OPEN. FOR BUSINESS.
In-Band Network Telemetry - A Powerful Analytics Framework for your Data Center

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Barefoot Networks
Barefoot Solutions and SONiC

Growing Open Ecosystem

Barefoot Advanced Apps (Network Analytics and more)

Barefoot SDE/Compiler

Barefoot Hardware

Tofino™ ASIC

Capilano™ SDE

Deep Insight™ Analytics

Supported Devices and Platforms

<table>
<thead>
<tr>
<th>Switch Vendor</th>
<th>Switch SKU</th>
<th>ASIC Vendor</th>
<th>Tofino-ASIC</th>
<th>Port Configuration</th>
<th>SONIC Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNC</td>
<td>OSW1800</td>
<td>Barefoot</td>
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New P4 App WG & Open Community initiatives

Charter
- Data-Plane Telemetry (e.g. INT)
- Security: Heavy-hitter Detection
- Services Offload: (e.g. Layer-4 LB)
- In-Network Cache for distributed services
- In-Network Consensus protocol

Initial Accomplishments
- 30+ Active Customers: OEM and Technology vendors
- Open Sourced INT and Telemetry Report Specs

OVS Orbit PODcast on P4 INT (B. Pfaff, C. Kim): [https://ovsorbit.org/#e46](https://ovsorbit.org/#e46)
How INT works, upcoming OVS support for INT and SDN vendors involvement

IETF 100 – Barefoot delivers first ever hardware-based (Tofino) In-situ OAM implementation:
Barefoot Networks Demonstrates In-situ Operations, Administration and Management (IOAM) Showcasing the Power of Programmable Forwarding Plane Technology
Today’s Network Monitoring ...

Expensive and Inefficient

Can’t capture microbursts

No Visibility = No Control

Switch OS

Ping
Traceroute
SNMP
Sflow

ASIC

Microburst

100s ns – 10s usec

10s ms – 10s sec

Service Issue

Must be the Network

Network Ops Admin
1. Which path did my packet take?

   “I visited Switch 1 @780ns, Switch 9 @1.3µs, Switch 12 @2.4µs”

2. Which rules did my packet follow?

   “In Switch 1, I followed rules 75 and 250. In Switch 9, I followed rules 3 and 80.”
3. “How long did my packet queue at each switch?”

4. “Who did my packet share the queue with?”

“Delay: 100ns, 200ns, 19740ns”
3 “How long did my packet queue at each switch?”

4 “Who did my packet share the queue with?”

“Delay: 100ns, 200ns, 19740ns”
The network should answer these questions:

1. "Which path did my packet take?"
2. "Which rules did my packet follow?"
3. "How long did it queue at each switch?"
4. "Who did it share the queues with?"

Tofino + Deep Insight can answer all four questions. For the first time. At full line rate. Without generating any additional packets!
How it works and how we use the data

Leverages In-Band Network Telemetry (INT)
https://github.com/p4lang/p4-applications/tree/master/telemetry/specs

Add: SwitchID, Arrival Time, Queue Delay, Matched Rules, ...
SPRINT: A Fully Featured, High-Performance INT

FULLY COMPATIBLE SUPERSET OF A VANILLA INT IMPLEMENTATION

Smart
- What to Observe
- What to Collect
- Intelligent Triggers
- Scalable and Accurate (nanosecond)
- Built-in Load Balancing

Programmable
- Adapt to customers requirements
- Flexible encapsulation through P4
- Open specifications and ecosystem

Real Time
- Data-plane Streaming
- Packet-by-packet Anomaly detection
- Real time Analytics with Deep Insight
/* INT: add switch id */
action int_set_header_0() {
    add_header(int_switch_id_header);
    modify_field(int_switch_id_header.switch_id,
                 global_config_metadata.switch_id);
}

/* INT: add ingress timestamp */
action int_set_header_1() {
    add_header(int_ingress_tstamp_header);
    modify_field(int_ingress_tstamp_header.ingress_tstamp,
                 i2e_metadata.ingress_tstamp);
}

/* INT: add egress timestamp */
action int_set_header_2() {
    add_header(int_egress_tstamp_header);
    modify_field(int_egress_tstamp_header.egress_tstamp,
                 eg_intr_md_from_parser_aux.egress_global_tstamp);
}

P4 code snippet: switch ID, ingress and egress timestamp
Extending Telemetry everywhere...

Network Devices (Tofino)  SmartNICs  Bare-Metal Servers (with eBPF)  Hypervisor Servers (with OvS)
Extending Telemetry everywhere...

Over 10 ODM systems

**Supported Devices and Platforms**

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Multiple OEMs Announced in CY 2017-18

Network Devices (Tofino)

White-box Solution #1

White-box Solution #N

OEM Vendors
Extending Telemetry everywhere...

More NIC vendors to come...
Barefoot Deep Insight Monitoring System

Barefoot Data-Plane Telemetry
- Scalable In-Band Network Telemetry
- Intelligent Deduplication and Triggers
- Tofino Hardware Primitives
- Line Rate Monitoring

Barefoot Deep Insight Monitoring System

3rd Party Network Management Solutions

Deep Insight Open Northbound APIs

Deep Insight Analytics Software
- Real-time Anomaly Detection
- Machine Learning based Analytics
- Modular Architecture
- Seamless Scale-out on Commodity Servers

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Deep Insight Real-Time Rich Analytics

**Anomalies:**
- Congested Flow
- High End-to-End Latency
- High Hop Latency
- Path Change
- Path Loop

**Events:**
- New Flow
- Flow Termination
- E2E Latency Change
- Hop Latency Change
- Unused Link
- Unused Switch

**Drop Reports with Rich Metadata:**
- Timestamp
- Drop Reason
- Packet 5-tuple... and more
- Packet metadata
- Switch-Id
- Ingress/Egress Port-Id
- Queue-Id

Deep Insight
Open Northbound APIs
Open Standards and Open Source references

Open Source Technical References

- In-band Network Telemetry (P4.org App WG) by Alibaba, Arista, Barefoot, Dell, Intel, VMware: https://github.com/p4lang/p4-applications/tree/master/docs


- In-situ OAM (IETF) by Facebook, Cisco, Barefoot, Comcast, etc: https://tools.ietf.org/html/draft-brockners-inband-oam-data-07