IEEE CVT Briefing

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Exponential growth of data

Annual Size of the Global Datasphere

Source: Data Age 2025, sponsored by Seagate with data from IDC Global DataSphere, Nov 2018
General Industry Trend: Rise of the Domain-Specific Architectures (DSAs)

- **Computers**
  - Java
  - Compiler
  - CPU

- **Graphics**
  - OpenCL
  - Compiler
  - GPU

- **Signal Processing**
  - Matlab
  - Compiler
  - CSP

- **Machine Learning**
  - TensorFlow
  - Compiler
  - TPU

- **Networking**
  - P4
  - Compiler
  - Tofino & Tofino 2
New Use Cases Unleashed Through SW Defined HW

Networking

P4 Compiler

Tofino (PISA)

More...

Storage/Memory Interconnect

ML/DL Interconnect

DNS Cache

Network Packet Broker

Firewall & DDoS

Layer 4 Load Balancer

Telemetry Analytics

Enterprise/Telco/SP Switching

Cloud Switching
P4-programmable Connectivity Across the Network

Access | Edge | Core | Data Center | Cloud

Access

Edge

Core

Data Center | Cloud

P4-Programmable Fabric

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Vision: Network as a Programmable Platform

Control Plane

P4Runtime Contract

Control App
Control App
Control App
Control App

Generation & Verification

Control code
Contract
Dataplane code

P4-OVS
P4 NIC

Switch OS
Switch OS
Switch OS

P4 switch
P4 switch
P4 switch

P4-OVS
NIC
P4 NIC

Fine-grained Per-packet Measurement
Barefoot Technology & Products

Tofino  
Family of P4-programmable Ethernet switch ASICs with P4 compiler and SDK

Tofino 2

P4 Studio
State-of-the-art compiler for Tofino and Tofino 2 and Development Environment

P4 Insight
P4 Code Debug Tool and P4 Compiler

Deep Insight
Network performance monitoring and analytics software
Tofino Programmable Switching ASIC Portfolio

**Tofino**

- **6.4 Tbps**
- **1.2 Tbps**
- **2.0 Tbps**
- **3.2 Tbps**

Programmable Ethernet Switch ASIC w/ **25Gbps** SerDes

- **16nm** Process Node

Optimized for

- **100GbE** / **50GbE** / **40GbE** / **25GbE** / **10GbE**

compute connectivity

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**Tofino 2**

- **12.8 Tbps**
- **4.0 Tbps**
- **4.8 Tbps**
- **6.4 Tbps**
- **8.0 Tbps**

Programmable Ethernet Switch ASIC w/ **56Gbps** SerDes

- **7nm** Process Node

Optimized for

- **400GbE** / **200GbE** / **100GbE** / **50GbE** / **25GbE** / **10GbE**

compute connectivity
Why Programmable Pipeline?

Features and table-sizes are **hard-coded**, **NOT** optimized and often **unused**

**FIXED-FUNCTION**
- Behavior cannot be changed
- Poor to little visibility
- New functionality requires hardware upgrade

**P4-PROGRAMMABLE**
+ Optimized to the end-user needs
+ Real-time visibility
+ Software upgradable hardware

User specifies headers to be parsed in a P4 program
User specifies tables & size needs and packet processing functions in a P4 Program

Pipeline is **fully workload-optimized**
Developer Ecosystem

P4 Features
- Open Spec, Compiler, Test Frameworks, and more
- Protocol Independent
- Target Independent

Strong community
- 4000+ developers trained and growing
- 100+ member organizations
- Expanding across the globe

Accelerating adoption
- Expanding adoption by new vendors
- Switches, NICs, FPGA, Software Data Planes
Tofino Applications and Benefits

Applications
- Leaf/Spine Switch
- Network Packet Broker
- Load Balancer
- Traffic Tester
- Gateways
- UPF
- BNG

Applications
- P4 Compiler
- P4 Insight
- Switch Application API
- Program (P4) & Device (Fixed) API
- Unified ASIC Driver
- Control Plane (Local/Remote)
- SAI

Switch Platform
- Tofino™ / Tofino™ 2 + FPGA

Benefits
- 14% Higher Performance
- > billions of PPS
- Pipeline Programmability
- x features & visibility
- Deterministic Low Latency
- x hundreds of ns
- 14% Lower Power
- < watts/port

Stateless NAT Implementation

**Tofino Border Relay**
- Normal TCP and UDP packets are translated in Tofino ~99% of traffic
  - MAP pre-fixes handled in Tofino
  - Tofino performs anti-spoofing checks for v4 & v6
- Exceptional packets are punted to CPU w/o decrementing TTL
- Hybrid approach provide faster deployment & significant cost savings
  - Equivalent solution would require 15ea. appliances with 5KW power in 15RU
  - Tofino solution draws 830W max in 3RU
P4 & INT Implementation For DDoS Mitigation

When malicious patterns are detected:
- SDN controller is notified
- Controller updates P4 enabled devices thru GRPC, Thrift, HTTP or RPC
- P4 devices are instructed how to handle packets based on the pattern signature

3 customer premises w/ 2 or more devices
- P4 enabled gateways are connected to aggregate switch
- P4 enabled aggregate switch connected to core switch
- P4 enabled core switch connected to the internet and analytics engine for pattern recognition

When controller receives an alert signature:
- Controller alerts the operator
- Gateway attributes enable customer identification
- Operator can contact the customer to notify them which devices are compromised
Keysight UHD100T32

**Problem Statement:**

- With mass deployment in modern data centers, 100G has matured
- Customers are challenged with density and cost pressures on their test infrastructure

**Solution:**

- 1RU, 32x100G, line rate traffic tester based on Tofino
  - Support fan out speeds (50/40/25/10GE)
  - Supported by innovative clientless operation via web interface with REST APIs
  - Provides extremely cost effective solution
Thank You!