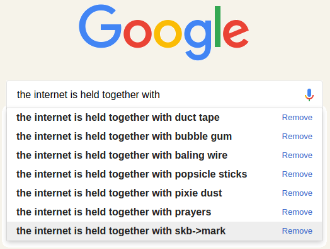
LINUX PLUMBERS CONFERENCE
August 24-28, 2020

Packet mark in a Cloud Native world

Joe Stringer

Cilium.io



the internet is held together with

the internet is held together with duct tape Remove
the internet is held together with bubble gum Remove
the internet is held together with baling wire Remove
the internet is held together with popsicle sticks Remove
the internet is held together with pixie dust Remove
the internet is held together with prayers Remove
the internet is held together with skb->mark Remove

Overview

Mark of the 🐧

- `fw_mark`
- `skb_mark`
- `ct_mark`
- `SO_MARK`
- `xfrm_mark`
- `pkt_mark`

```
struct sk_buff {
        ...
        __u32 mark;
        ...
}
```

So what does the mark represent?

- Nothing..

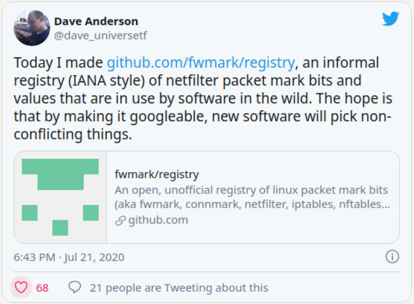
So what does the mark represent?

- Nothing..
- Anything!

So what does the mark represent?

- Nothing..
- Anything!
- **MAGIC.** ✨

Background


Dave Anderson
@dave_universetf

Today I made github.com/fwmark/registry, an informal registry (IANA style) of netfilter packet mark bits and values that are in use by software in the wild. The hope is that by making it googleable, new software will pick non-conflicting things.

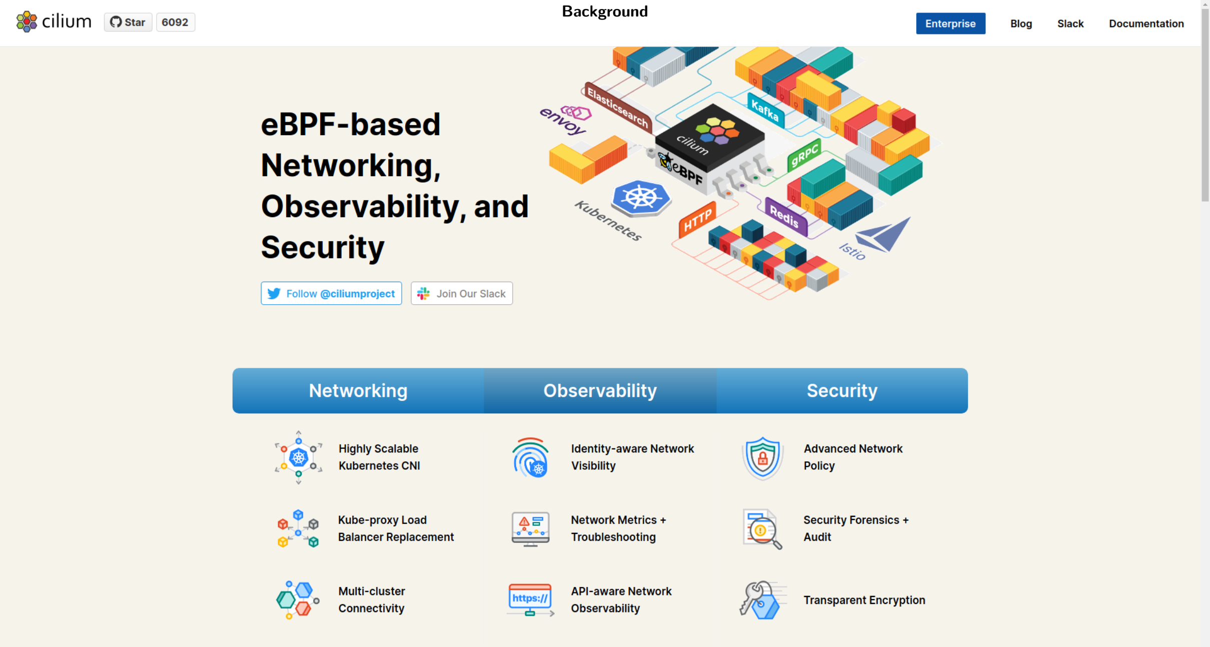
fwmark/registry
An open, unofficial registry of linux packet mark bits (aka fwmark, connmark, netfilter, iptables, nftables...
github.com

6:43 PM · Jul 21, 2020

68 21 people are Tweeting about this

https://twitter.com/dave_universetf/status/1285752332135788544

Background



eBPF-based Networking, Observability, and Security

Networking	Observability	Security
Highly Scalable Kubernetes CNI	Identity-aware Network Visibility	Advanced Network Policy
Kube-proxy Load Balancer Replacement	Network Metrics + Troubleshooting	Security Forensics + Audit
Multi-cluster Connectivity	API-aware Network Observability	Transparent Encryption

Cloud Native networking

kubernetes

KUBE ROUTER

OPENSHIFT

aws

cilium

Istio

weave net

ANTREA

flannel

Methodology

1. Look at CNCF landscape[1]
2. Find the project on GitHub
3. Search for $mark_name
4. ???
5. Knowledge!

[1] `https://landscape.cncf.io/category=cloud-native-network&format=card-mode&grouping=category`

Use cases

Network policy

- 1 bit, two variations:
  - 1 bit -> drop [2]
  - 1 bit -> allow
- Store complex path through rules into mark
- Typically netfilter -> netfilter

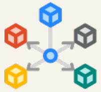
[2] Kubernetes default

Transparent encryption

- 2+ bits
  - 1 bit encrypt, 1 bit decrypt
  - Variation: key selector
- { eBPF, netfilter } -> xfrm

Virtual IP services

- 1+ bits, request DNAT
  - 1 bit: route towards bridge for DNAT
  - 30 bits representing hashed 3-tuple
- { eBPF, netfilter } -> routing -> netfilter
- OVS -> routing -> OVS



IP masquerade

- 1+ bits, request SNAT
  - Variation: 1 bit, Skip SNAT
  - Variation: 32 bits for source address selection
- Connection may not originate on the node
- {eBPF, OVS, netfilter} -> netfilter

Multi-homing

- 1 bit, two variations:
  - Reply via primary device
    - Default: Pod communicates via secondary device
    - Inbound connections must reply via primary device
    - Store & restore in connmark
  - Route via management interface
- { socket, netfilter } -> routing

Application identity

- Variable bits
  - 4 bit pattern: “local” traffic
  - 16+ bits: Carry Identity to destination
    - Policy routing
    - Portmap plugin
- { eBPF, netfilter } -> routing -> eBPF

Service proxy

- 1+ bits depending on context
  - 1 bit, route locally
  - 16 bit tproxy port towards proxy
  - 16+ bit Identity from proxy
- eBPF -> { netfilter, routing }
- netfilter -> routing
- socket -> { eBPF, netfilter },

Observations & Challenges

Marking your territory

- Bitwise usage
  - Simpler interoperability
- Full-mark
  - More values to work with
  - Most usage doesn't make use of this

A tiny bit of overload

- Use every feature: 100+ bits
  - ...but there's only 32 bits to play with?
- Mitigation: Encode meaning in bit range
  - Use [0x0000..0x000F] rather than bits in 0xFFFF
- Mitigation: Overload bits on different paths
  - Ingress / Egress
  - Make semantics dependent on packet fields

Sharing is caring

- Driven by common deployment scenarios
- The clearer responsibility assignment you have, the better
- Not free (in effort or in complexity)

One does not simply understand skb mark

- Required reading: network stack diagram
- Distinct bits do not guarantee integration
  - skb, conn matches may steer packets
- Fun: replies disappear
- Proxies: Double the connections, double the fun

Less is more

- "If only I had more bits..."
- Consolidate subsystem usage
- Extend generic mark space?
- Formalize some use cases?

Summary

- Powerful mechanism for cross-subsystem programming
- Uncertainty when bits are OK to use
- There are more uses than there are bits

Cilium

- https://cilium.io
- https://cilium.io/slack
- https://github.com/cilium/cilium
- https://twitter.com/ciliumproject

Mark registry

- https://github.com/fwmark/registry