SDN and Next Generation Communication Infrastructure for End-to-End Connectivity in the IoT Era

February 11, 2015
Knowing Your Connectivity is Important!

By David Fletcher / CloudTweaks.com

By Erika Rossi
Panel Discussion Focuses

SDN and Next Generation Communication Infrastructure for End-to-End Connectivity in the IoT Era

- Examine the impacts of IoT on communication infrastructure.

- How SDN/NFV may offer some of the solutions.

- Envision 5 years from now, in 2020, how our network infrastructure looks like.
Panelists

Prof. Guru Parulkar
Co-Founder & Executive Director of the Open Network Research Center (ONRC) and Consulting Professor at Stanford University

Mr. Motoyoshi Sekiya
Director of Fujitsu Laboratories of America

Mr. Bob Lieber
Director of DiamondIP, British Telecom
SDN and Next Generation Communication Infrastructure for End-to-End Connectivity in the IoT Era

Motoyoshi Sekiya
Fujitsu Laboratories of America, Inc. (FLA)

February 11, 2015
Introduction

- **Emerging Technologies**
  - SDN (Software defined networking) and NFV (Network function virtualization)
  - Big data and Cloud computing
  - IoT (Internet of Things) $7 trillion market by 2020!!

"By 2020, the global Internet will consist of 50 billion connected smartphones, tags, televisions, cars, kitchen appliances, surveillance cameras, utility meters, and what not" - [http://share.cisco.com/internet-of-things.html](http://share.cisco.com/internet-of-things.html)

- **Network Requirements**
  - Scalable
  - Intelligent
  - Ubiquitous
  - Dynamic
  - Mobile
  - Heterogeneous
  - On-demand
  - Access everywhere
  - Location independent
  - IoT, SDN islands and flows, layers, etc.
  - Automation and control
Data generated by IoTs will reach 400ZBs/year in 2018! Data has to be transported over core networks to the cloud for processing/analytics.
What is the Impact on Core Networks?

■ Tremendous increase data volume
  ■ Capacity requirements will continue \( \rightarrow \) Optical Transmission

■ Tremendous variety of QoE requirement
  ■ Sensor \( \rightarrow \) burst or continuous, small data
  ■ Car \( \rightarrow \) mobility, Camera \( \rightarrow \) real-time…
  Several application require, low latency, BW, extreme reliability
  Network has to manage these variety of requirement.

■ Tremendous increase number of data source
  ■ More aggregation points, hops \( \rightarrow \) complexity..
Virtualization is the Key – SDN Brings Reality

**Challenge!!**

- **Virtual Network**
- Scalable number
- Heterogeneous variety
- Reliability

**Connect over heterogeneous**
- Layer, Protocol, Vendor independent
  - Provide usability
  - Complexity is hidden to user
  - Efficient resource usage
  - Reliability realized in virtual layer

**Connect EtoE on virtualized layer**
- SDN enabled

**Network Design**

- **Automatic**
- **Manual**

**Network Configuration**

- **Static**
  - NMS: Pre-design
  - Fixed HW: Classic ROADM
- **Dynamic**
  - SDN: Automated Design
  - Programmable HW: Flexible ROADM
Optical Network will be virtualized in IoT Era

Large capacity with low latency **programmable** network with **dynamic/flexible**

- Virtual Optical Network provide connectivity for applications on DCs
  - Operator create virtual slices of the network to match traffic patterns of applications

- Optical network provide flexible network resources for virtual networks
  - Circuit-based, Deterministic, High BW and low latency
  - More than 3 times better utilization of physical resources

→ Some work is presented in ECOC 2014, OFC 2014, GLOBECOM 2014
Is SDN Cover E-to-E, App to User?

- Application of SDN to the DC network is studied and benefits have been shown.
- Expanding SDN to the WAN is the hot topic and on going now.
- Next challenge might be the Mobile and Sensor network.
  - Manage connectivity of End Device and DC in cloud is most important to provide better QoE.
Network in Future

- **A network service** = a virtual network request integrating many things
- A virtual network request -> managed by orchestration with **distributed DCs**
- **Application running on VMs** -> flexible Source/Destination and network

Core network will be dynamic/flexible. Virtualized (optical) network brings true layer conversion and enable connections to everything
FUJITSU

shaping tomorrow with you

Copyright 2015 FUJITSU
SDN and IoT: Any Synergy?

Guru Parulkar, Stanford and ON.Lab
parulkar@stanford.edu
SDN and IoT

SDN and IoT are two mega trends

Mega Trend 1 + Mega Trend 2 = Mega Mega Trend? Maybe...
What is SDN?

Open Interface(s)

Routing

TE

Mobility

Network Map Abstraction

Separation of Data and Control Plane

Network OS

Packet Forwarding

Open interface to Forwarding Abstraction: L1/L2/L3

Programmable Basestation
Why SDN?

- Brings openness and programmability to infrastructure
  - to enable innovation

- Accelerates new revenue generating services
  - With right abstractions, open APIs, and competition

- Helps reduce Opex
  - Exploit abstractions for automation and autonomic systems

- Helps reduce Capex
  - Move away from closed proprietary complex boxes
SDN Building Blocks

Closed

SDN Network Operating System

- Control Apps
- Config Apps
- Mgmt Apps

Agent
OS
Loader
Merchant Silicon

Whitebox

Legacy
SDN Activities...

- Building blocks
  - Software defined switching silicon
  - Forwarding devices: Modified legacy devices and white boxes for packet switches, ROADM's, ...
  - Switch OS
  - Network OS
  - Network Virtualization
  - Orchestrator: Integration with NFV and Cloud

- Use Cases for various domains of use
  - Data Center
  - Enterprise
  - Service provider
    - Packet and optical switches

- Trials and Deployments for various domains of use
ON.Lab Activities: ONOS as an Open Source SDN OS

Scalability, HA, Performance, ...

High Throughput:
~500K-1M paths setups / second
~3-6M network state ops / second

High Volume:
~500GB-1TB of network

Difficult challenge!
Target Use Cases

Core Packet-Optical

POP
Built like a Data Center

Metro Packet-Optical

Central Office
Built like a Data Center

Access
Wired Access
Wireless Access
Enterprise Access
Wireless Access
Wired Access
Wireless Access
Enterprise Access
Wired Access
Is SDN a good approach to building IoT?

Yes but IoT has its own priorities...
Secure Internet of Things Project (SITP)

Stanford University, UC Berkeley, and the University of Michigan

Steve Eglash, Executive Director
Philip Levis, Faculty Director
Secure Internet of Things Project (SITP)
Two Goals

1. *Data security*: research and define new cryptographic computational models for secure data analytics and actuation on enormous streams of real-time data from embedded systems.

2. *System security*: Research and implement a secure, open source hardware/software framework that makes it easy to quickly build Internet of Things applications that use these new computational models.
How does SDN Apply to IoT?

MGC Architecture

SDN Applies

End application

3G/4G, TCP/IP

Cloud

But other issues dominate for now.

6lowpan, ZigBee, ZWave, Bluetooth, WiFi, WirelessHART

eMbedded devices
Important Takeaways

- SDN and IoT are two big and important trends
- Yes they are synergistic
  - IoT should use “software defined” and logically centralized control
  - IoT can be one of growth opportunities for SDN
- Both are in early stages of development
  - They will see their own adoption cycle
- Coupling SDN and IoT is not necessarily the best winning strategy
  - SDN and IoT need to solve many hard problems of their own
SDN and Next Generation Communication Infrastructure for End-to-End Connectivity in the IoT Era
Explosion of devices competing for Internet service…

Extremely large amounts of data will be generated from diverse locations that will be aggregated at significantly high-velocity; this is expected to increase the need to better index, store, and process this data…

Could reach 30 Billion Devices by 2020
Balance Evolving Network Trends – SDN and IoT

• SDN’s cleverly route network traffic – making networks smart…

• Smarter networks make the most of deployed resources

• SDN’s look to reduce bottlenecks and enhance network efficiencies
  – Service Chaining sequences application-specific processes for provisioning
  – Bandwidth Calendaring aides in QOS for VTC vs Data interconnectivity
  – Dynamic Load Management enables on-the-fly bandwidth changes

• Remember accompanying underlying technologies (ie:: DHCP & DNS services)

• Deploy adequate tools to manage IP address growth (IPv4 / IPv6 considerations)

OpenFlow is a communications protocol
Basic SDN Architecture

**APPLICATION LAYER**

- API
- API
- API
- API

**CONTROLLER**

- API
- API
- API
- API

**INFRASTRUCTURE (PHYSICAL NETWORK)**

OpenFlow enables SDN – sits on top of TCP
Considerations – SDN and IoT

• Many different vendors // Consider Open Platforms vs Vendor Specific

• Understand SDN technology and what it means to your IoT strategy

• Ensure Quality of Service is maintained throughout deployment

• Determine if existing network equipment sustainable to implement SDN

• Start with a small region of your network as a pilot then expand accordingly

• Speak with other organizations to recognise lessons learned

• Perform thorough due diligence on network // Pro-Service engagement
Not just connected – Interconnected

IPv4

IPv6

DNS

DHCP
the Art of connecting is working in harmony

Thank you