Moonshot: Implementing the Next Generation of Network Telemetry Technologies

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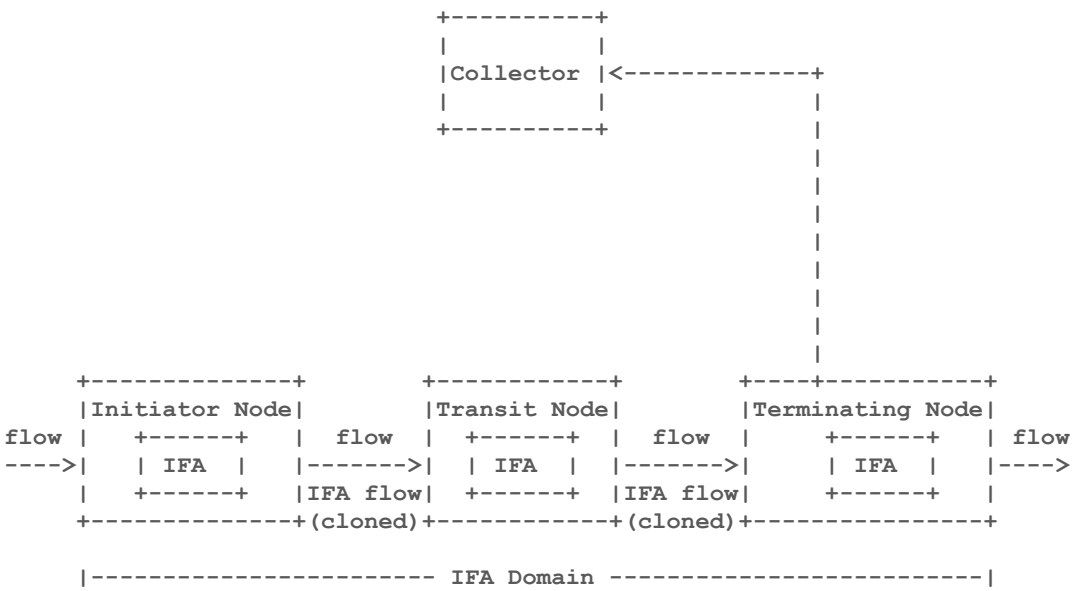
Introduction to Network Telemetry

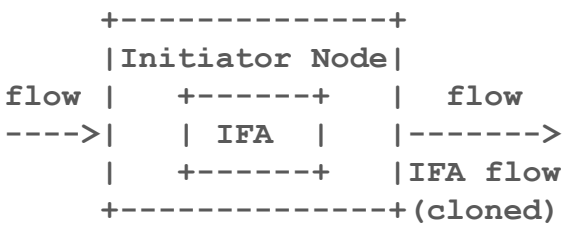
Introduction to Network Telemetry

- Generic network-wide method for reporting and collecting network state information on packets as they traverse the network
- Packets contain *telemetry instructions* and each supported device responds to those instructions by adding metadata to frames
- *Telemetry instructions* can be added *In-Situ* to existing frames or to sampled frames that are transmitted simultaneously with existing traffic
- Standards like IOAM, INT, and IFA all describe ways to implement Network Telemetry

Network Telemetry Components

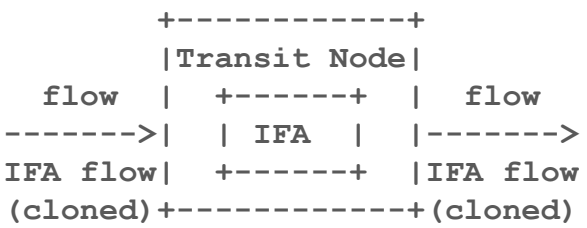


Source or Initiator Node



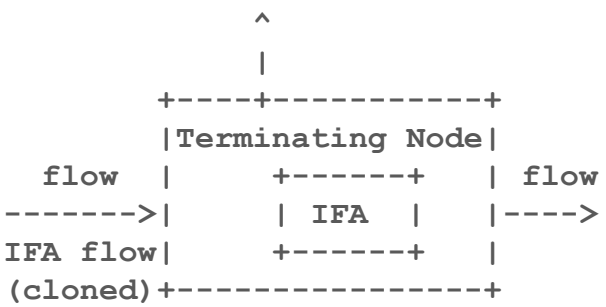
Node that adds telemetry instructions to frames -- in-band or out-of-band

Transit Hop or Transit Node



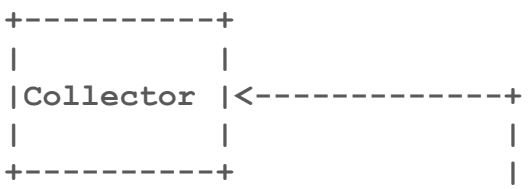
Any node that adds telemetry metadata to frame that contains telemetry instructions

Sink or Terminating Node



Node that removes telemetry headers from frames and sends them to a collector

Collector



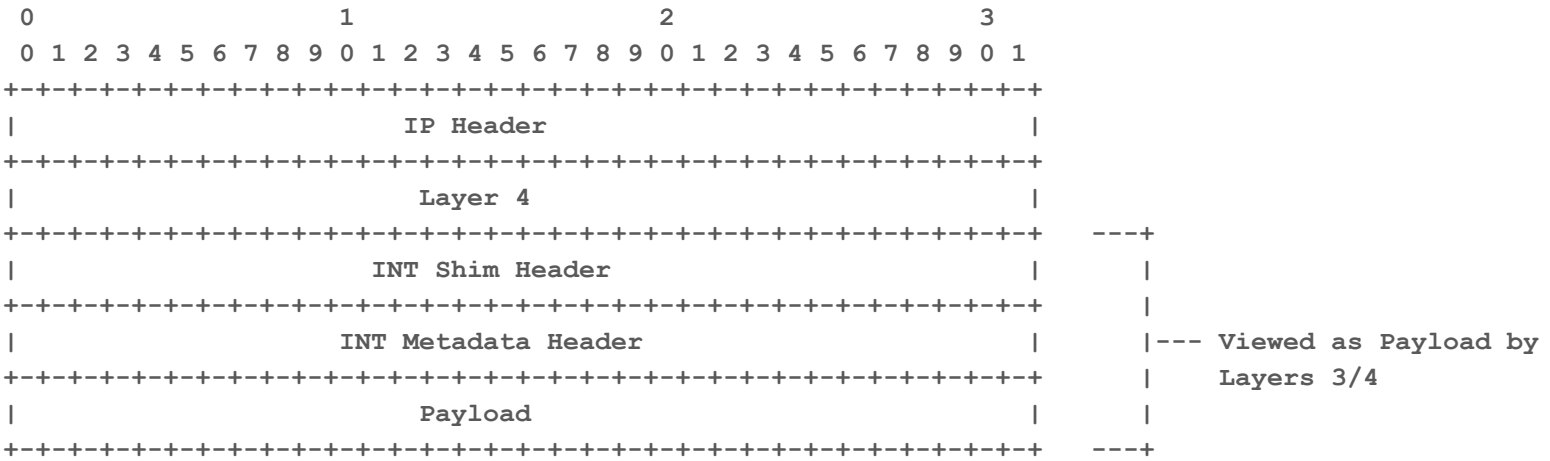
Any application that will receive and process telemetry data collected by Sink or Terminating Node

Inband Network Telemetry (INT)

Inband Network Telemetry (INT)

- Framework suggested by P4.org
- True In-band monitoring as frames are modified as they traverse the network
- Compatible with encapsulation formats that have extension/option capabilities
  - INT over VXLAN (as VXLAN payload, per GPE extension)
  - INT over Geneve (as Geneve option)
  - INT over GRE (as a shim between GRE header and encapsulated payload)
  - INT over NSH (as NSH payload)
- Support for IP/IPv6 TCP/UDP traffic not as easy since there is not room for extensions
  - INT header and metadata transparently added to payload

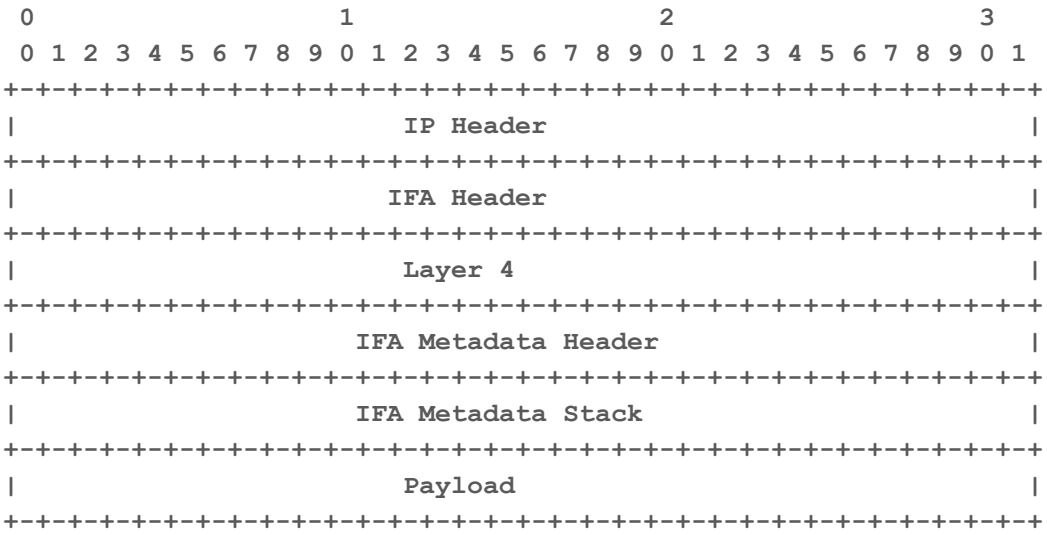
INT IPv4/TCP Frame Format



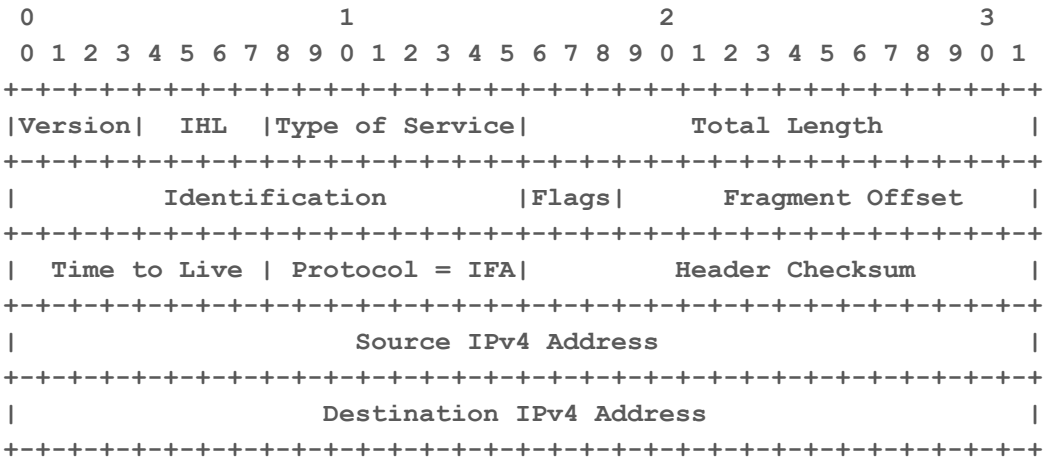
Inband Flow Analyzer (IFA)

- Specification released later to address perceived shortcomings of IOAM and INT
- Adds ability to sent telemetry instructions in sampled/copied frames rather than original frames
- Frame format aims to be compatible with more hardware

IFA IPv4/TCP Frame Format



IFA IPv4 Header



Telemetry Software Architecture

Source or Initiator Node

Desired Functionality	Kernel Implementation
Packet Sampling	TC or netfilter
Packet Mirroring (IFA)	TC
Packet Redirect	TC or XDP/eBPF
Encapsulate and Transmit	new lwtunnel type or XDP/eBPF

Transit Hop or Transit Node

Desired Functionality	Kernel Implementation
Match on INT/IFA Frame	TC
Update Metadata and Transmit	new lwtunnel type or XDP/eBPF

Sink or Terminating Node

Desired Functionality	Kernel Implementation
Match on INT/IFA Frame	TC or netfilter
Collect metadata from frame	new lwtunnel type or XDP/eBPF
Send frame to collector	new lwtunnel type or XDP/eBPF
Transmit original frame (INT)	new lwtunnel type or XDP/eBPF

Thinking Beyond the Linux Kernel Datapath

Hardware Support

- Switch Hardware
  - INT is backed by P4, but probably not limited to devices with programmable dataplanes
  - Customer demand will dictate support in fixed-function devices
- NIC Hardware
  - NIC+FPGA solutions for IOAM exist -- ASICs will add support soon
  - NIC vendors are active in INT and IFA standards writing -- likely based on customer demand

Network-based configuration

- Kernel datapath examples all presume configuration by netlink
- As hardware support for IFA is added, expect configuration over network
  - Common in switches
  - Becoming more common in servers used for baremetal deployments

Userspace Implementations

- Unlikely to be a DPDK application just for INT/IFA
- Libraries for DPDK-based applications could be created to add INT/IFA functionality to existing dataplane applications

Development and Deployment Risks

User Risk

- Protocols and packet types can change
- Risk is minimized when single organization controls entire infrastructure

Community Risk

- Early acceptance to Linux kernel could be problematic if software not kept up to date across infrastructure
- Risk is minimized when single organization controls entire infrastructure

Děkuji!