

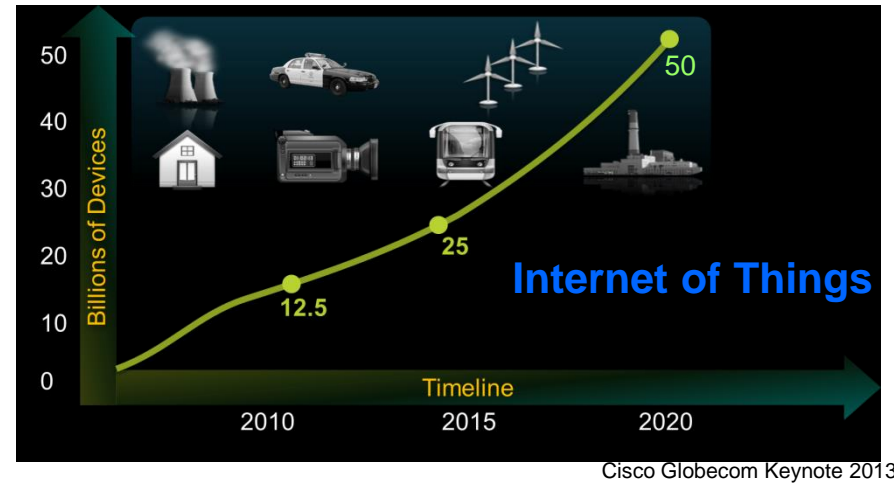
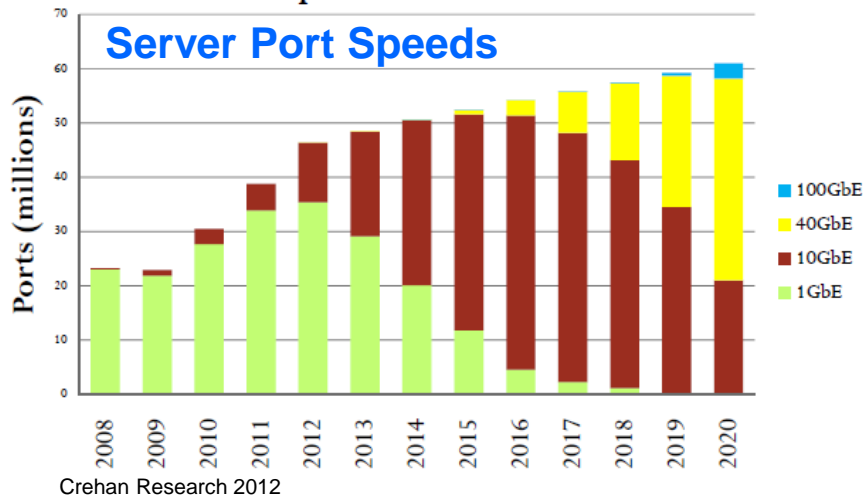
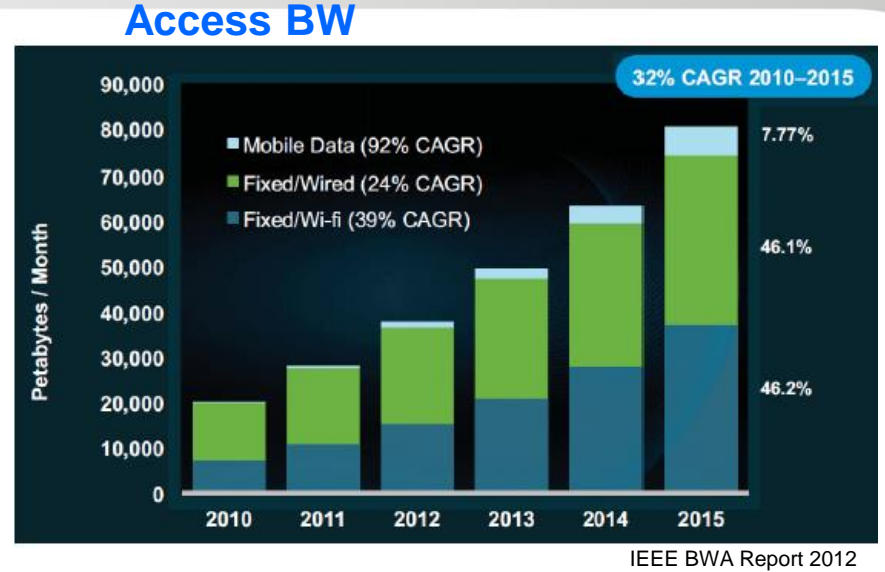
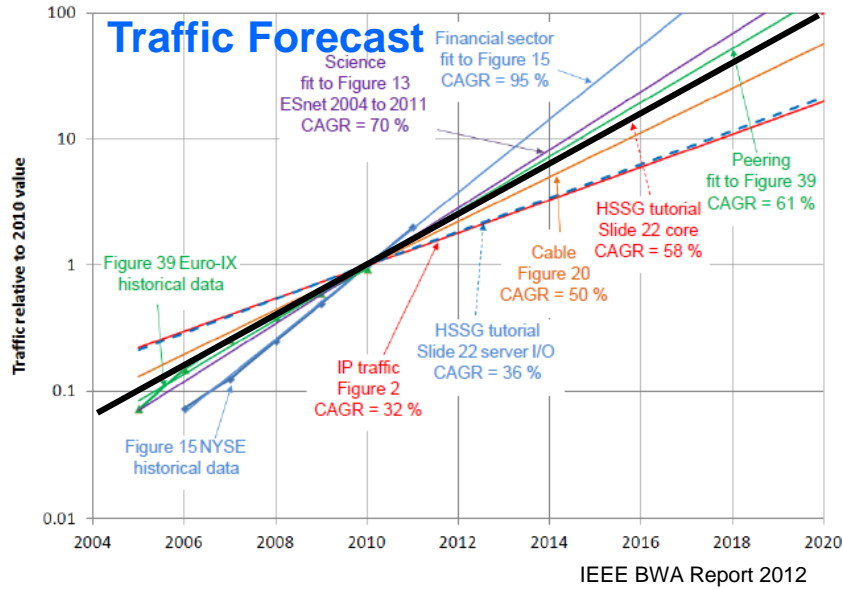
Jan 22, 2014

Flexible Optical Transport Networks – 100 Gb/s and beyond

Paparao Palacharla

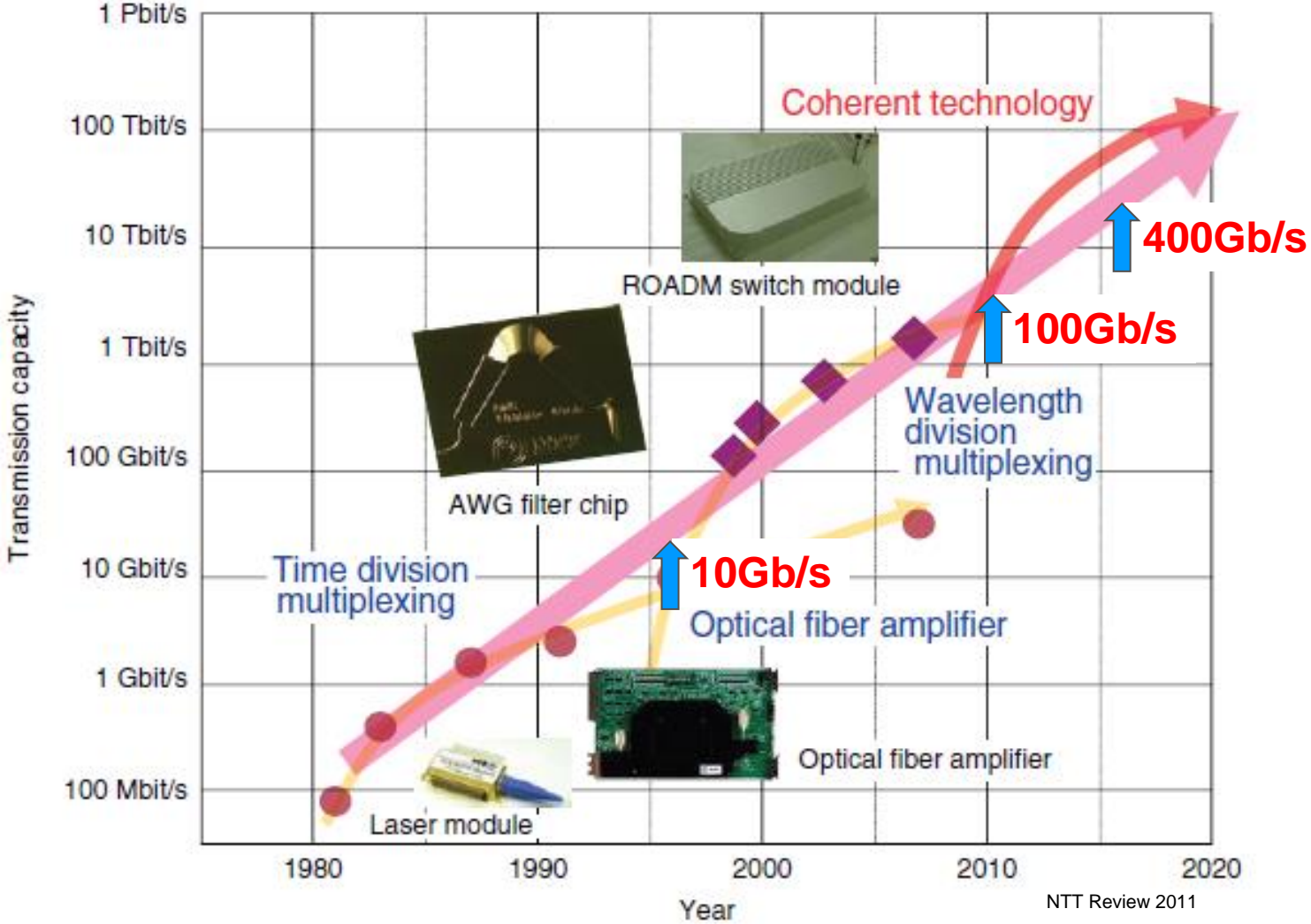
Fujitsu Laboratories of America (FLA)
Richardson, TX

Traffic Growth: "Everything Connected to Everything"



More Users × **More Devices** × **More Bandwidth** = **Bandwidth Explosion**

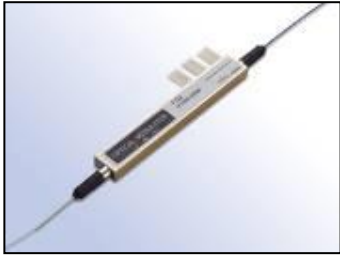
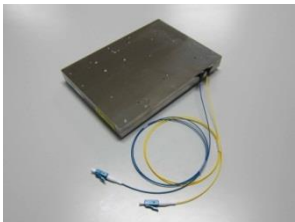
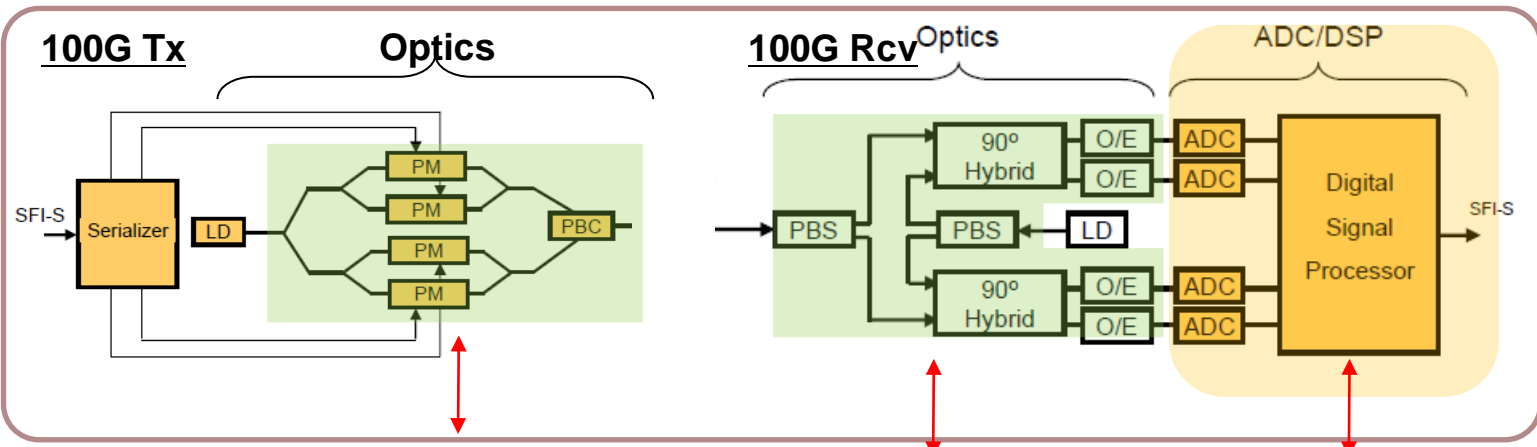
Optical Transmission Capacity



100Gb/s Transport

■ Coherent Transmission

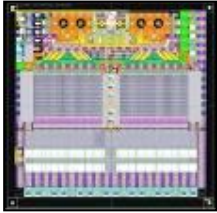
- Modulation (DP-QPSK, Dual Polarization Quadrature Phase Shift Keying)
- DSP – compensation of optical impairments
- Simplifies route/path design and provisioning – enables traffic re-routing in mesh networks



Fujitsu Optical Components
DP-QPSK Modulator



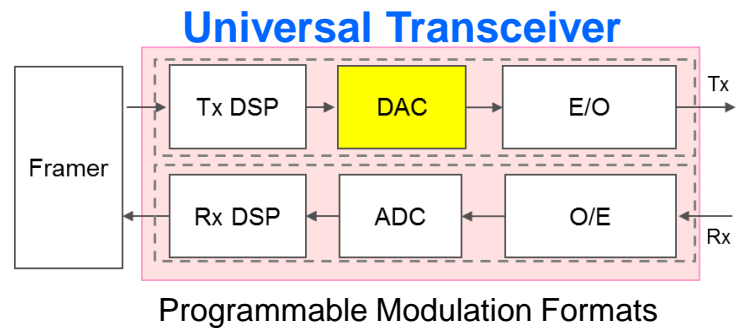
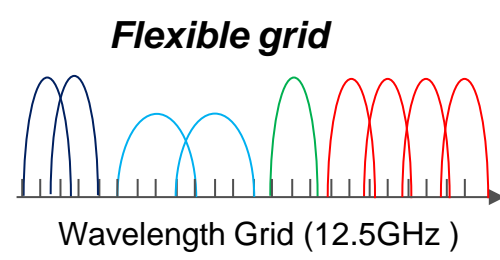
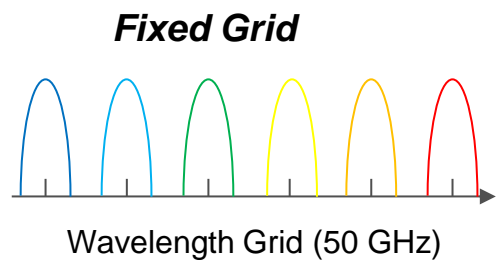
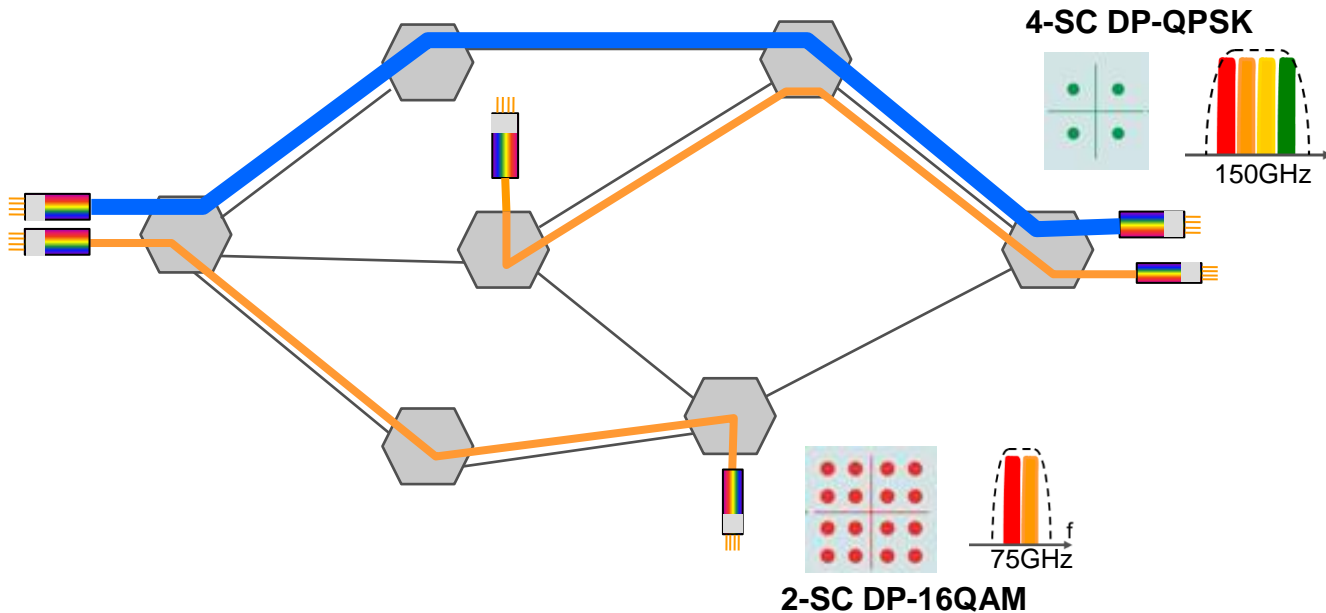
Fujitsu Optical Components
DP-QPSK Coherent Rcv



Fujitsu Semiconductor
65 Gsa/s ADC

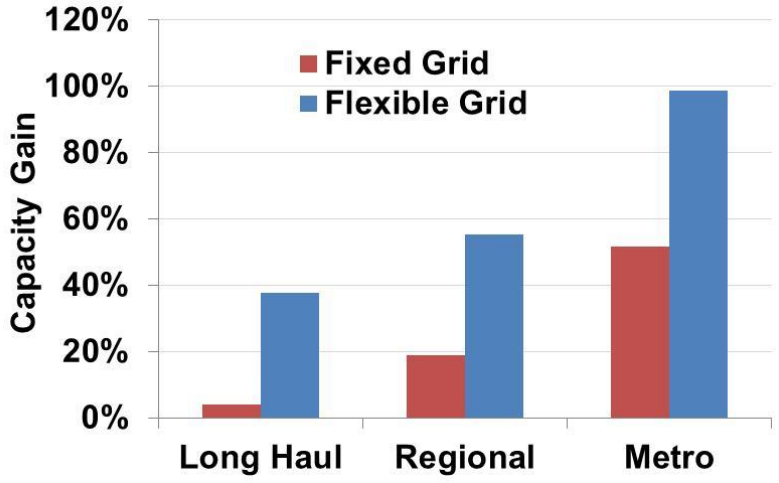
400Gb/s Transport

- **Super-channel transmission** - Multiple sub-carriers are tightly packed for higher spectral efficiency, managed/ operated as single entity
- *Flexibly adjust spectrum/bandwidth, data rate and reach* to match traffic demands – minimize overall resource usage in the network



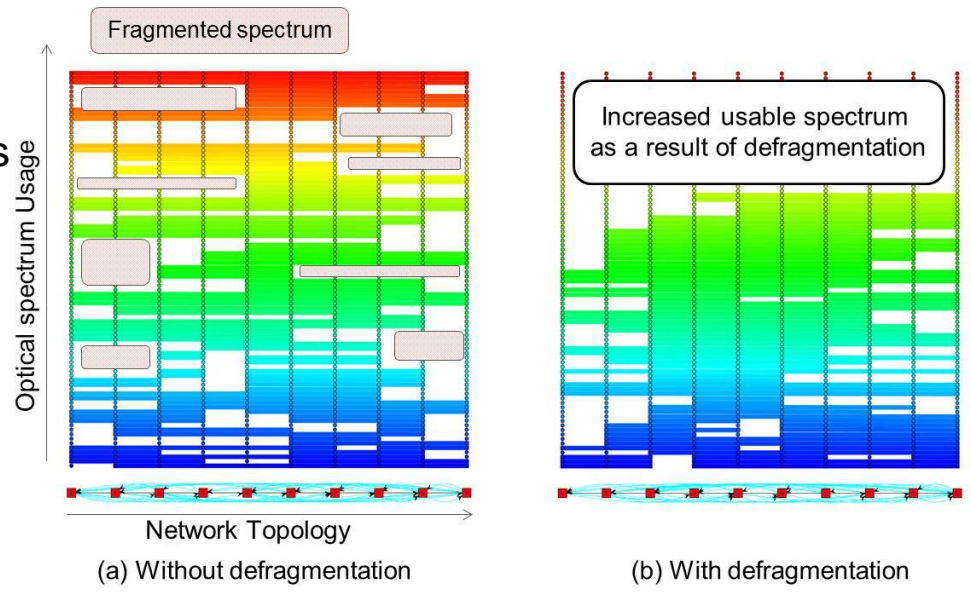
Flexible Optical Transport Networks

- Enable super-channel transmission of 400Gb/s
 - Adaptive modulation to match reach
 - Fixed grid (50GHz), Flexible grid (n x 12.5GHz)
 - Reference condition – fixed modulation, 50GHz grid



■ Challenge – Spectrum Fragmentation

- Signals can occupy different number of spectrum slots, the uneven usage of slots causes spectrum fragmentation
- Hitless spectrum defragmentation procedure

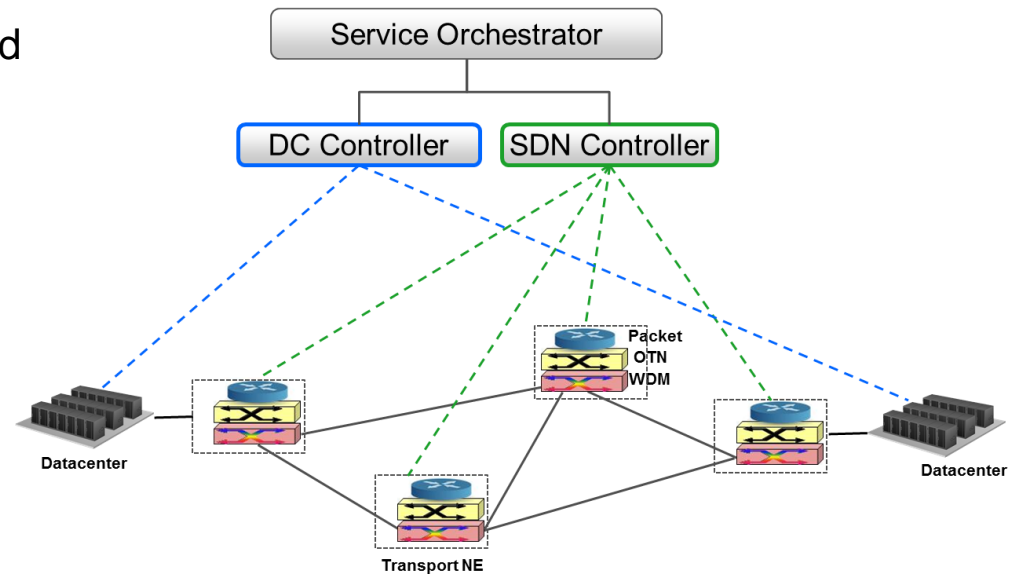
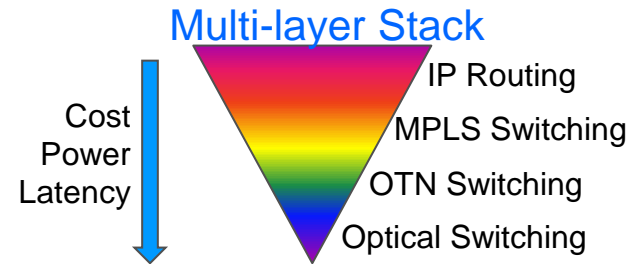


SDN for Transport Networks

- SDN – initially focused on packet switching and intra-datacenter networking
- Focus shifting to WAN including optical transport networks, also wireless

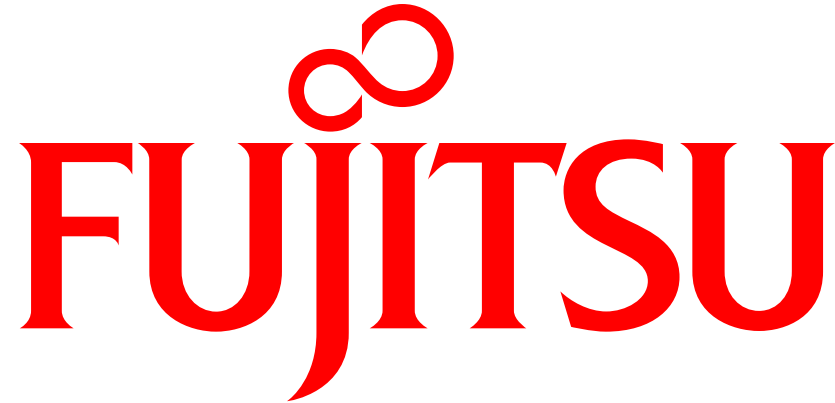
■ Why SDN for transport networks?

- Programmability and centralized open interfaces to multi-layer (Packet, OTN, WDM) network for optimized efficiency
 - For example, deliver end-to-end connectivity to meet cost, latency or other constraints
- Ability to offer dynamic connectivity and application services
- Improved service agility
- Virtualization to achieve multi-tenancy



- Standardization in Optical Transport Working Group (OTWG)/Open Networking Foundation (ONF)

Please visit us at Exhibit #10



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