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Fujitsu North America Technology Forum 2015

Breakout Session

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

February 11, 2015

IoT Challenges

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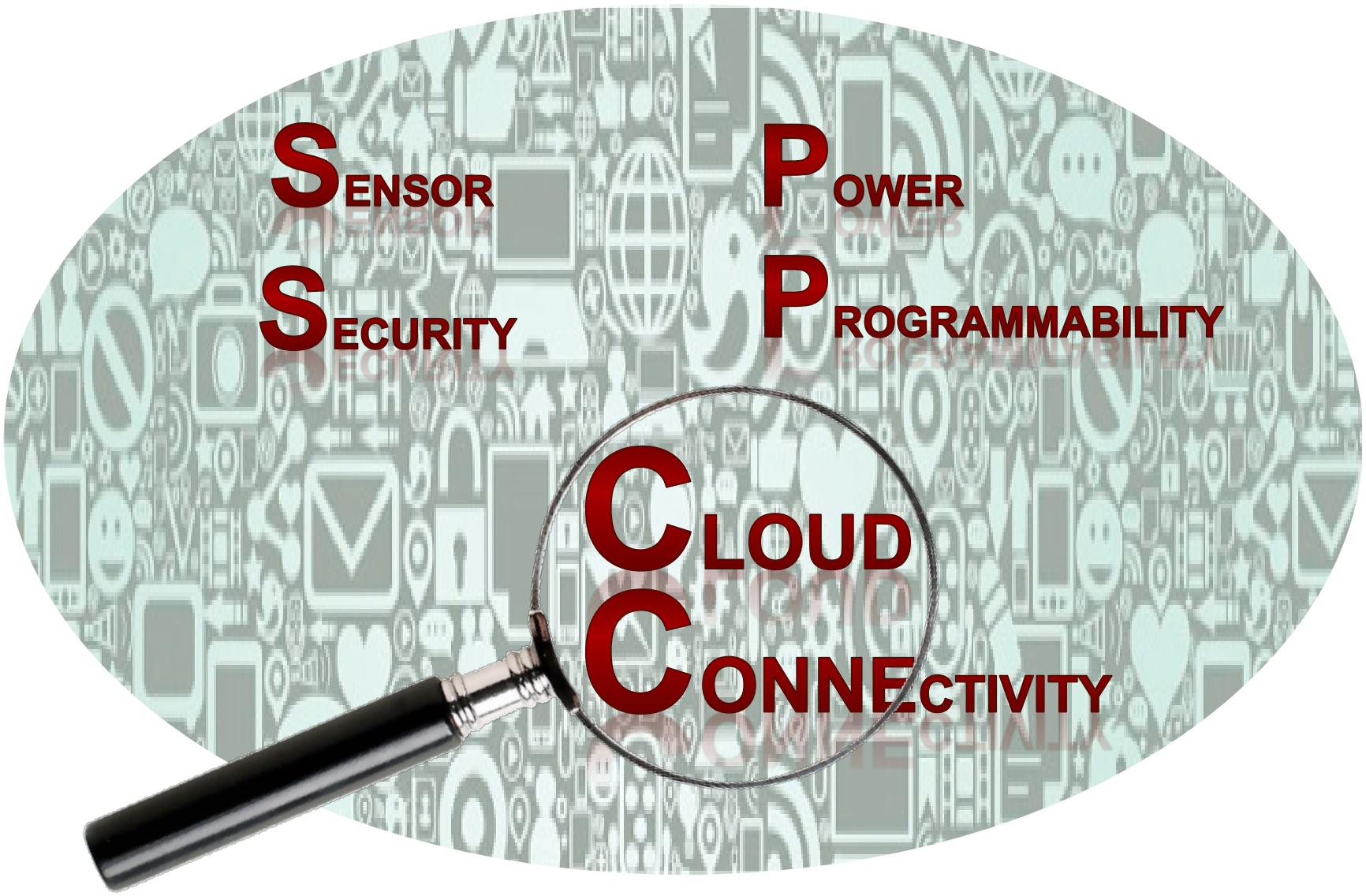
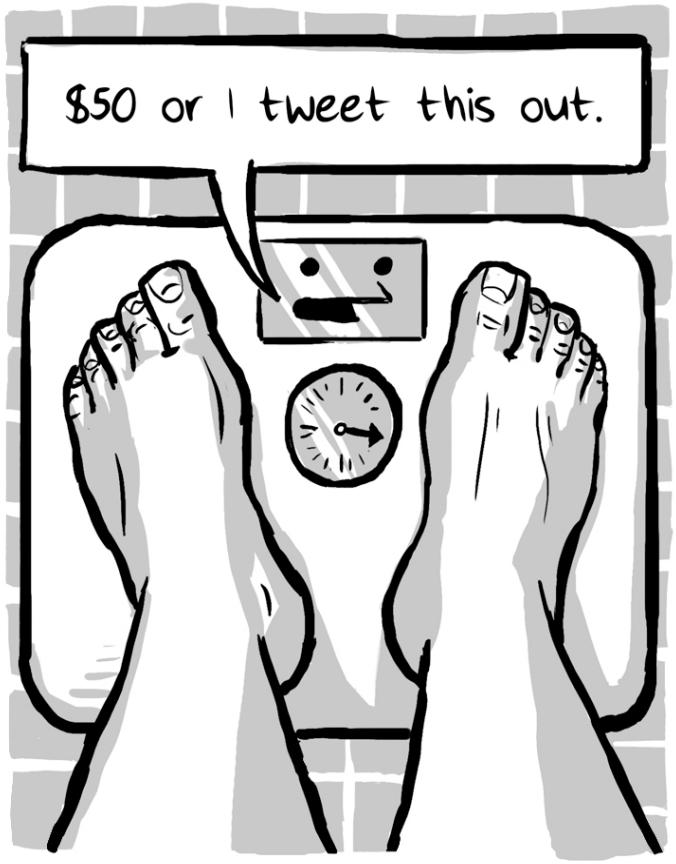


Knowing Your Connectivity is Important !

By David Fletcher / CloudTweaks.com



By Erika Rossi

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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

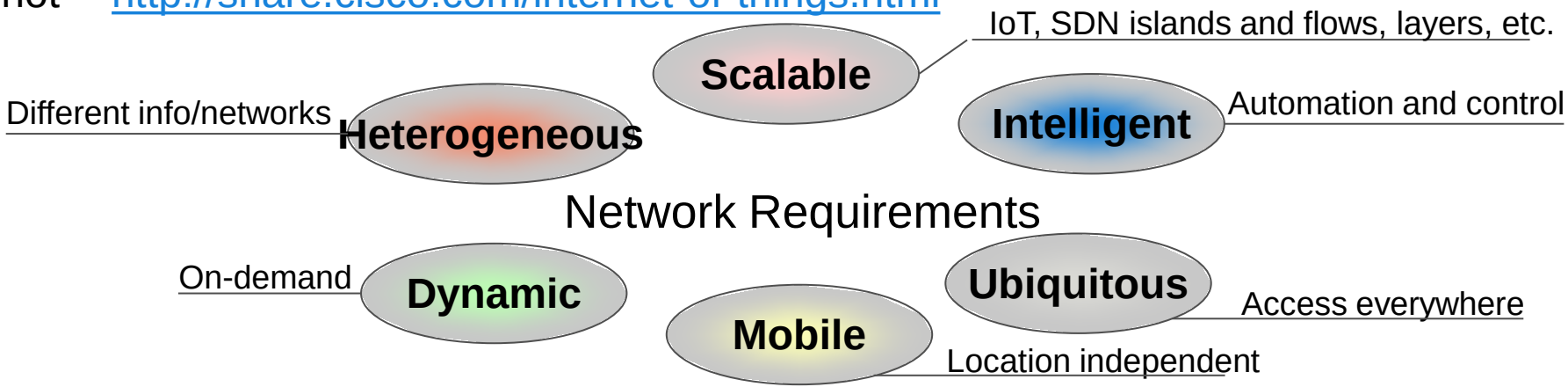
Motoyoshi Sekiya **Fujitsu Laboratories of America, Inc. (FLA)**

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



IoT/M2M Traffic Growth

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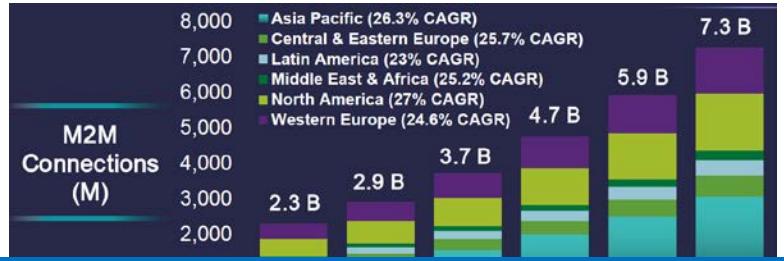
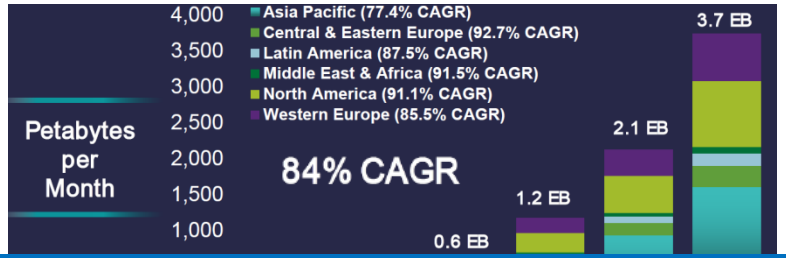
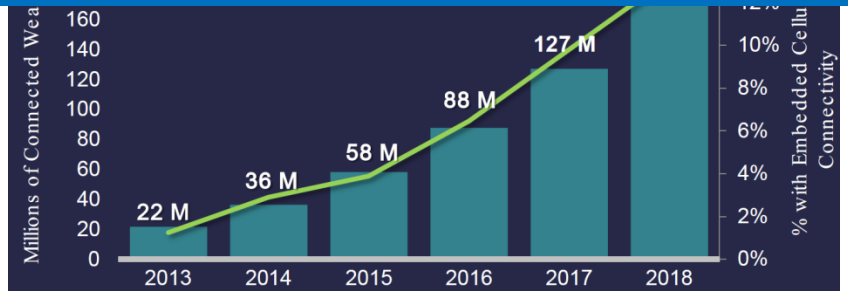
Global M2M Connections

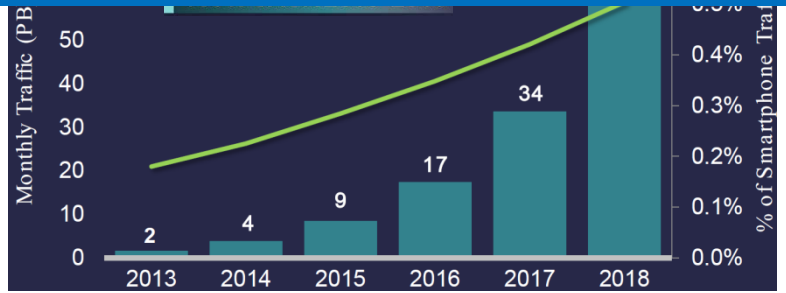


Global M2M Traffic



Data generated by IoTs will reach 400ZBs/year in 2018!
Data has to be transported over core networks to the cloud for processing/analytics



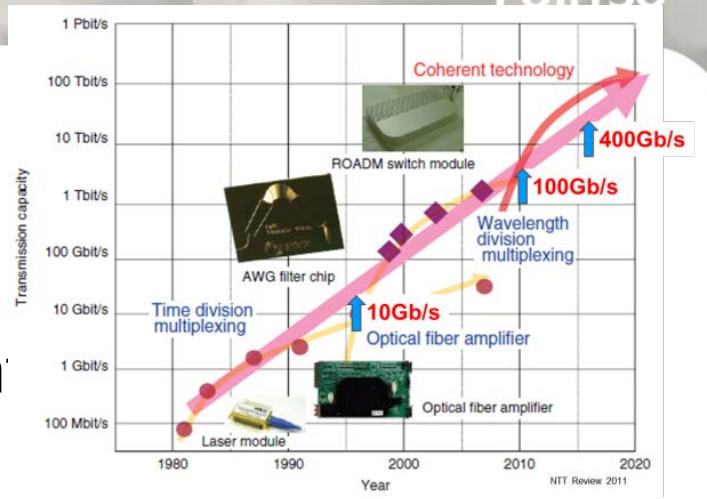


Cisco VNI Global Mobile Study 2013-2018

What is the Impact on Core Networks?

- Tremendous increase data volume
  - Capacity requirements will continue →Optical Transmission

Scalable



- Tremendous variety of QoE requiremen
  - Sensor → burst or continuous, small data

    Car → mobility, Camera → real-time…

Several application require , low latency, BW , extreme reliability
Network has to manage these variety of requirement.

Heterogeneous

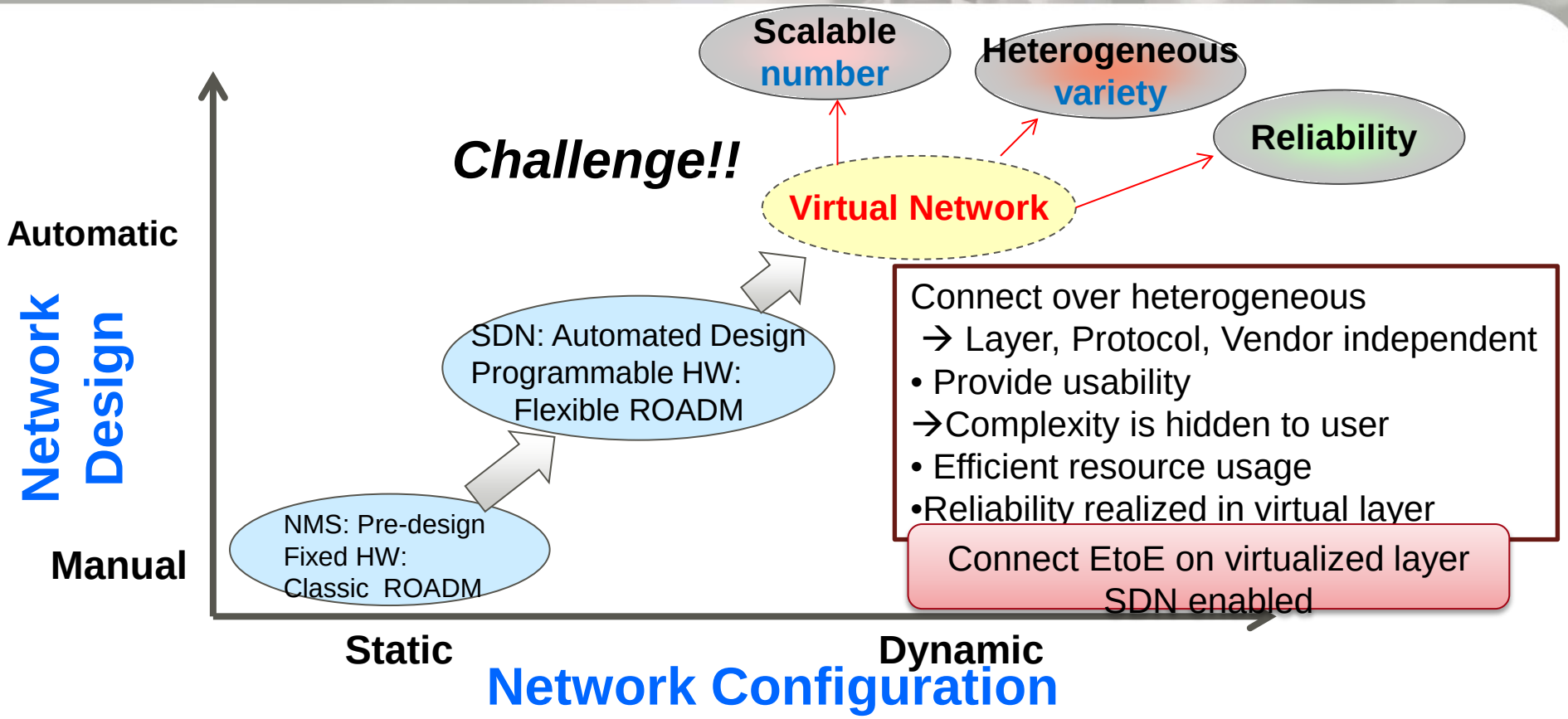
Dynamic

- Tremendous increase number of data source
  - More aggregation points, hops → complexity..

Reliability

Intelligent

Virtualization is the Key – SDN Brings Reality



Optical Network will be virtualized in IoT Era

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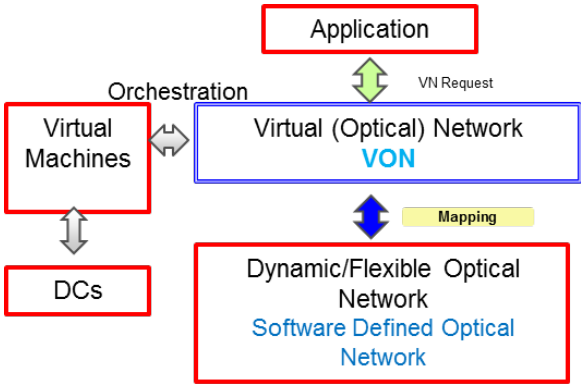
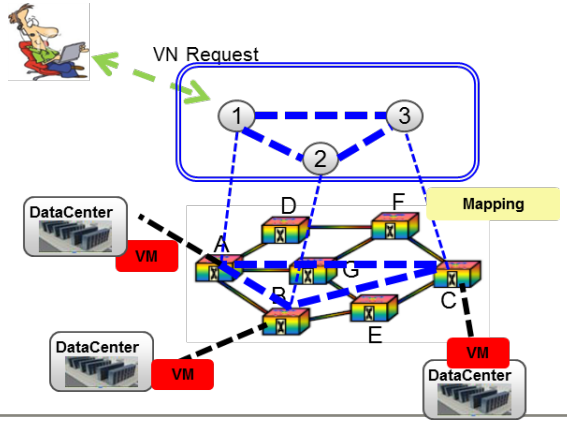
Large capacity with low latency programmable network with dynamic/flexible

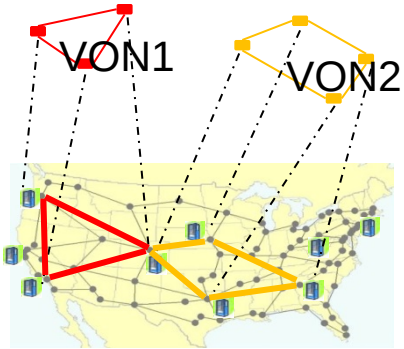
- Virtual Optical Network provide connectivity for applications on DCs
  - Operator create virtual slices of the network to match traffic patterns of applications
- Optical network provide flexible network resources for virtual networks
  - Circuit-based, Deterministic, High BW and low latency
  - More than 3 times better utilization of physical resources
    → Some work is presented in ECOC 2014,OFC 2014, GLOBECOM 2014

Heterogeneous

Scalable

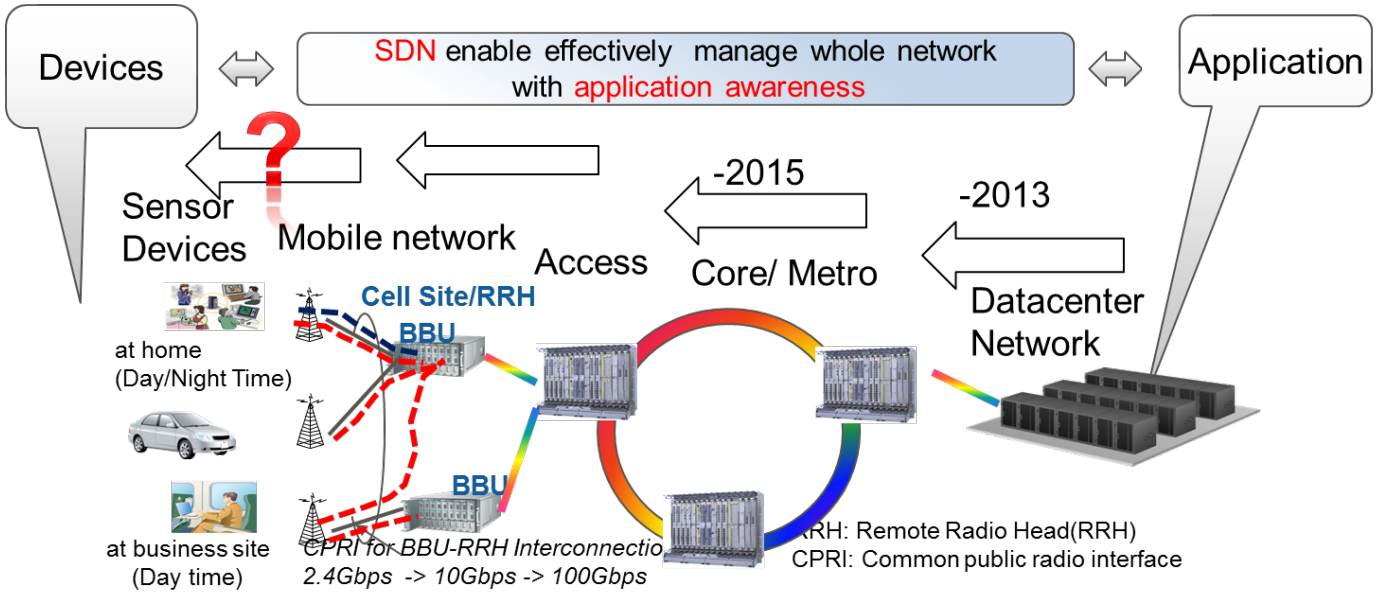




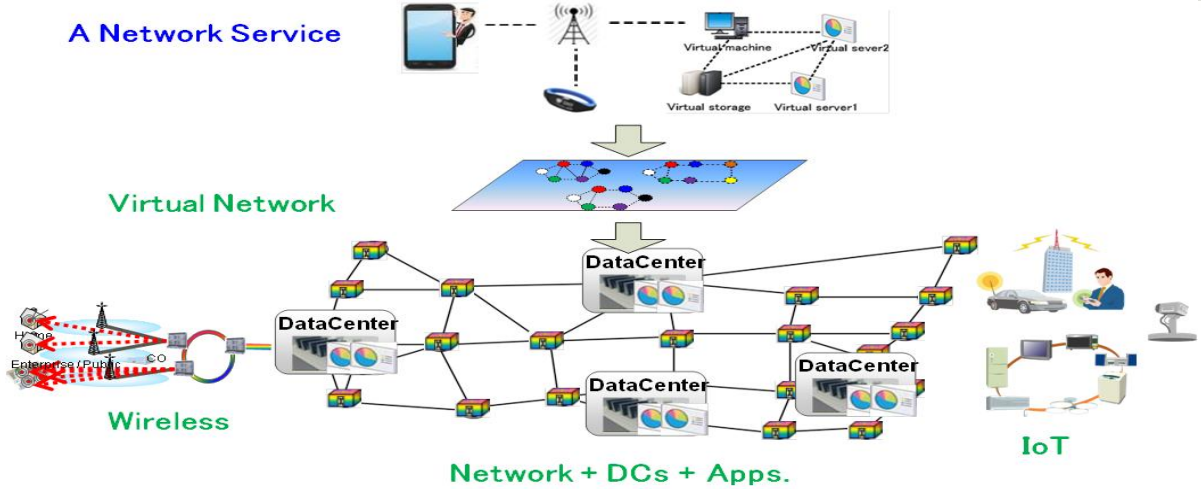


Is SDN Cover E-to-E, App to User?

- 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

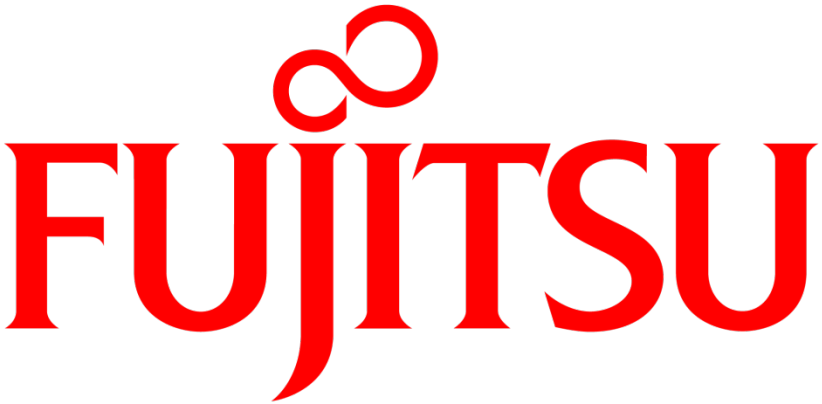


Network in Future



- 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



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SDN and IoT: Any Synergy?

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

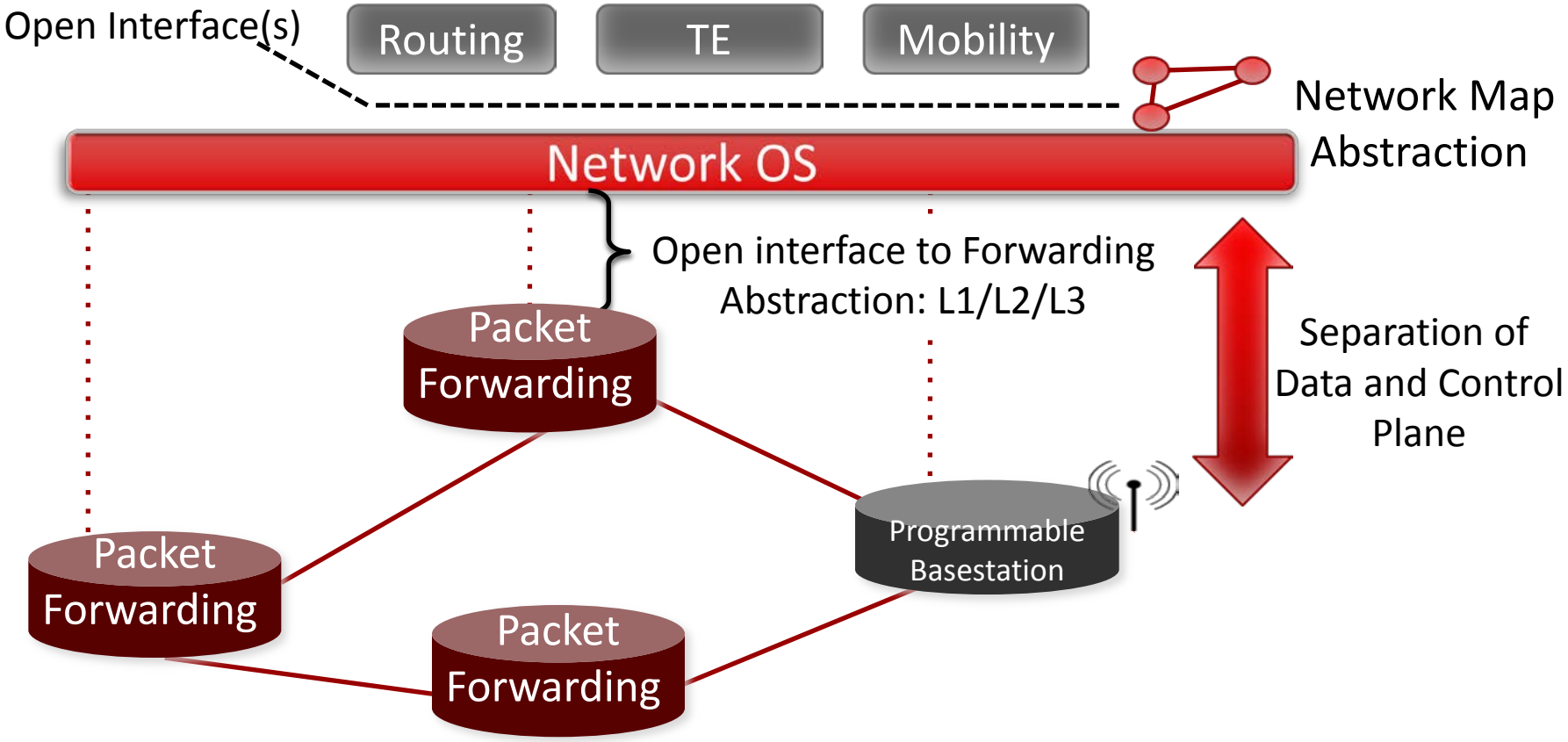
SDN and IoT

SDN and IoT are two mega trends

Mega Trend 1 + Mega Trend 2 = Mega Mega Trend?

Maybe…

What is SDN?

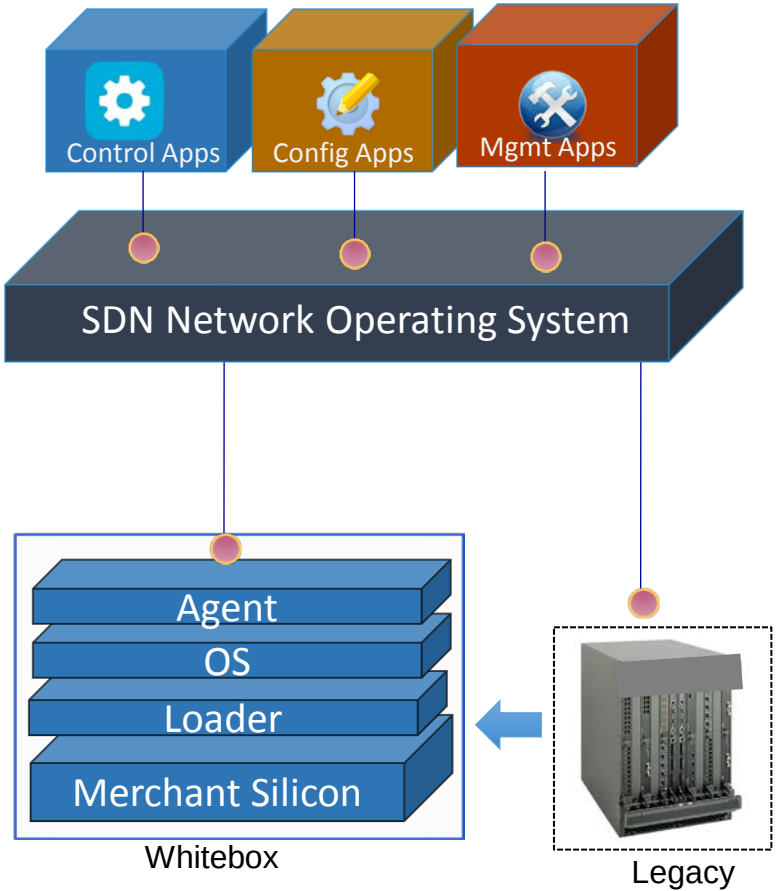

Open Interface(s)
Routing
TE
Mobility
Network Map
Abstraction
Network OS
Open interface to Forwarding
Abstraction: L1/L2/L3
Separation of
Data and Control
Plane
Packet
Forwarding
Packet
Forwarding
Packet
Forwarding
Programmable
Basestation

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 Activities…

- Building blocks
  - Software defined switching silicon
  - Forwarding devices: Modified legacy devices and white boxes for packet switches, ROADMs, …
  - 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

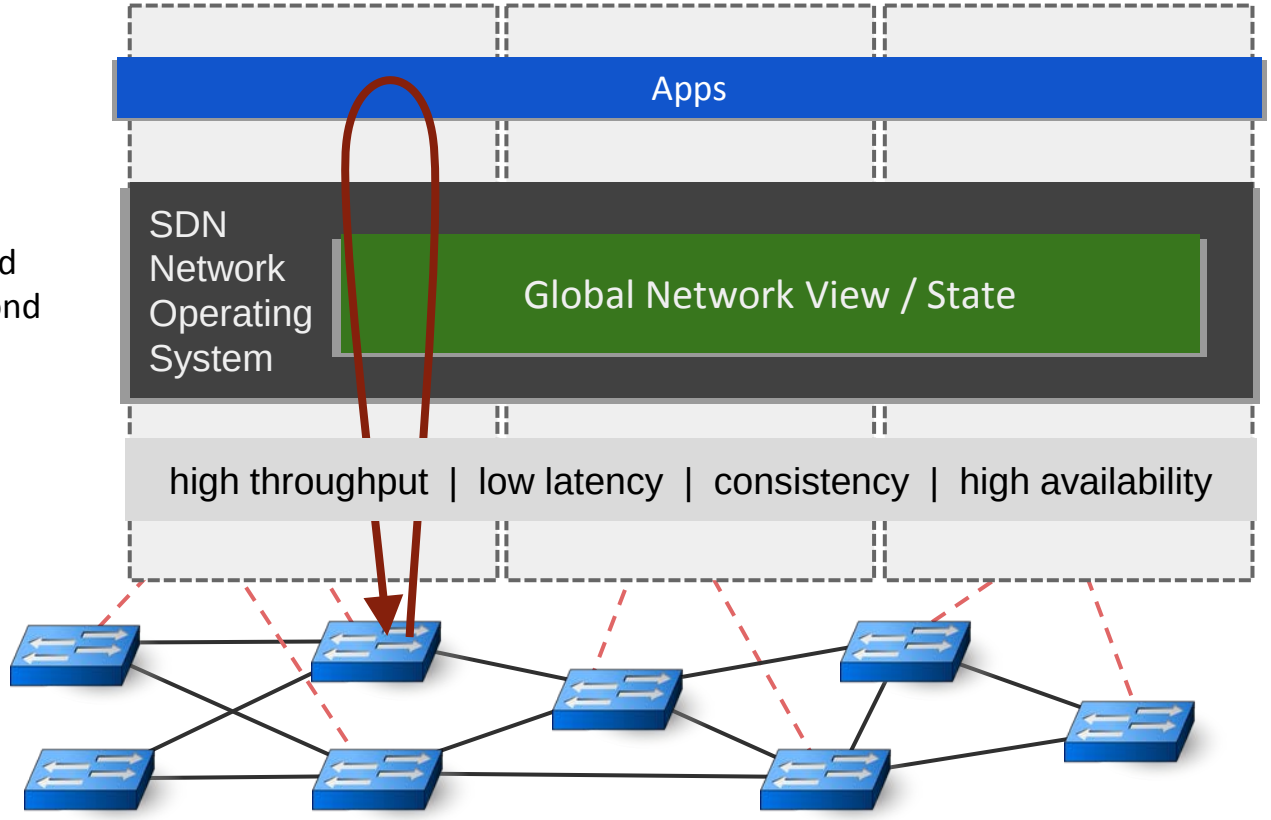
ON.Lab Activities: ONOS as an Open Source SDN OS

Scalability, HA, Performance, …

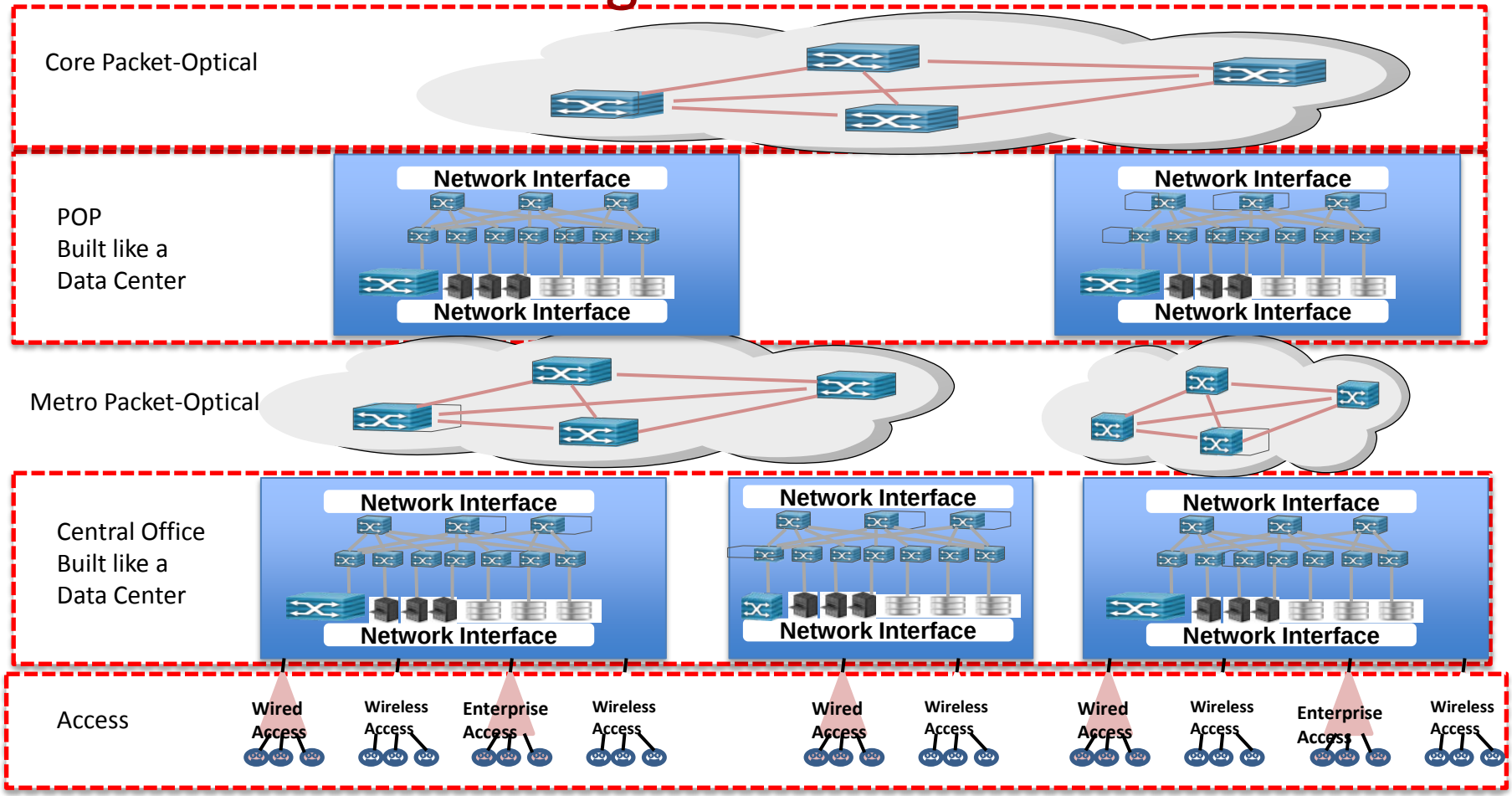
High Throughput:
~500K-1M paths setups / second
~3-6M network state ops / second

High Volume:
~500GB-1TB of networ

Difficult challenge!



Target Use Cases



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

Who?

Philip Levis
Stanford
Embedded Systems

Mark Horowitz
Stanford
Hardware

Christopher Ré
Stanford
Data Analytics

Dan Boneh
Stanford
Cryptography

Dawson Engler
Stanford
Software

Keith Winstein
Stanford
Networks

Prabal Dutta
Michigan
Embedded Systems

David Mazières
Stanford
Security

Björn Hartmann
Berkeley
Prototyping

Raluca Ada Popa
Berkeley
Security

Greg Kovacs
Stanford
Medical Sensing

Christos Kozyrakis
Stanford
Cloud Architecture

Steve Eglash
Stanford
Executive Director

Philip Levis
Stanford
Faculty Director

IoT: MGC Architecture

eMbedded devices

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

Gateways

Cloud

3G/4G, TCP/IP

End application

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?

eMbedded devices

SDN Applies

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

MGC Architecture

Cloud

Gateways

3G/4G, TCP/IP

SDN Applies

But other issues dominate for now

End application

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…

Refrigerators

Mobile Phones

Smart Outlets

Bluetooth Padlocks

Tablets

Heart Monitoring Implants

Intelligent Doorbells with Facial Recognition

Switches

Alarms

Dryers

Sensors

Automobiles

Robotics

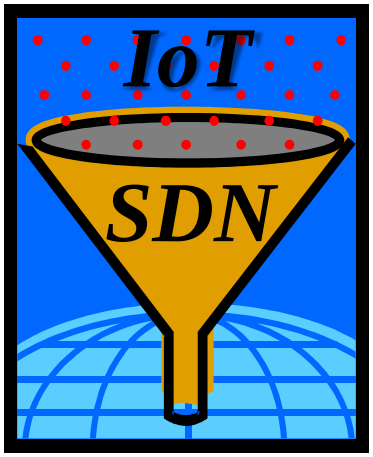
Sprinklers

Routers

Laptops

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…

Vending Machines



Thermostats

Coffee Machines

Biochip Transponders

Smart Watches

Connected Motorcycle Helmets

Speakers

Health Equipment

Smart Batteries

Traffic Lights

Washers

Video Tele Conferencing

Garage Doors

Pet Tracking Devices

Window Shades

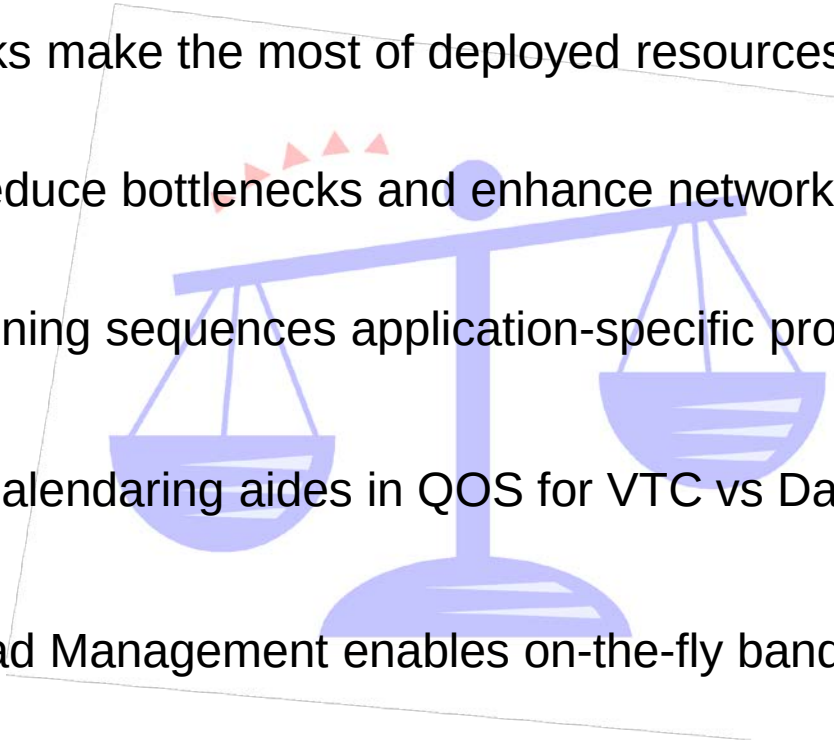
Baby Monitors

Smart Propane Tank Gauge

Could reach 30 Billion Devices by 2020

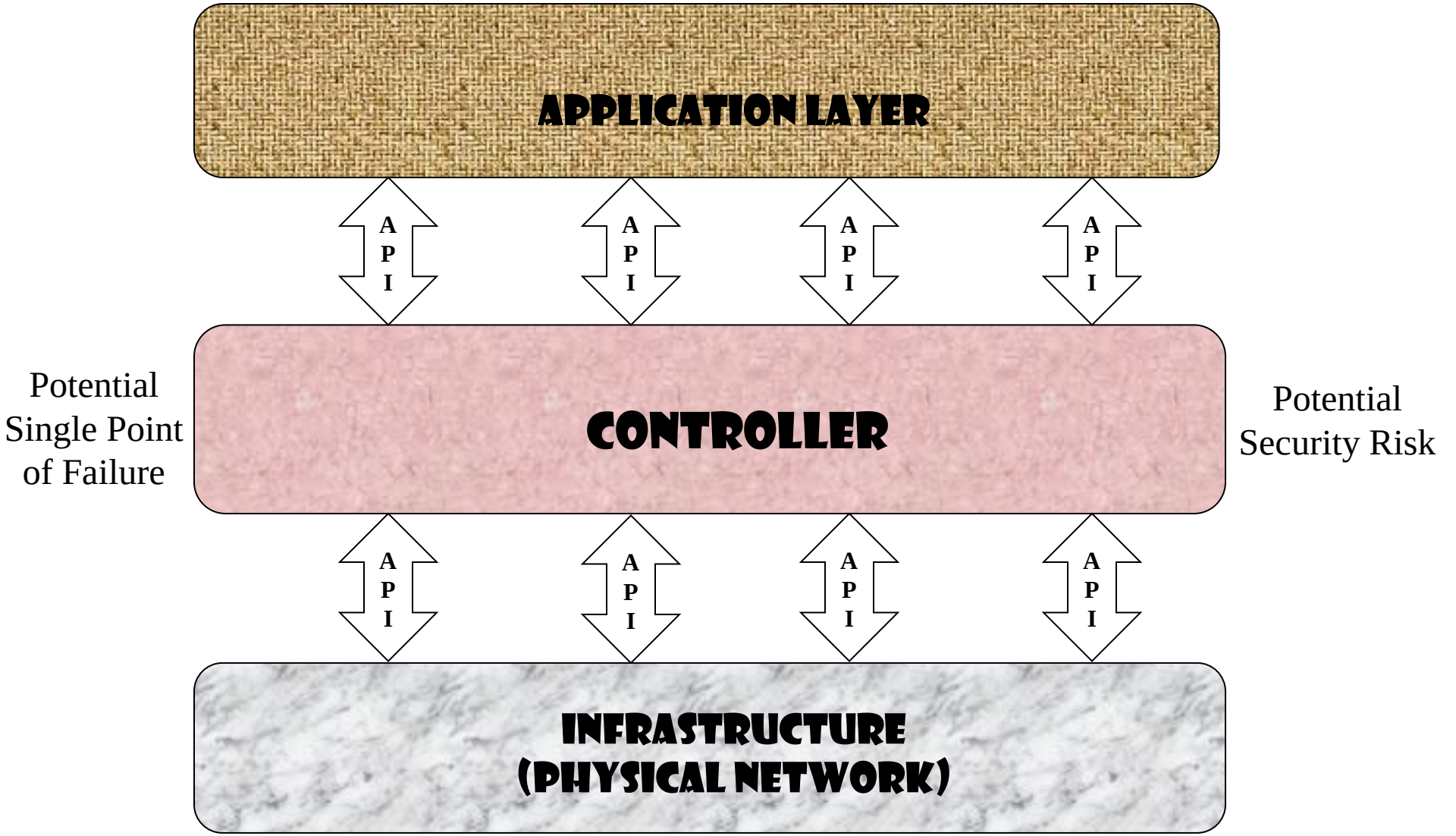
Balance Evolving Network Trends – SDN and IoT

- 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

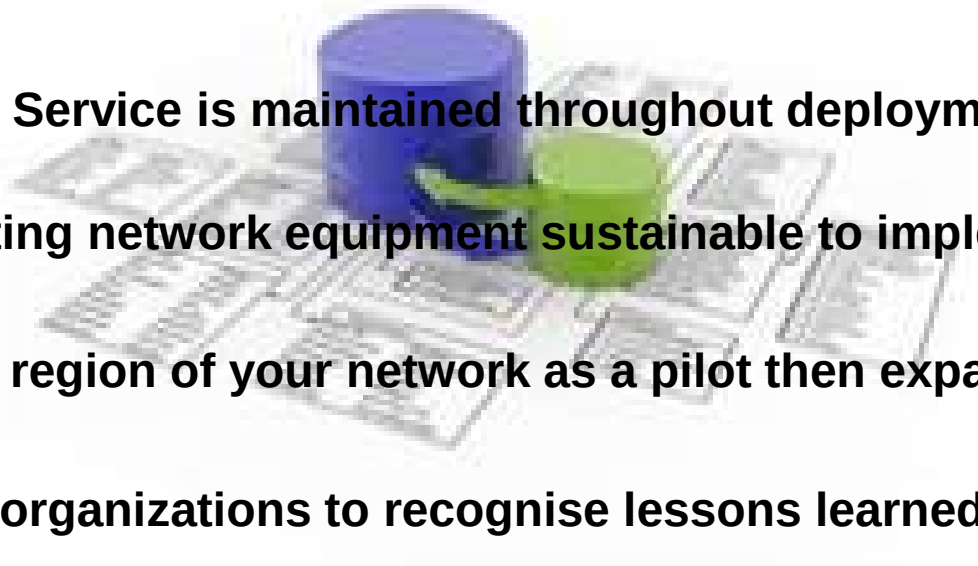
Basic SDN Architecture



OpenFlow enables SDN – sits on top of TCP

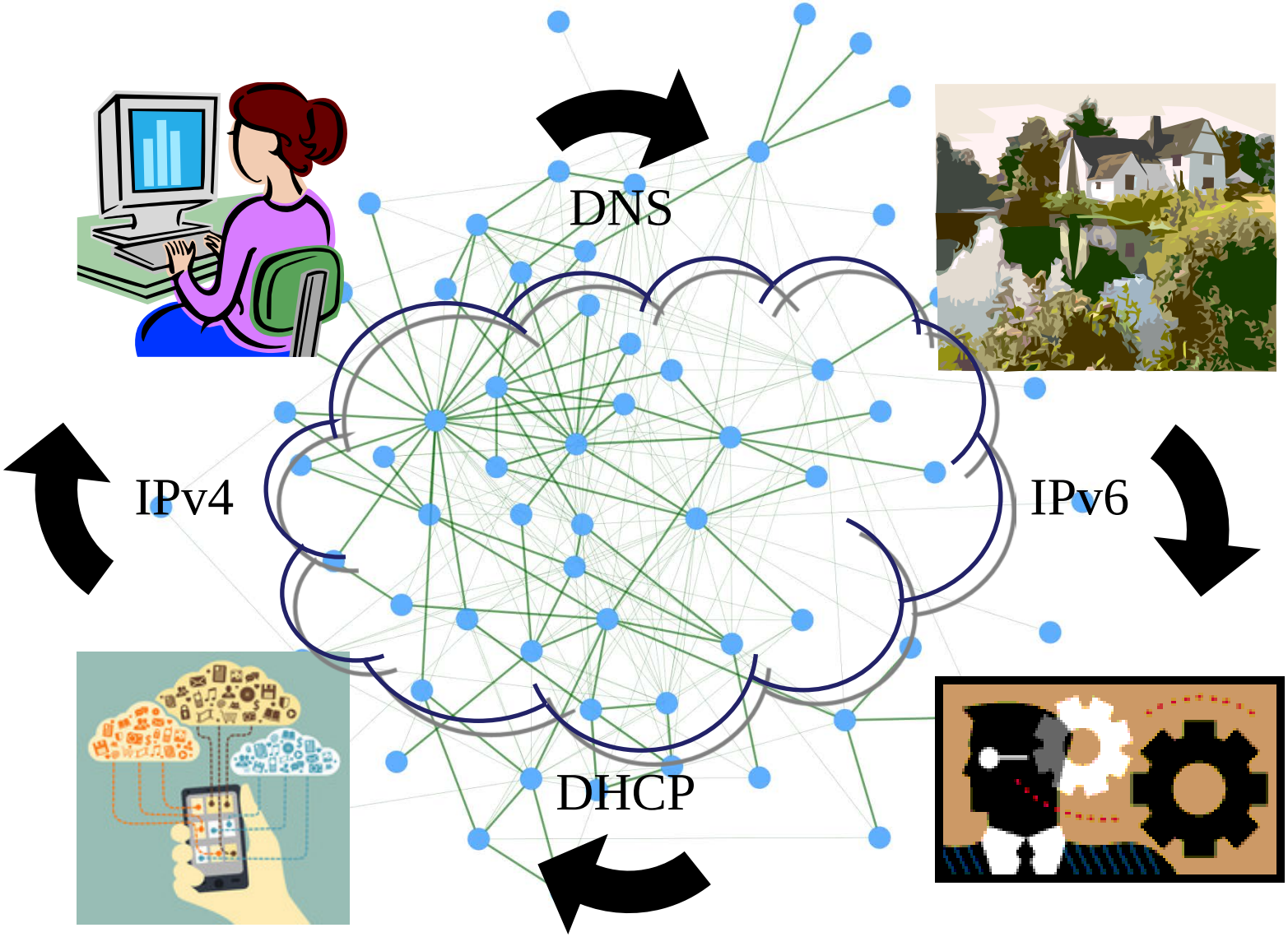
Considerations – SDN and IoT

- **Many different vendors // Consider Open Platforms vs Vender 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**



Fully Understand Security Aspects

Not just connected – Interconnected



Thank you