

# Intel® Intelligent Fabric Vision and P4 Technology

P4 Workshop Taiwan, Dec 21, 2021

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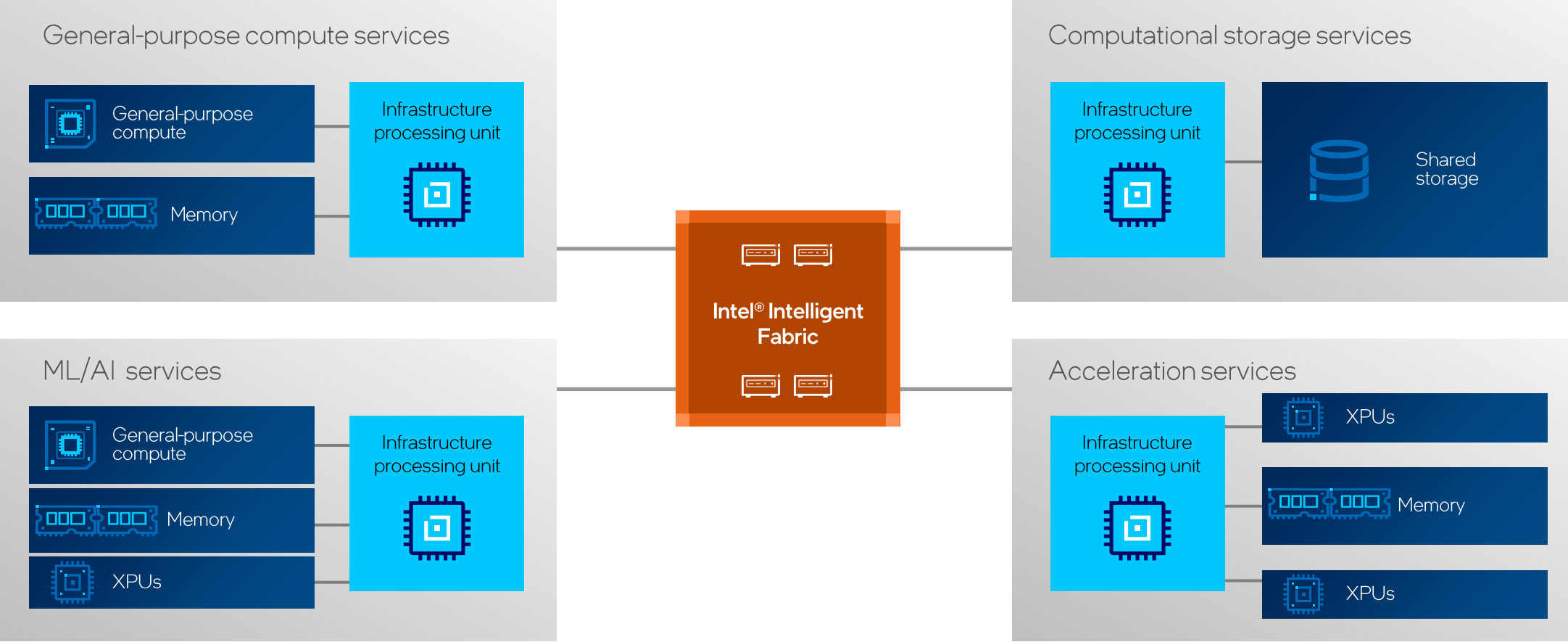
The Intel logo is located in the bottom left corner of the slide. It consists of the word "intel" in a white, lowercase, sans-serif font, with a registered trademark symbol (®) to its upper right. The logo is positioned on a dark blue background, with a lighter blue square partially overlapping it from the left.

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# AGENDA

- Vison: Intel® Intelligent Fabric for the Data Center of the Future
- Key Technologies
  - P4 Programming Language
  - In-band Network Telemetry
  - Congestion Control with Remote Priority Flow Control (Remote PFC)
- Products and Applications
- Call to Action

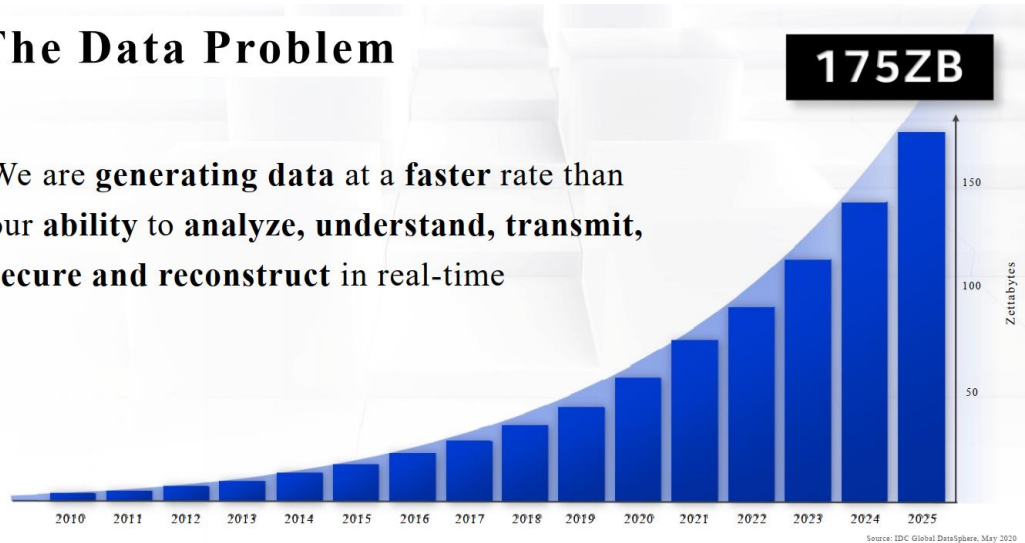
# Data Center of the Future: Intel® Intelligent Fabric



# Networking Challenges

## The Data Problem

We are **generating data** at a **faster** rate than our **ability to analyze, understand, transmit, secure and reconstruct** in real-time



- Move to Cloud-native architecture with container-based processing, orchestration and automation
- AI and changing workloads spawn need for growing network optimizations
- Distributed, scale-out world is changing architecture
- Operational challenges of root causing network slowdowns
- End-to-end Security
- Increasing network CAPEX and OPEX investment for service providers

Network needs to get smarter while increasing bandwidth

# VISION: Intel® Intelligent Fabric

End-to-End Co-Optimizations

Photonics Integration

## OPTICAL MODULES

High-bandwidth connectivity at 100G, 400G and beyond

## ETHERNET SWITCH

P4-programmable scale-out fabric with uncompromising performance

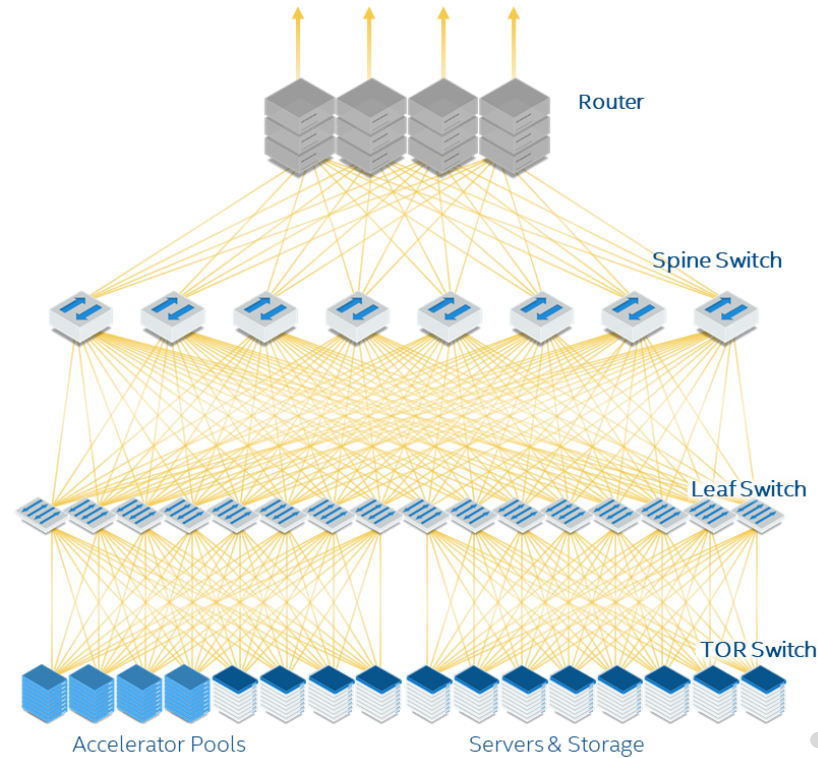
## ETHERNET IPUs and NETWORK ADAPTERS

Programmable infrastructure acceleration for demanding data movement

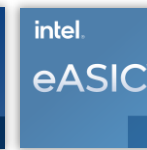
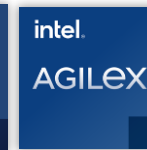
## CPUs & xPUs

Fabric-enabled endpoints aligned to accelerators & software pipelines

- Ease of Use
- Massive Bandwidth
- AI-driven Self-monitoring / Self-analyzing / Self-healing
- Enhanced Security
- End-to-end Optimization w/Fabric Telemetry
- Improved Density / Power / Cost



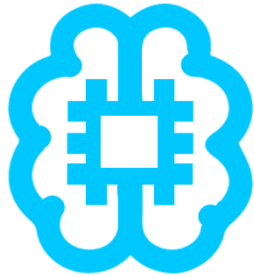
## Intel Portfolio



## Industry Standards



# Intel® Intelligent Fabric Key Benefit Vectors



## INTELLIGENCE

- Fully Customizable P4-Programmable Pipeline
- Intelligent Packet Processing for Accelerating AI/ML Workloads
- Expandable Table and Buffer Sizes with Intel® FPGAs
- Enhanced Security with Intel® Software Guard Extensions (Intel® SGX) and Intel® Trust Domain Extensions (Intel® TDX)



## PERFORMANCE

- 6.4/12.8/25.6 Tbps Total Throughput
- 112G/56G SerDes for high speed and easy migration
- High speed Intel® Silicon Photonics
- Power-optimized Hyperscaler Use Cases for Intel® Tofino™ Intelligent Fabric Processors



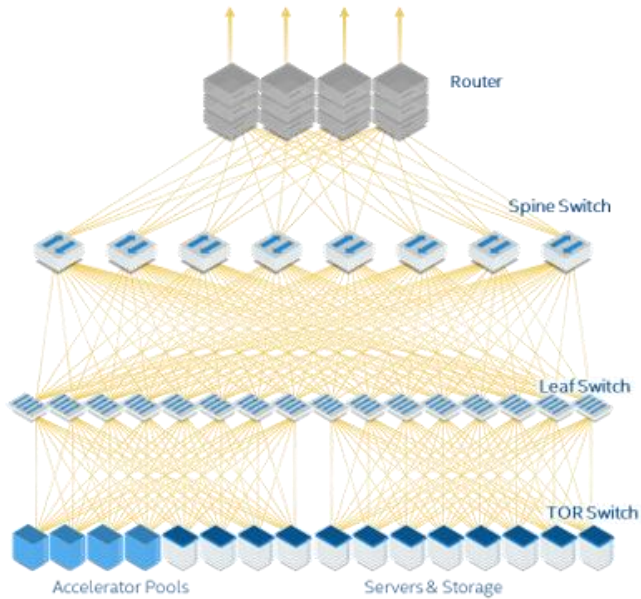
## VISIBILITY & CONTROL

- Enhanced Congestion Control
- Identify delays or hotspots with real-time In-band Network Telemetry (INT)
- Analyze packet flows with Deep Insight Network Analytics Software
- Remedy using AI or Deep Insight reports
- Traffic monitoring and steering for enhanced security and reliable transport
- Increase INT data available with Intel® IPUs and Ethernet Network Adapters

# At the Heart of Intel® Intelligent Fabric

## Intel® Tofino™ 3 Intelligent Fabric Processor

New! Announced  
at Intel Innovation  
in Oct '21



Challenge: Explosion in 5G and IoT data, distributed workloads; requires AI and cloud-to-edge visibility

Solution:  
Intel® Tofino™ 3 Intelligent Fabric Processor (IFP)

Optimized for:  
Cloud and Edge Data Centers  
HPC  
Comms moving to Cloud technologies



Intelligence



Performance – up to 25.6 Tbps



Visibility & Control



# Switch to Intelligence with Intel Tofino 3 IFP

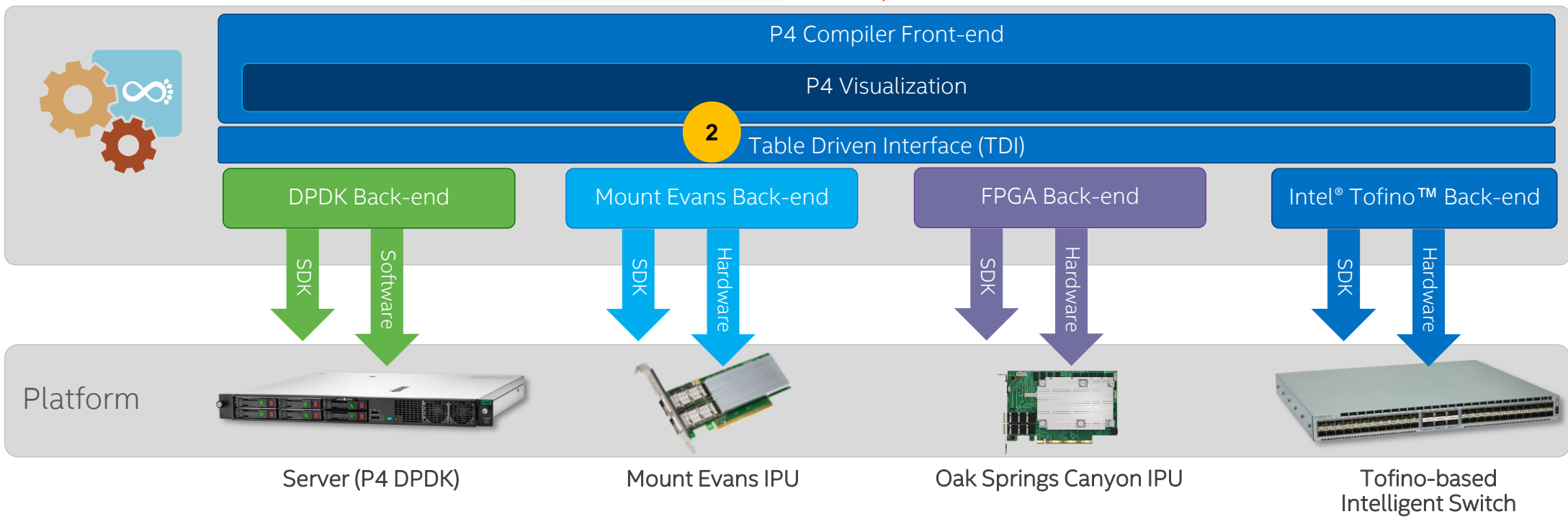
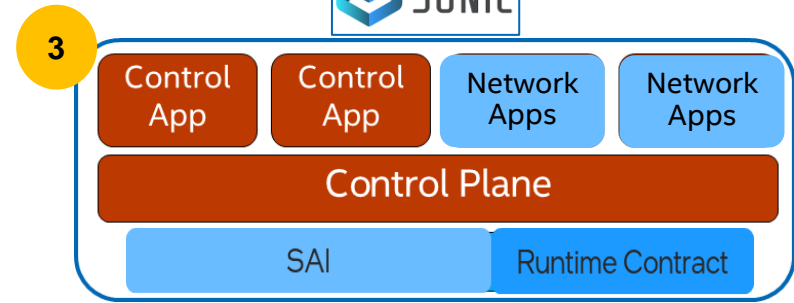
# End-to-End Software Architecture

Programming Model Across Servers, IPU, FPGAs & Switches



1

```
P4 Program
table routing {
  key = { ipv4.dstAddr : lpm; }
  actions = { drop; route; }
  size : 2048; }
control ingress() {
  apply {
    routing.apply(); }
}
```





# Key Technologies

# P4: Built with community support



**Intel is an active member** in the P4 community, providing knowledge and expertise to end users from all walks of life.



**Widespread adoption:**  
Growing community of 4000+ developers, 100+ member organizations



Telcos



Cloud operators



Researchers



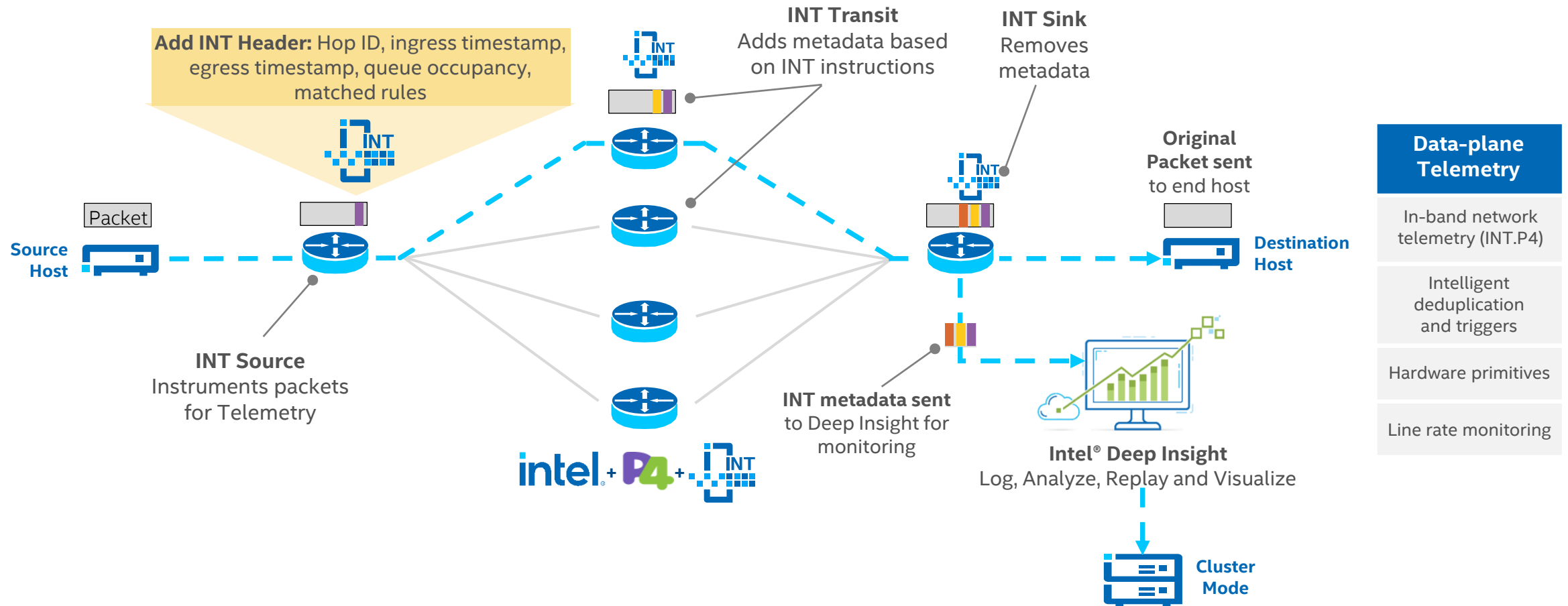
OEMs



System integrators

Visit [p4.org](https://p4.org) for more information

# Follow each packet's journey from beginning to end



Answer for **every** packet...

- 1 Why is it here?
- 2 How did it get here?
- 3 How long was it delayed?
- 4 Why was it delayed?

# Remote Priority Flow Control (Remote PFC) Edge-to-Edge View

What is Remote PFC?

- Edge-to-Edge signaling of congestion
- Flow control that instantly 'flattens the curve'
- Signaling + 'source' flow ctrl all in sub-RTT

Remote PFC d

- ~~aim 100% le~~
- ~~e2e congest~~
- ~~Pause Agg/C~~
- ~~Need greenfield de~~

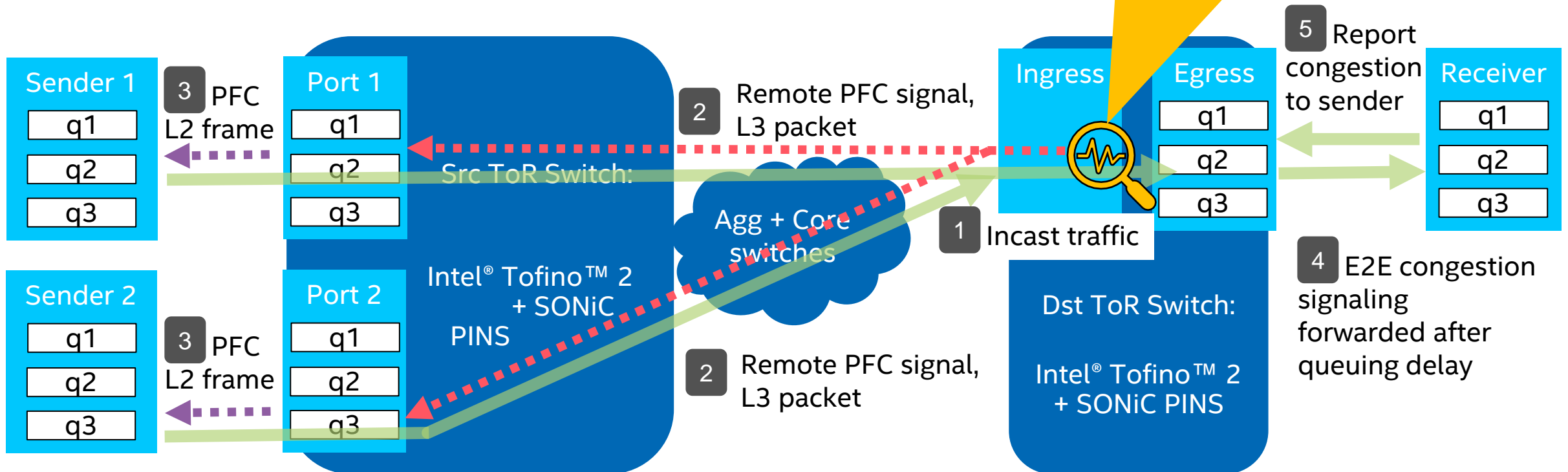
Example of Benefits of  
Intelligence

Next Session:

Improved Congestion Control with P4-based  
Remote Priority Flow Control (Remote PFC)

By Jeremias Blendin

→ ToR-only upgrade



# Products and Applications

# Intel® Tofino™ Intelligent Fabric Processors

## Tofino (16nm)



- 1.8 to 6.4 Tbps
- 25G SerDes

## Tofino 2 (7nm)



- 3.2 to 12.8 Tbps
- Modular Chip Design
- 56G SerDes

## Tofino 3 (7nm)



- 12.8 to 25.6 Tbps
- Modular Chip Design
- 112G/56G SerDes

### Intelligence

- P4 Programmable
- AI/ML Acceleration
- Highly-Secure

### Performance

- Up to 25.6 Tbps throughput
- 112G/56G SerDes
- Power-Optimized Use-Cases

### Visibility and Control

- Edge-to-cloud real-time telemetry
- Enhanced congestion control
- Self-healing network capabilities

Status: Production now      Production now      Future

# Explore and innovate with new P4 Applications

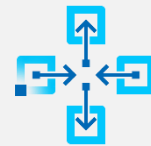


```
reads {table int_table
}
ip.protocol;
}
actions {
  export_queue_latency;
}
}
```

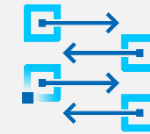
```
actionadd_header(int_header);
modify_field(int_header.kind, TCP_OPTION_INT);
modify_field(int_header.len, TCP_OPTION_INT_LEN);
modify_field(int_header.sw_id, sw_id);
modify_field(int_header.q_latency,
  intrinsic_metadata.deq_timedelta);
add_to_field(tcp.dataOffset, 2);
add_to_field(ipv4.totalLen, 8);
subtract_from_field(ingress_metadata.tcpLength,
  12);
}
export_queue_latency (sw_id) {
```



**Intel® Tofino™  
Intelligent  
Fabric  
Processors**



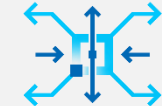
**Enhanced routing**



**Enhanced switching**



**Physical to virtual**



**Broadband Network Gateway (BNG)**



**Security, DDoS detection**



**L4 load balancing**



**Tunnel gateways**



**Network Packet Broker (NPB)**



**Real-time telemetry**



**DNS caching**



**User Plane Function (UPF)**

## *University Grant Opportunity:*

# Intel Connectivity Research Program (ICRP) Fast Forward Initiative





- Goal to accelerate the best network programmability research of tomorrow
- We are looking for the most ground-breaking, industry-advancing experiments involving the P4 programming language
- Grants will assist ICRP members in acquiring hardware for their projects
- Participating vendors: APS Networks, Edgecore Networks, Netberg, UFI
- Special consideration given to projects which advance the state of the art in the following areas: Intelligence, Performance, Visibility & Control
- Applications due December 31, 2021 with selection by January 14, 2022

[Link to application \(https://bit.ly/3F3qAAC\)](https://bit.ly/3F3qAAC)



# Summary/Call to Action – Ways to Get Involved

- Join the P4.org community 
- Contribute to the OCP SONiC project 
- Learn at the Intel® Connectivity Academy and Contribute to the Intel® Connectivity Research Program

## Intel® Connectivity Academy

Led by top experts in the P4 programming language and Intel® Tofino™ series architecture, these courses accelerate acquiring the in-depth knowledge you need to begin working with programmable network devices.

## Join the Intel® Connectivity Research Program

Become a member of the community and collaborate with industry peers to create the next generation of networking innovation where performance and programmability can be delivered together.

- Visit [intel.com/IFP](https://intel.com/IFP) for more info on Intel® Intelligent Fabric Processors (Intel® IFPs)

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