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Packet Metadata - Where Are Thee?

Our journey ([1], [2]) to let BPF programs and user-space apps attach rich metadata to packets is far from over. In this talk, we'll share what's been done, what's next, what we've learned, and where are the dragons we've yet to slay.

Part I: Upstream Progress and Roadmap

We'll cover:

- Why we shifted from the old “skb traits” idea [3] to reusing existing skb metadata.
- How bpf_dynptr came to the rescue, and why skb->data_meta still haunts us.
- The blockers that keep metadata from traveling cleanly through the Rx path and how we plan to fix them.
- Our roadmap for making metadata work on the Tx path.
- Ideas for producing and consuming metadata directly in the network stack.

Part II: Lessons from Production

Since our last update [2], we've built several features with packet metadata in Cloudflare production environment. We'll share hard-earned lessons, including:

- Managing metadata contents and optimizing metadata area size.
- Using a TLV structure to encode metadata, and how we shuffle it between packet data, metadata area, and maps.
- Real-world challenges of reading and writing metadata efficiently.
- Passing metadata from packet to socket layers in the absence of network stack support, with full access for TCP via socket options—and our creative hacks for UDP.

Finally, we'll discuss where things still hurt:

- Testing headaches and why BPF_PROG_RUN needs love.
- What an ideal user API would look like for us.

If you're curious about where packet metadata is headed, or want to help shape the future, this session is for you.

[1] <https://lpc.events/event/18/contributions/1935/>

[2] <https://www.netdevconf.info/0x19/sessions/talk/traits-rich-packet-metadata.html>

[3] <https://lore.kernel.org/all/20250422-afabre-traits-010-rfc2-v2-0-92bcc6b146c9@arthurfabre.com/>

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