Next Generation Broadband Networks

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Next Generation Broadband Networks

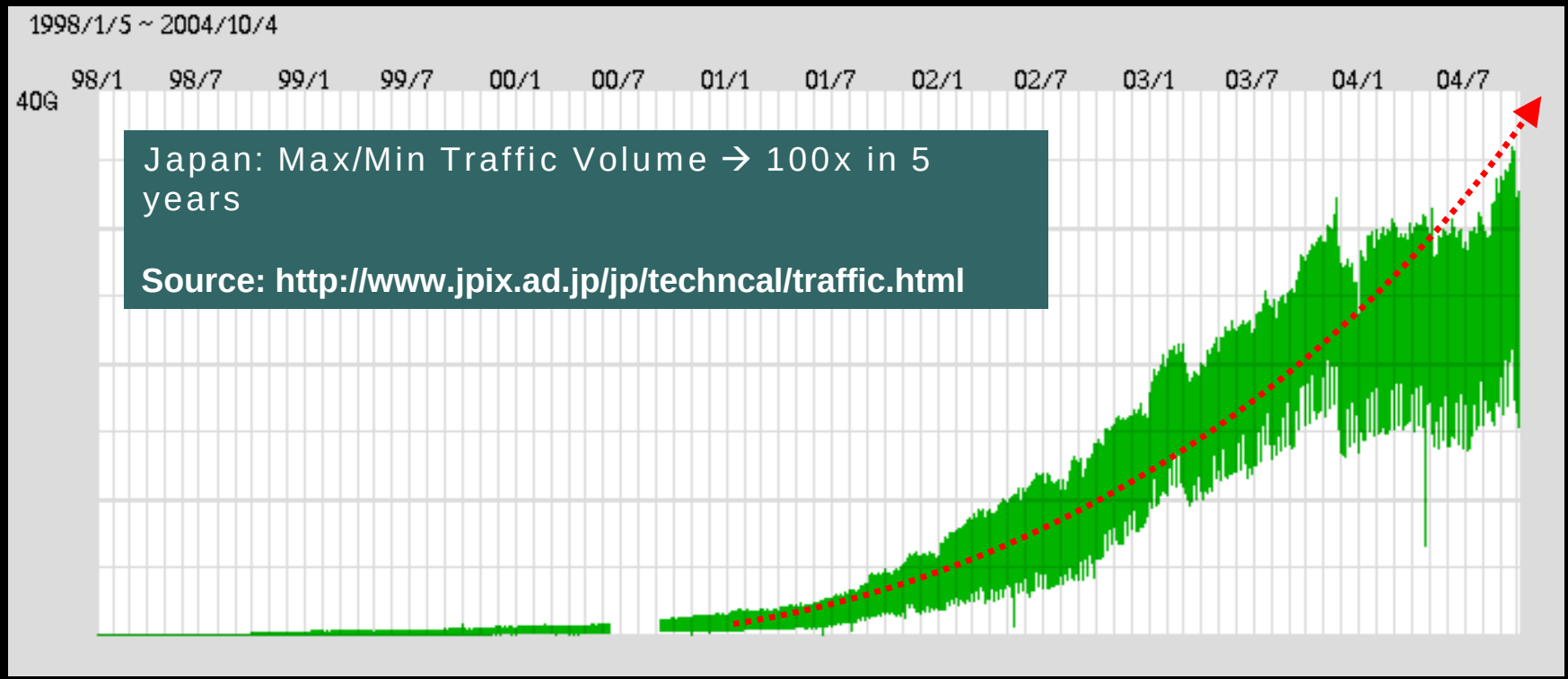
Cisco.com

- The broadband opportunity, in Asia and worldwide
- Cisco R&D for the broadband opportunity
- IP-Optical Integration: building broadband networks efficiently
- Early-adopter example of IP+Optical integration

Broadband driving factors in Asia

- Asia is world-leader in...
  - True broadband access (up to 100 Mbit/sec commonplace)
  - Mobile communications (3G and beyond)
- Significantly ahead of other geographies
- Unique situation with IPv6 adoption

Network Growth - the need for broadband



- **Only a true optical layer can accommodate such traffic growth!!!**

Broadband in Asia – Implications for Cisco

- Need to benefit from this leadership…
- …and apply to products for worldwide market
- Conclusion:

Create development centre in Tokyo!

Cisco Japan Development Center (JDC)

- Software development for worldwide markets…
- …defined by Japanese requirements
- Development of features for IOS and IOS-XR router software:
  - Intelligent Edge
  - IPv6
  - IP Mobility
- Initially 10 engineers, based in Tokyo

Broadband Network Core Architecture IP+Optical Integration

How to support this broadband growth?

- More core bandwidth
- Dense Wave Division Multiplexing
- IP+Optical Integration

Increasing circuit bandwidth

- OC-192 now widespread
- OC-768 adoption starting
- Cisco's answer is the CRS-1 for ultimate bandwidth core networks

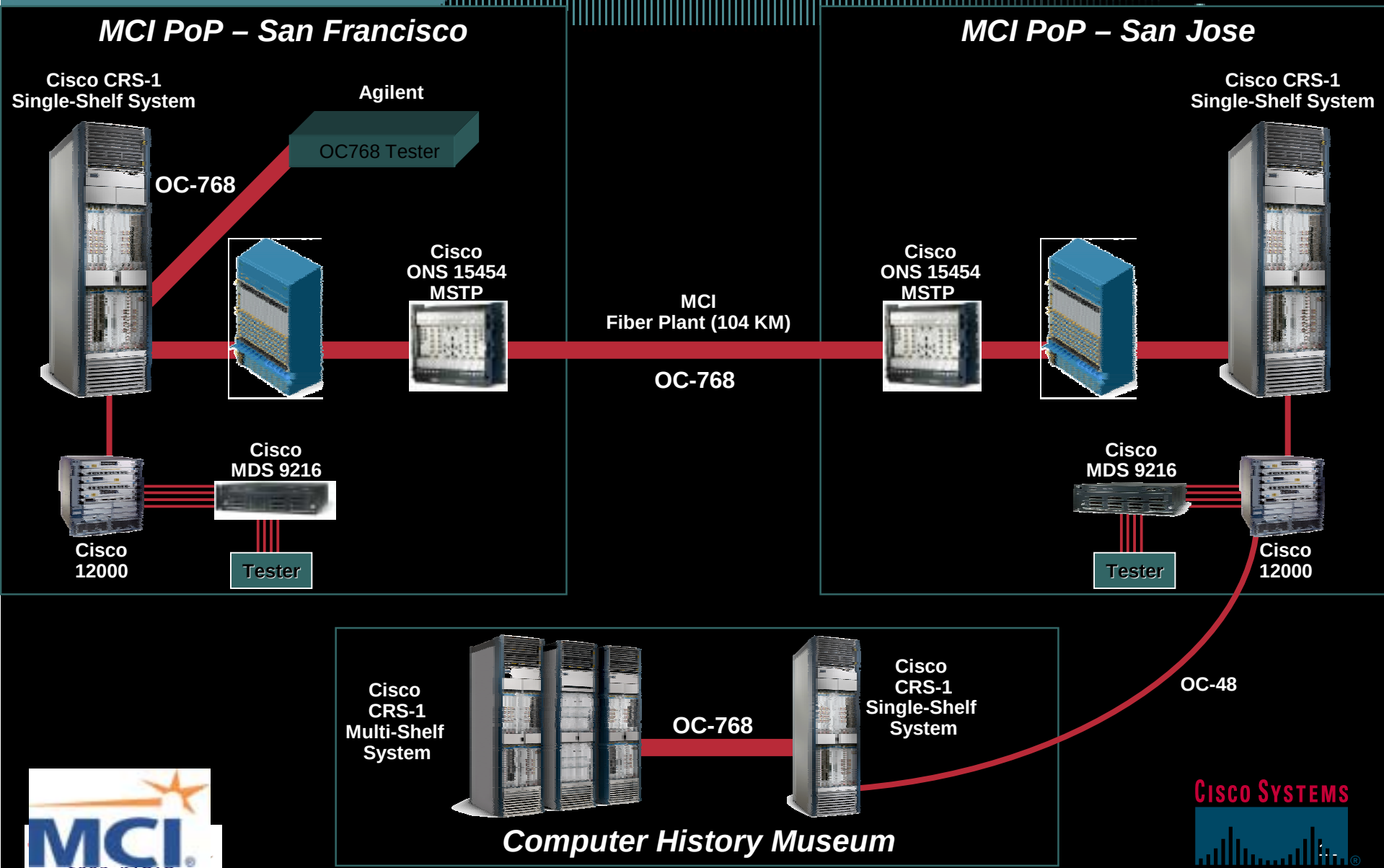
IP+Optical Integration

Cisco's IP+Optical Strategy:
Building blocks & Technologies

- **IP/Optical Element Integration:**
  - 10G DWDM interfaces on routers as an entry point into the optical domain
  - 40G DWDM interface over 10Gbps transport
  - 2.5G WDM for lower end applications
  - Advanced LH DWDM layer w extensive optical control loops and monitoring
  - Ring Optical Switching using ROADMs
  - Mesh Optical switching using λ Routers
- **Control Plane Technologies:**
  - LMP
  - Peer model (GMPLS)
  - Overlay model (O-UNI)
- **Network Management Integration**

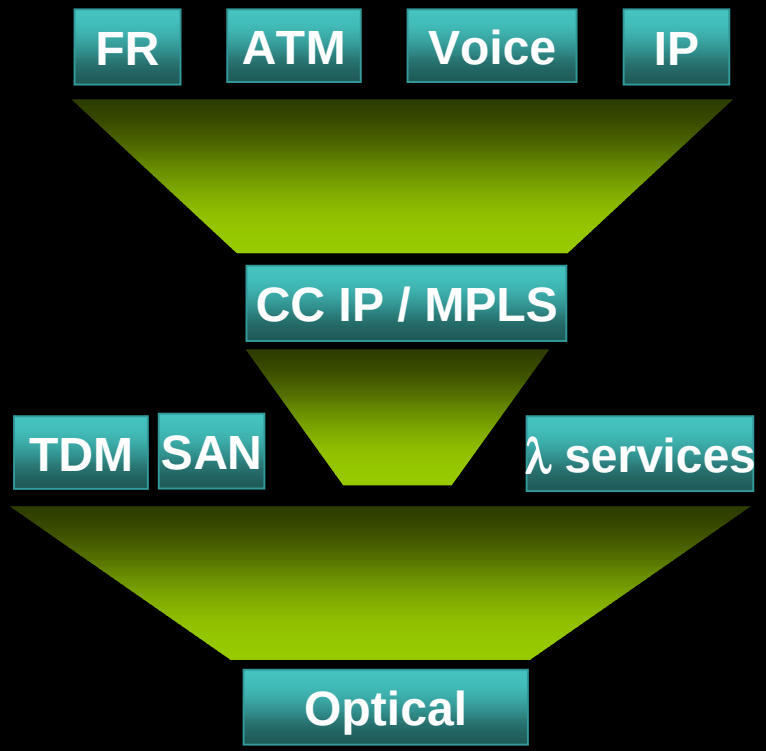
World's First 40G IP Transmission:

Power by Cisco CRS-1 and MSTP (DWDM) over MCI Infrastructure



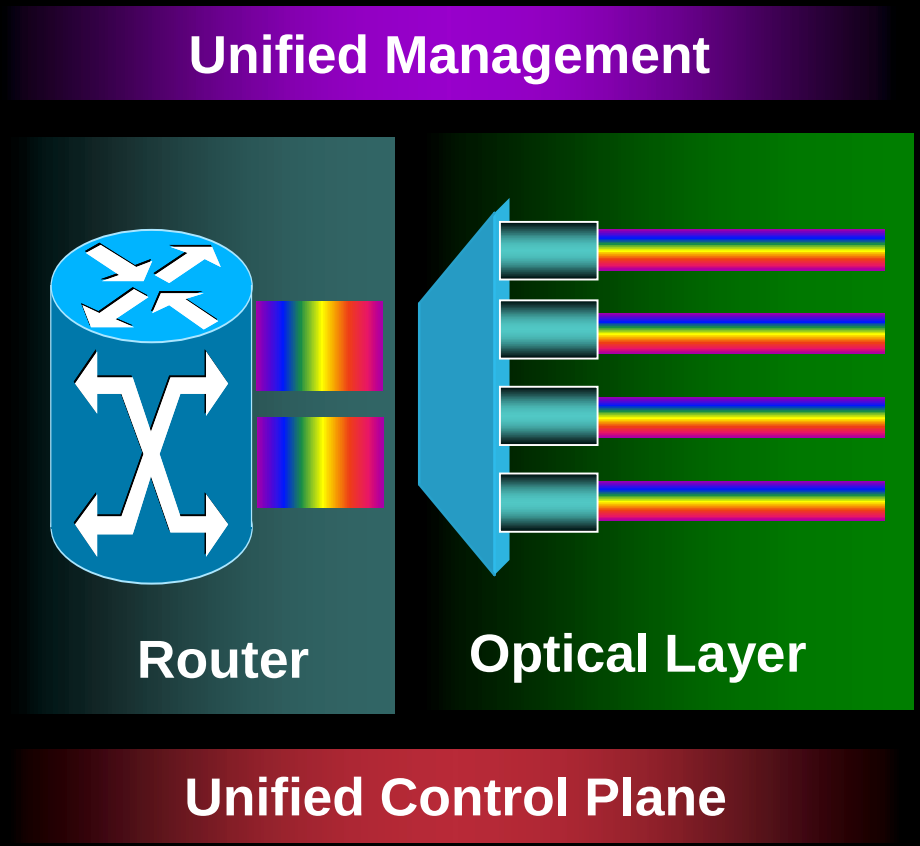
IP+Optical Integration

- Packet layer convergence to IP/MPLS is starting to deliver CAPEX and OPEX savings in core networks
- 20%-40% additional CAPEX/OPEX saving can be had by converging the IP layer and the optical layer
- The building blocks exist: core routers, DWDM layer (MSTP), and converged management and control efforts



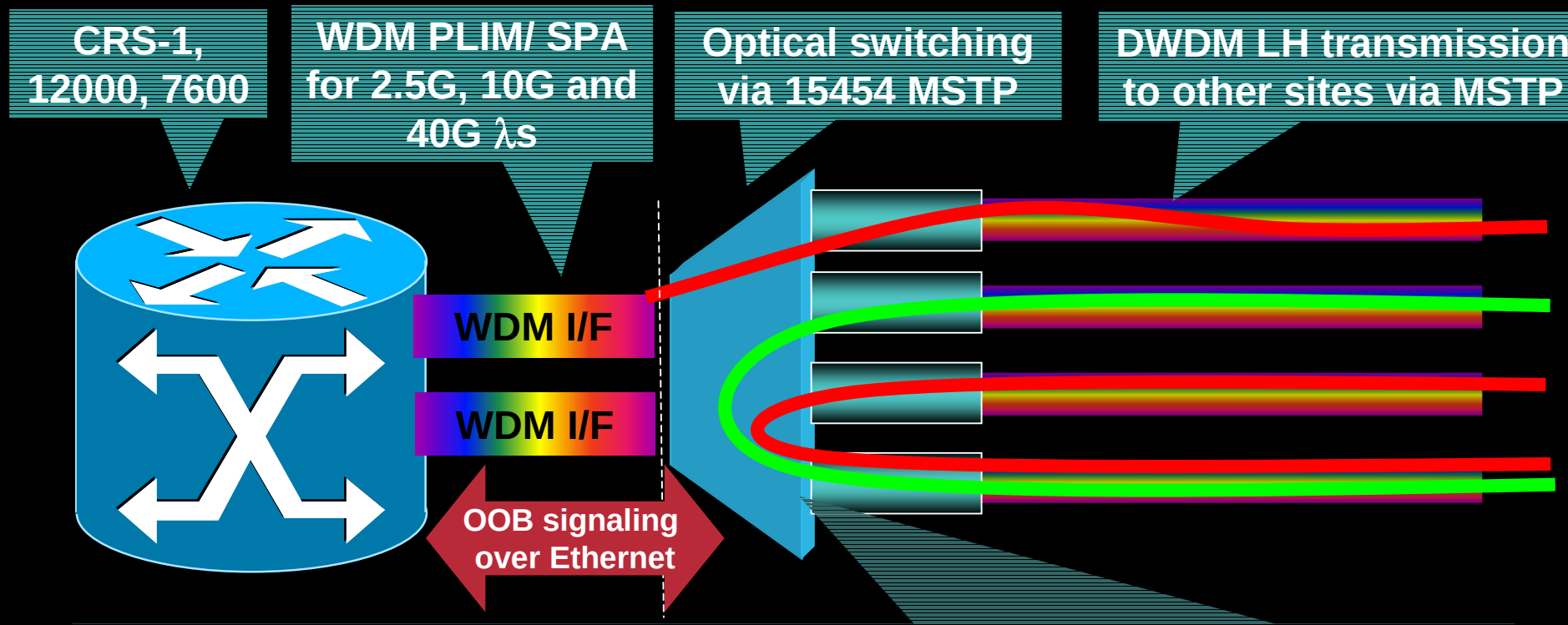
IP+Optical Building blocks

- Goal: end-to-end optical layer onto which TDM, IP & λ services converge
- This solution includes 4 elements:
  1. Colored interfaces directly on the router
  2. A Switched Converged Open Optical Layer
  3. Integrated management
  4. Integrated control plane



Cisco's IP+Optical Strategy:
Base Architecture

CTM managing CRS-1 and 15454 MSTP today



- Optical bypass – without OEO conversion for lowest cost

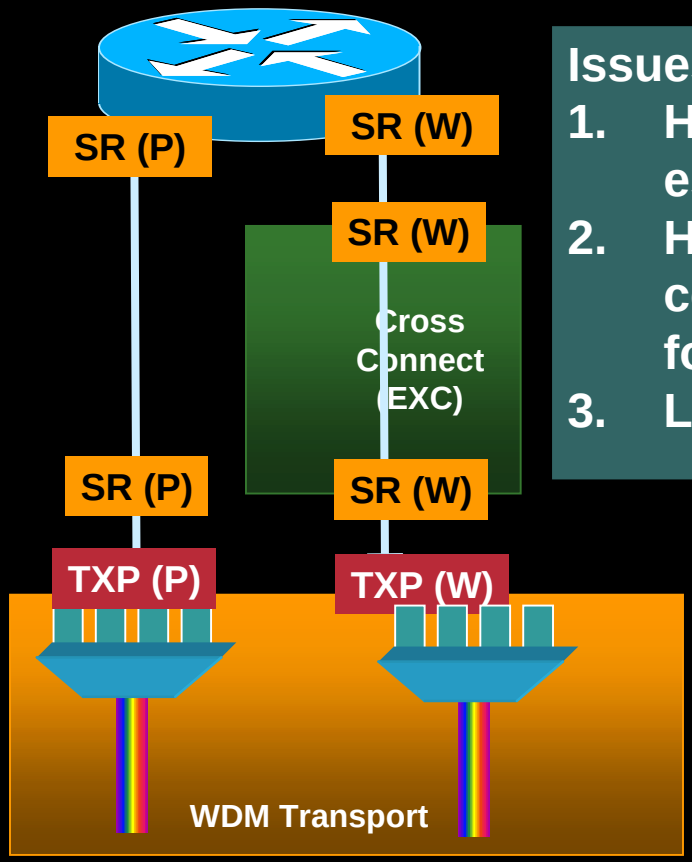
  Regens introduced as needed for very long connections (>1000 km)

Innovative extensions to GMPLS to make is DWDM aware

CAPEX Issues with Current Architecture

Many non-revenue generating costly interconnections

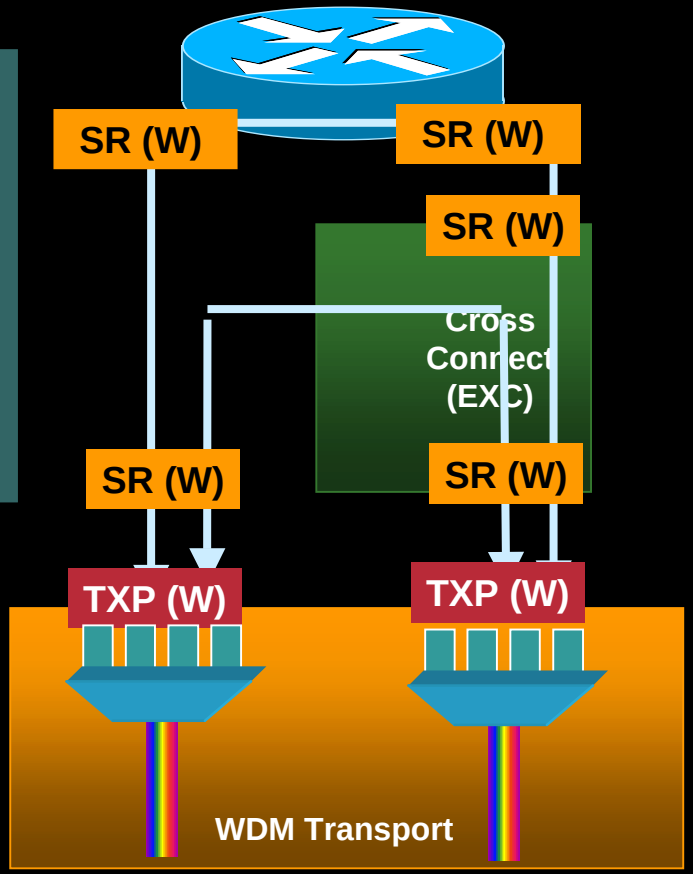
IP Source/Sink Nodes



Issues:

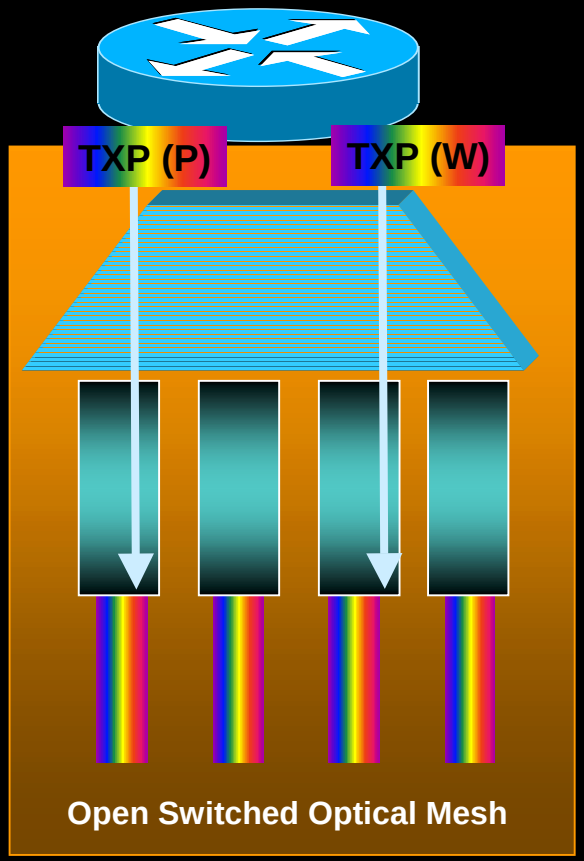
1. High CAPEX – especially at 40G!
2. High OPEX: power consumption & footprint
3. Lower reliability

Transit Nodes



Cisco's IP+Optical Strategy:
Simplifying the Network and Reducing its Cost

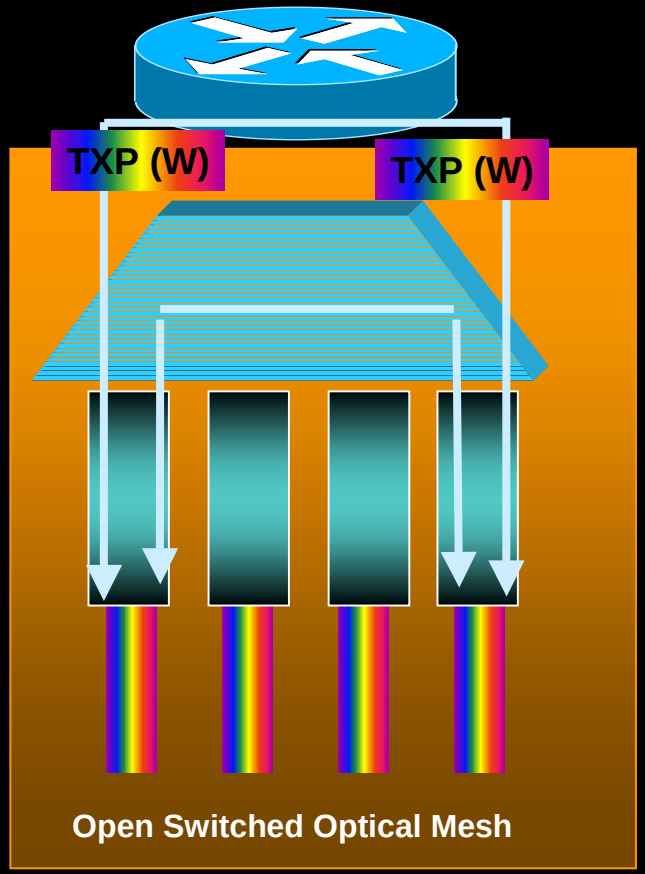
IP Source/Sink Nodes



Issues solved:

1. Racks of transponders eliminated
2. Reduced number of O-E-O conversions increases reliability

Transit Nodes



Next Generation Optical Layer

Planning & simulation tool

Auto Node Setup

ROADM

Auto Power Control

True power measurement

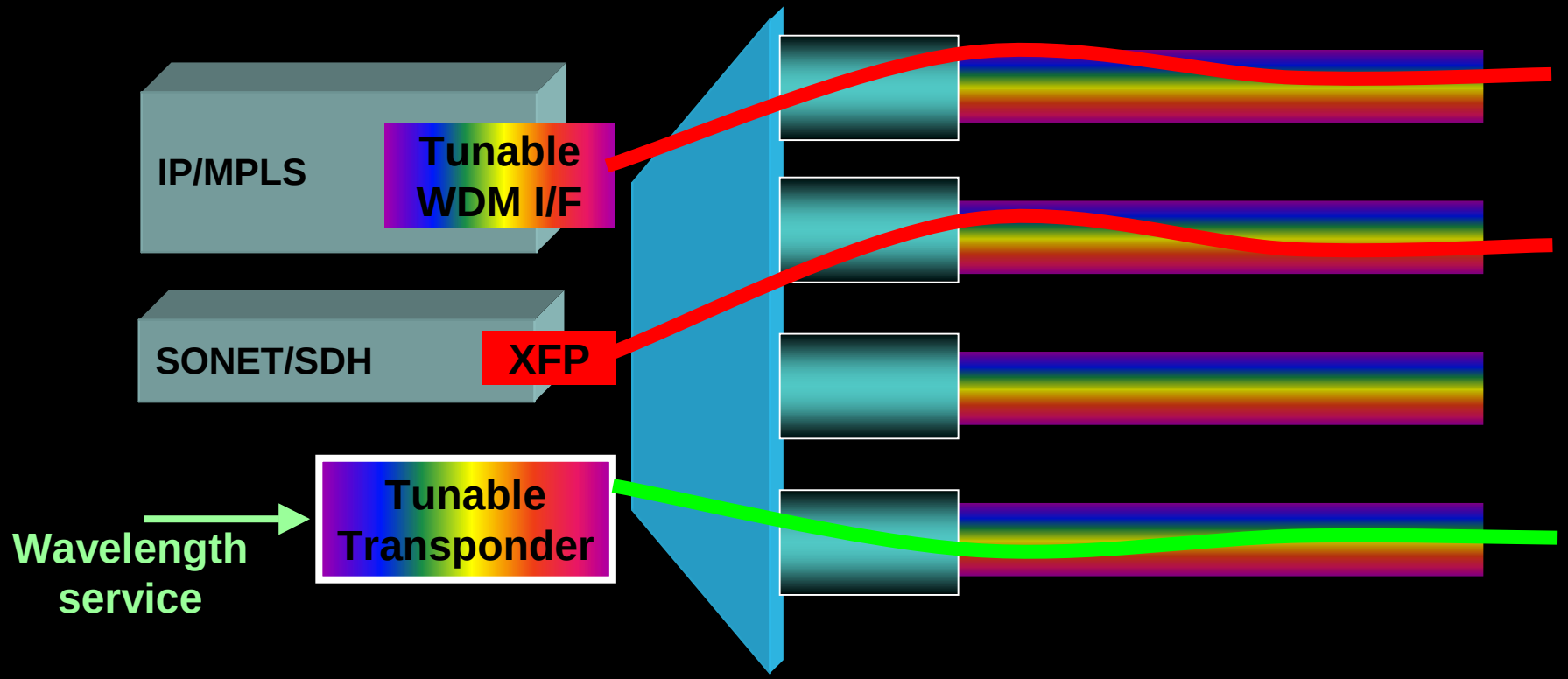
Sophisticated EMS

Easy planning with sophisticated tool

Automated optical layer for end-to-end connection setup; Manual patching of client at end-points only

Simplified, graphical A-Z lightpath provisioning & trouble shooting via CTM

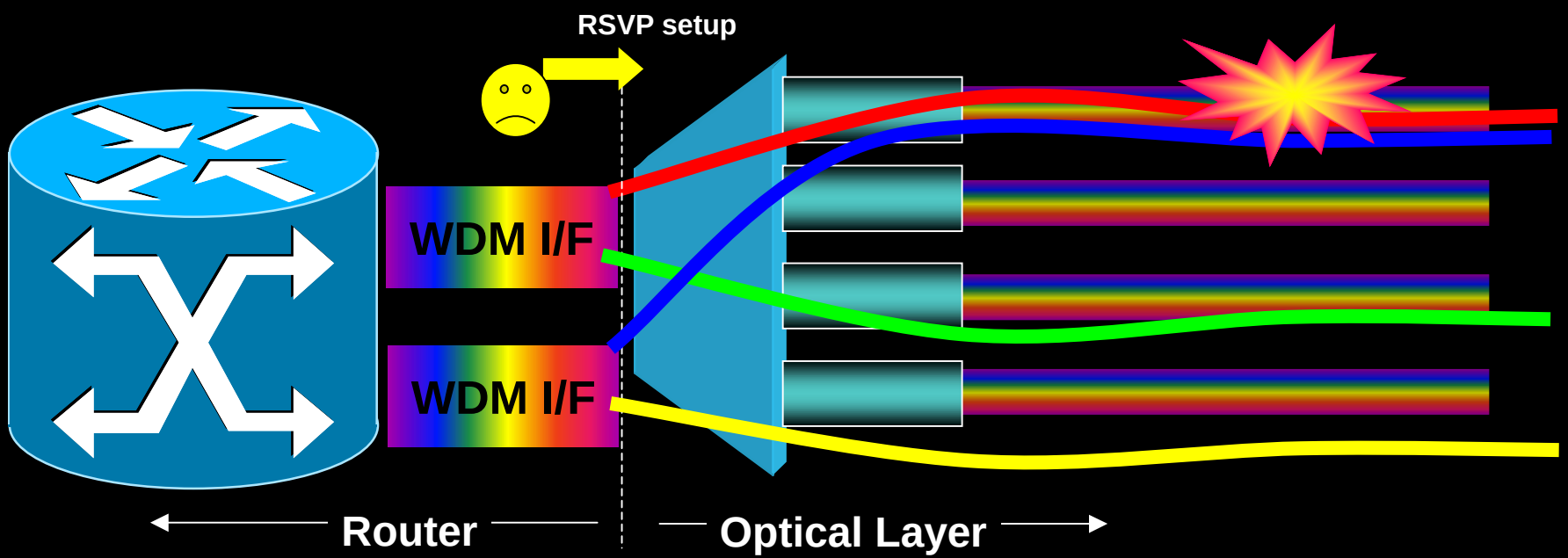
The Switched Open Optical Convergence Layer:
Also for TDM Trunks and Optical Services



One optical layer for packet and TDM client, as well as future high bandwidth "λ on demand"

The Switched Open Optical Convergence Layer:

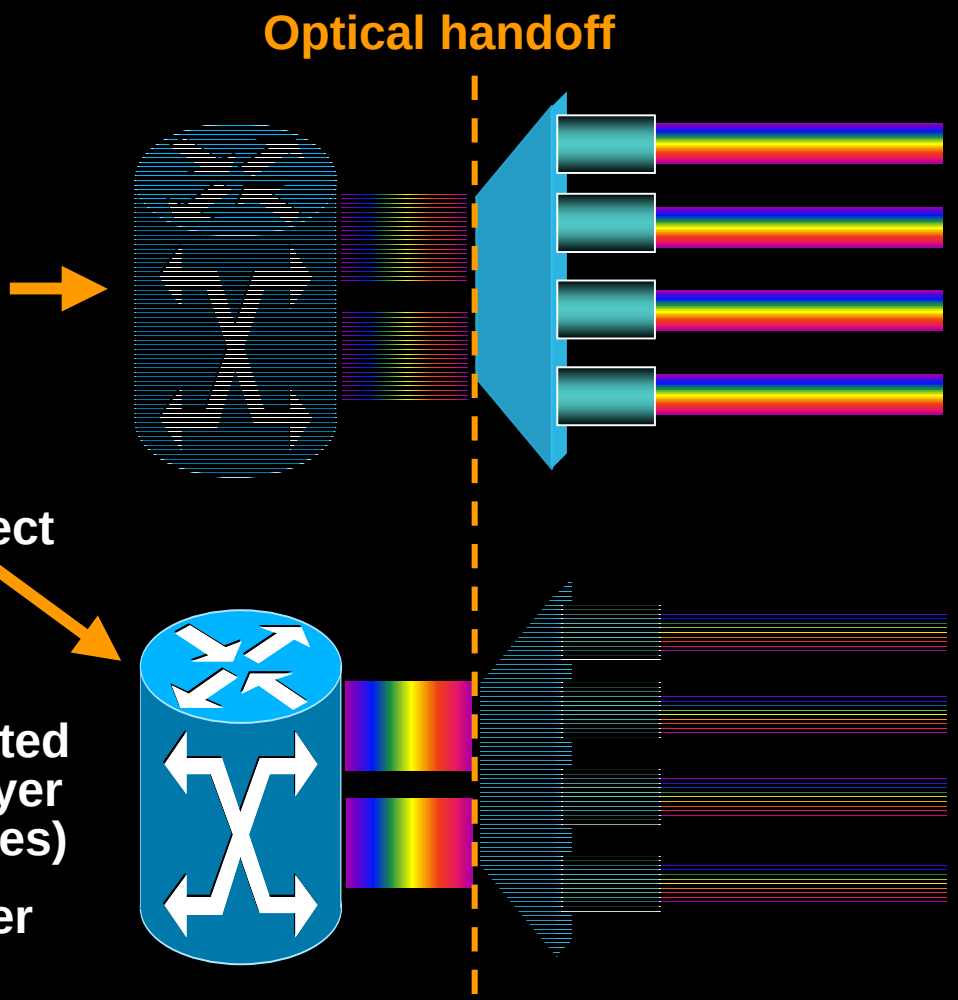
Advanced capabilities



- Flexible switching in the network from day 1:
  - Any router can connect over switched optical layer to any peer router
- Providing hooks for future advanced capabilities via software upgrade:
  - In case of optical layer failures, the optimal response may be restoration in the optical domain – need fast end to end coordination

The Switched Open Optical Convergence Layer:
How is it "Open"?

- The Optical Convergence Layer needs to be open in 2 ways:
  1. Any client can connect to the optical layer via transponder or colored interface
  2. The ITU interfaces on routers can directly connect into any optical layer
- The use-cases for both are:
  1. Non-Cisco clients connected over converged optical layer (DXCs, MSPPs, WL services)
  2. Cisco routers working over non-Cisco optical layer

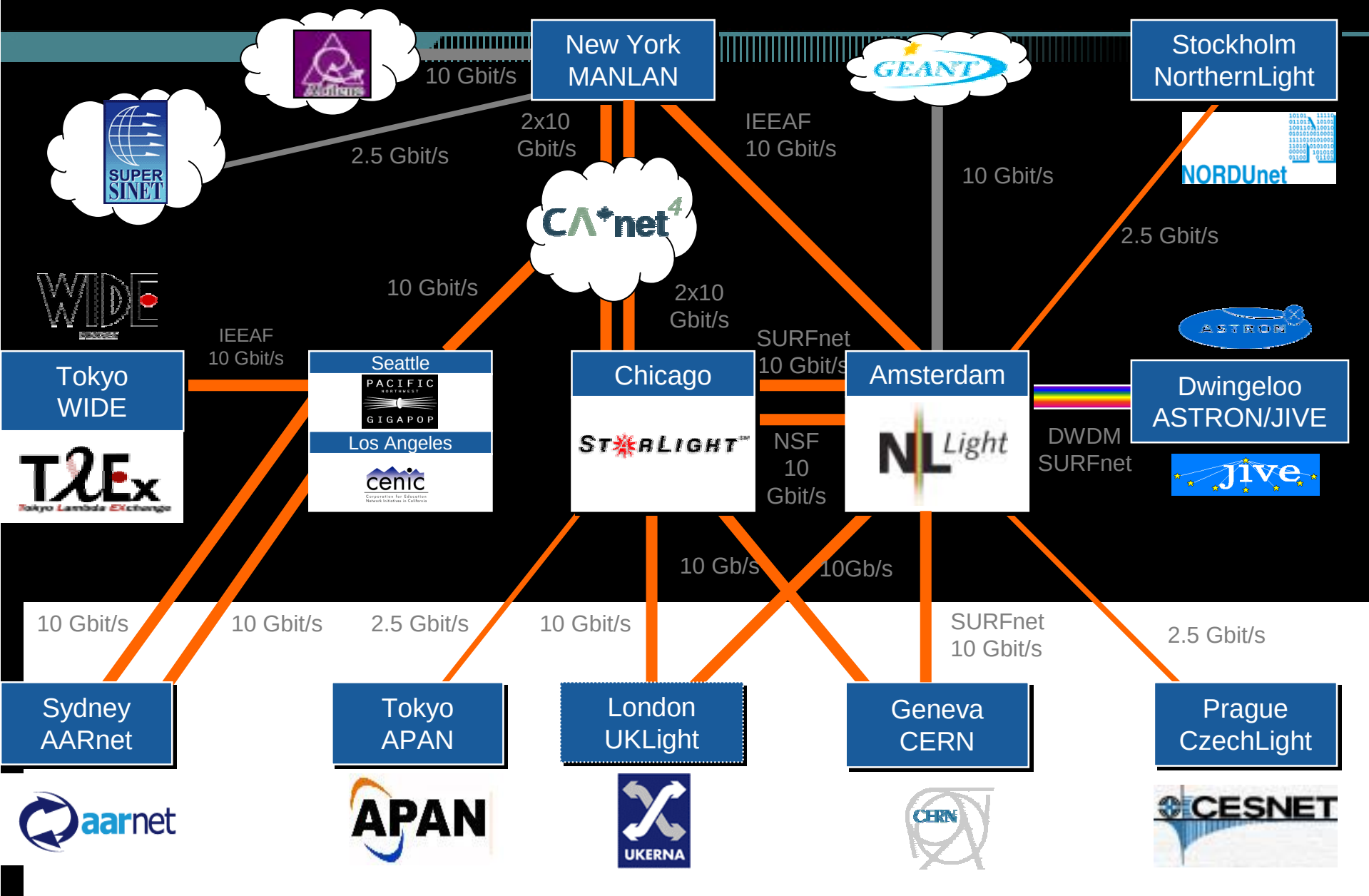


The Switched Open Optical Convergence Layer:
Can optical interoperability be achieved?

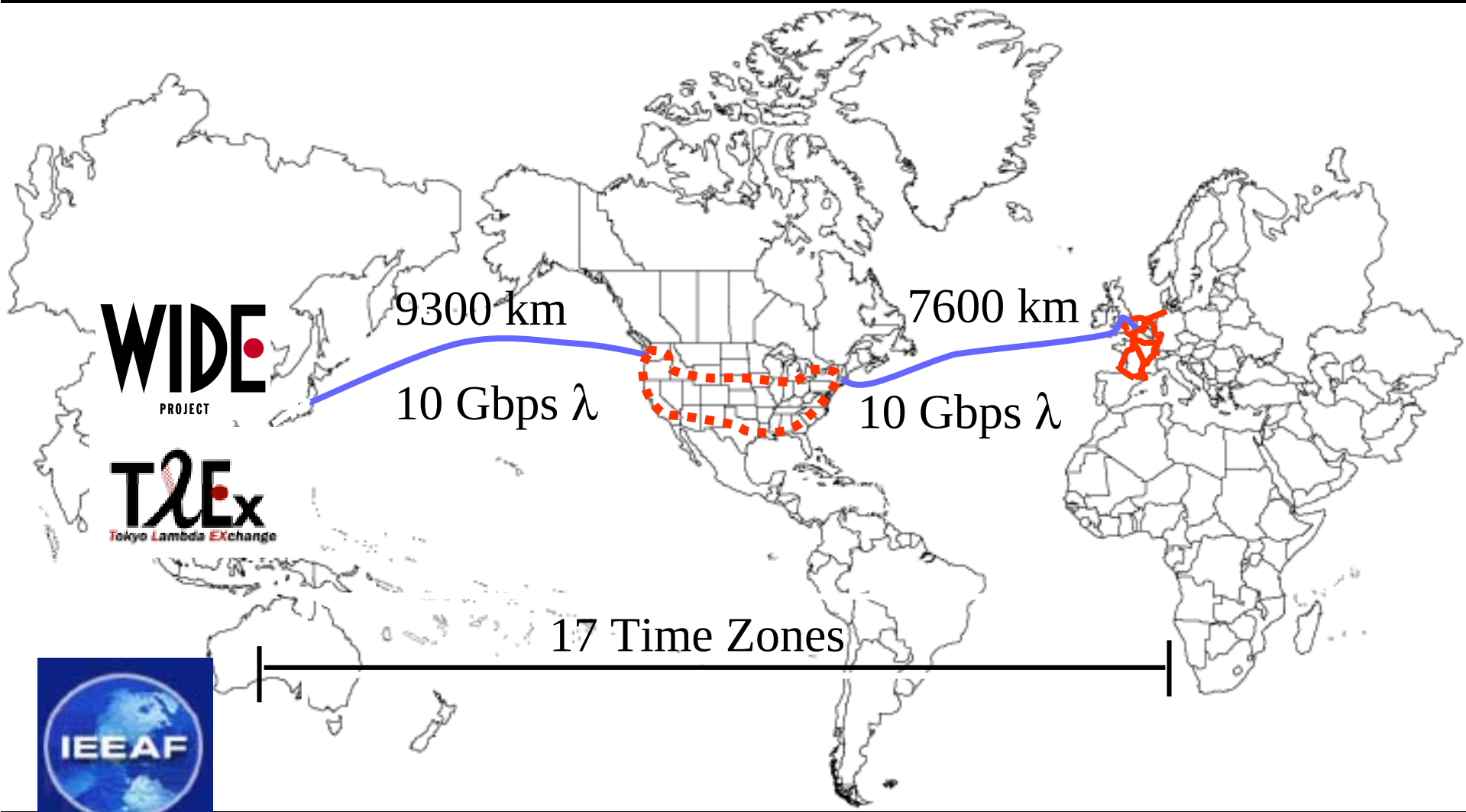
- **Feasible if optical capability is not pushed to the limit**
  1. **Reasonable channel spacing (50-100GHz)**
  2. **Regional reach (500-1000 km)**
  3. **Standard modulation format at 2.5G and 10G**
  4. **Standard G.709 frame and FEC**
  5. **Deploy single-vendor optical islands – as done for SONET/SDH**
- **Optical layer is less sensitive to format changes**
- **Still requires SP push for vendors to agree on pre-standard attributes**

Lambda Networking in Practice

Global Lambda Integrated Facility



World Longest 10GE connection between Japan and CERN, Switzerland



Lambda Networking Test bed in Korea

Source: KREOnet2

Thank You!