



Creating Infinite
Possibilities.

Photon Avatars in the Comcast Cosmos: An End-to-End View of Comcast Core, Metro and Access Networks

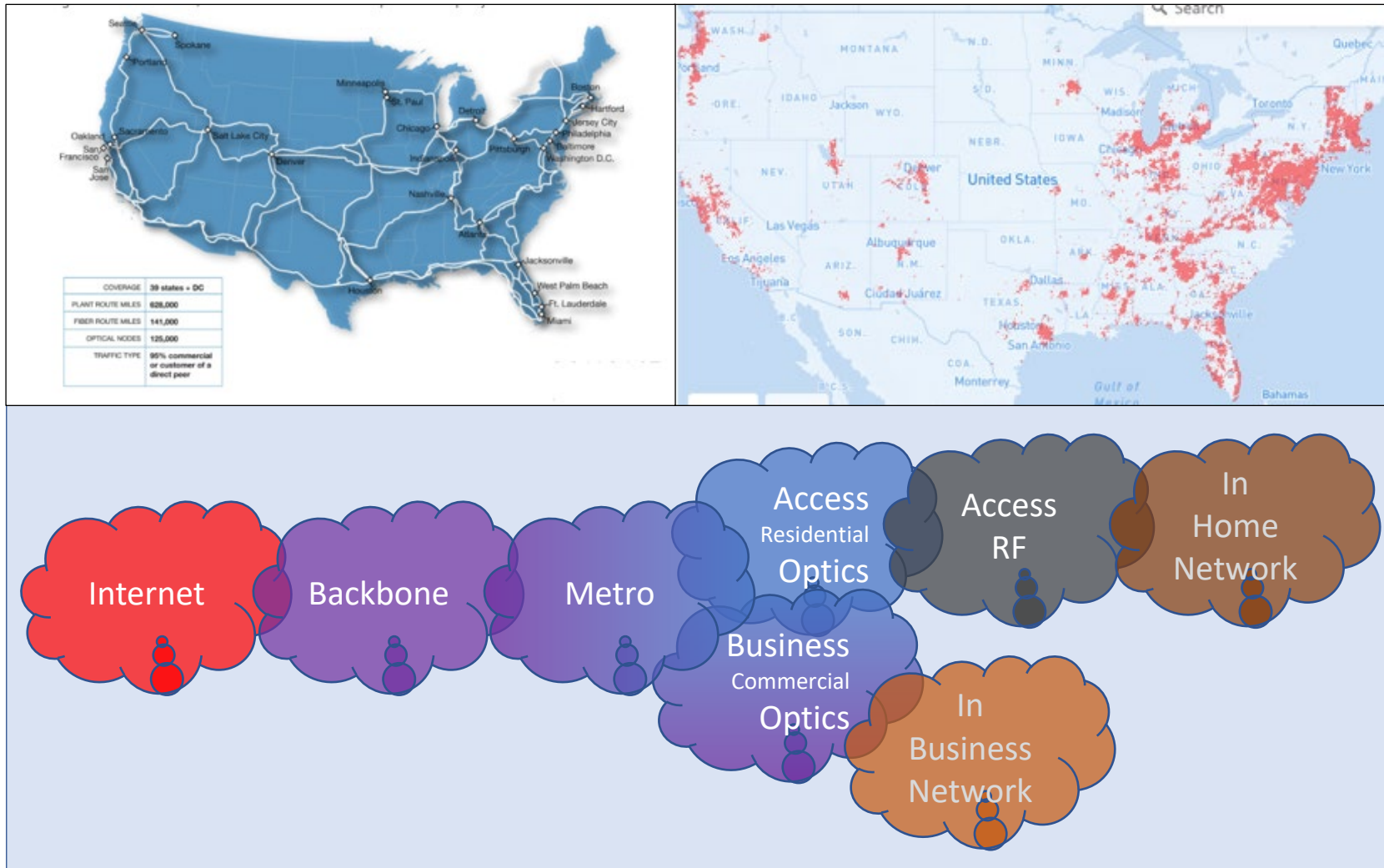
Venk Mutalik

Fellow

Comcast

1.860.262.4479 venk_mutalik@comcast.com

The Big Picture: Core – Metro - Access Networks

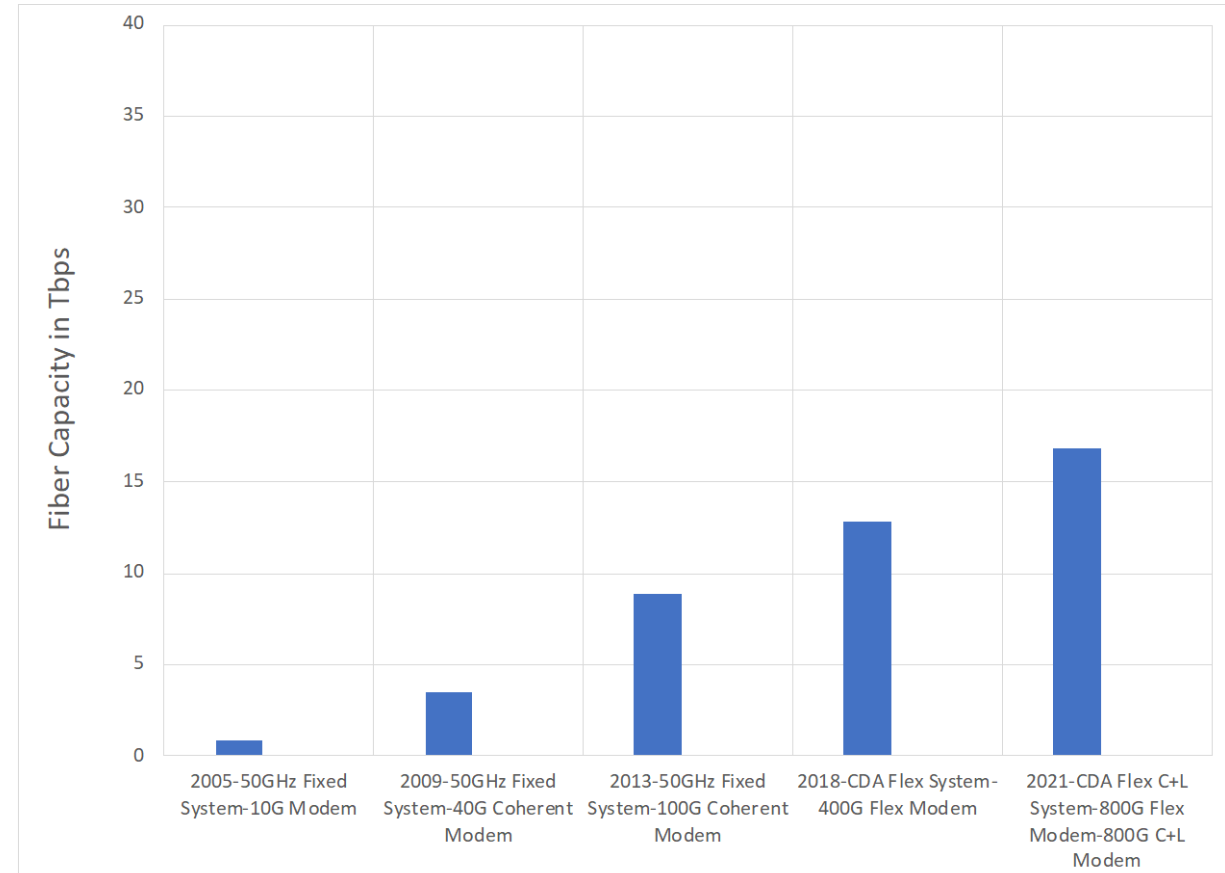


Introduction

- The Big Picture
- The Backbone Network
- The Metro Network
- The Access Network
- Conclusions

The Backbone

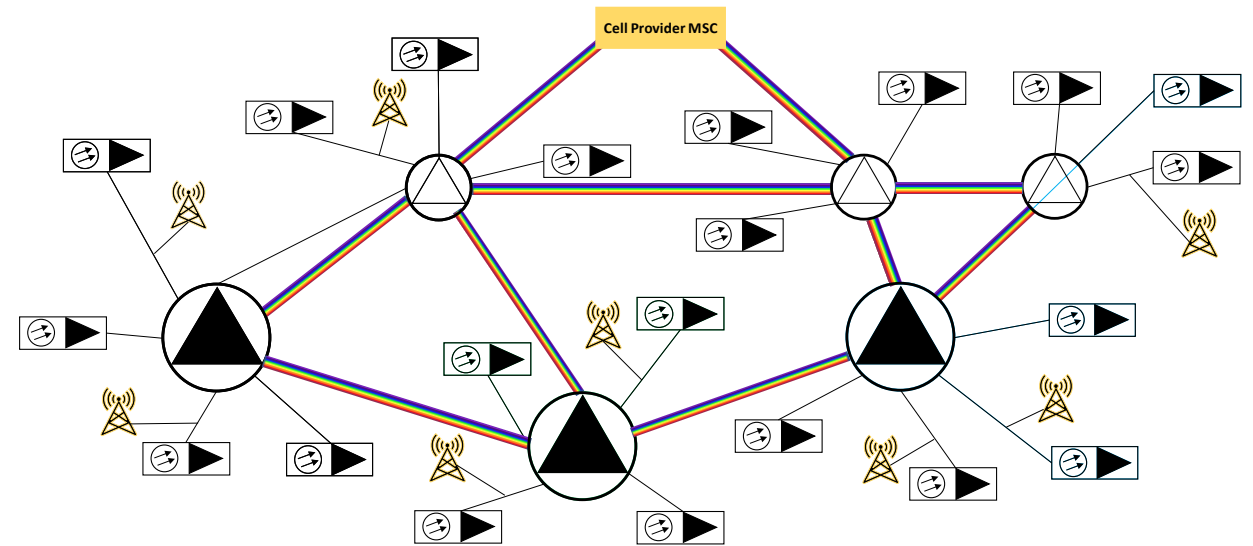
- Began as 28 separate Networks
- Moved to a 2-Fiber National Backbone
 - Passed thru the 28 Metros
 - Fiber Lateral interconnections
 - Connect to the Carrier Hotels site
- 2005-2013 Based off of 50G Fixed Grid
 - 10G, 40G and 100G WLs
 - Transponders and ROADMs
- By 2015 moved to Flex Grid
 - 100G, 400G and a move to 800G
 - Transponder/Plugs and ROADMs
- Innovations
 - Power and CI
 - IPoDWDM and Alien Waves
 - Network Automation



Relentless CAGR growth, Ceaseless Innovations

The Metro

- Began as separate Networks
- Acquisitions and organic growth fed
- Now operate as ONE MSO metro
- Meshy, Responsive and Reliable



Metro Basics

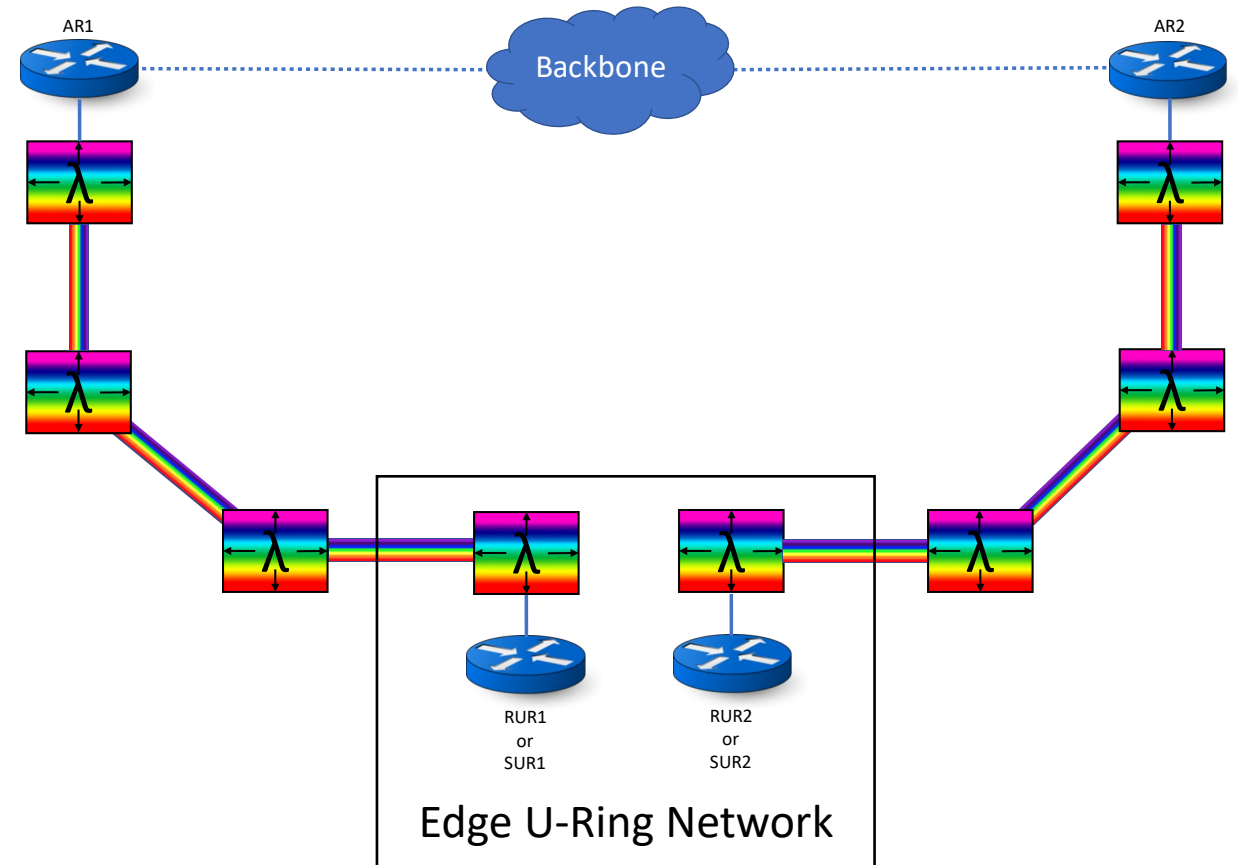
Basic Metros are all U-Rings

- Connected to dual Backbone locations
- ROADM degrees => Meshy networks
- Meshy Network => Higher Connectivity
- Meshy Network => Low Latency Options

Traffic: Capacity vs. Connectivity

- Law of Large Numbers
- Resi – High Capacity but Predictable
- Com – Low Capacity but Un-Predictable

Logical U-Rings



Optics – Form Factors - Reach and ROADMs

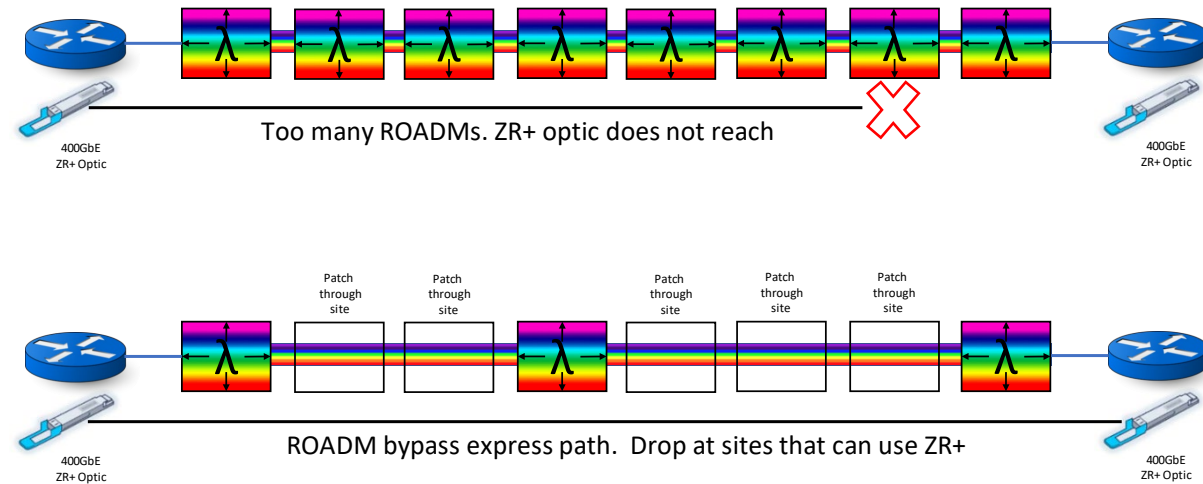
New Pluggables are out and about

- 400G ZR at -10dBm and ZR+ at 0dBm
- Convenience but at a tradeoff
- Drops and Connectivity

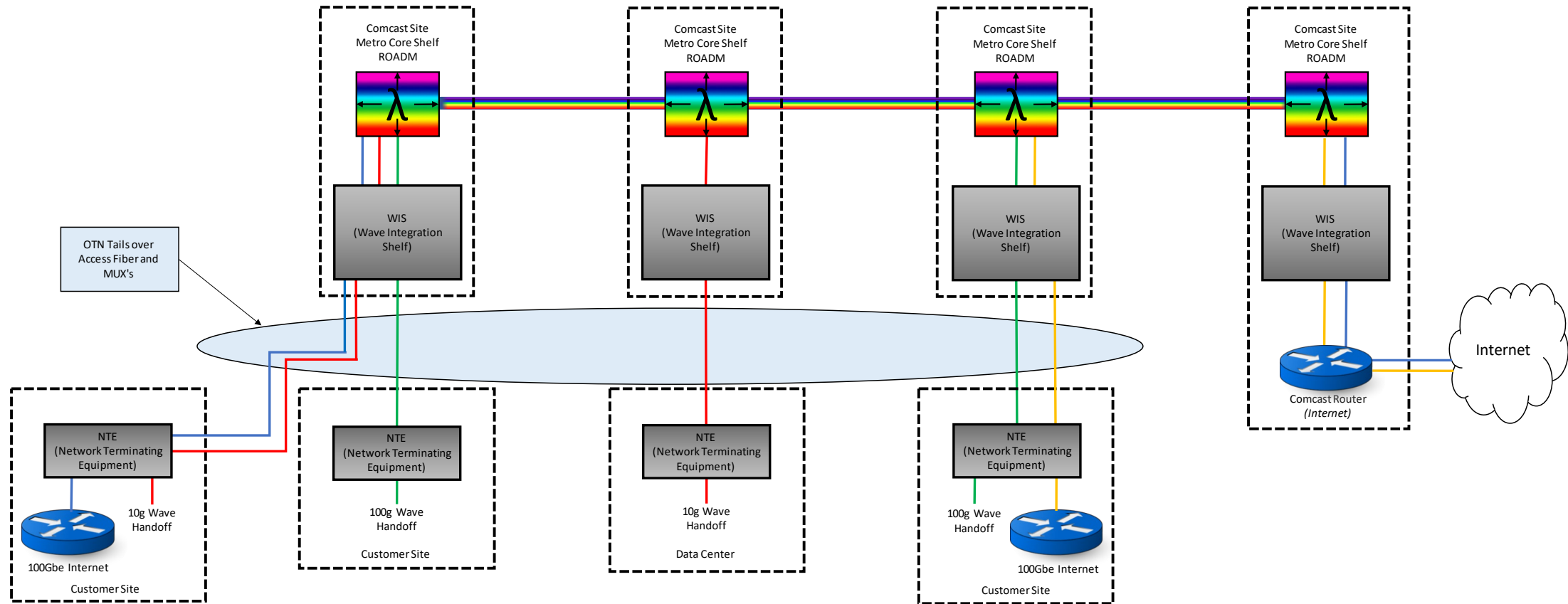
Line Systems and Aliens

- IPoDWDM
- Operations and Support

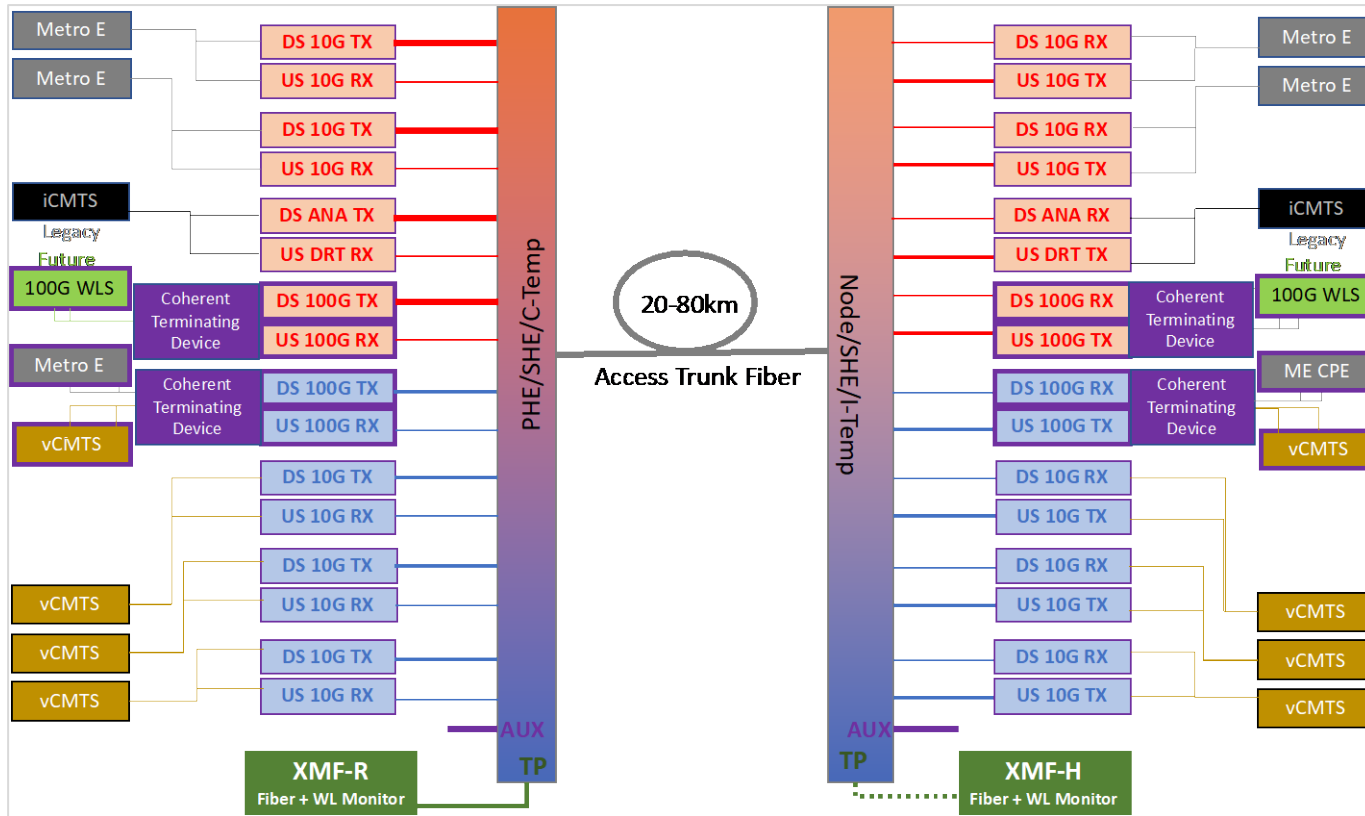
Metro and Access Networks together



Leveraging Access and Metro to serve Commercial Services



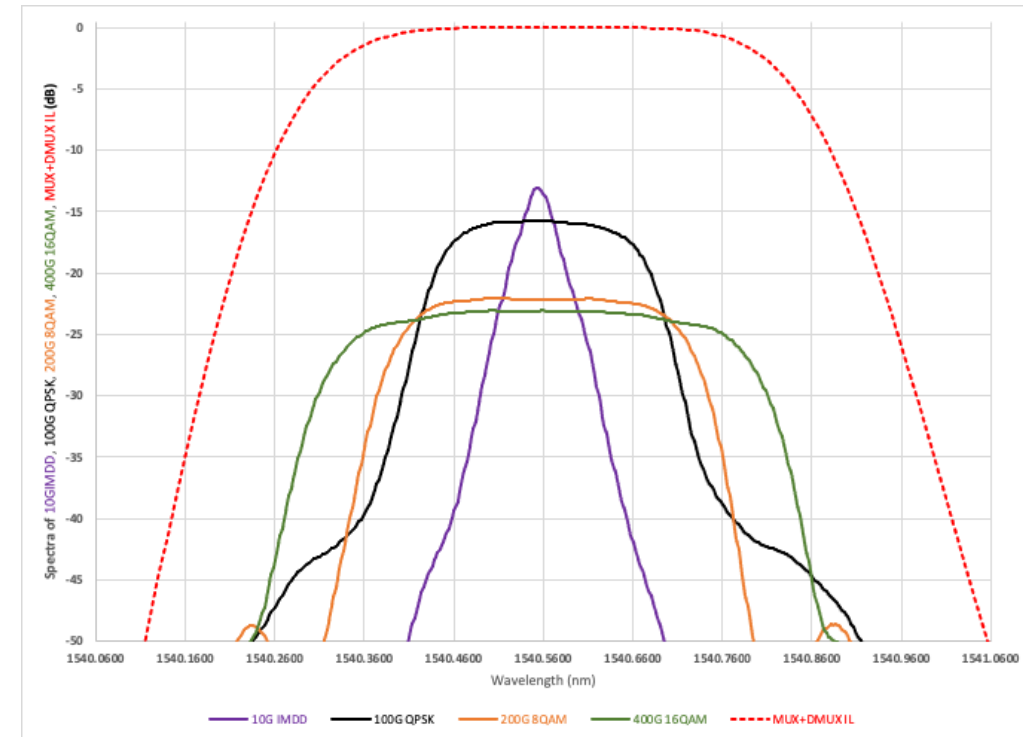
Access System



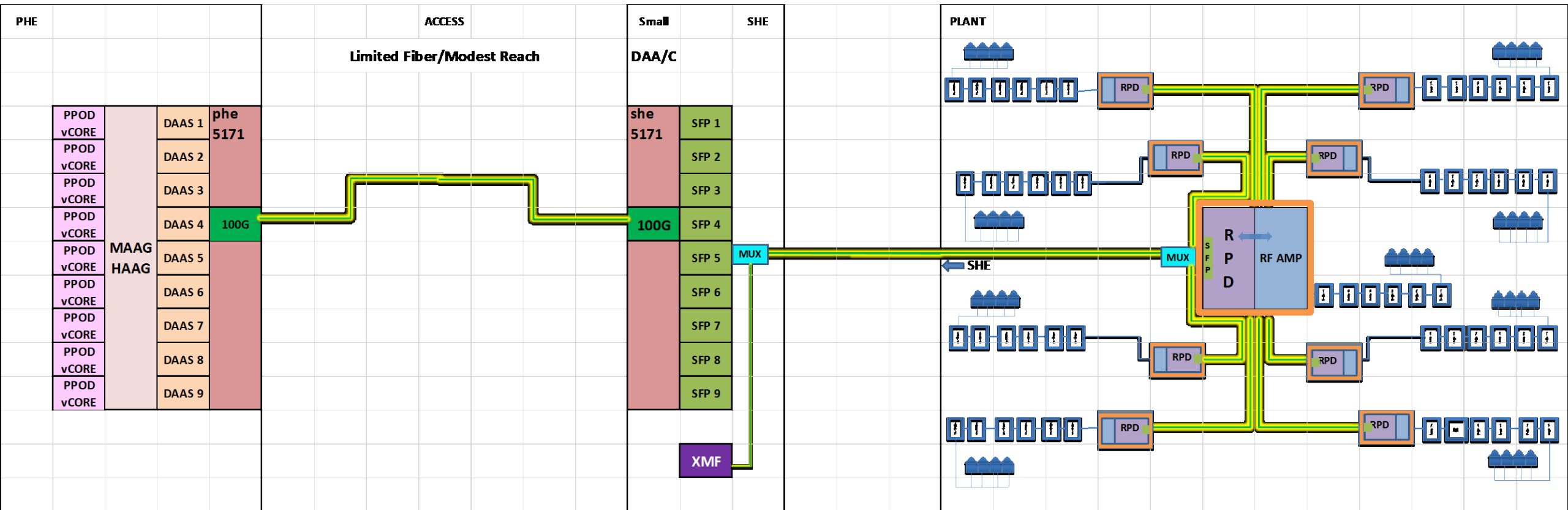
Bi-Directional, single fiber operation

Legacy Analog, Digital Return, 10G DAA, 10G PON, 100G Coherent
Usually no in path EDFA - Continuous and Pervasive Monitoring

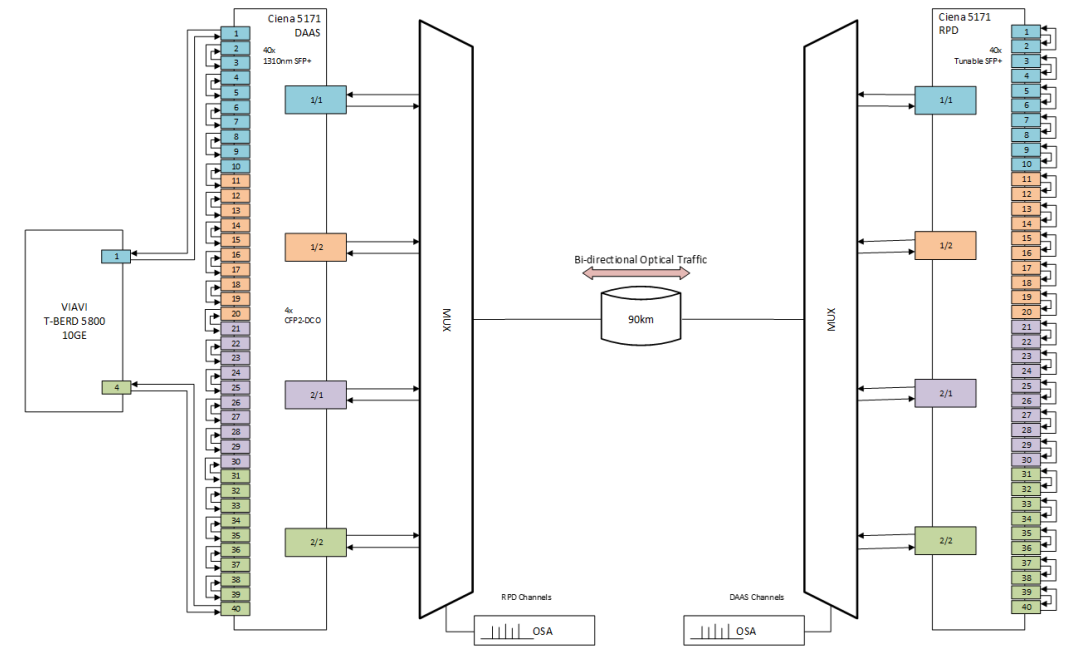
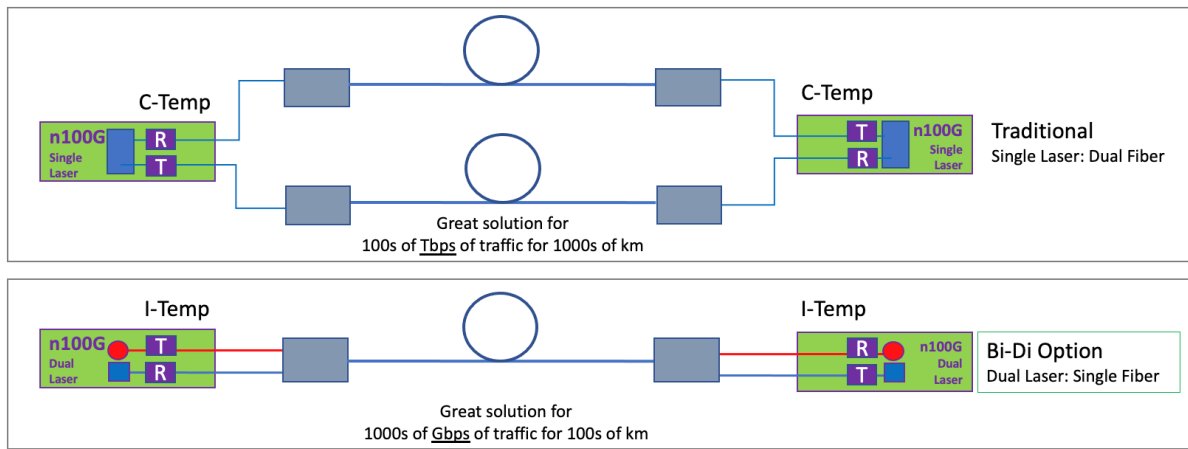
Optical Passives



Enable Bi-Directional, single strand operation
10G DAA, 100G, 200G and 400G
100G Spacing grid – accommodate Flex ...



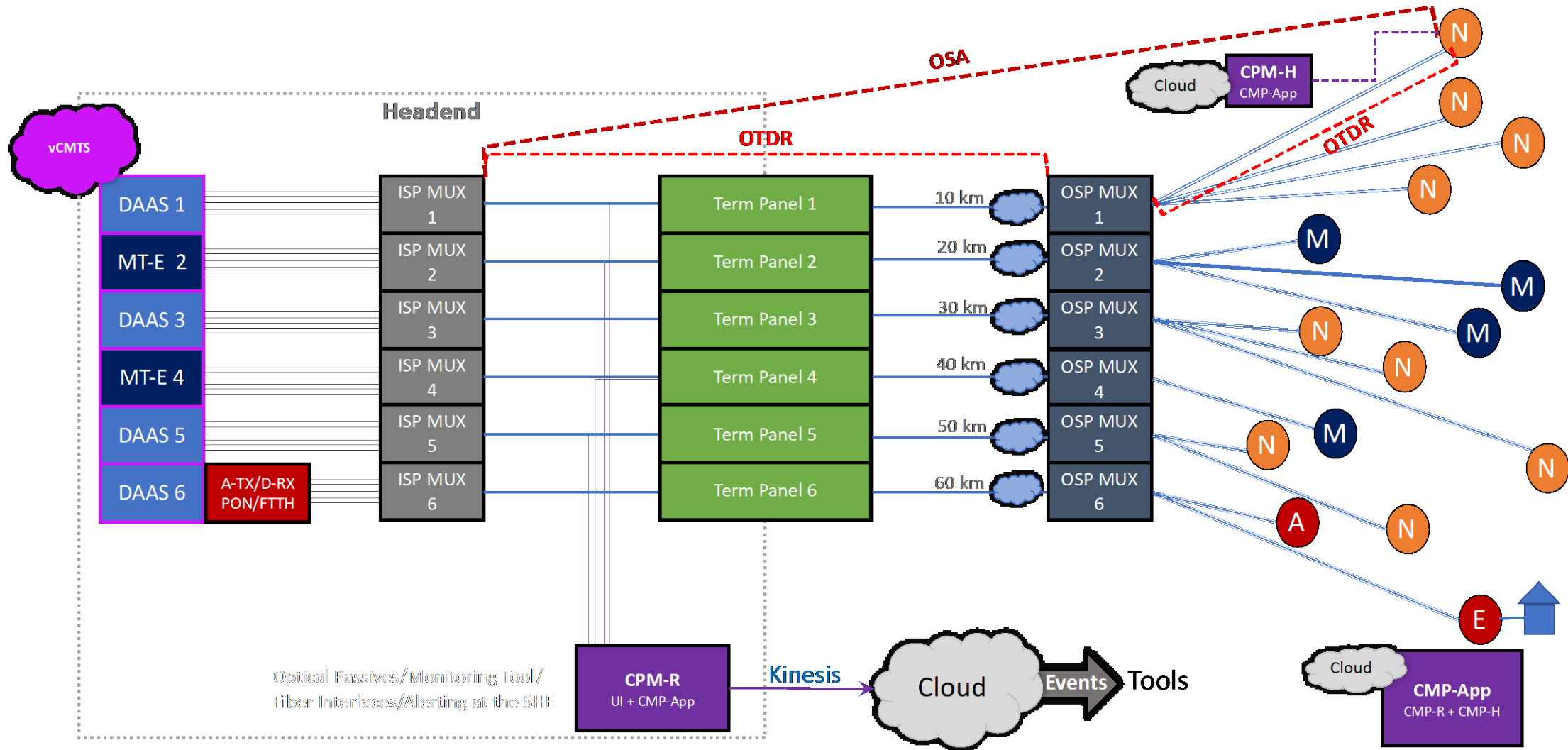
100G Coherent Innovation: PoC and Trial



Dual Laser Bi-Directional CFP2 100G Coherent Optics
 Interconnect DAA Systems across fiber and CI impacted areas
 Provide a path for an Optically Convergent Access Architecture

Hybrid Loop Test: $90 * 2 * 40 = 7200\text{km}$ cumulative
 Single Fiber, Bi-Directional, I-Temp Capable Optics
 No Errors – Limited Jitter

Continuous and Pervasive Monitoring



Conclusions

- Life of a Photon in Comcast described ...
 - Rebirths along the way - Internet -> Core -> Metro -> Access -> Customers and back
- Comcast Networks are all driven by organic growth and acquisitions
 - Built and augmented over the years
 - Innovations in Capacity, Reliability and Connectivity across Core, Metro and Access
 - Moves towards IPoDWDM/Alien Waves in Metro and Core
 - Leveraging Metro and Access to serve commercial customers
 - Innovative Bi-directional dual laser Coherent plugs for the access domain
 - Converged Access Architecture with Continuous and Pervasive Monitoring



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Possibilities.

Thank You!

Venk Mutalik, Steve Ruppa, Fred Bartholf, Bob Gaydos, Steve Surdam, Amarildo Vieira, Dan Rice

Comcast

1.860.262.4479 venk_mutalik@comcast.com