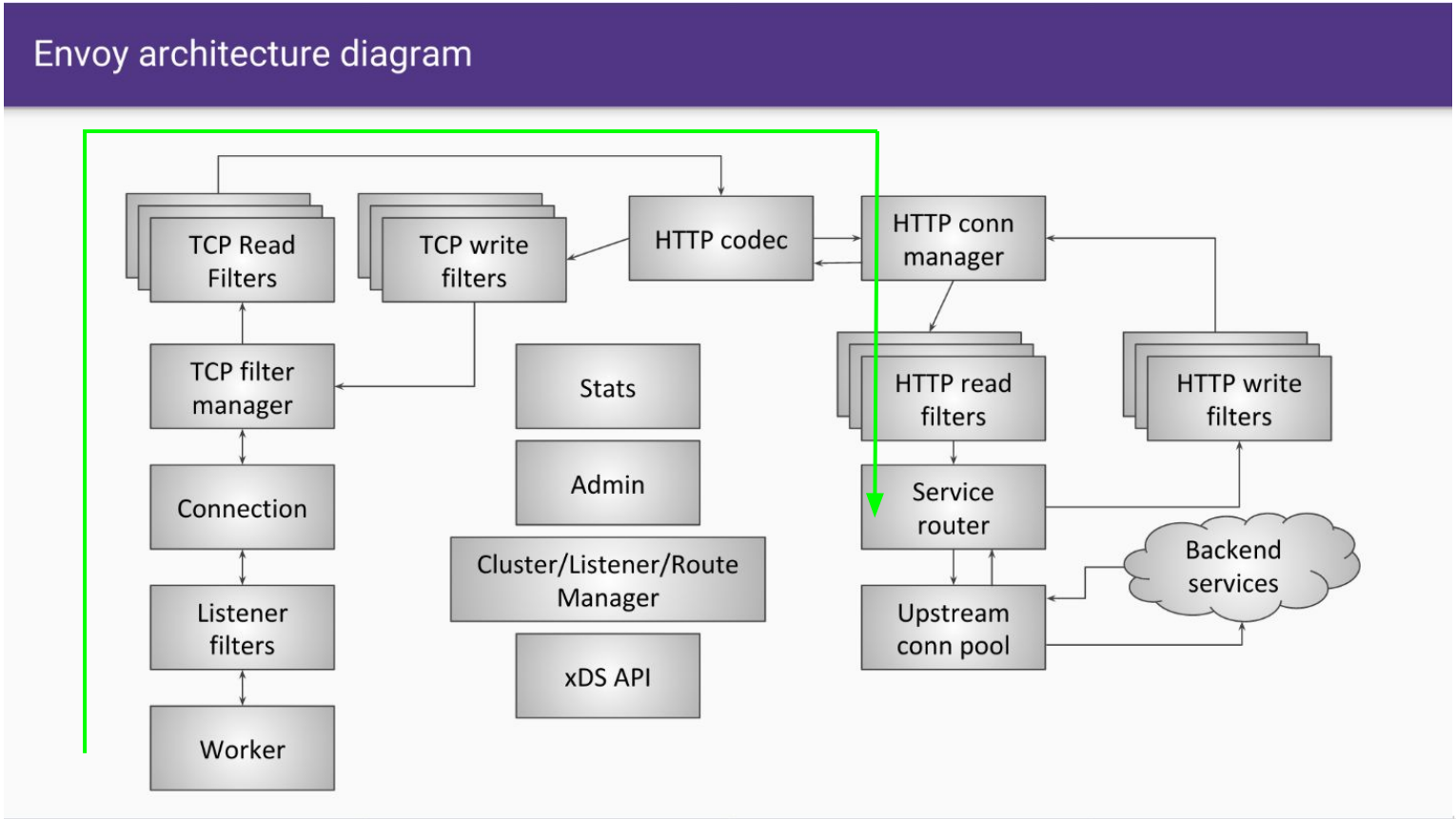
envoy - operation - filter chains



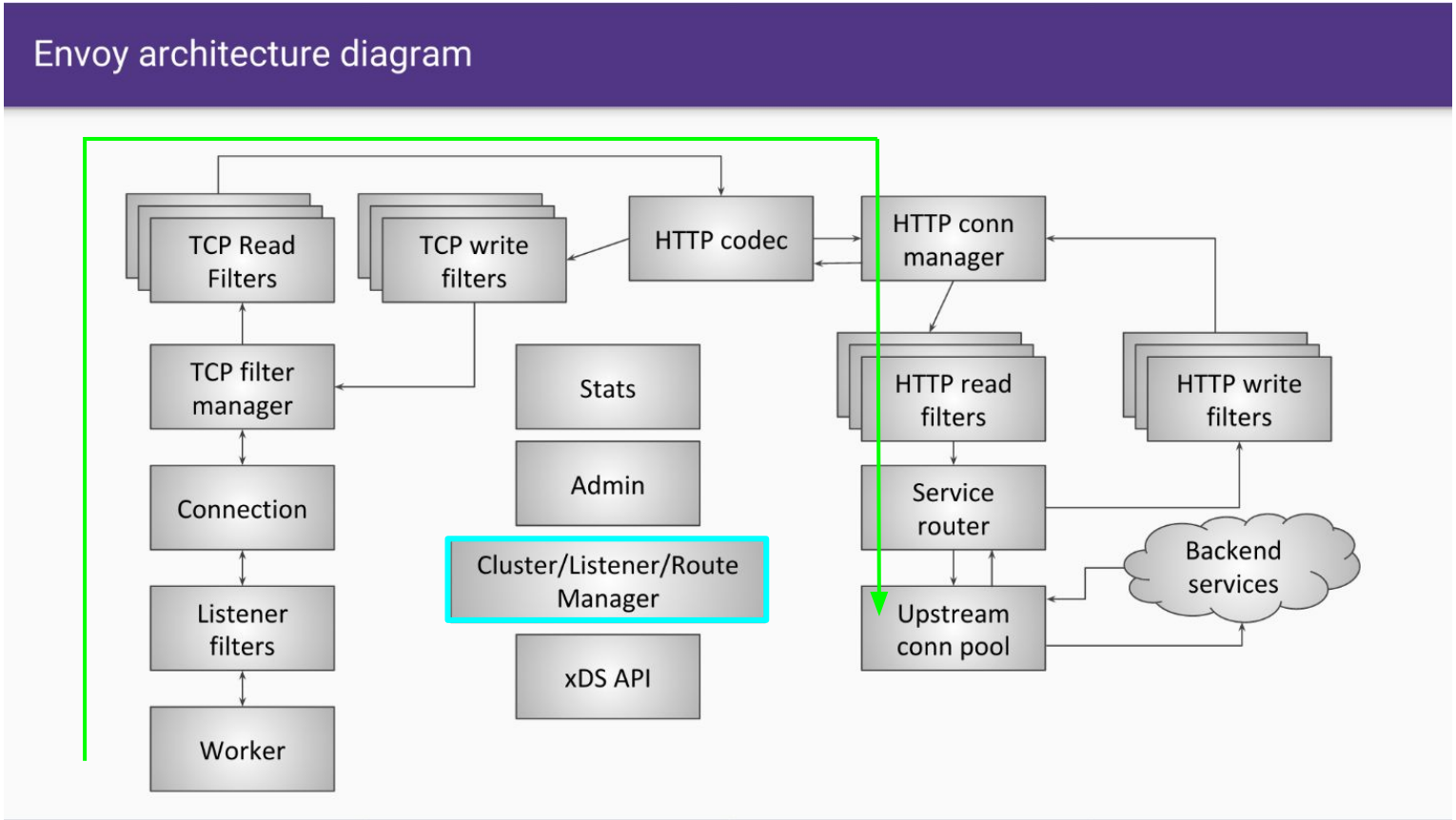
envoy - operation - cluster manager



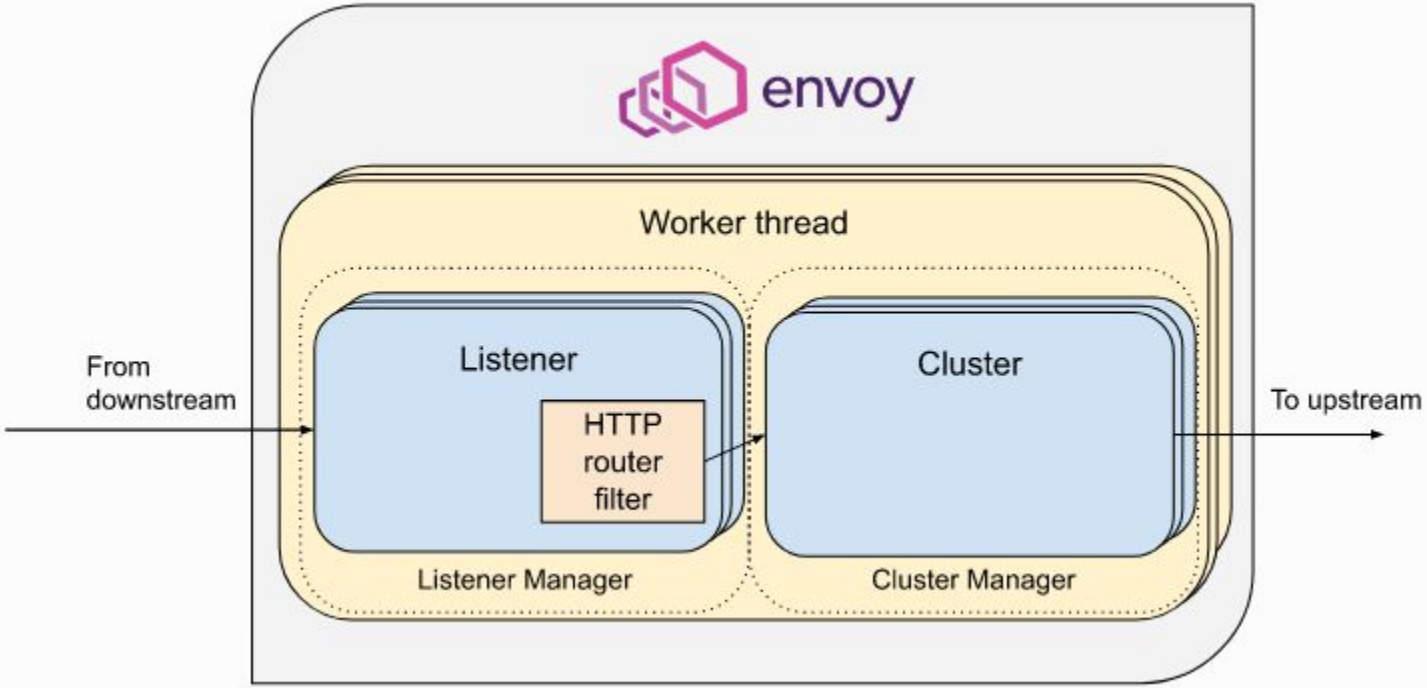
envoy - operation - cluster manager



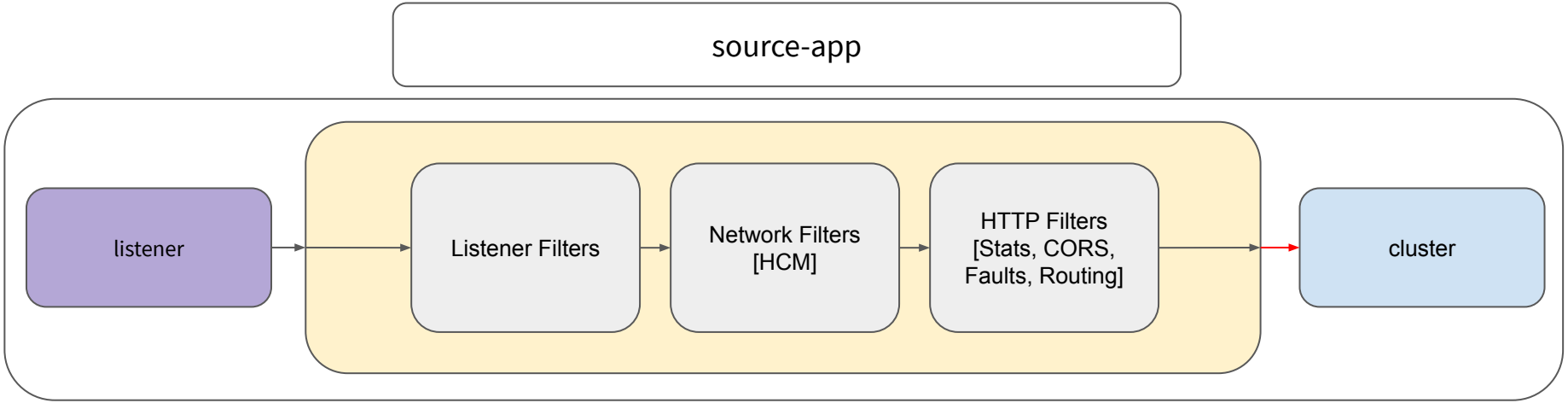
envoy - operation - cluster manager



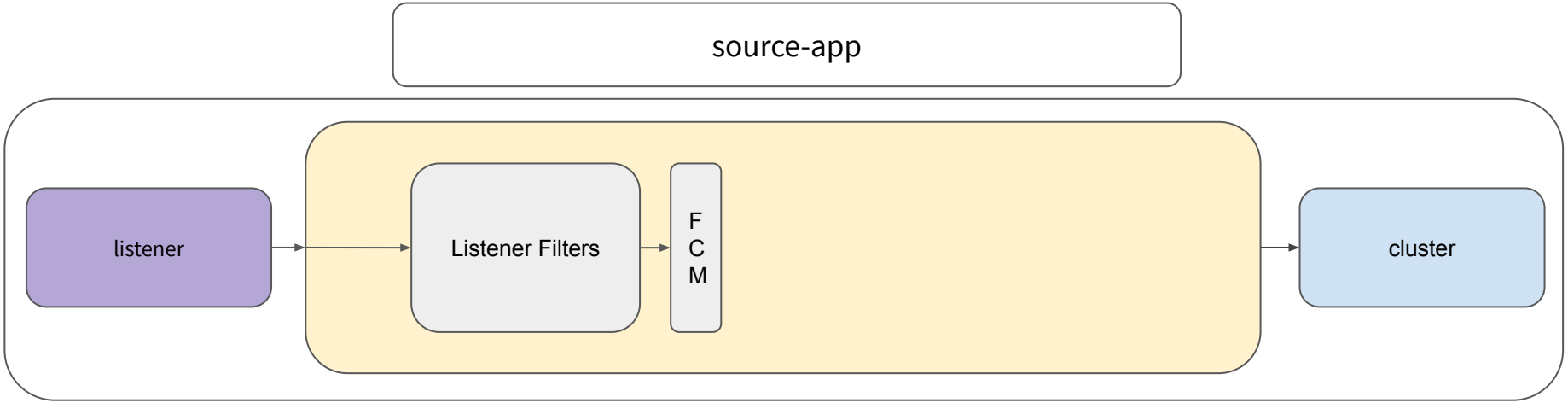
envoy - operation - cluster manager



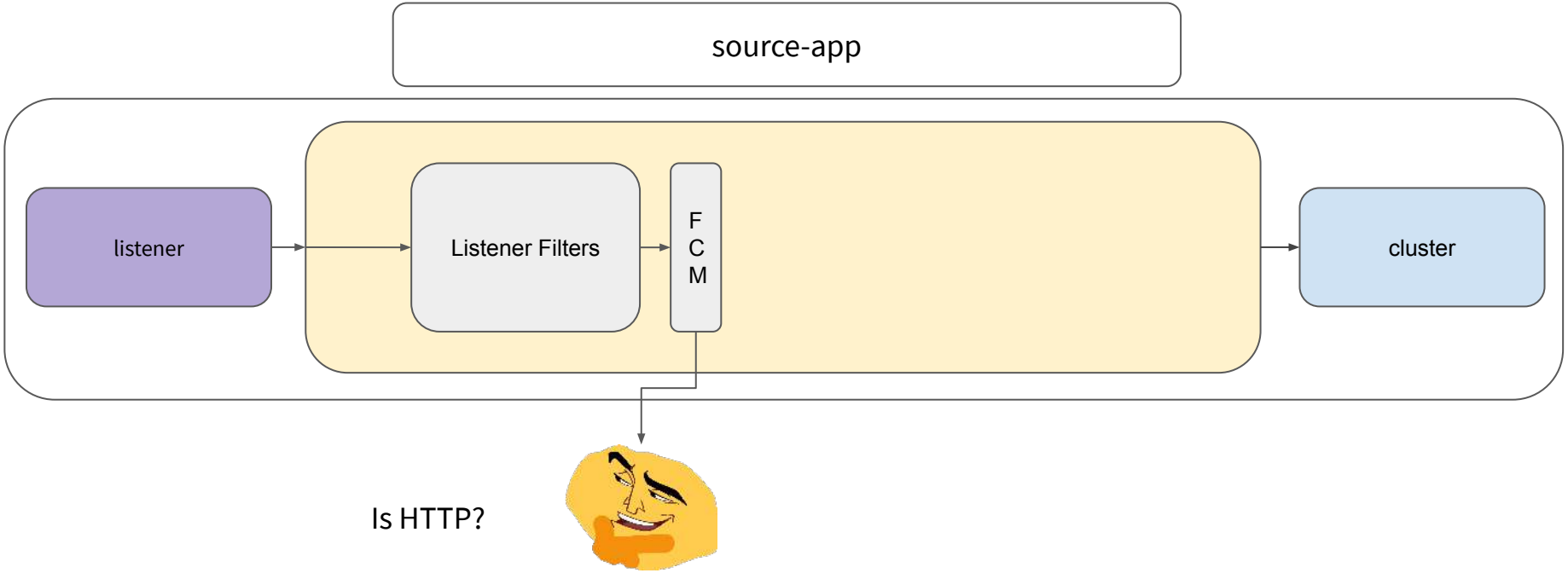
envoy - operation - filter chains



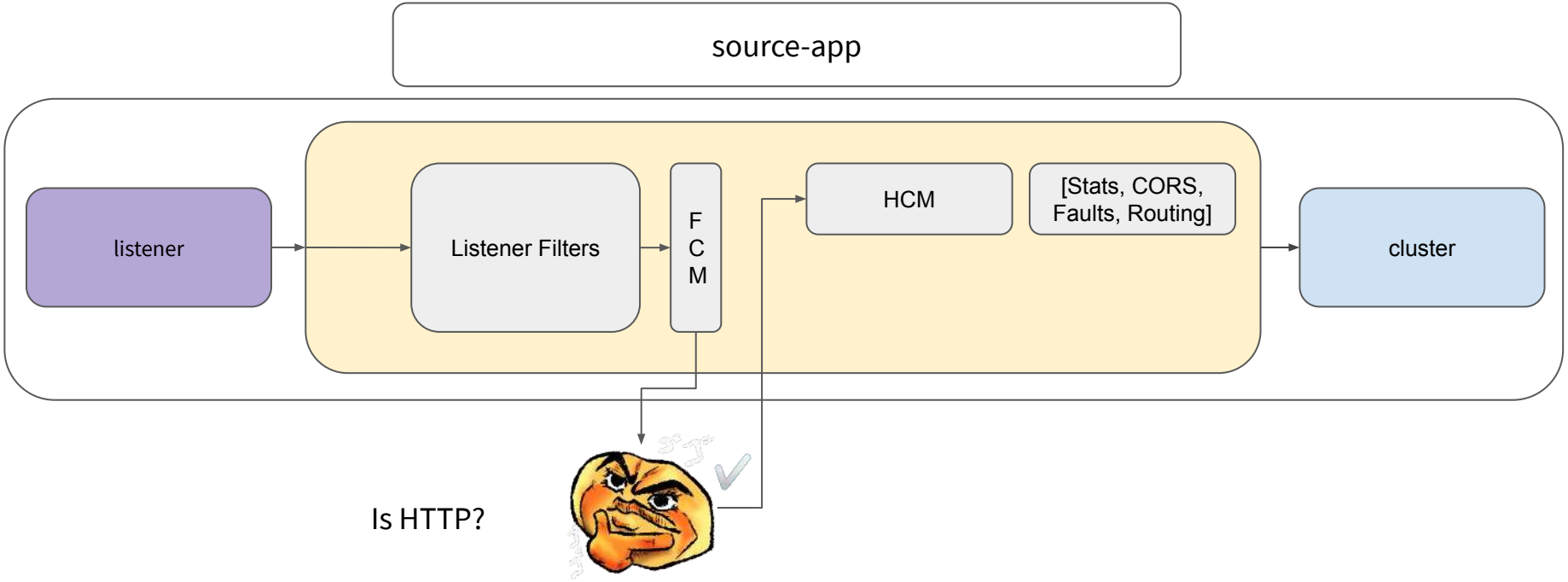
envoy - operation - filter chain match



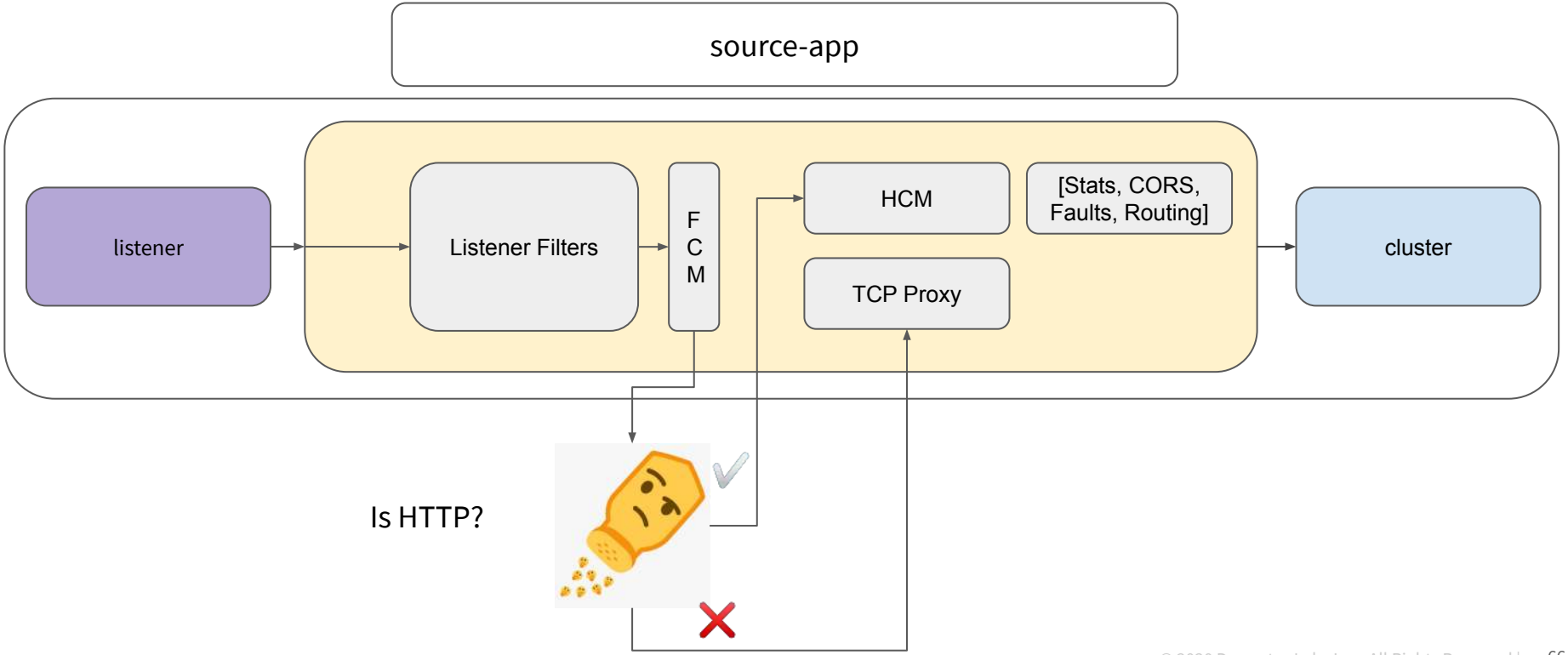
envoy - operation - filter chain match



envoy - operation - filter chain match



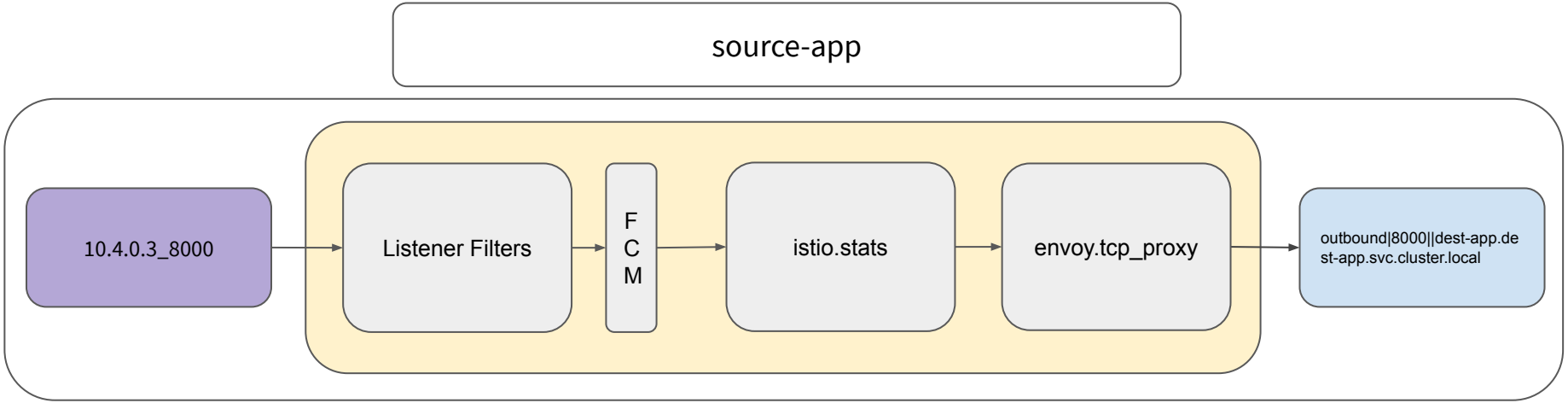
envoy - operation - filter chain match



envoy - operation - filter chain match


```
{
  "name": "0.0.0.0_15010",
  "active_state": {
    "version_info": "2020-12-05T22:58:30Z/8",
    "listener": {
      "@type": "type.googleapis.com/envoy.api.v2.Listener",
      "name": "0.0.0.0_15010",
      "address": {
        "socket_address": {
          "address": "0.0.0.0",
          "port_value": 15010
        }
      },
      "filter_chains": [
        {
          "filter_chain_match": {
            "application_protocols": [
              "http/1.0",
              "http/1.1",
              "h2c"
            ]
          },
          "filters": [ … ] // 1 item
        },
        {
          "filter_chain_match": {},
          "filters": [ … ], // 2 items
          "metadata": { … }, // 1 item
          "name": "PassthroughFilterChain"
        }
      ],
      "deprecated_v1": { … }, // 1 item
      "listener_filters": [ … ], // 2 items
      "listener_filters_timeout": "0.100s",
      "traffic_direction": "OUTBOUND",
      "continue_on_listener_filters_timeout": true
    },
    "last_updated": "2020-12-05T23:00:19.805Z"
  }
},
```


envoy - operation



envoy - operation

```
gke-compute-stage-preemptible-n1-stan-bddbfc3b-thtc /home/rob # iptables -t nat -S
-P PREROUTING ACCEPT
-P INPUT ACCEPT
-P OUTPUT ACCEPT
-P POSTROUTING ACCEPT
-N ISTIO_INBOUND
-N ISTIO_IN_REDIRECT
-N ISTIO_OUTPUT
-N ISTIO_REDIRECT
-A PREROUTING -p tcp -j ISTIO_INBOUND
-A OUTPUT -p tcp -j ISTIO_OUTPUT
-A ISTIO_INBOUND -p tcp -m tcp --dport 22 -j RETURN
-A ISTIO_INBOUND -p tcp -m tcp --dport 15090 -j RETURN
-A ISTIO_INBOUND -p tcp -m tcp --dport 15021 -j RETURN
-A ISTIO_INBOUND -p tcp -m tcp --dport 15020 -j RETURN
-A ISTIO_INBOUND -p tcp -j ISTIO_IN_REDIRECT
-A ISTIO_IN_REDIRECT -p tcp -j REDIRECT --to-ports 15006
-A ISTIO_OUTPUT -s 127.0.0.6/32 -o lo -j RETURN
-A ISTIO_OUTPUT ! -d 127.0.0.1/32 -o lo -m owner --uid-owner 1337 -j ISTIO_IN_REDIRECT
-A ISTIO_OUTPUT -o lo -m owner ! --uid-owner 1337 -j RETURN
-A ISTIO_OUTPUT -m owner --uid-owner 1337 -j RETURN
-A ISTIO_OUTPUT ! -d 127.0.0.1/32 -o lo -m owner --gid-owner 1337 -j ISTIO_IN_REDIRECT
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-A ISTIO_OUTPUT -d 127.0.0.1/32 -j RETURN
-A ISTIO_OUTPUT -j ISTIO_REDIRECT
-A ISTIO_REDIRECT -p tcp -j REDIRECT --to-ports 15001
```

envoy - operation

```
gke-compute-stage-preemptible-n1-stan-bddbfc3b-thtc /home/rob # iptables -t nat -S
-P PREROUTING ACCEPT
-P INPUT ACCEPT
-P OUTPUT ACCEPT
-P POSTROUTING ACCEPT
-N ISTIO_INBOUND
-N ISTIO_IN_REDIRECT
-N ISTIO_OUTPUT
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-A ISTIO_OUTPUT -m owner --gid-owner 1337 -j RETURN
-A ISTIO_OUTPUT -d 127.0.0.1/32 -j RETURN
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-A ISTIO_REDIRECT -p tcp -j REDIRECT --to-ports 15001
```

envoy - operation

```
gke-compute-stage-preemptible-n1-stan-bddbfc3b-thtc /home/rob # iptables -t nat -S
-P PREROUTING ACCEPT
-P INPUT ACCEPT
-P OUTPUT ACCEPT
-P POSTROUTING ACCEPT
-N ISTIO_INBOUND
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```

envoy - operation

```
gke-compute-stage-preemptible-n1-stan-bddbfc3b-thtc /home/rob # iptables -t nat -S
-P PREROUTING ACCEPT
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-P OUTPUT ACCEPT
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-N ISTIO_IN_REDIRECT
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-A ISTIO_IN_REDIRECT -p tcp -j REDIRECT --to-ports 15006
-A ISTIO_OUTPUT                                                    -j ISTIO_IN_REDIRECT
-A ISTIO_OUTPUT                                                    -j ISTIO_IN_REDIRECT
-A ISTIO_OUTPUT -j ISTIO_REDIRECT
-A ISTIO_REDIRECT -p tcp -j REDIRECT --to-ports 15001
```

envoy - operation

```
gke-compute-stage-preemptible-n1-stan-bddbfc3b-thtc /home/rob # iptables -t nat -S
-P PREROUTING ACCEPT
-P INPUT ACCEPT
-P OUTPUT ACCEPT
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-N ISTIO_INBOUND
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-A ISTIO_INBOUND -p tcp -m tcp --dport 15020 -j RETURN
-A ISTIO_INBOUND -p tcp -j ISTIO_IN_REDIRECT
-A ISTIO_IN_REDIRECT -p tcp -j REDIRECT --to-ports 15006
[redacted]
-A ISTIO_REDIRECT -p tcp -j REDIRECT --to-ports 15001
```

envoy - operation

```
gke-compute-stage-preemptible-n1-stan-bddbfc3b-thtc /home/rob # iptables -t nat -S
-P PREROUTING ACCEPT
-P INPUT ACCEPT
-P OUTPUT ACCEPT
-P POSTROUTING ACCEPT
-N ISTIO_INBOUND
-N ISTIO_IN_REDIRECT
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-A ISTIO_OUTPUT -d 127.0.0.1/32 -j RETURN
-A ISTIO_OUTPUT -j ISTIO_REDIRECT
-A ISTIO_REDIRECT -p tcp -j REDIRECT --to-ports 15001
```
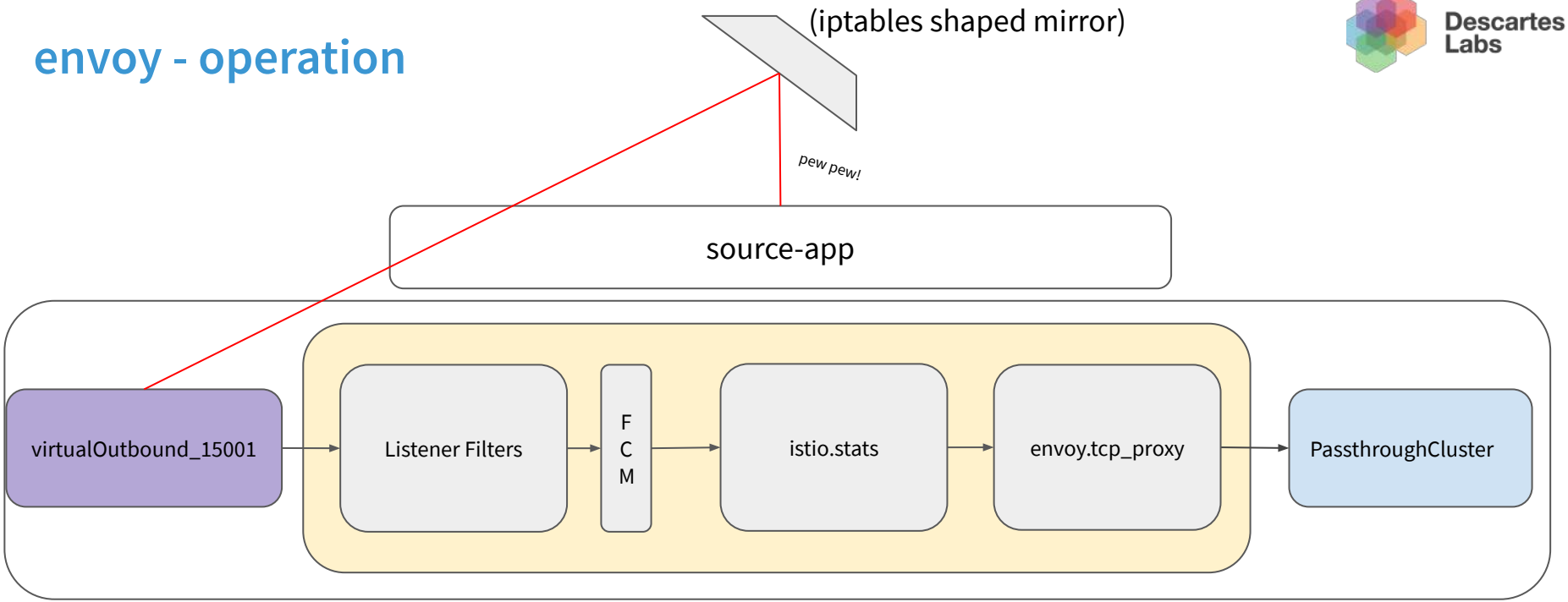
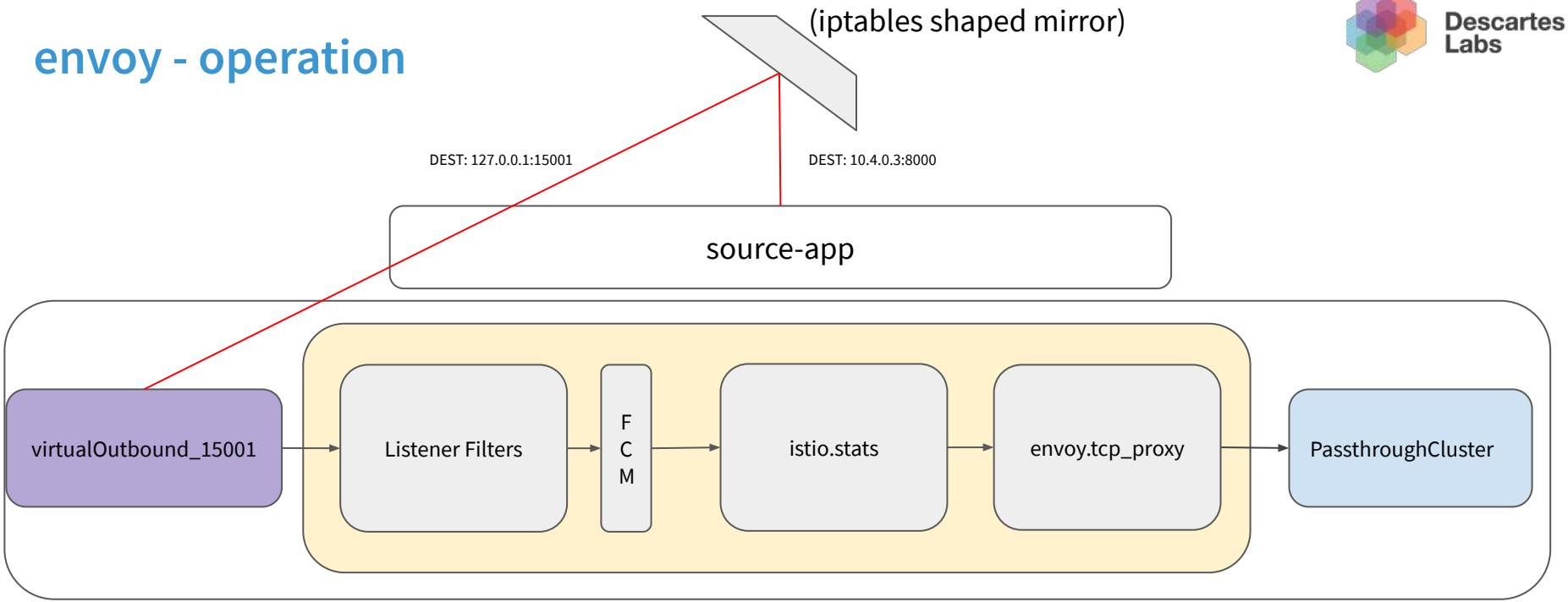

envoy - operation

```
$ ss -ltp
State    Recv-Q    Send-Q        Local Address:Port        Peer Address:Port
LISTEN   0         128                0.0.0.0:15021            0.0.0.0:*        users:(("envoy",pid=14,fd=25))
LISTEN   0         128                0.0.0.0:15090            0.0.0.0:*        users:(("envoy",pid=14,fd=24))
LISTEN   0         128              127.0.0.1:15000            0.0.0.0:*        users:(("envoy",pid=14,fd=14))
LISTEN   0         128                0.0.0.0:15001            0.0.0.0:*        users:(("envoy",pid=14,fd=45))
LISTEN   0         128                0.0.0.0:15006            0.0.0.0:*        users:(("envoy",pid=14,fd=46))
LISTEN   0         1024                     *:15020                  *:*        users:(("pilot-agent",pid=1,fd=7))
$
```

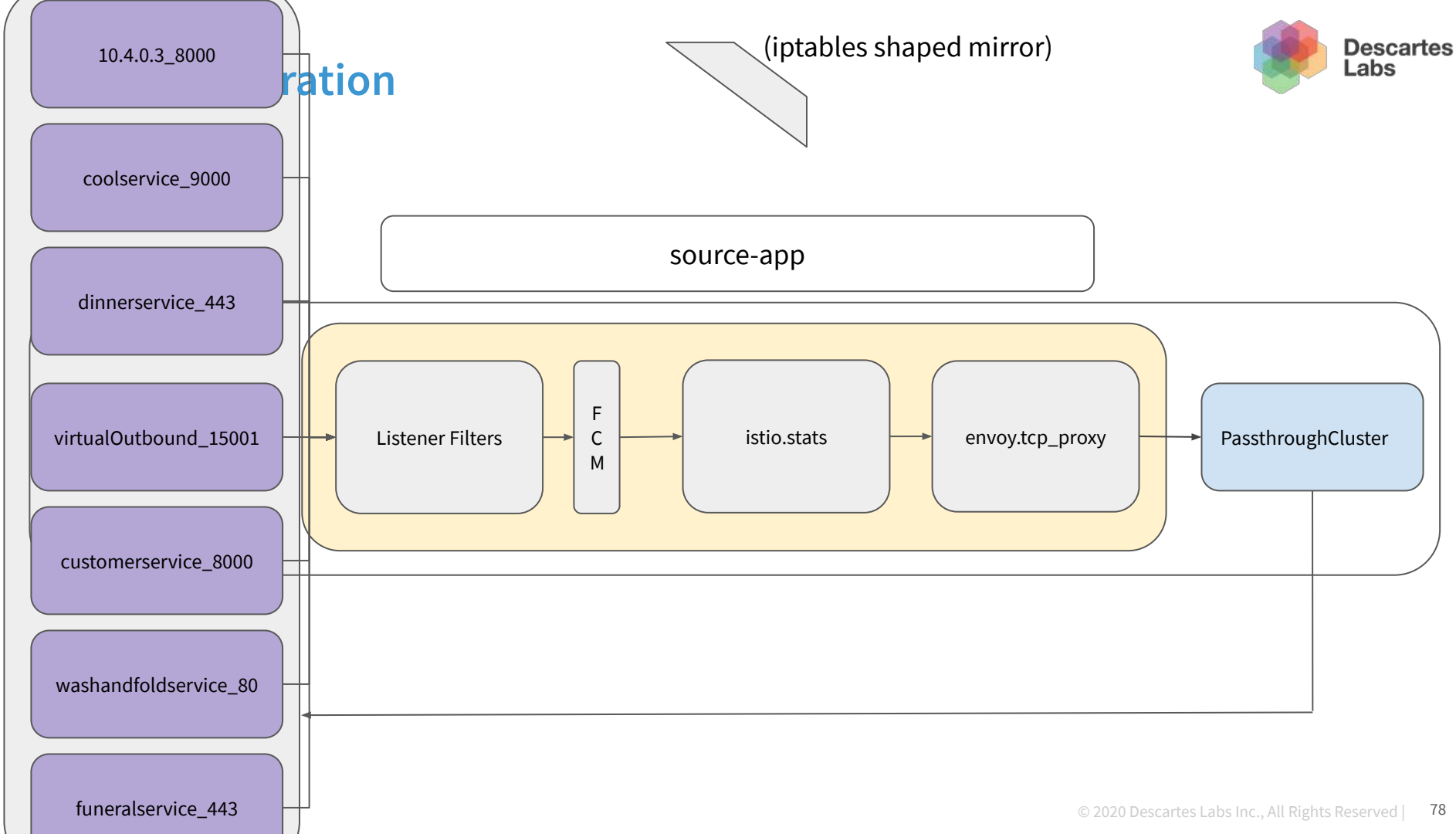
envoy - operation



envoy - operation



ration



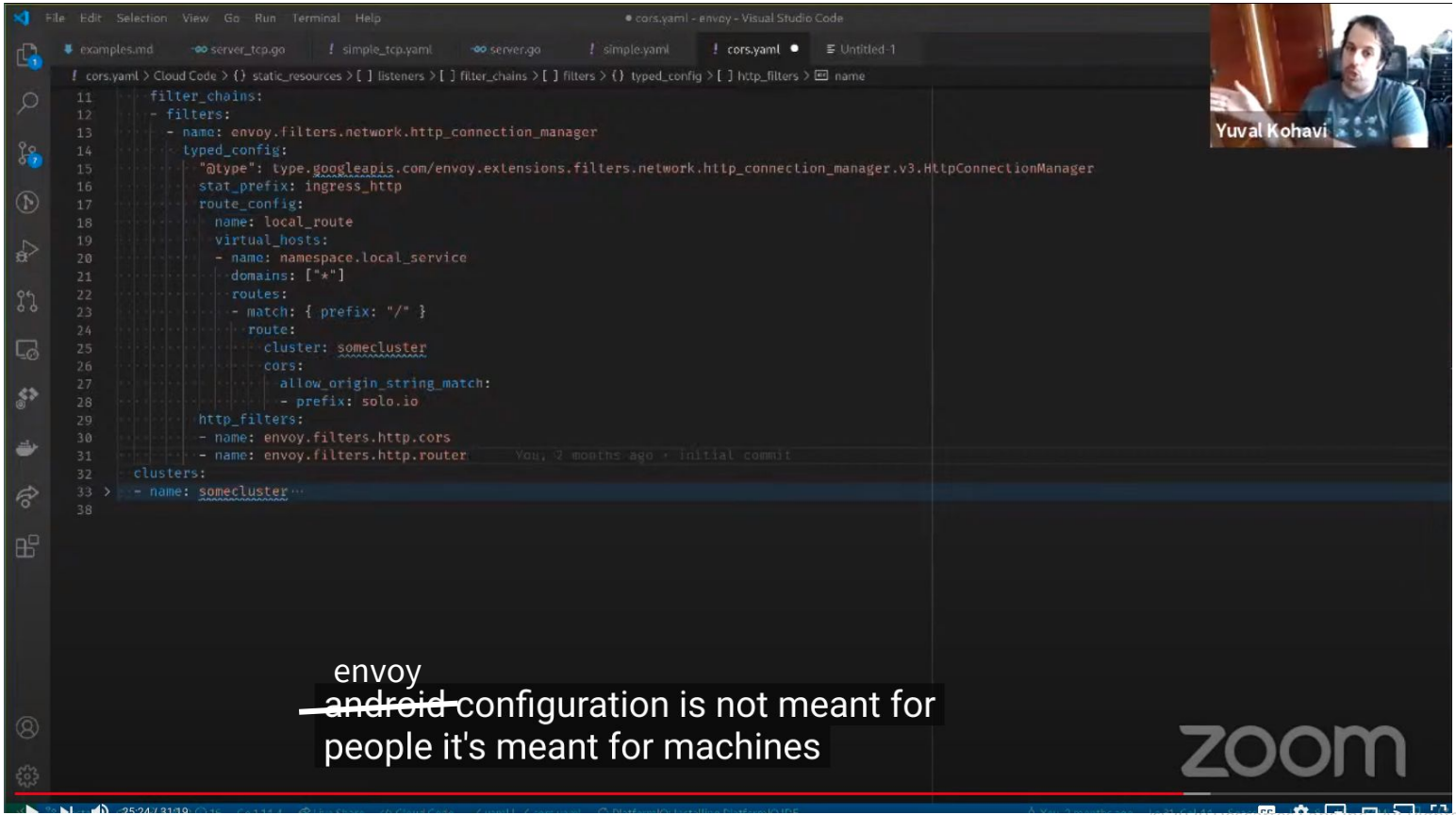
*professional SRE

Envoy: Configuration

-

Sidecar proxy with knobs on.

envoy - config

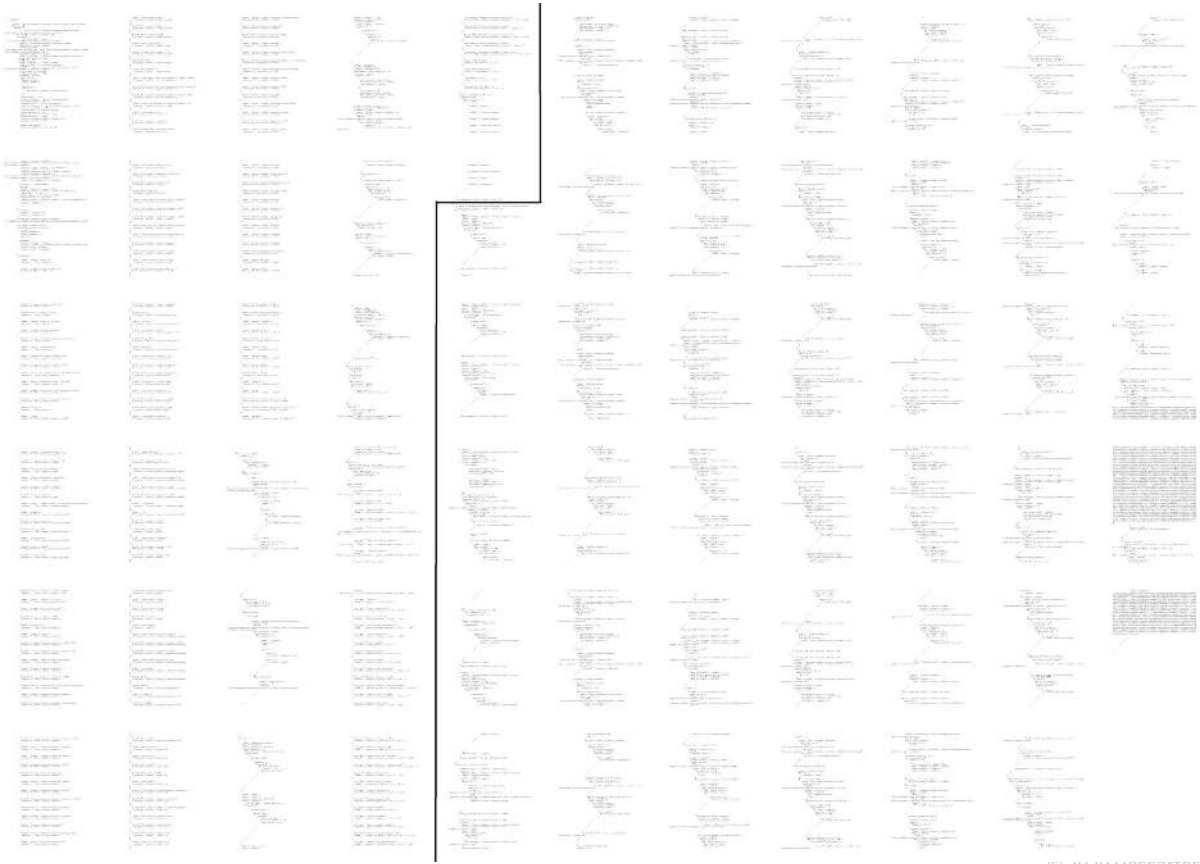


envoy - config

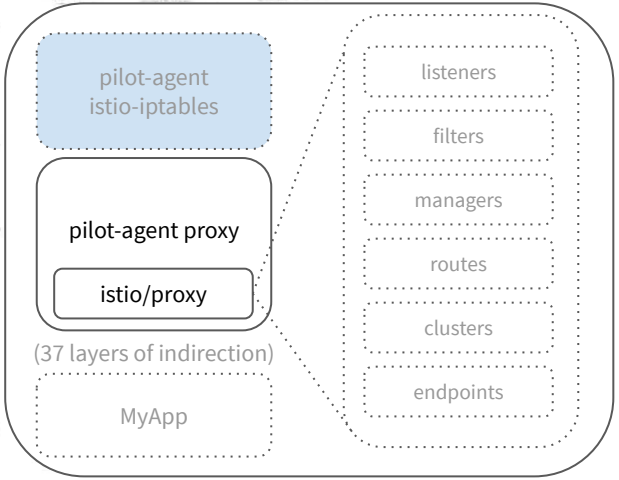
```yaml
admin:
  access_log_path: /tmp/admin_access.log
  address:
    socket_address: { address: 127.0.0.1, port_value: 9901 }

static_resources:
  listeners:
  - name: listener_0
    address:
      socket_address: { address: 127.0.0.1, port_value: 10000 }
    filter_chains:
    - filters:
      - name: envoy.filters.network.http_connection_manager
        typed_config:
          "@type": type.googleapis.com/envoy.extensions.filters.network.http_connection_manager.v3.HttpConnectionManager
          stat_prefix: ingress_http
          codec_type: AUTO
          route_config:
            name: local_route
            virtual_hosts:
            - name: local_service
              domains: ["*"]
              routes:
              - match: { prefix: "/" }
                route: { cluster: some_service }
          http_filters:
          - name: envoy.filters.http.router
  clusters:
  - name: some_service
    connect_timeout: 0.25s
    type: STATIC
    lb_policy: ROUND_ROBIN
    load_assignment:
      cluster_name: some_service
      endpoints:
      - lb_endpoints:
        - endpoint:
            address:
              socket_address:
                address: 127.0.0.1
                port_value: 1234
```

envoy - config

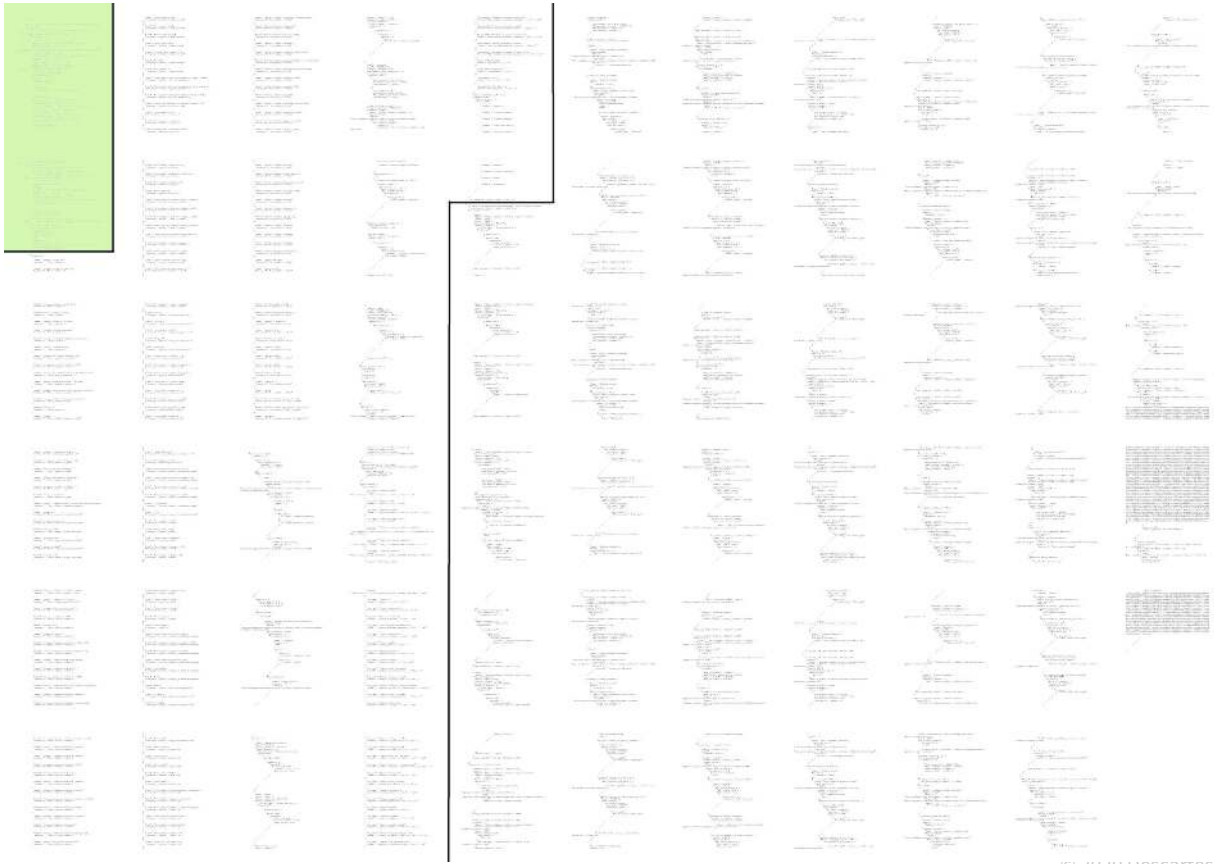
envoy - config - bootstrap



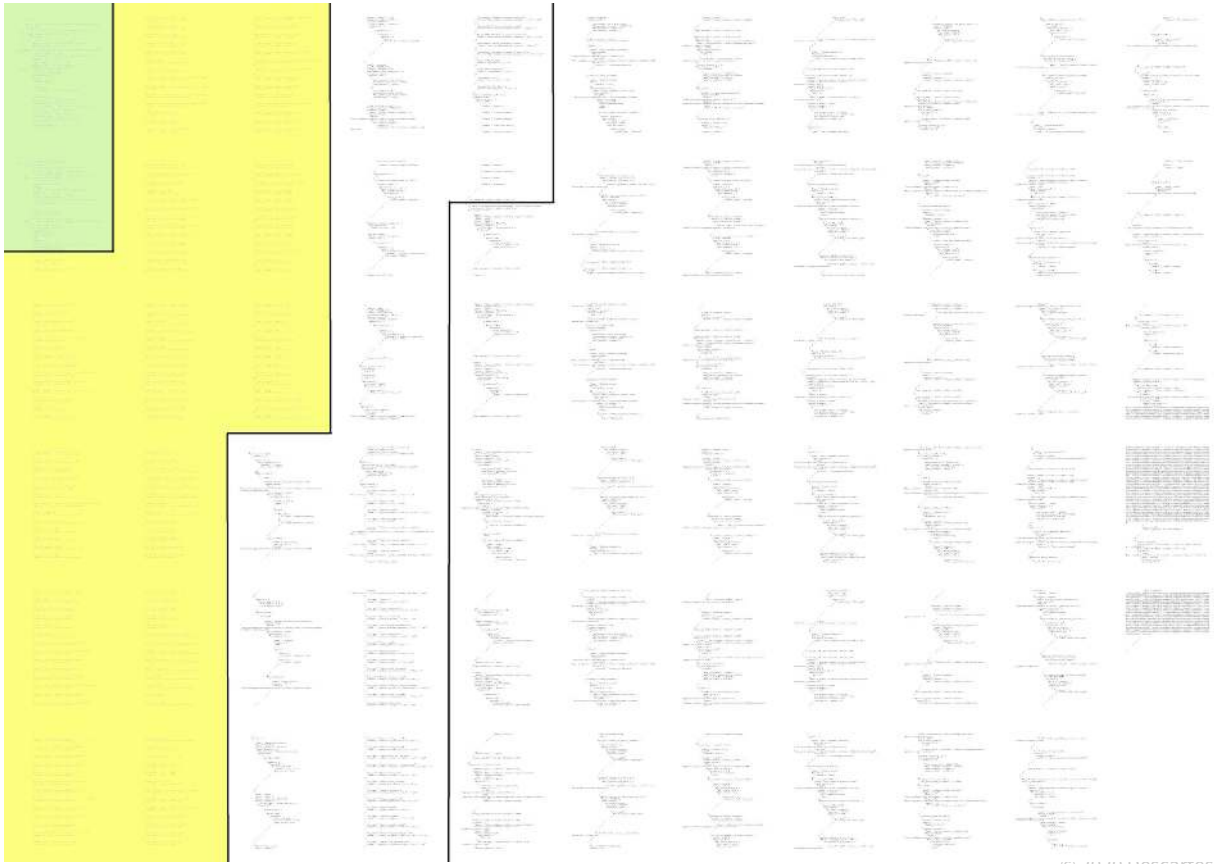
envoy - config - bootstrap



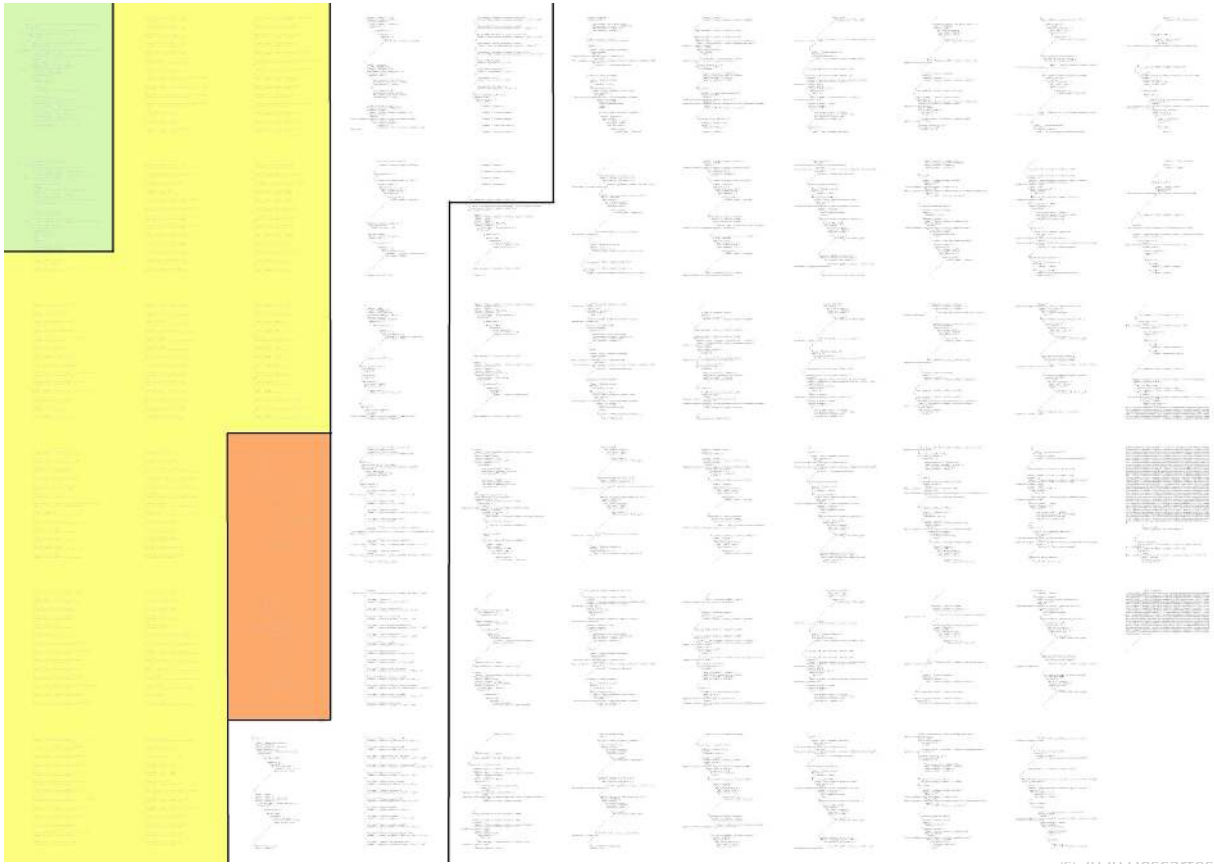
envoy - config - bootstrap



envoy - config - bootstrap



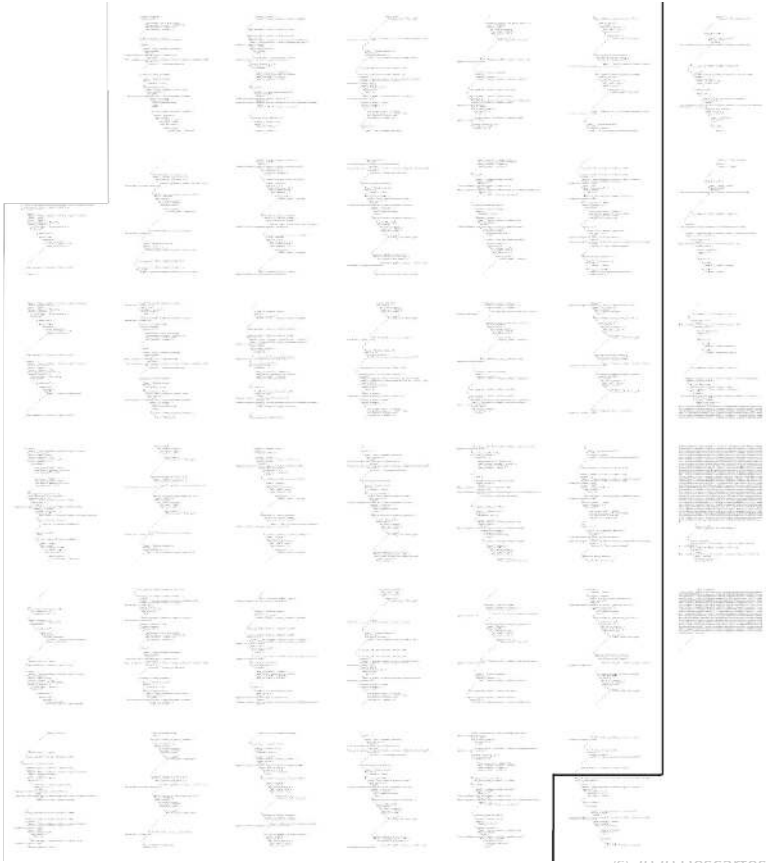
envoy - config - bootstrap



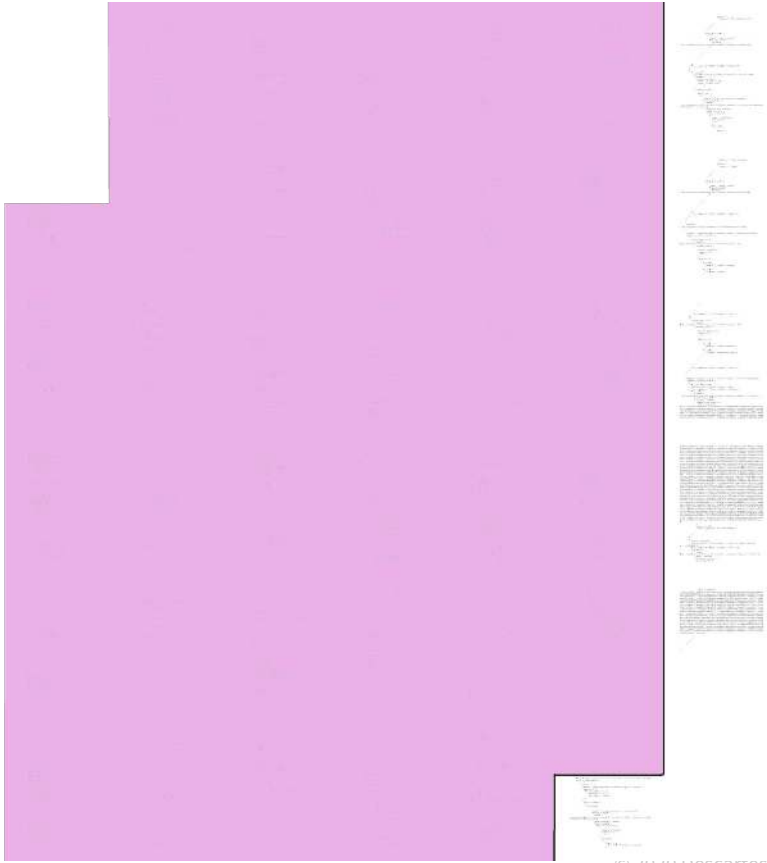
envoy - config - bootstrap

envoy - config - bootstrap

envoy - config



envoy - config - clusters



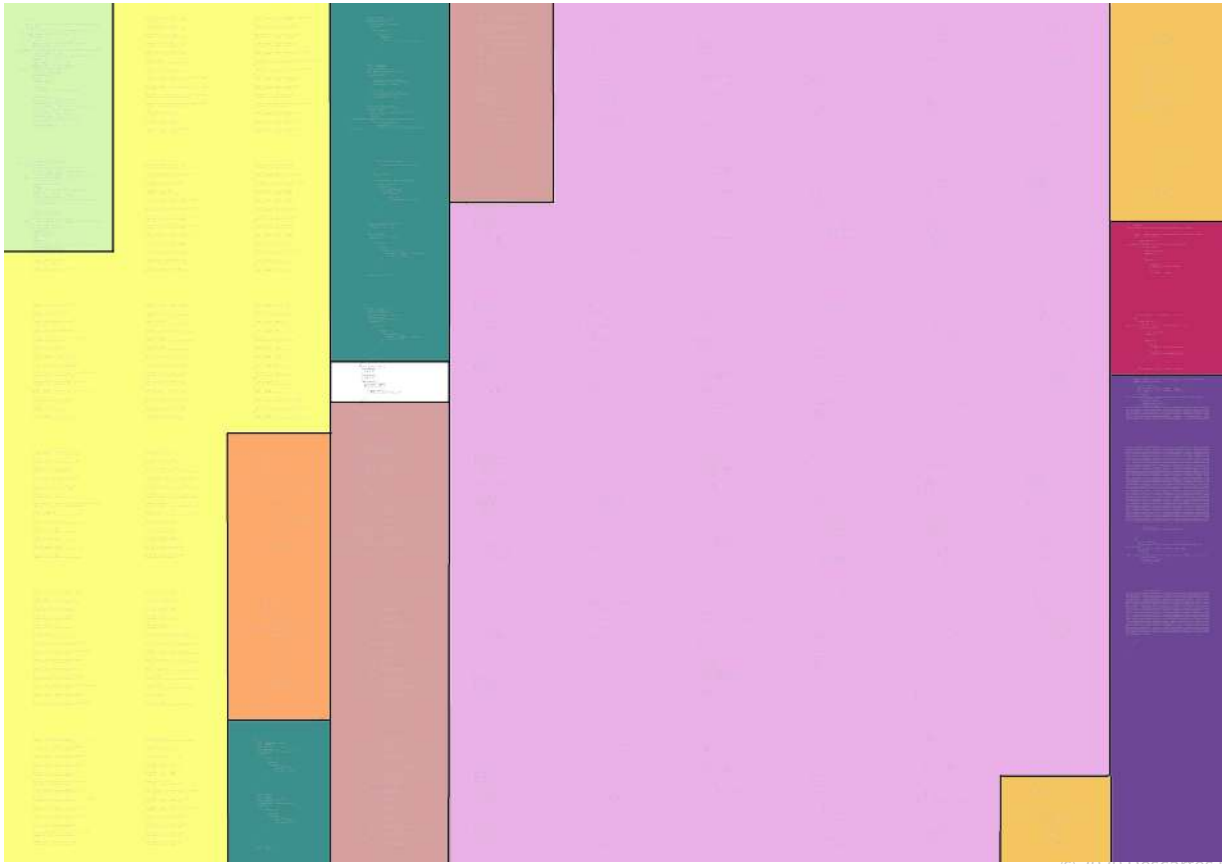
envoy - config

envoy - config - listeners

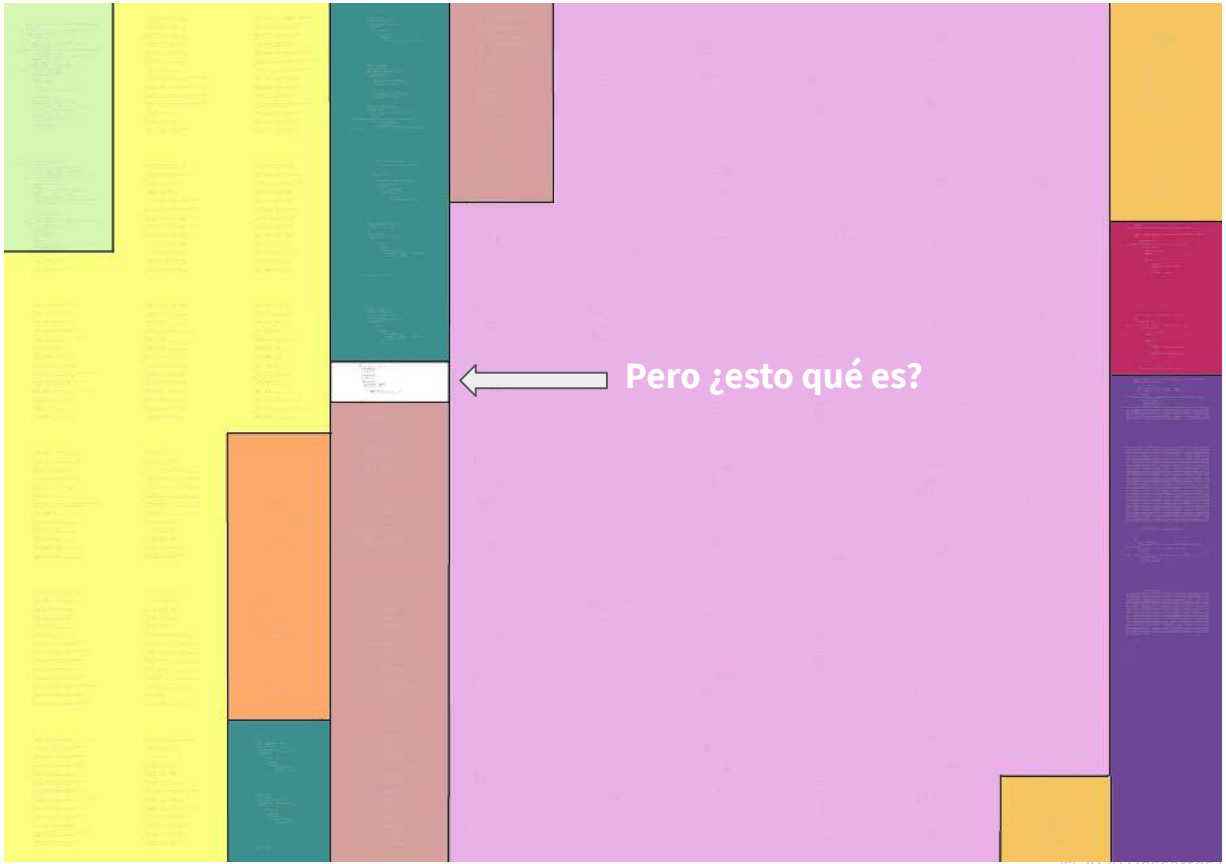
envoy - config - routes

envoy - config - secrets

envoy - config



envoy - config



envoy - config

```
"dynamic_resources": {
    "lds_config": {
        "ads": {}
    },
    "cds_config": {
        "ads": {}
    },
    "ads_config": {
        "api_type": "GRPC",
        "grpc_services": [
            {
                "envoy_grpc": {
                    "cluster_name": "xds-grpc"
                }
            }
        ]
    }
},
```

envoy - config


```
▼ "static_resources": {
  ▶ "listeners": [ … ], // 2 items
  ▼ "clusters": [
    ▶ { … }, // 4 items
    ▶ { … }, // 4 items
    ▶ { … }, // 5 items
    ▼ {
        "name": "xds-grpc",
        "type": "STRICT_DNS",
        "connect_timeout": "1s",
        "max_requests_per_connection": 1,
      ▶ "circuit_breakers": { … }, // 1 item
        "http2_protocol_options": {},
        "dns_lookup_family": "V4_ONLY",
      ▶ "transport_socket": { … }, // 2 items
      ▶ "upstream_connection_options": { … }, // 1 item
      ▼ "load_assignment": {
          "cluster_name": "xds-grpc",
        ▼ "endpoints": [
          ▼ {
            ▼ "lb_endpoints": [
              ▼ {
                ▼ "endpoint": {
                  ▼ "address": {
                    ▼ "socket_address": {
                        "address": "istiod.istio-system.svc",
                        "port_value": 15012
                      }
                    }
                  }
                }
              ]
            }
          ]
        },
        "respect_dns_ttl": true
      },
    ▶ { … } // 6 items
    ]
  },
```


[FIN, ACK]

Cuteness to soothe the spirit.

Metadata

Descartes Labs

This document URL: https://bit.ly/3pFMT78

References include links to Istio Community documents in gdrive. To access these documents you need to be a member of this google group.

Istio Acronyms

CR - Custom Resource - a specific instance of the defined spec
CRD - Custom Resource Definition - the spec for a Custom Resource
SD - Service Discovery
MX - Metadata Exchange - Istio specific Envoy extension providing “mixer like” attribute data without mixer
MCP - Mesh Configuration Protocol - how Istio components communicate

Envoy Acronyms

FCM - Filter Chain Match
ALS - Access Log Service
xDS - x Discovery Service (like the x in DircectX)
- Current version as of writing is v3, v2 supported but deprecated
- CDS cluster discovery service
- LDS listener discovery service
- RDS route discovery service
- SDS secret discovery service
- There are a few other more obscure ones in here too

UDPA - Universal Data Plane API (XDS v4)
UDPA-TP - UDPA Transport Protocol
UDPA-DM - UPDA Data Model
ORCA - Open Request Cost Aggregation - load reporting
DPLB - Data Plane Load Balancer
- This appears to refer to xDS / UDPA clients, like Envoy itself

Terminology

Upstream - where envoy sends requests to
Downstream - where envoy receives requests from
Management Server - xDS Server AKA control plane AKA istiod

