Is Innovation in Hardware Dead?
Santa Clara, CA  |  Thursday, March 17  |  2:00pm–3:30pm

Cliff Grossner, Ph.D.
Research Director, Data Center, Cloud & SDN
IHS Technology
Open Networking (ON) Started in the Data Center

The Door Opens for Software Innovation

2011–2013
White Box Bare Metal
The Fabric Is Born

2014–2015
Branded Bare Metal
The Orchestrated Fabric

2016–2019
Open Data Center Networking
The Autonomous Fabric

2020 & Beyond
Open Network
The Unified IT Infrastructure
Open Networking Is Taking the Data Center

Switching Hardware Is Commoditized

**Average Percent**

**Bare Metal Service Provider Data Center Ethernet Switch Ports**
- 2017: 27%
- Now: 12%

**Bare Metal Enterprise Data Center Ethernet Switch Ports**
- 2018: 13%
- Now: 7%

*Source: IHS Infonetics Data Center SDN Strategies Global Service Provider Survey, October 2015*
*Source: IHS Infonetics Data Center SDN Strategies North American Enterprise Survey, February 2016*
SDN & NFV: Innovation in Software Spreads

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Revenue (US$ Billions)

- NFV
- blank1
- blank2
- DC and Enterprise SDN
- Carrier SDN

CY14
- $0.8
- $0.8
- $0.1

CY19
- $13.1
- $11.6
- $5.7
## Majority of Revenue Is from Existing Segments

### Carrier, DC and Enterprise LAN SDN Market

<table>
<thead>
<tr>
<th>Source</th>
<th>$B</th>
<th>% of 2019 Market</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>$4.8</td>
<td>27%</td>
<td>SDN: Orchestration and Controller, SDN Network</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Apps, Outsourced Services</td>
</tr>
<tr>
<td>Displaced</td>
<td>$1.5</td>
<td>9%</td>
<td>SDN: Orchestration and Controller</td>
</tr>
<tr>
<td>Existing</td>
<td>$11.6</td>
<td>64%</td>
<td>SDN: SDN Hardware</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$17.9</td>
<td>100%</td>
<td>Total Carrier, DC and Enterprise LAN SDN</td>
</tr>
</tbody>
</table>

### Carrier NFV Market

<table>
<thead>
<tr>
<th>Source</th>
<th>$B</th>
<th>% of 2019 Market</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>$1.2</td>
<td>10%</td>
<td>NFV: NFV MANO, Outsourced Services</td>
</tr>
<tr>
<td>Displaced</td>
<td>$1.8</td>
<td>16%</td>
<td>NFV: NFVI Hardware</td>
</tr>
<tr>
<td>Existing</td>
<td>$8.6</td>
<td>74%</td>
<td>NFV: VNFs</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$11.6</td>
<td>100%</td>
<td>Total Carrier NFV</td>
</tr>
</tbody>
</table>
Takeaways

Software innovation spreads from data center to all networks

Commodity hardware taking significant market share

Has the pendulum swung too far?
Is Hardware Innovation Dead?

Ritch Dusome
CEO CENGN
What is CENGN?

Consortium of ICT Industry Leaders
- Partner with Universities & Colleges (Student Interns)
- Drive Innovation to Commercialization (Small Medium Enterprise)

Unique Open Source Multivendor Physical and Virtual DC & WAN
Independent interoperability Testing Centre; TestaaService (SDN, NFV, IoT)
Services (Commercialization Acceleration, Testing and Lab, Innovation for Hire, Technical Training)

Headquarters in Ottawa, Ontario, Canada
- Data Centre, WAN, Staff (DevOps, Project, Marketing)
- Funded by Canadian Federal Government and Industry
Current CENGN Members

- allstream
- btI
- CISCO
- EWA
- EXFO
- FUJITSU
- Invest Ottawa
- Juniper Networks
- Mistral Venture Partners
- NOKIA
- Rogers
- TELUS
- VIAVI
Multi-Site Multi-Domain Data Center Capacity Management

• SMB:
• Member:
• Partners:
• Use-case:
  – Bandwidth on Demand for Inter-DC applications such as Workload migration with the use of SDN at optical and switching layers.
• Project Summary:
  – Showcase the ability of a network under SDN to control (based on OpenDaylight (ODL)) elephant flows, based on an application trigger
  – Features a scenario that throttles low priority traffic to a minimum bandwidth in order to accommodate the transfer of a large flow of data between the two data centres
  – This will be demonstrated using live link in the CANARIE network between Ottawa and Montreal
OpenFlow Switch - Hybrid MPLS L2-VPN

- SMB: NoviFlow
- Member: TELUS
- Use-case:
  - MPLS VPN network transition from traditional PE/CE to SDN controlled PE/CE
- Summary:
  - MPLS Layer 2 VPN solution with Openflow-based Noviflow switch PE and CE in one end and a traditional MPLS PE/CE at the other end
  - SDN Openflow controller (Cubro, ONOS, ODL) for provisioning and control of the Noviflow PE and CE
  - End to end solution demonstrated at CENGN
  - Demo using Web application
Smart City Infrastructure and Services

- **SMB:**
- **Member:**
- **Use-case:**
  - Smart City applications and services over programmable infrastructure and network
- **Project Summary:**
  - Showcase a complete end-to-end Smart City infrastructure, management and services in a lab environment initially, followed by a pilot project in Ottawa
  - Features fibre infrastructure controller that makes it possible to have shared substrate networks leveraged in isolation by a variety of networks for emerging services.
  - Features a Services Control Gateway that manages delivery of user-specific services to different market segments
  - Demonstrate specific applications for small business, traffic control etc.
Is Innovation in Hardware Dead?

• Yes
  • The world is Code!
  • SW is eating the world!

• No
  • FPGA, ASIC, GPU, … still required for high Performance & Scale
  • Place in the network is important for price, power, performance, scale, function
  • X86, ARM Scale
  • Specific Function Hardware such as DPI, FW require Hardware specific assist
Is Innovation in Hardware Dead?

Martin Izzard
Barefoot Networks
Evolution of SDN with Programmable HW

"Control stops where Data Plane starts"

Today

"Control down to the wire"

Future

“Control stops where Data Plane starts”

What networks need ...

Open

Today

Future
Evolution of Programmable Hardware

Compute
- C/C++/...
- Compiler

Graphics
- OpenGL/...
- Compiler

DSP
- C/C++/...
- Compiler

Networking
- ?
- Compiler

“Networking is late to the game!”
P4 - Programming Language for Networking

“Custom Networking across the Entire Network”
Is Hardware Innovation Dead?

Bruce Gregory
CEO, Corsa Technology
WAN Optimized Switching and Routing HW for SDN
Performance - Scale - Flexibility

SDN in the Campus

Campus Gateway
L2 VLAN / IP Gateway

SDN in the WAN

10G/100G Metro
10/100G DCI
10G/100G ISP Core
AS Boundary
Is Innovation in Hardware Dead?

• Innovate or Die – we don’t need to learn this again
• Innovation in Hardware is out of favor, but it’s still critical
• SDN assumes a richly programmable, flexible underlay network
  • Put the right performance in the right place at the right price
  • The hardware serves the software master – the move to network orchestration has changed the requirements put on the hardware
  • It’s hard to innovate at the network or application layer with feet of clay
Is Hardware Innovation Dead?

Walter Miron
Director of Technology Strategy TELUS
Is Hardware Innovation Dead?

Walter Miron
March 2016

“In the middle of difficulty lies opportunity”
- Albert Einstein
About TELUS

- TELUS is Canada’s fastest-growing national telecommunications company providing a wide range of communications products and services including wireless, data, IP, voice, television, entertainment and video, and healthcare IT products and services.
- $11.8 billion of annual revenue.
- 13.5 million customer connections, including:
  - 8.0 million wireless subscribers
  - 3.2 million wireline network access lines
  - 1.45 million Internet subscribers, and
  - 1,000,000 TELUS TV customers.

TELUS’ Customers First priority is focused on creating a best-in-class customer experience as measured by the voice of our customers.
The Big Rocks facing Service Providers

- Core growing at 80% CAGR
- Long Innovation and provisioning cycles
- Integration costs are cumbersome
- Industrialization of Internet driving expectations for reliability, low latency, price competition
- Rapidly evolving standards in SDN community - technology maturity
- Proprietary boundaries still exist hindering systems integration and interoperability
Common Infrastructure for network Virtualized Function

- Open standards
- Multi-Purpose, multi-tenant
- Elastic Functions/Resources
- Flexible function and vendor choices
- Support for service chaining
- Reduced Time to revenue
- Reduced platform costs

SDN & NFV = Time to market reduction and Improved TCO in terms of people, common facilities, and common hardware
Is Innovation in Hardware Dead?

**Software Innovation**
- Networking functions (DPI, FW, LB etc.) performed on non-purpose built appliances...
- Virtualization is increasing complexity e.g.
  - Network spend going down...
  - Admin and Management going up...
  - Requires NetOps - Automated FCAPS
- Crossover for vendors:
  - H/W vendors becoming S/W vendors...

**Hardware Innovation**
- H/W vendors are still relevant as (at least some) network functions are still closed, complex and proprietary, for foreseeable future...
- Multi-core CPUs can push packets through COTS H/W at ASIC speeds
- For network core (40G/100G), generic CPU including muti-core does not seem to be realistic
- General purpose CPUs are evolving to gain ASIC-like performance

**Continued Innovation in** common hardware capability and performance is required to reap the promised SDN and NFV benefits