

Cilium: Connecting, Observing, and Securing Kubernetes and Beyond with eBPF



Bill Mulligan
Isovalent @ Cisco

Joe Stevens
Ascend.io

Ahmed Bebars
The New York Times

Anna Kapuścińska
Isovalent @ Cisco



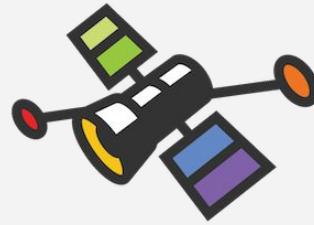
Welcome to Cilium

Bill Mulligan, Isovalent at Cisco





Cilium



Hubble



Tetragon

Scalable, Secure, Efficient
Networking L3-L7

Network
Observability

Security Observability &
Runtime Enforcement



20k ⭐'s for Cilium

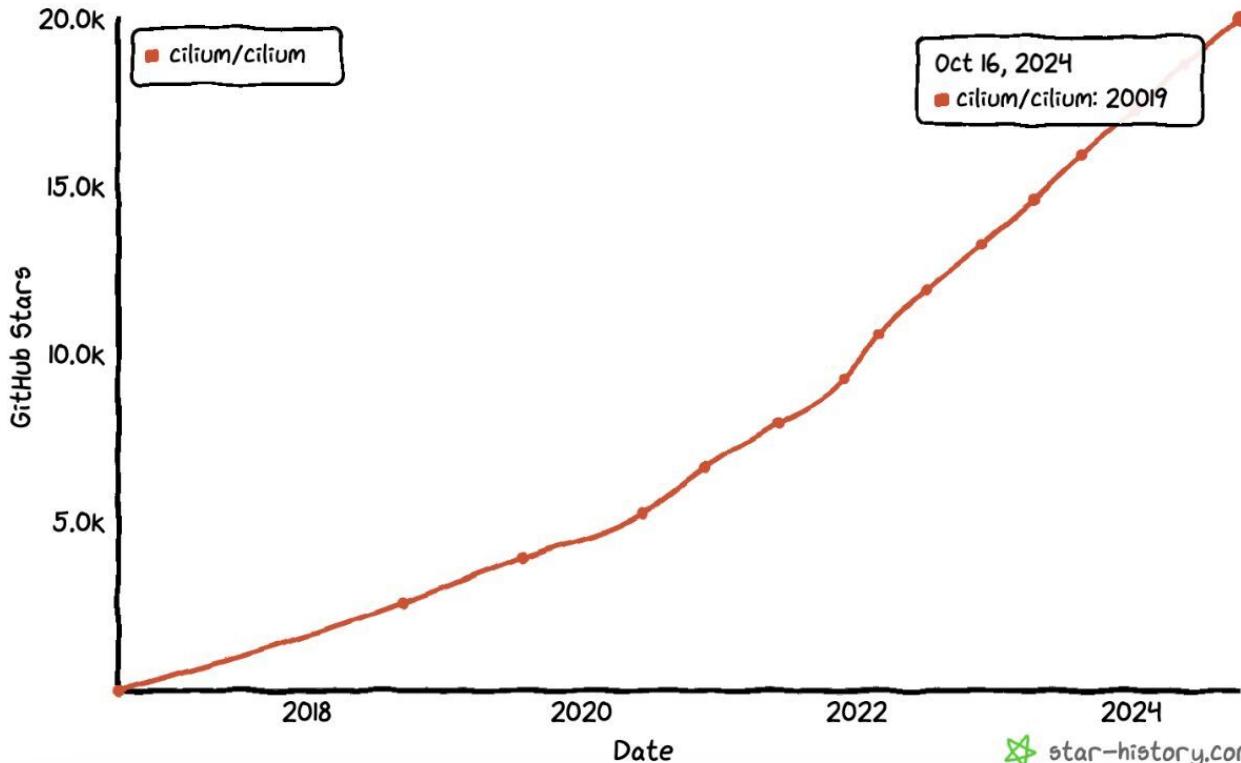


KubeCon

CloudNativeCon

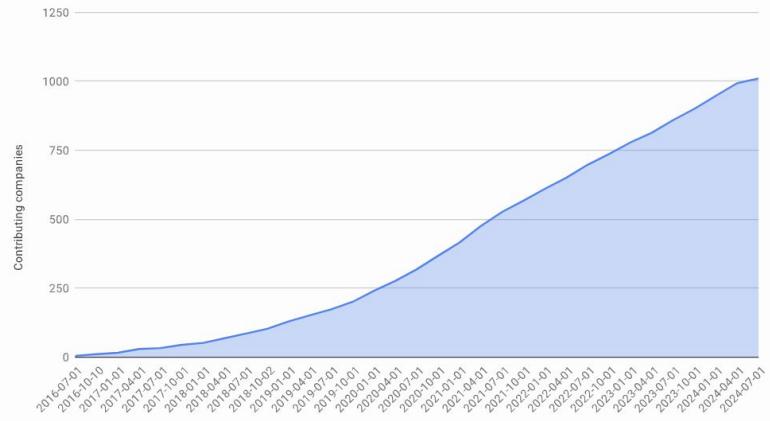
North America 2024

Star History

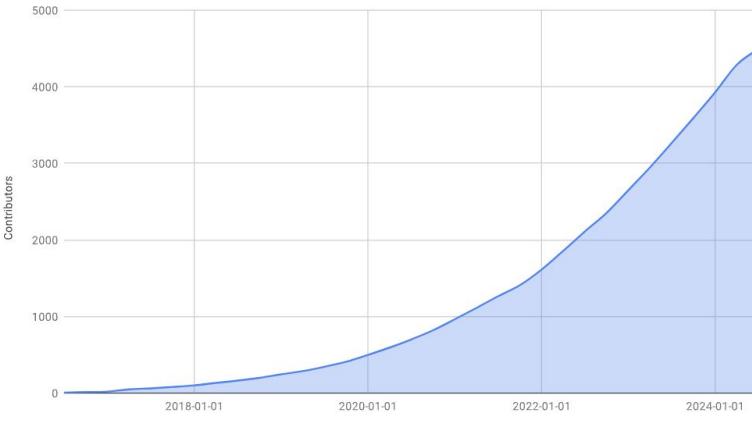


Cilium Project Journey Report

Cumulative growth of contributing companies 2016-07-01 – 2024-07-01



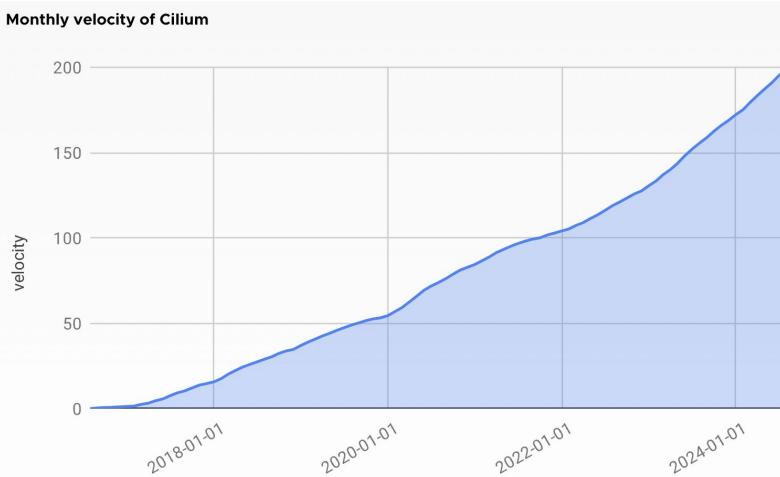
Cumulative growth in contributors 2016-07-01 – 2024-07-01



“Being a graduated project helped new users recognize that Cilium was already widely adopted at scale, and had become the **standard solution for Kubernetes networking and security**. It has now been adopted by all the major public clouds, who have also **contributed engineering efforts into the project**”



Cilium Project Journey Report



“Cilium was able to become the **standard for cloud native networking** because it was founded and built on eBPF and eBPF is also helping Cilium **tackle the challenges of observability and security** with Hubble and Tetragon”



153 public users, 74 public stories

Adopters																																																																																																											
<p>Here are some of the organizations we know are using Cilium. If you're using Cilium and aren't on this list, please email us a pull request!</p> <table border="1"> <tbody> <tr> <td> Adobe What Makes a Good Multi-tenant Kubernetes Solution</td> <td> Alibaba Cloud Alibaba Cloud uses Cilium as their CNL for their multi-tenanted Kubernetes offering</td> <td> ASCENDIO Ascendio uses Cilium as their CNL across multiple cloud providers</td> <td> aws AWS picks Cilium for Networking & Security on CNL Argument</td> </tr> <tr> <td>CASE STUDY · TALK 1 · TALK 4</td> <td>CASE STUDY · BLOG 1 · BLOG 2</td> <td>READ CASE STUDY</td> <td>READ BLOG</td> </tr> <tr> <td> Microsoft Microsoft chooses Cilium for Azure networking</td> <td> Bell Bell uses Cilium and eBPF for network networking</td> <td> Bloomberg Bloomberg averages Cilium in internal data sandboxes that receive user generated data outside the sandbox</td> <td> bmc BMC uses Cilium as a CNL option in their BMC Ready Innovation Suite and BMC Container Management Git Provider</td> </tr> <tr> <td>WATCH TALK · 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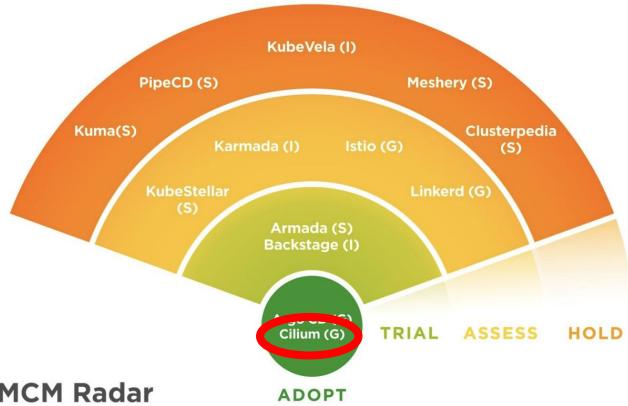
CNCF Tech Radar - Multicloud



KubeCon

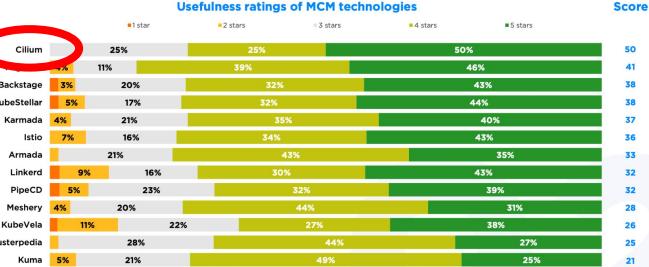
CloudNativeCon

North America 2024



2. Multicloud Application Management Technologies

Usefulness ratings of multicloud application management technologies



Question wording: How would you rate the following multicloud management tools/products with respect to these aspects (Usefulness)?
% of developers familiar with each technology | Score (% of 5 star ratings minus the % of 1 and 2 star ratings) (n=204)

03 2024 | CNCF Technology Landscape Radar

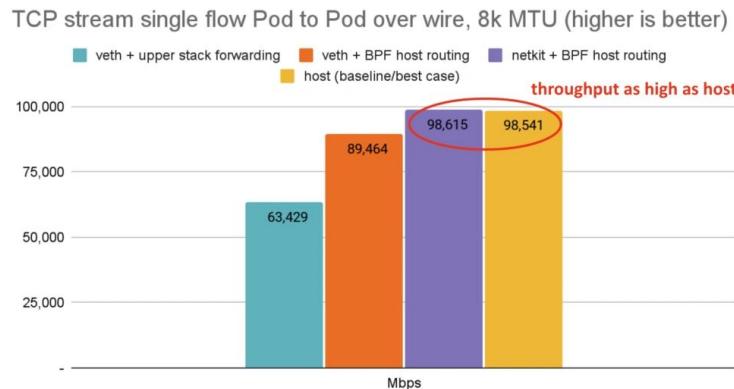
11

Cilium received the highest usefulness score (+50), as well as receiving no negative, 1 or 2 star, ratings.



Cilium 1.16 Networking

- **Cilium netkit:** container-network throughput and latency as fast as host-network
- **Service Traffic Distribution:** successor to topology-aware routing
- **Multicast Support**



1.16 Service Mesh & Ingress/Gateway API

- **Gateway API 1.1 Support**
- **GAMMA Support:** East-west traffic management for the cluster via Gateway API
- **L7 Envoy Proxy as dedicated DaemonSet**

```
apiVersion: gateway.networking.k8s.io/v1
kind: HTTPRoute
metadata:
  name: gamma-route
spec:
  parentRefs:
    - group: ""
      kind: Service
      name: echo
```



Cilium 1.16 and Tetragon Security

- **Port Range** support in Network Policies
- **Network Policy Validation** and filesystem default

Tetragon

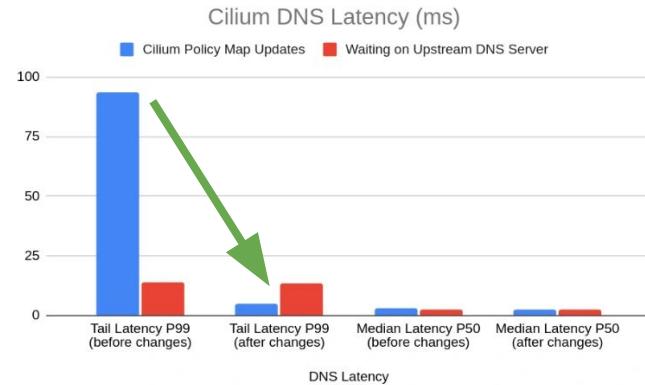
- Kubernetes **identity aware** policies
- **Redaction filters** for events

```
apiVersion: "cilium.io/v2"
kind: CiliumNetworkPolicy
metadata:
  name: "range-port-rule"
spec:
  description: "L3-L4 policy to restrict range of ports"
```



Cilium 1.16 Day 2 Operations and Scale

- Improved DNS-based network policy performance: **5x reduction in tail latency** for DNS-based network policies
- New ELF Loader Logic: **Median memory usage** of Cilium was **decreased by 24%**



Cilium @ NYT

Ahmed Bebars, The New York Times

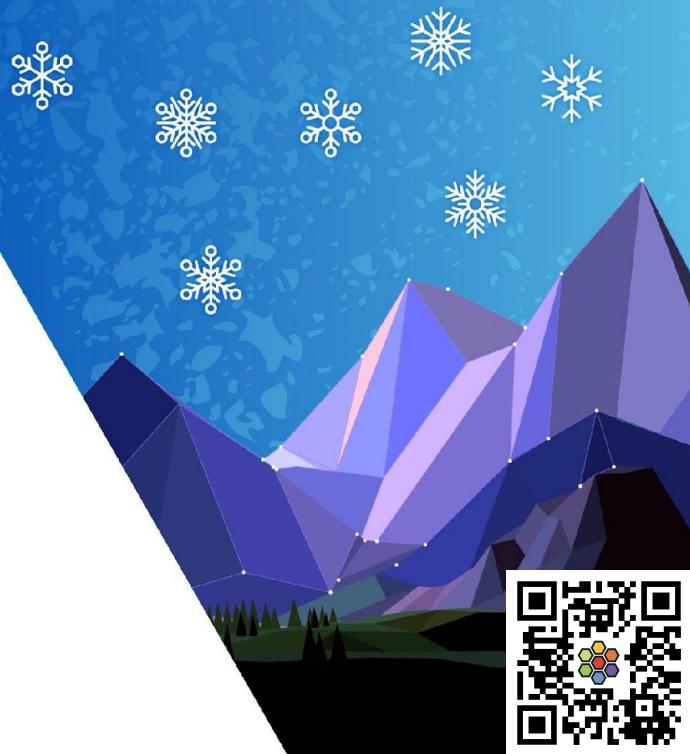


KubeCon



CloudNativeCon

North America 2024

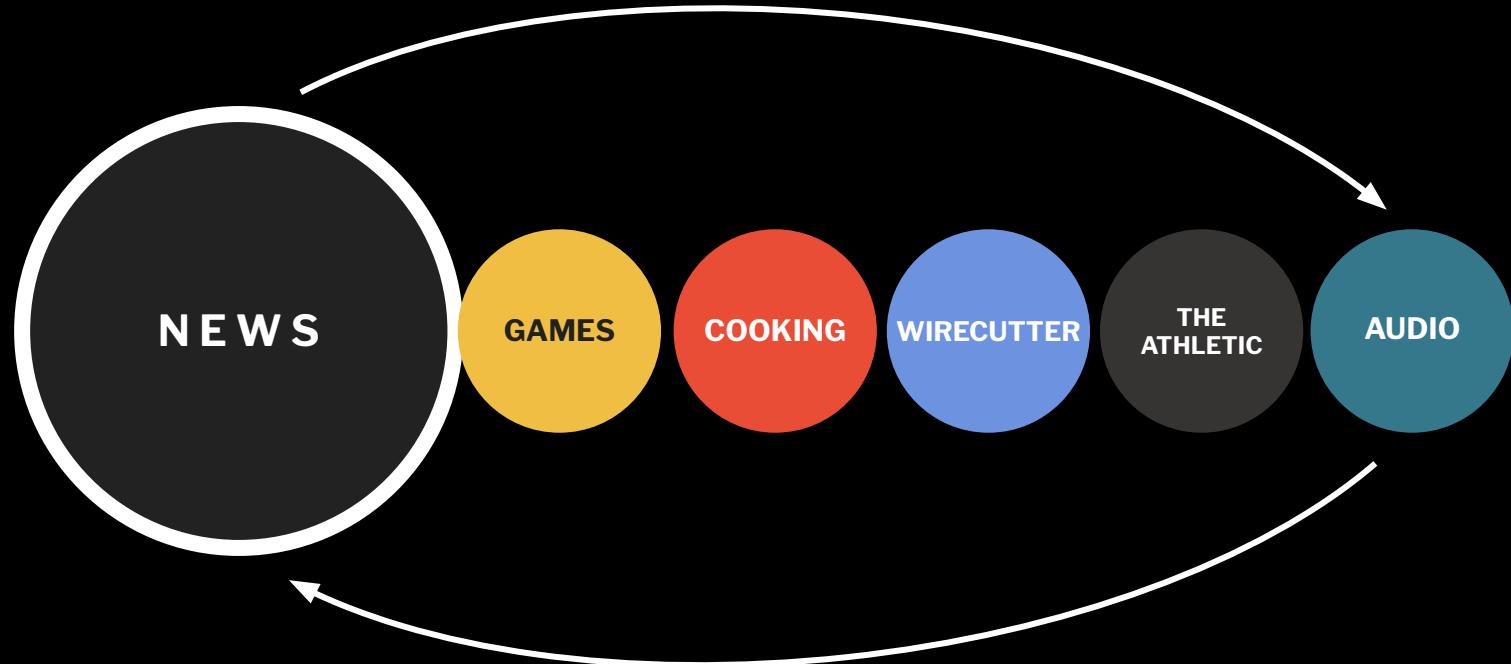


Hi, I'm Ahmed Bebars

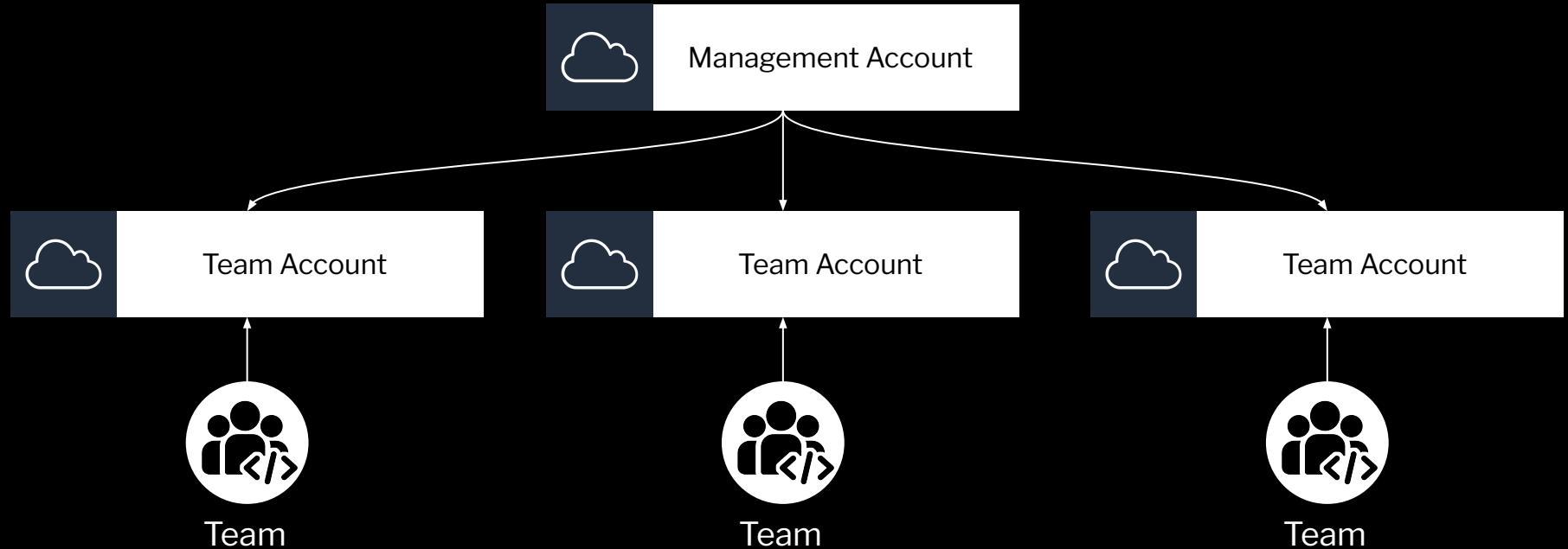
Principal Engineer

My focus is about building a reliable platform
and ensure our infrastructure is well-managed

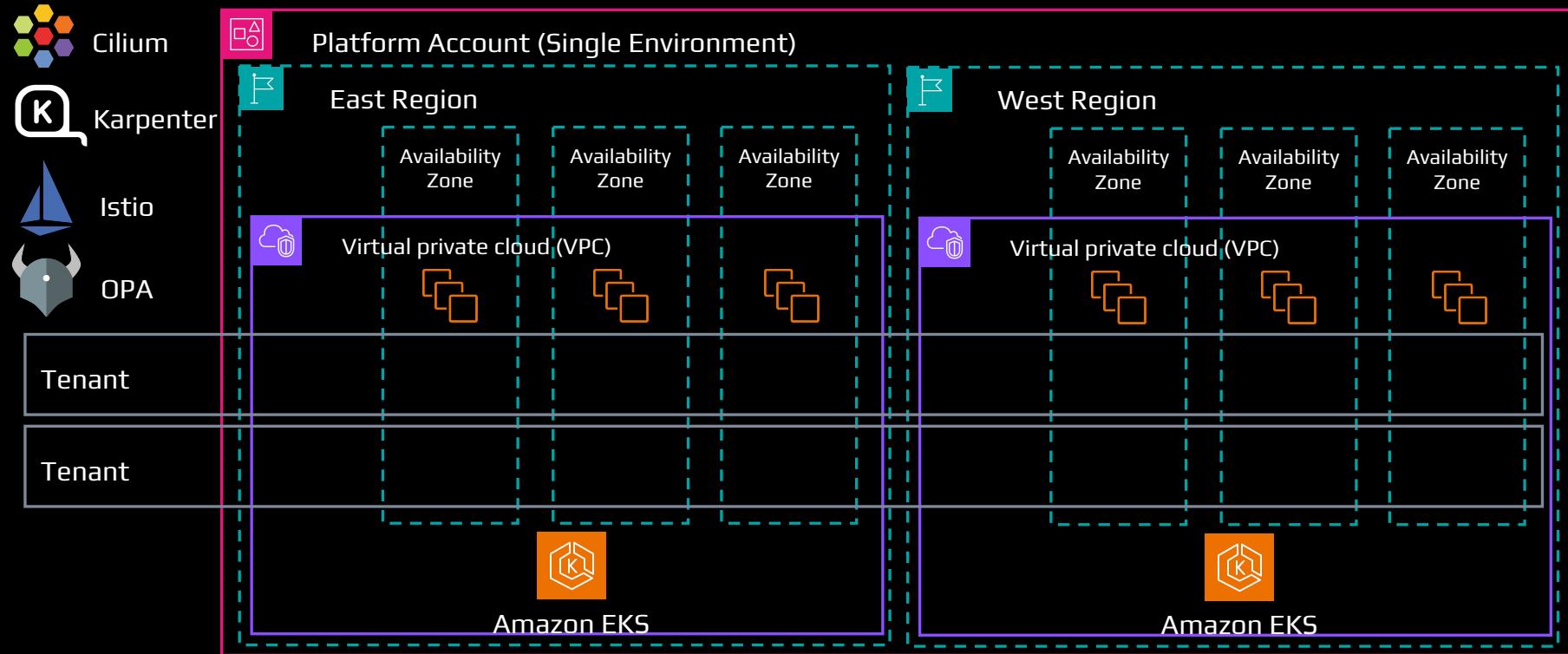




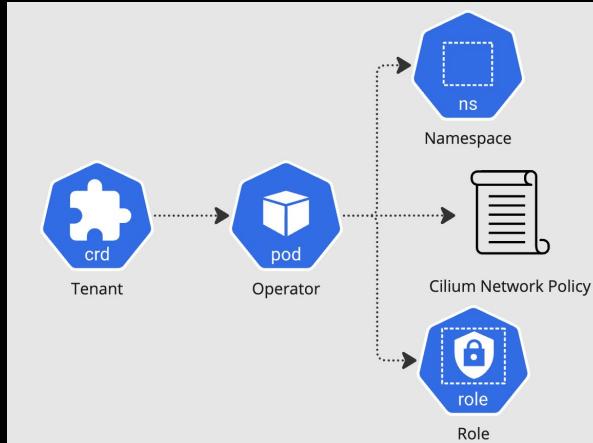
Multi-Account Architecture



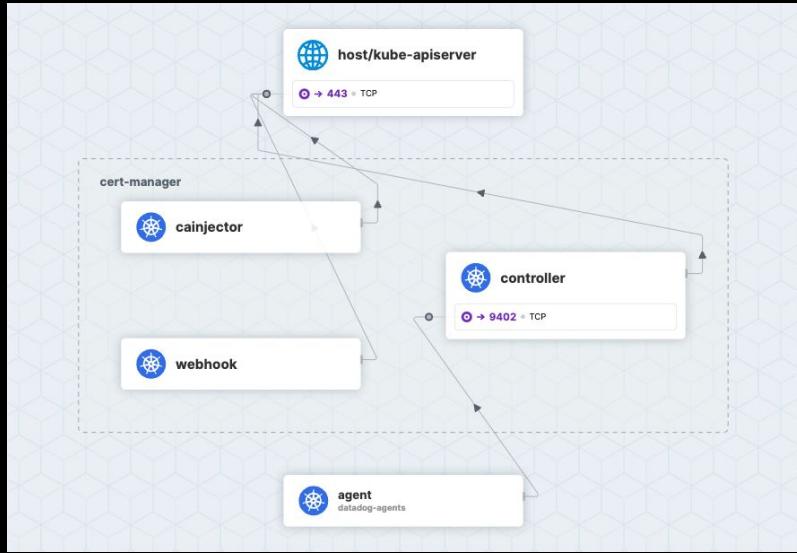
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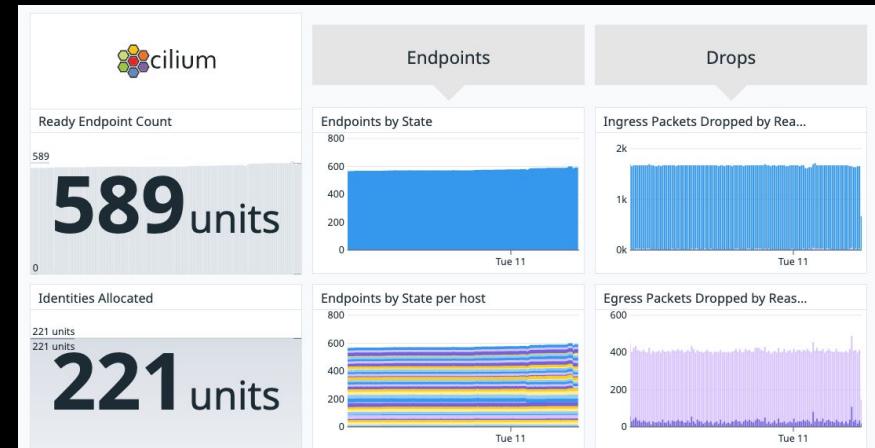
Strong Network Isolation



Detailed Observability

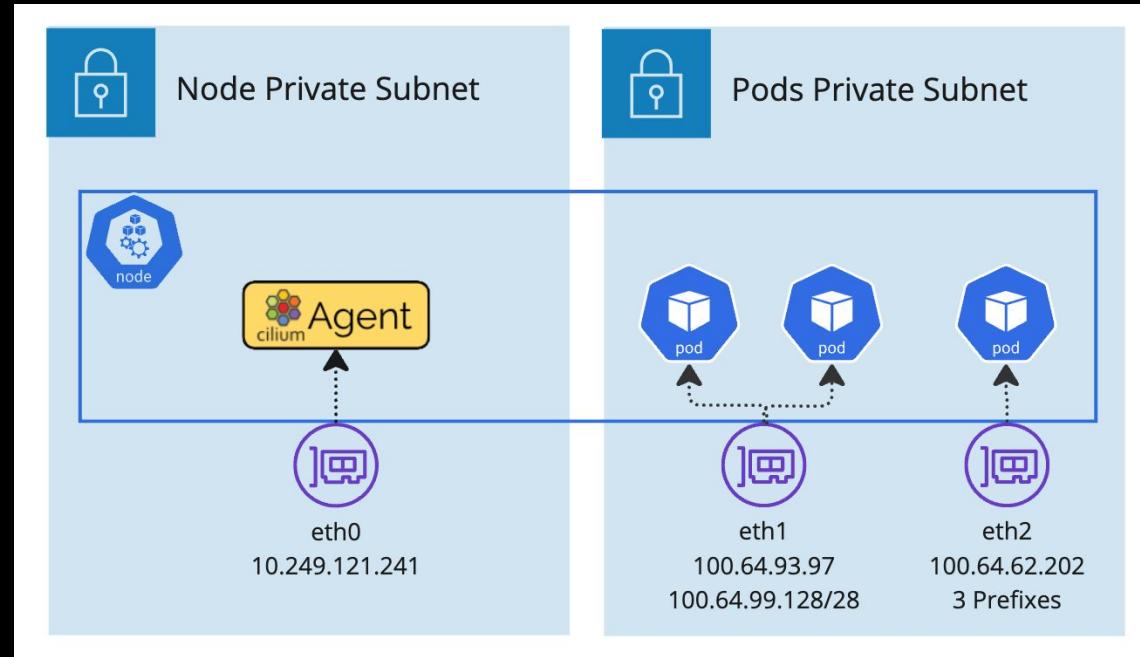


Hubble & Flows



Metrics

ENI Mode



Other Talks

- [Designing and Securing a Multi-Tenant Runtime Environment at the New York Times](#)
- [What We Learned Designing & Securing a Multi-Tenant Developer Platform at The New York Times](#)
- [Revolutionizing Mesh Layers: Transitioning from Istio to Cilium](#)



Cilium @ Ascend.io

Joe Stevens, Ascend.io



Who am I?

- **Name:** Joe Stevens (they/them)
- **What do I do:** I lead infrastructure and many other eng things at Ascend.io
- **Ascend.io:** We offer a platform for data pipeline automation with AI to accelerate user development



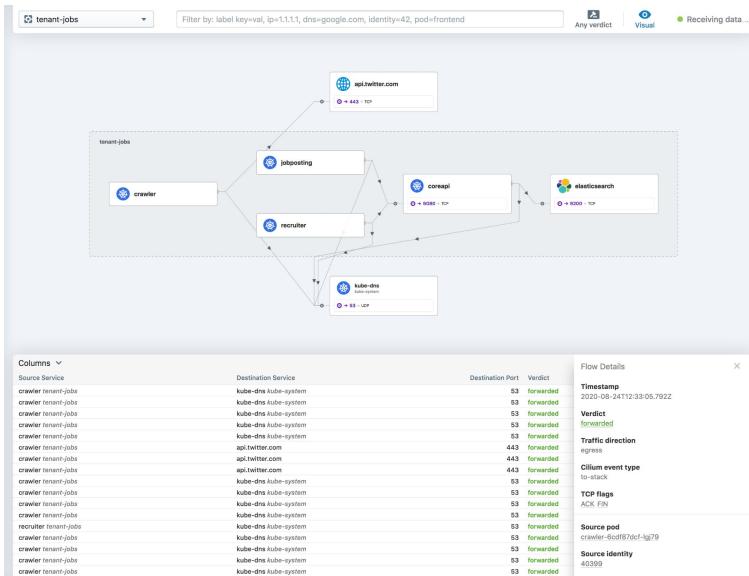
- Processing User Data
 - In-VPC Deploys
 - Multi-Cloud (on k8s)
 - Private Networking
 - Compliance Req's
 - Performance



Ascend Infrastructure



- **Consistent Infra**
 - We leverage GKE/EKS/AKS
 - Cilium gives us a consistent networking layer
 - Hubble (w/ UI) is the best network policy debugger around



Ascend Infrastructure

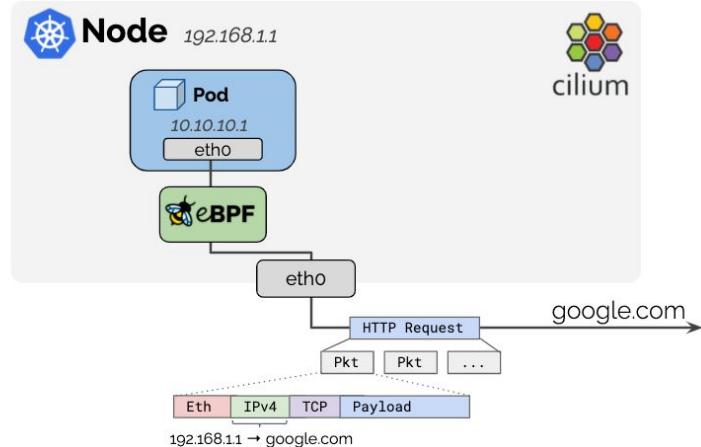


KubeCon

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North America 2024

- **IP Saturation**
 - Private networks are frequently IP-saturated
 - Every managed k8s defaults to VPC-native routing
 - Cilium allows us to masquerade/NAT our workloads



Ascend Infrastructure

- **Encryption in Transit**
 - You can roll your own many-component network encryption...
 - ...or you can just turn on WireGuard in Cilium



Ascend Infrastructure

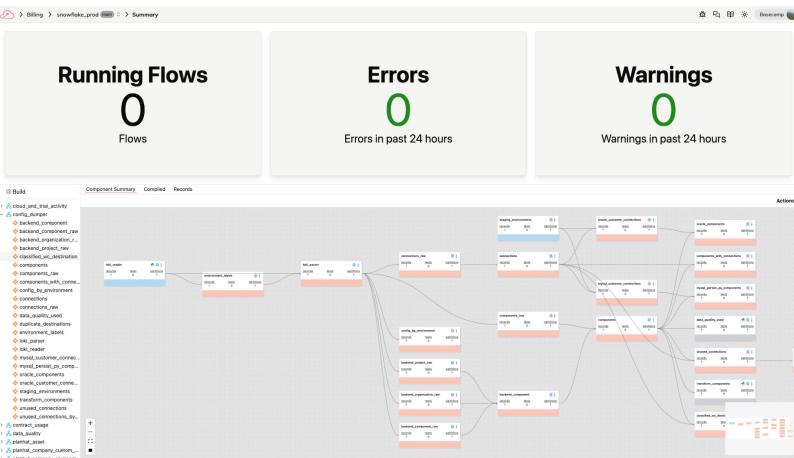
- **We Move Data (Lots of it)**
 - Cilium is performant
 - Netkit
 - BIG TCP
 - When new kernels show up you just get nice things with no additional work



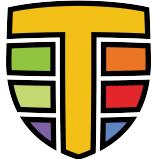
For more...



- **Ascend.io**
 - Check our site for upcoming product announcements!
 - **The Case Study**
 - <https://www.cncf.io/case-studies/ascend/>



Tetragon Community Updates



Use cases



Policy library



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tetragon / examples / tracingpolicy / ⌂

anfedotoff and kkourt Update LSM tracingPolicy examples ⌂

- Name
- ..
- cves
- host-changes
- process-credentials
- process-exec
- bpf.yaml
- datagram-with-selectors.yaml
- datagram-with-sock-tracking.yaml
- datagram.yaml
- datagram_518.yaml
- dev_hard_start_xmit.yaml
- dev_queue_xmit.yaml
- dns-only-specified-servers.yaml

Documentation / Use Cases

Use Cases

This section presents various use cases on process, files, network and security monitoring and enforcement.

By default, Tetragon monitors process lifecycle, learn more about that in the [dedicated use cases](#).

For more advanced use cases, Tetragon can observe tracepoints and arbitrary kernel calls via kprobes. For that, Tetragon must be extended and configured with custom resources objects named [TracingPolicy](#). It can then generates `process_tracepoint` and `process_kprobes` events.

Process lifecycle

Tetragon observes by default the process lifecycle via exec and exit

Filename access

Monitor filename access using kprobe hooks

Network observability

Monitor TCP connect using kprobe hooks

Linux process credentials

Monitor Linux process credentials

Host System Changes

Monitor Host System changes

Security Profiles

Observe and record security events

eBPF Subsystem Interactions

Description

Audit BPF program loads and BPFFS interactions

Use Case

Understanding BPF programs loaded in a cluster and interactions between applications and programs can identify bugs and malicious or unexpected BPF activity.

Policy

bpf.yaml

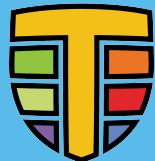
Example jq Filter

```
jq 'select(.process_kprobe != null) | select(.process_kprobe.function_name | test("bpf_check")) | "\\".time
```

Example Output

```
"2023-11-01T02:56:54.926493604Z /usr/bin/bpftrace prog list programType:BPF_PROG_TYPE_SOCKET_FILTER program
```

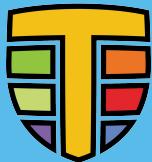
tetragon.io/docs/policy-library/examples/tracingpolicy in  repo



Feature highlights

- **Robust Enforcement:**
 - persistence during restarts and OCI hooks integration
- **Linux Security Modules (LSM)**
 - events
- **User Stack Traces**
- **Redaction Filters**

```
apiVersion: cilium.io/v1alpha1
kind: TracingPolicy
metadata:
  name: kubecon-policy
spec:
  lsmhooks:
    - hook: file_open
      selectors:
        - matchActions:
          - action: Peet
            kernelStackTrace: true
            userStackTrace: true
```



It's growing



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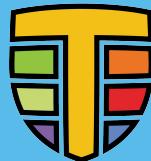
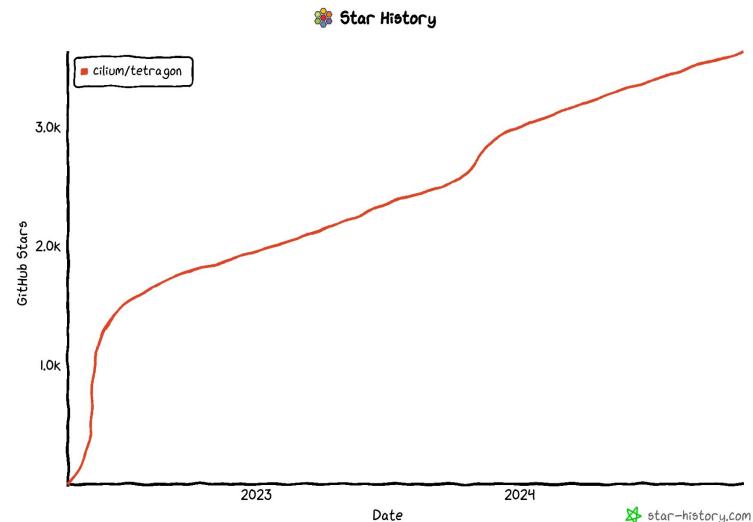
North America 2024

100+ contributors

4k+ commits

3.6k+ stars

3 months release cadence



Contribfest



KubeCon

CloudNativeCon

North America 2024

Today 4:30 - 6:00 PM

Room 355A

Come to contribute,
discuss, get help or learn!



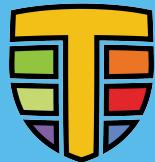
Contribfest: Kickstart Your eBPF Journey with Tetragon



Thursday November 14, 2024 4:30pm - 6:00pm MST

Salt Palace | Level 3 | 355 A

Tetragon and eBPF have a lot of buzz and this is your chance to get involved diving into the bytecode or docs! Tetragon's docs are still young and your new contributor's perspective will be a superpower for spotting issues or unclear wording in the various quickstarts, guides, and concepts pages. The project's CLI, tetra, is another great opportunity for those interested in code contributions around ease of use, testing, and consistency in flags and output. Tetragon's documentation tech stack uses Markdown, built with Hugo, and a customized Docsy theme. The CLI is written in Go with the Cobra library and uses gRPC to communicate with the agent. While this session should help you get more familiar with Tetragon and can lead to more contributions in the future, those technologies are also used in Kubernetes and many other CNCF projects.



Stay in touch

community meeting

Monthly on the second Monday
6:00 PM Europe time

More info:

isogo.to/tetragon-meeting-notes or
tetragon.io, Github, Slack

Slack



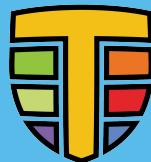
#tetragon channel in Cilium & eBPF
Slack - cilium.slack.com

Tetragon Community Meeting Notes

Meeting link: <https://meet.google.com/gri-abun-fkt>
Meeting notes (this document): <https://isogo.to/tetragon-meeting-notes>
Community Meeting calendar: <https://isogo.to/tetragon-meeting-calendar>

Next meeting: Dec 9, 2024 6:00 PM GMT+1 [Click to add the recurring meeting to your calendar](#)

GitHub repository: <https://github.com/cilium/tetragon>
Documentation: <https://tetragon.io/docs/>
Meeting time in your local timezone <https://mytime.io/4pm/UTC>



Cilium Community Updates



2nd Cilium Developer Summit



KubeCon



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Participants from CoreWeave, Datadog, Google, Isovalent, Microsoft

Thanks to Google for hosting!

12 New Cilium Case Studies from CNCF



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Alibaba Cloud

—

Number One
Cloud service provider in APAC

Alibaba Cloud turns to Cilium for improved network performance and scalability

August 12, 2024

[READ CASE STUDY](#)

Seznam

—

1 MILLION
HTTP requests/second

Seznam opts for Cilium to boost performance and reduce costs

July 30, 2024

[READ CASE STUDY](#)

Kakao

—

102.5 Million
Monthly active users

Kakao improves network performance and lowers costs with Cilium

July 25, 2024

[READ CASE STUDY](#)

Nemlig.com

—

50,000 grocery boxes
Delivered daily

Boosting performance and security with Cilium

June 24, 2024

[READ CASE STUDY](#)

DigitalOcean

—

637,000 customers
in 190 countries

Scaling for the future with Cilium

June 24, 2024

[READ CASE STUDY](#)

PostFinance

—

4 Million
Customer transactions/day

Enhancing performance, scalability and observability with Cilium

June 12, 2024

[READ CASE STUDY](#)

G Data CyberDefense

—

1500+
ArgoCD applications

Migrating to Cilium for Better Networking, Visibility and Security

April 12, 2024

[READ CASE STUDY](#)

SmartNews

—

39
EKS Clusters

SmartNews leverages Cilium to improve performance and scaling

March 30, 2024

[READ CASE STUDY](#)

Rabobank

—

1.6 Billion
Calls per month

Self-service, Zero Trust Network Security

February 6, 2024

[READ CASE STUDY](#)

Form3

—

Billions
Of packets moved securely

Building a Resilient Payments Platform with Cilium

January 18, 2024

[READ CASE STUDY](#)

illionx

—

500,000
Data points secured every day

Securing the Networking Stack with Cilium

November 23, 2023

[READ CASE STUDY](#)

Trendyol

—

40%
Performance increase in clusters

Building a Performant Networking Infrastructure with Cilium

September 27, 2023

[READ CASE STUDY](#)



eBPF Verifier Audit



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“The eBPF verifier is the crucial gatekeeper in terms of the safety of eBPF programs. Over the past decade, a large amount of security vulnerability research has been carried out into the verifier and many bugs have been identified and fixed by the community.”

1 CVE found and fixed

github.com/ebpffoundation/publications

nccgroup[€]

eBPF Verifier Code Review
NCC Group
Version 1.0 – November 11, 2024



Prepared By
Chris Antley
Nathaniel Theis

Prepared For
eBPF Foundation

eBPF Threat Model



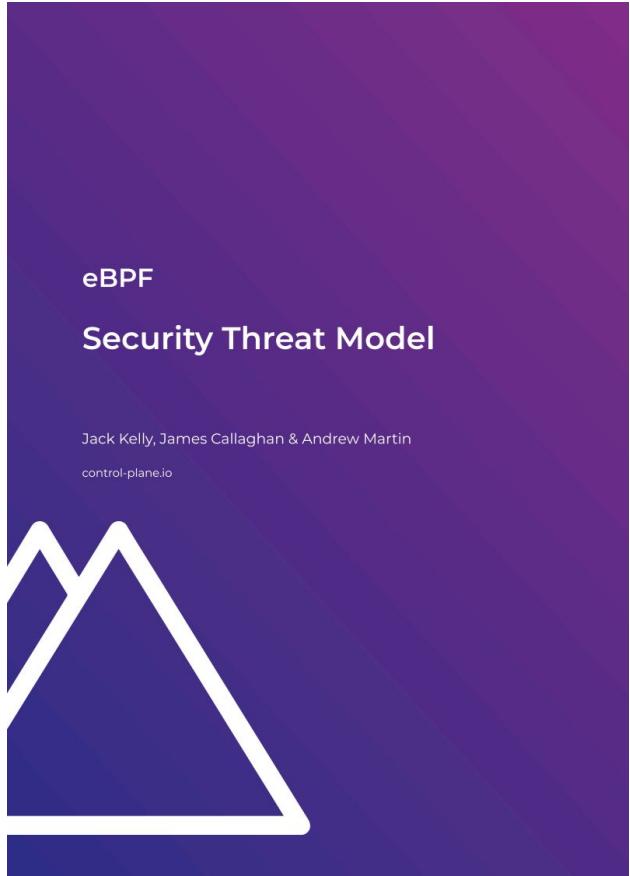
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“By safely enabling custom, kernel-level software without requiring kernel recompilation or reboot, it provides options for **increased security over traditional approaches** due to its rigorous validation of user-supplied code.”

github.com/ebpffoundation/publications



eBPF Threat Model



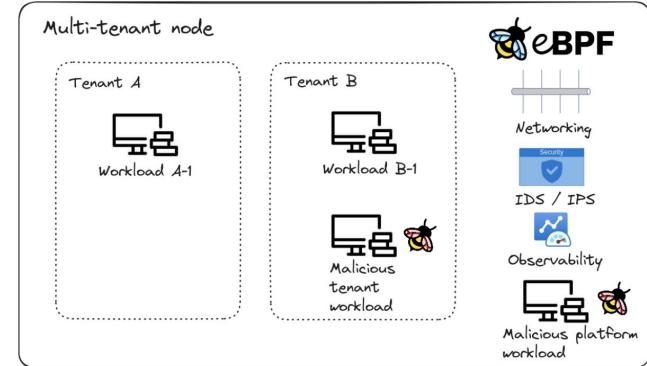
KubeCon

CloudNativeCon

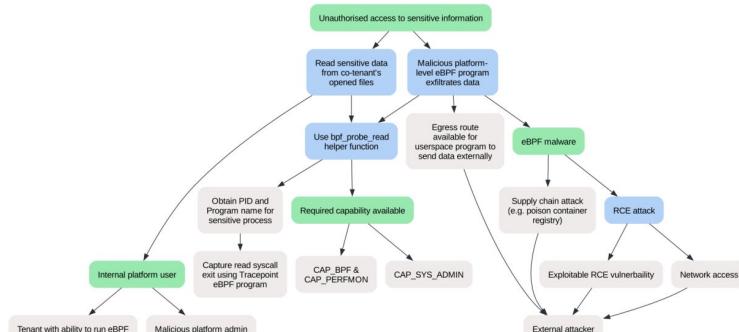
North America 2024

“eBPF provides a platform for building additional security controls that make systems more robust.”

“eBPF’s abilities enable more precise operations, making it easier to limit the risks associated with privileged processes and improving an organization’s security posture.”



github.com/ebpffoundation/publications



Cilium User Survey



KubeCon



CloudNativeCon

North America 2024

Cilium User Survey - 2024

Hello!

Thank you for your interest in the Cilium user survey. The Cilium community is looking for input on how our users are using Cilium and how we can best improve. Your answers will help the Cilium community prioritize work on existing and new features.

We commit to publishing anonymized results back to the community.

Thank you for taking the time to answer this survey.

bill.mulligan@isovalent.com [Switch account](#)



Not shared

What is your current use of Cilium?

- Running in Production
- Under Evaluation
- We are blocked and waiting on a feature/bug
- Other: _____

<https://isogo.to/cilium2024>



Cilium Certified Associate

[training.linuxfoundation.org - CCA](https://training.linuxfoundation.org/certifications/cilium-certified-associate)

The screenshot shows the Cilium Certified Associate (CCA) certification page on the Linux Foundation Education website. The page has a blue header with the Linux Foundation logo and navigation links for Catalog, Resources, Corporate Solutions, and Explore. A "MY TRAINING PORTAL" button is also visible. The main content area features a large title "Cilium Certified Associate (CCA)" with a "CERTIFICATION" button. Below the title, a description states: "The Cilium Certified Associate (CCA) exam confirms a user's knowledge of connecting, securing, and observing Kubernetes clusters using Cilium." To the right, there is a "CLOUD NATIVE OFFICIAL CONTENT CNCF" badge, a "cilium CERTIFIED ASSOCIATE" badge, and a price of "\$250 Exam only". Buttons for "Enroll Today" and "Get a Quote" are present. At the bottom, there are links for "Who Is It For", "About This Certification", and "What It Demonstrates".



Cilium Developer Meetings



Weekly: Wednesday, 5:00 pm Europe/Paris time

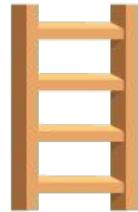
Monthly APAC-friendly timeslot: 3rd Wednesdays, 9:00 am Japan time

Zoom info & agenda on [cilium/cilium README](#) or Cilium Slack



Monthly Tetragon community meetings, 2nd Mondays,
6:00 pm Europe/Paris time

Zoom info & agenda on [cilium/tetragon README](#) or #tetragon



Cilium Contributor Ladder

Start here → github.com/cilium/community

Code  & non-code    contributions

Cilium @ KubeCon



22 talks, a Project Kiosk, Maintainer Track session





Learn More

cilium.io

github.com/cilium

 See you on Slack!