10 Gbit Ethernet

HNF-Europe Meeting

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Cern Geneva

Cisco Systems

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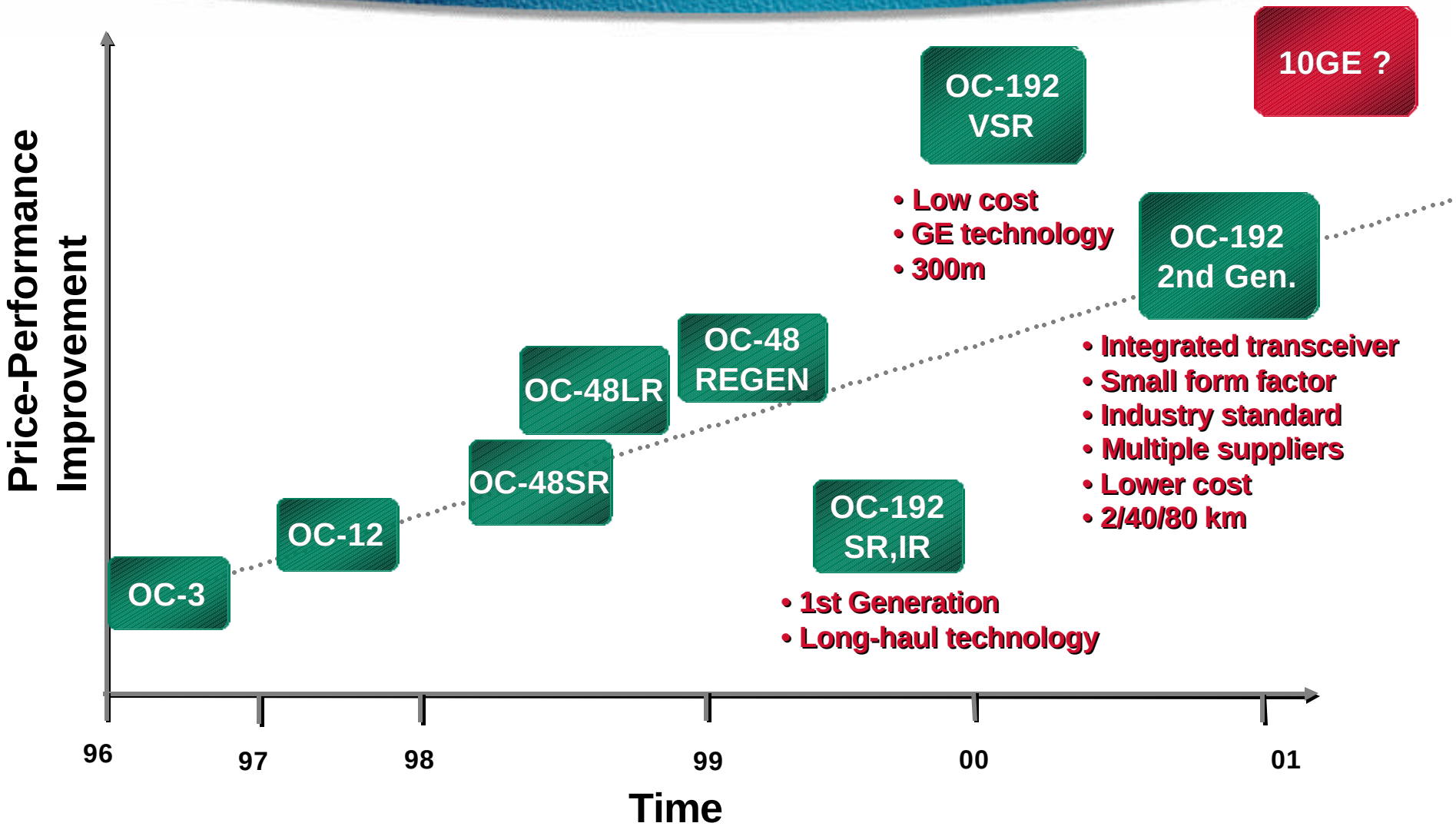
Cisco Systems

Agenda

- Introduction
- OC-192 Optics
- 10 Gigabit Ethernet
- Future Trends

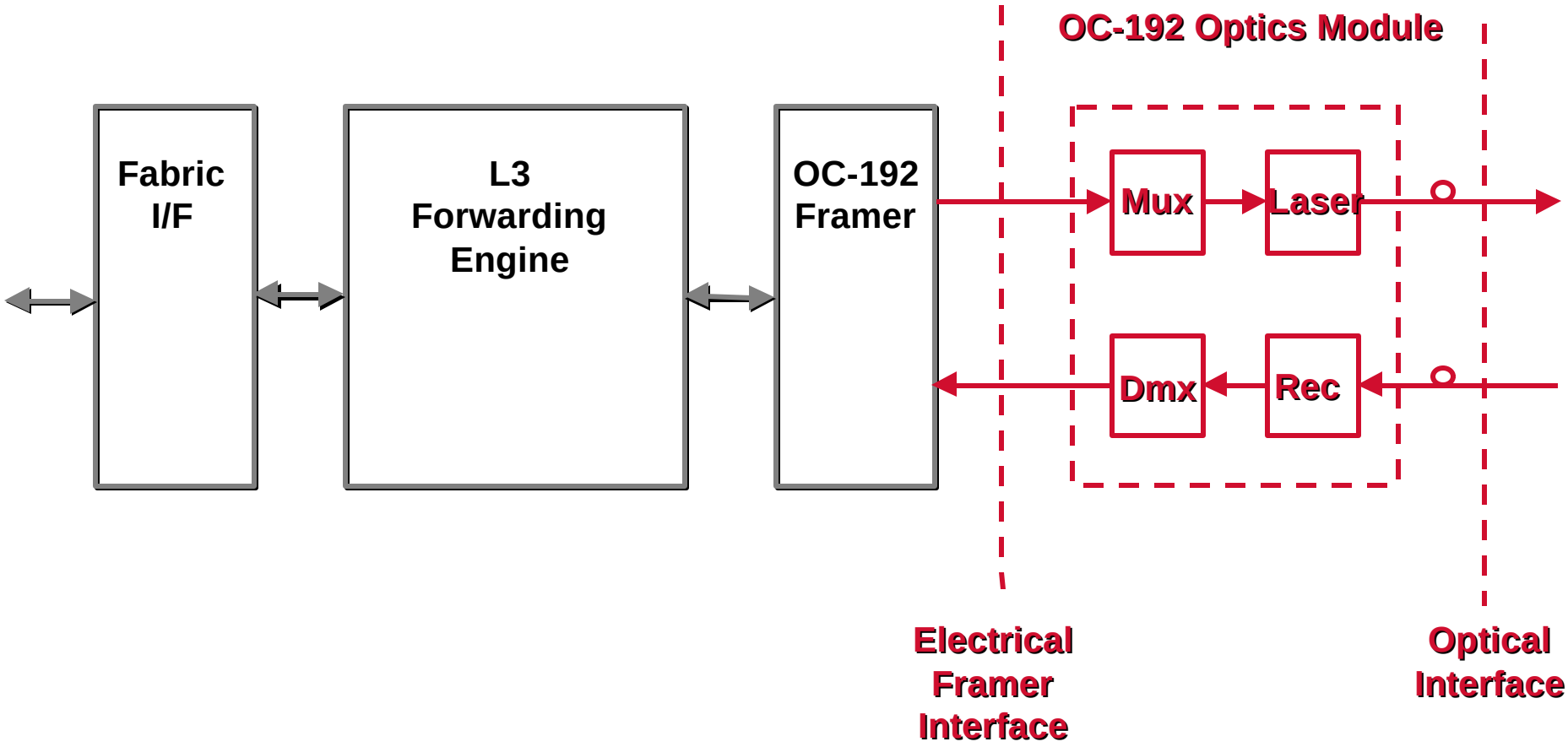
Router Optics Evolution



OC-192 Optics

Driving Down the Cost of Bandwidth

OC-192 Line Card Architecture



OC-192 Optics Evolution

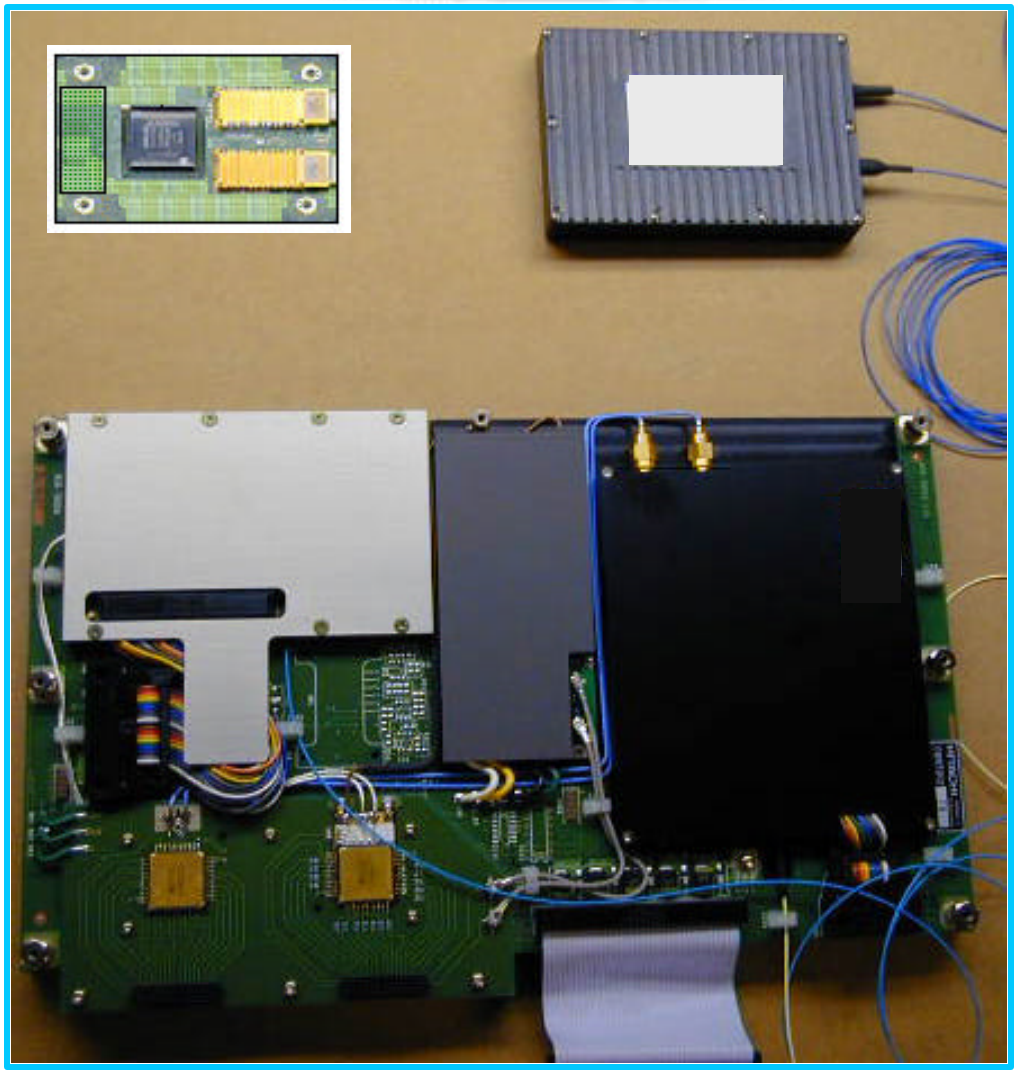
- **Primary goal is to drive down the cost of OC-192 interfaces**
- **Cost is driven by volume**
- **Volume is achieved by having well defined, standardized component and interface specifications**
- **Low cost OC-192 interfaces depend on:**
  - **Standard framer interface**
  - **Standard optical interfaces**
  - **Standard module specification**

Standard Optical Specifications

- **Current GR-1377 Specifications:**
  - **SR1-12 km—Direct modulated, 1310 nm, PIN**
  - **SR2-20 km—External modulated, 1550 nm, PIN**
  - **IR2-40 km—1550 nm, EA , PIN**
  - **LR-80 km—Optical Amplifier+Dispersion Comp**
- **Issues with GR-1377:**
  - **No 2km SR spec**
  - **No unamplified 80 km LR spec (APD-based)**
  - **Inconsistency with ITU G.691**

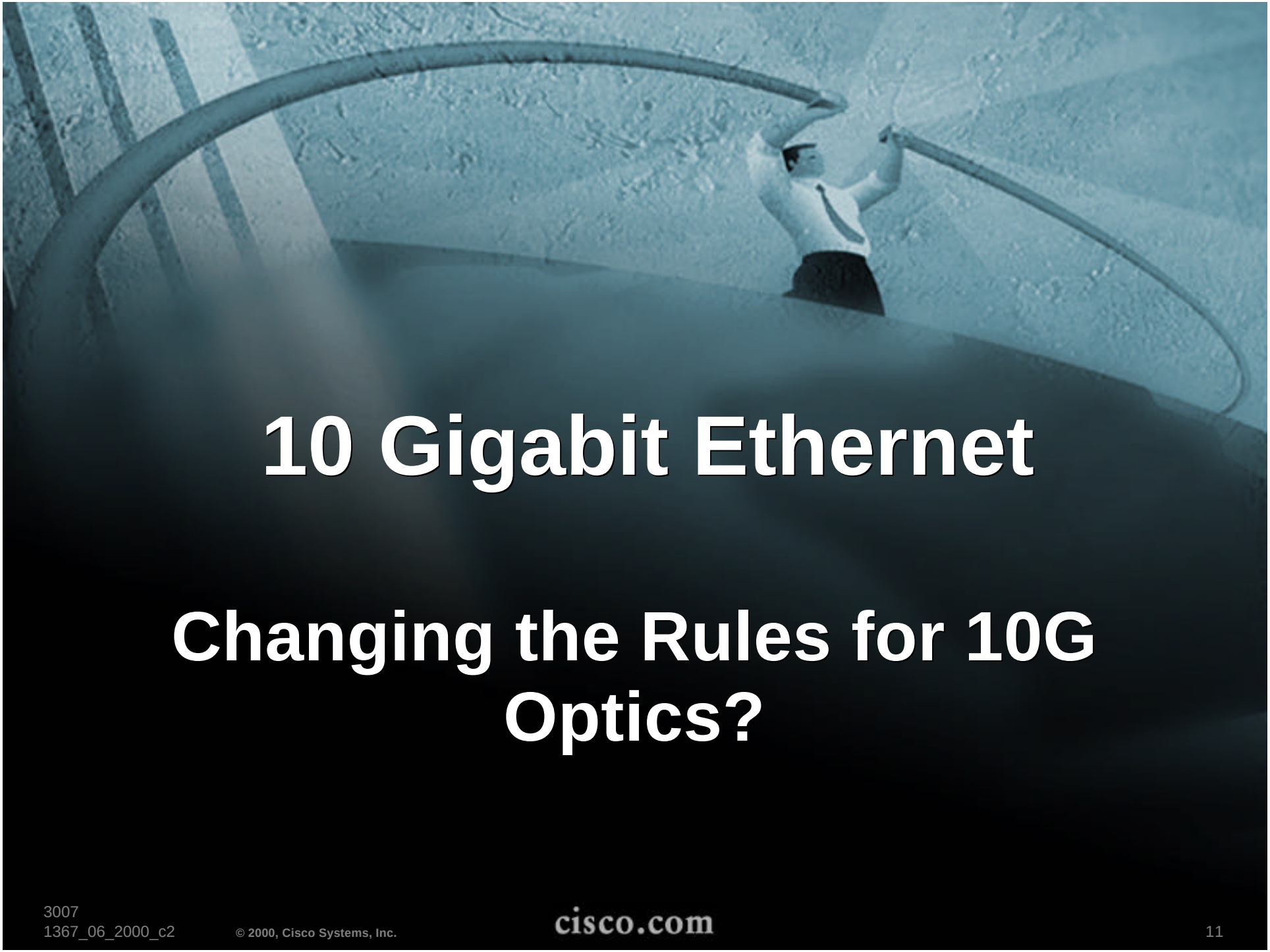
OC-192 Optics Summary

OC-192 VSR
(< 300m)



OC-192 2nd Gen
(2/40/80km)

OC-192 1st Gen
(2/40km)



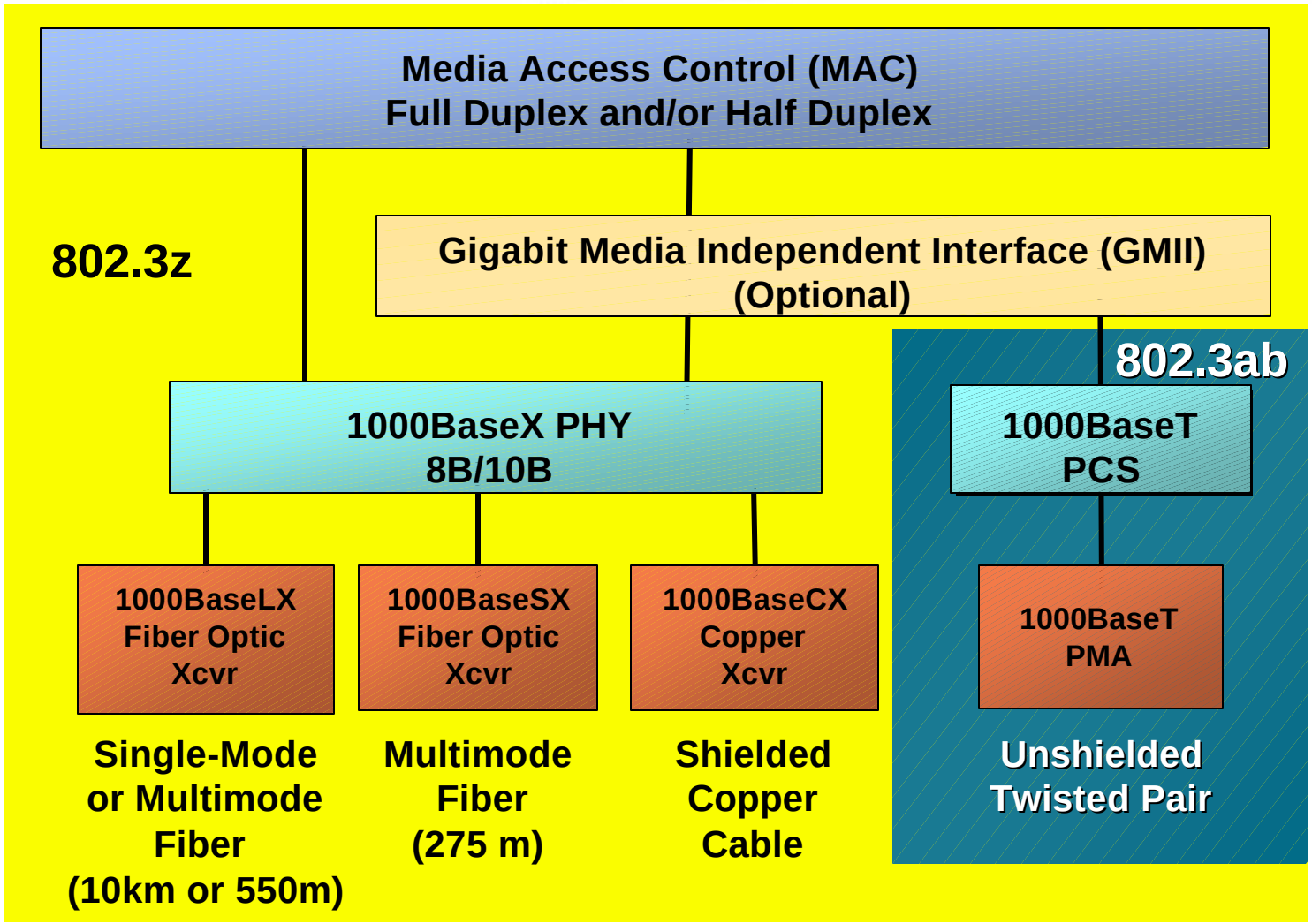
10 Gigabit Ethernet

Changing the Rules for 10G Optics?

Ethernet History

- 1980’s 10 Mbps Ethernet IEEE 802.3
- 1992-95 100 Mbps Ethernet IEEE 802.3u
- 1995-1999 1000 Mbps Ethernet IEEE 802.3z, 802.3ab
- 1998-2000 10/100/1000 Mbps Ethernet Link Aggregation IEEE 802.3ad
- 1999-2002 (March) 10 Gbps IEEE 802.3ae

GE Layer Diagram

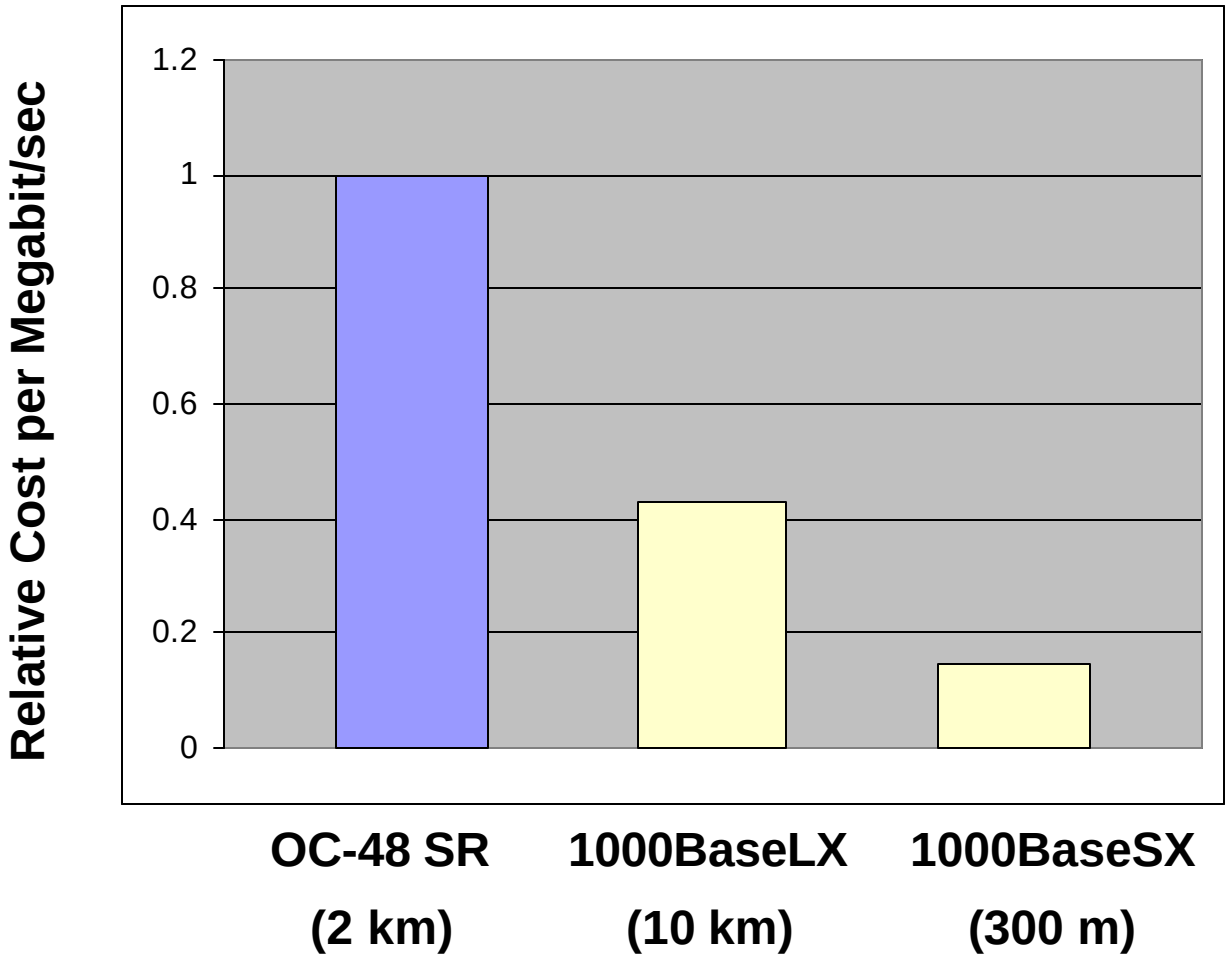


GBIC Module Flexibility

SX	Multimode only	275 meters
LX/LH	Multimode/ singlemode	550 meters/ 10 km
ZX	singlemode only	70km-100km

- Modular transceiver—'plug and play'
- Multiple suppliers
- Large volume—250K ports/month
- Low cost

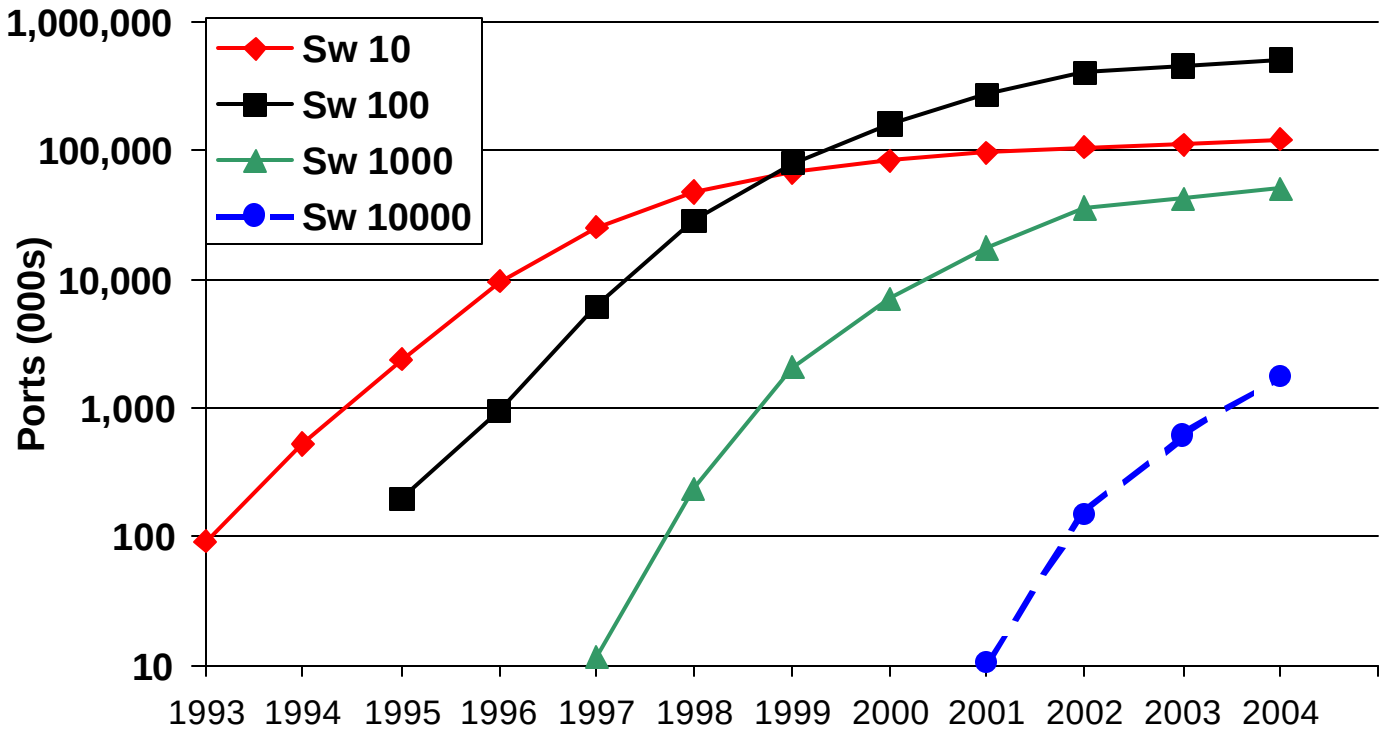
Gigabit Ethernet Cost Analysis



Why 10 Gigabit Ethernet

- Aggregates Gigabit Ethernet segments
- Scales Enterprise and Service Provider LAN backbones
- Leverages installed base of 250 million Ethernet switch ports
- Supports all types of traffic and services (data, packetized voice and video, IP)
- Supports metropolitan and wide area networks
- Faster and simpler than other alternatives

The Growth of Ethernet



People ask why Ethernet is cheap!

Sources: Sw 10, Sw 100, Sw 1000: Dell'Oro Group, Sw 10,000: Gartner Group Dataquest, Cisco Projections

Standard Status

- IEEE 802.3az (Task Force)
- Project kicked off in March, 1999
- Project approval January 2000
- First draft September 2000
- First ballot March 2001
- Completion March, 2002
- Very popular—100's of bodies at meetings (over 200 in Ottawa in May 00)

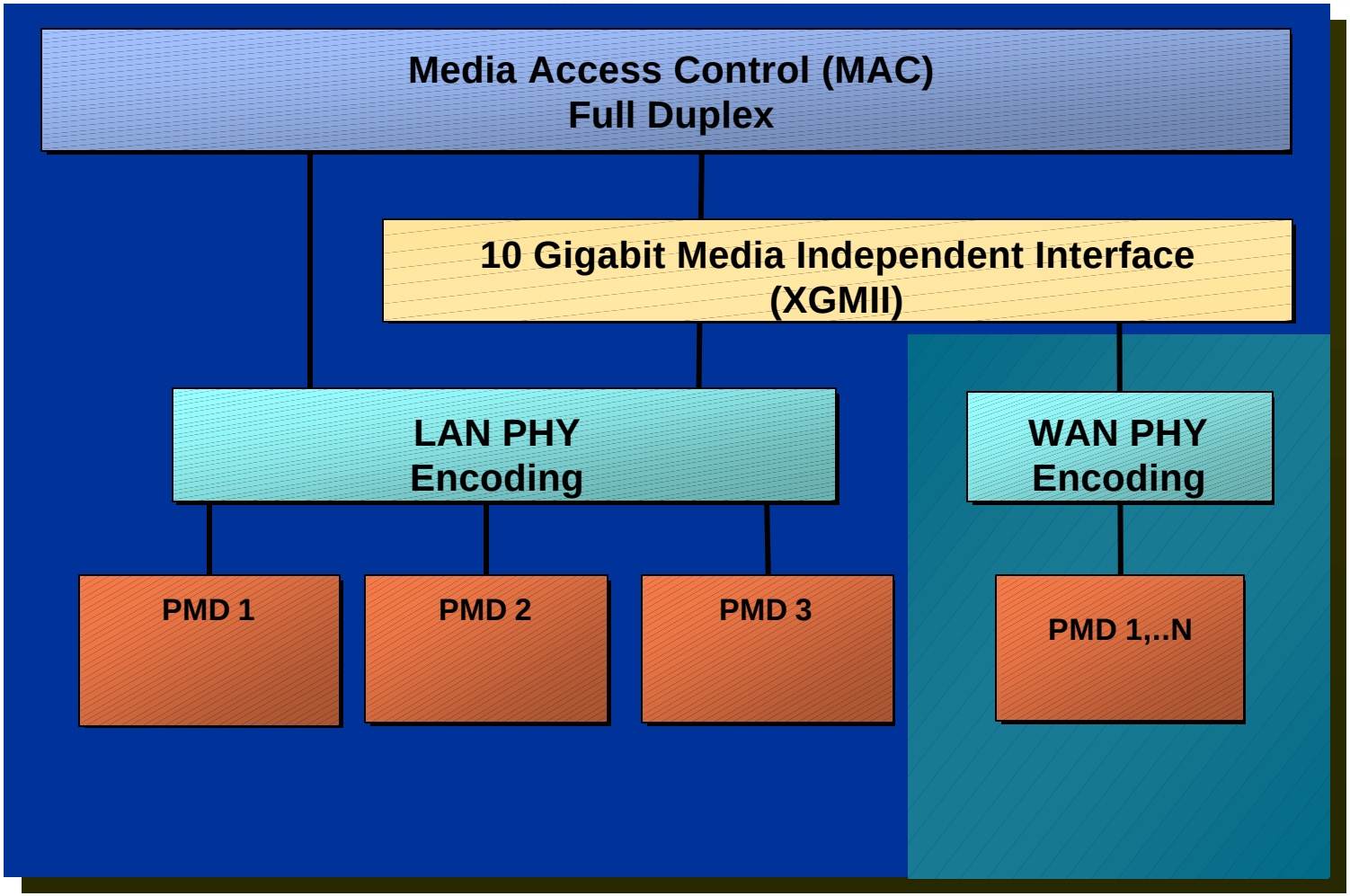
10 Gigabit Ethernet is Ethernet

- IEEE 802.3 Ethernet MAC
- IEEE 802.3 Ethernet Frame
- IEEE 802.3 Frame Size
- Full Duplex (no CSMA/CD)
- No distance limitation
- 3 application spaces: LAN, MAN, WAN

LAN PHY vs WAN PHY

- 10 Gigabit Ethernet is LAN and MAN/WAN technology
- WAN vendors (SDH/SONET) justify SONET/SDH friendly physical layer
- LAN vendors: Success of Ethernet because of simplicity and low cost

10 GbE Layer Diagram (possible)



Advantages of LAN PHY

- **Ethernet style coding techniques, simpler and lower cost than SONET framing**
- **maximum compatibility 10 / 100 / 1000 / 10000 Mbps**
- **Full 10 Gb data rate**

Advantages of WAN PHY

- Enables using SONET infrastructure for L1
- Requires some SONET features (OC-192, Framing, min Path/Section/Line overhead processing)
- Connects to SDH/SONET access devices
- Avoids costly function of SDH / SONET (TDM, OAM&P, Stratum clocking)

UNI PHY

- Consistent Encoding for seriel LAN PHY and SONET/SDH payload for a WAN PHY
- 64B/66B encode
- Low overhead (3%), seriel LAN PHY runs at 10.3 Gbaud
- WAN PHY solution puts 64B/66B encoded data stream into payload portion of SDH/SONET data stream

Distances

- **LAN distance goal**

  minimum 100 m over installed MMF

  minimum 300 over MMF

  minimum 10 km over SMF

- **MAN distance goal**

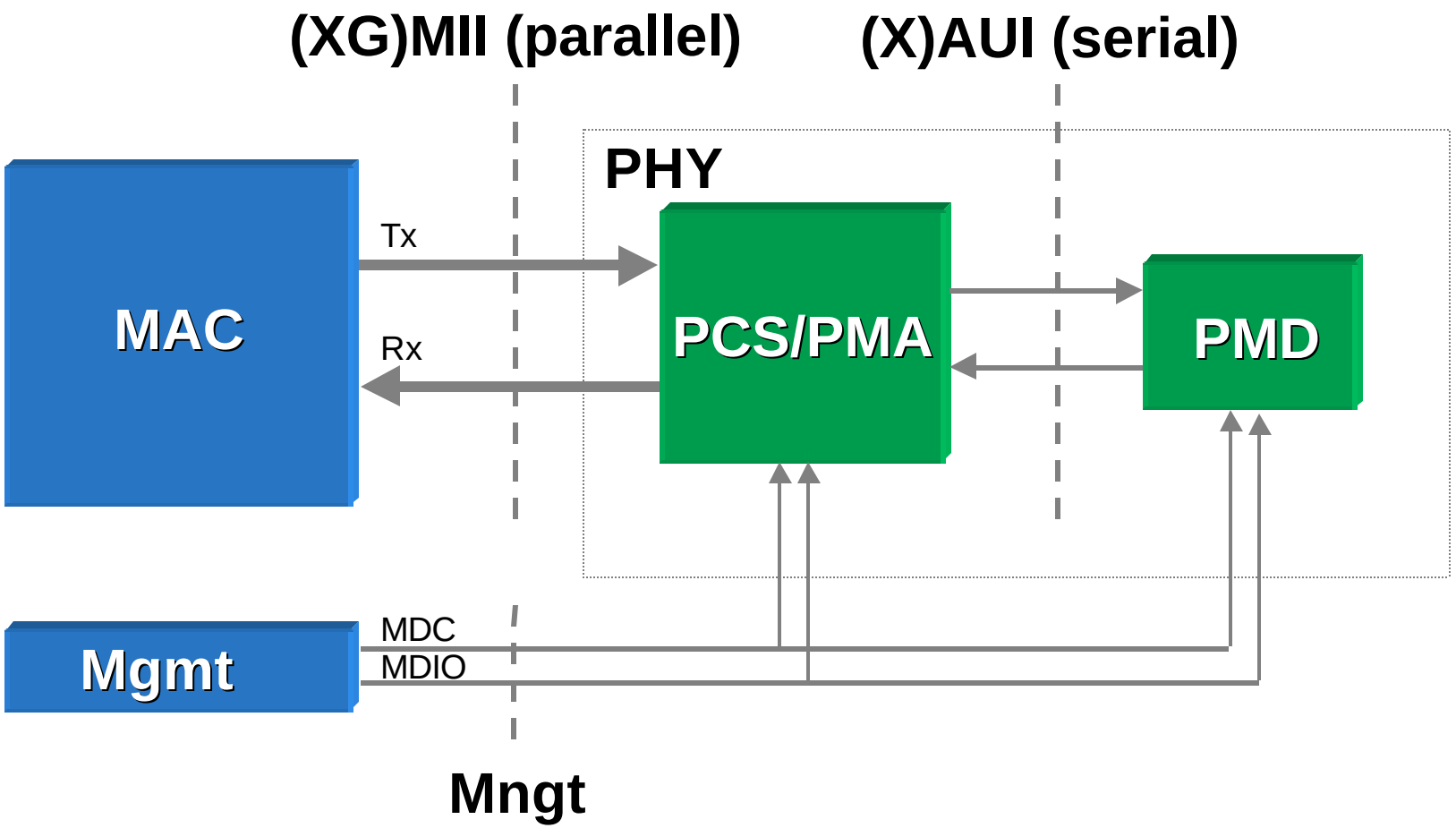
  minimum 40 km over SMF

  minimum 40-70 km over existing SMF 1550 nm

PMD Solutions

- **Standard will support both Seriel and CWDM Optics**
- **Today, only agreement on SMF**
- **MMF work in progress**

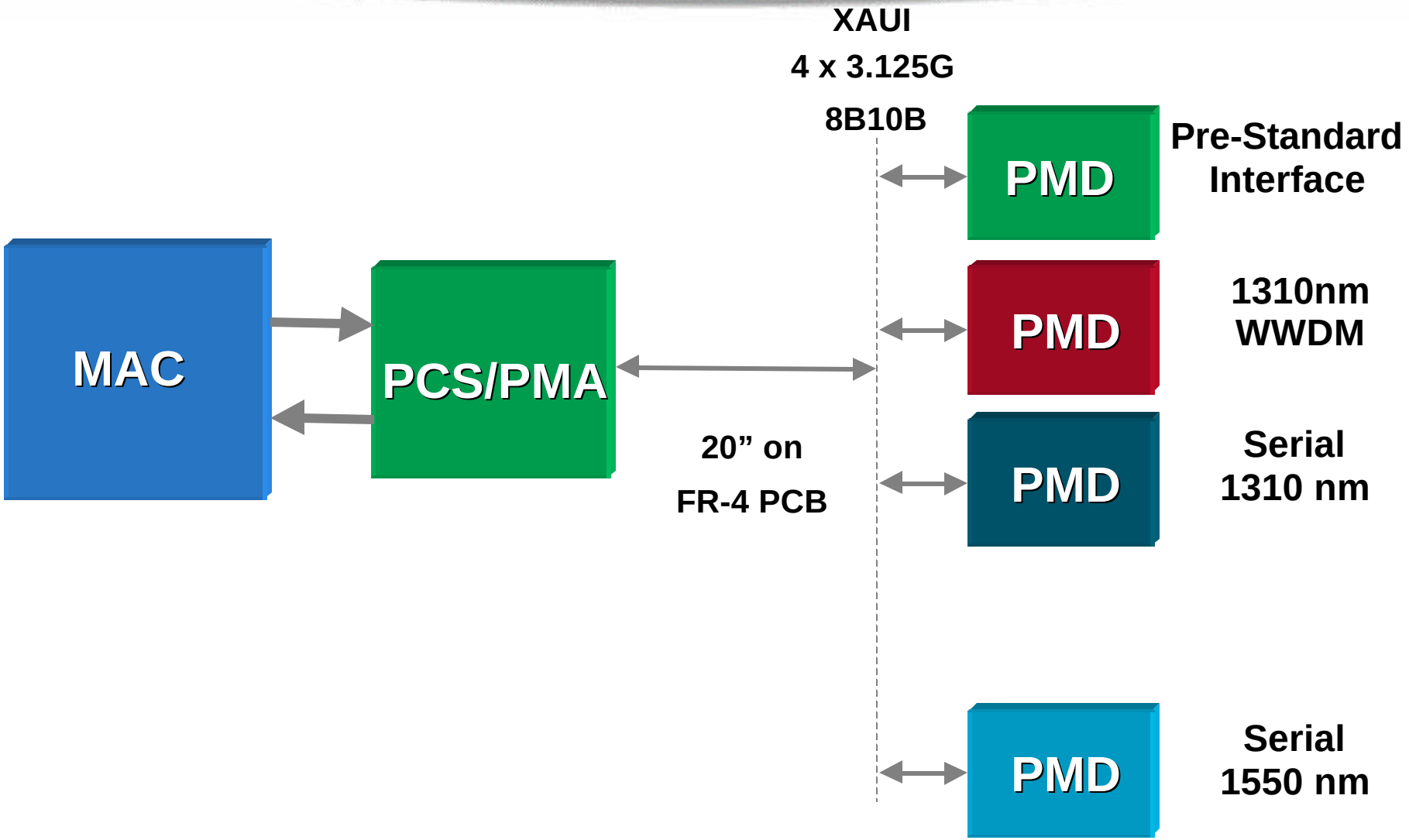
Ethernet Interfaces



The Solution—XAUI

- Flexible interface to optics
- 4 x 3.125 Gbaud serial
- 8B/ 10B coded
- Multiple applications
  - 10GigE
  - Fibre Channel
  - Infiniband (nee SIO, nee NGIO/ FIO)
- Suitable for transmission on FR—4 PCBs
  - 1. 5625 GHz

XAUI Applications



10 Gigabit Ethernet Status

- **Creation of first standard by Sept 2000**
- **Next Task Force meeting Nov 2000**
- **Included in baseline document (75 % consensus)**

  seriel 1550 nm transceiver, min 40 km on SMF

  seriel 1310 transceiver, min 10 km on SMF

10 Gigabit Ethernet Status

- **No consenus how to support MMF**

  one proposal, that supports FDDI grade fiber (62.5 mu, 160/500 Mhz*km, MMF) up to 300 meters

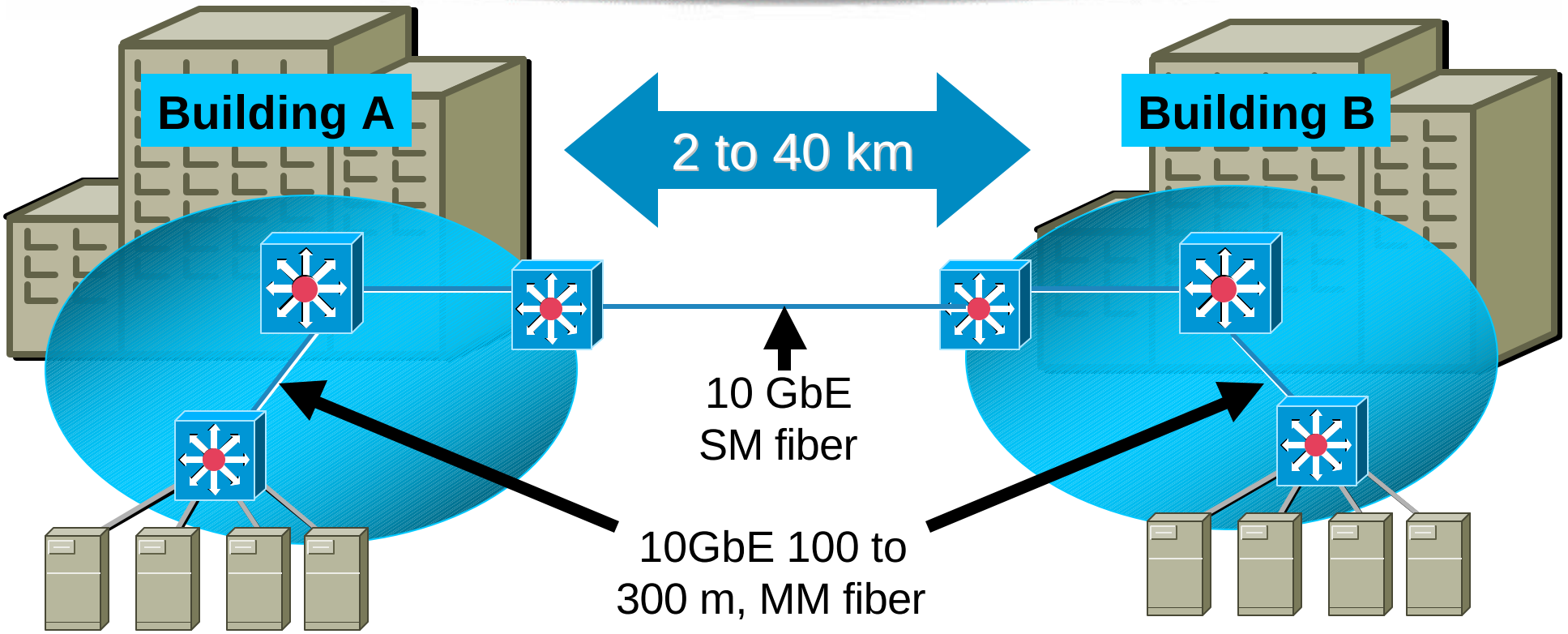
  new 50 mu MMF (2000/500 Mhz*km)

- **To be resolved in November meeting**

10 Gigabit Ethernet Status

- 1310 nm CDWM can meet both (2-10 km) SMF and 300 m on new or installed MMF
- 850 nm CDWM low cost, low power solution meeting all MMF requirements

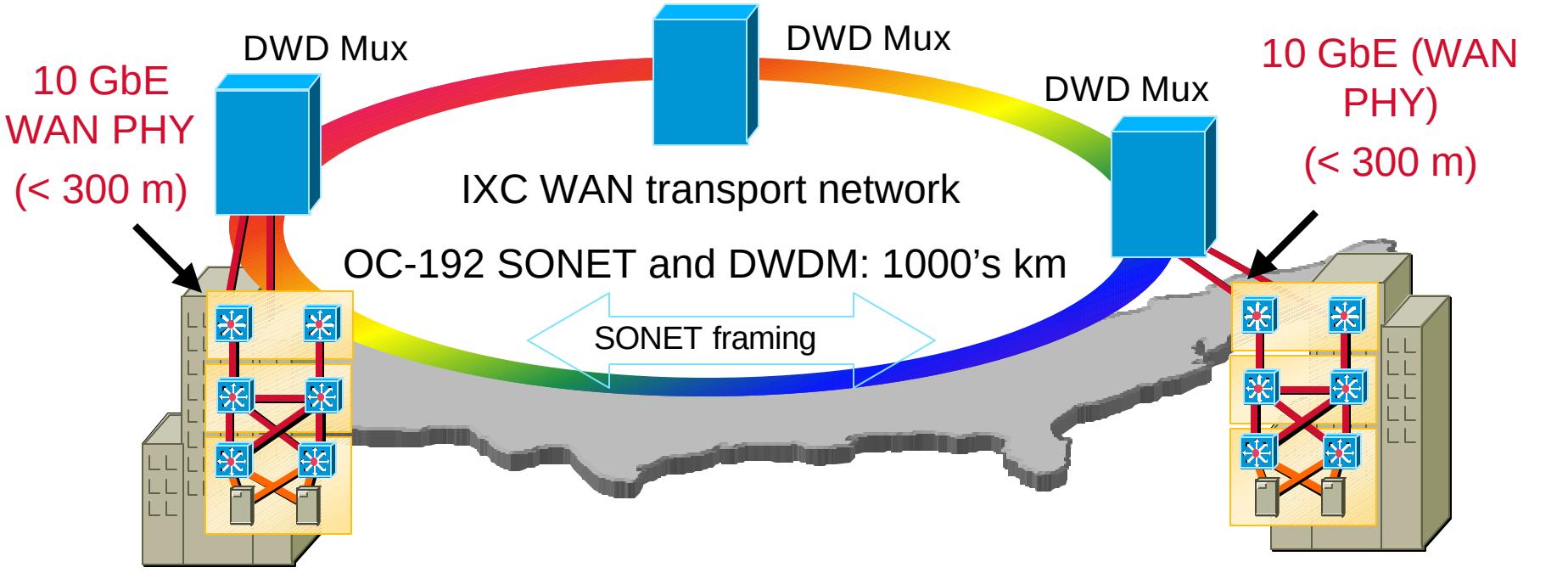
10 GbE LAN Applications



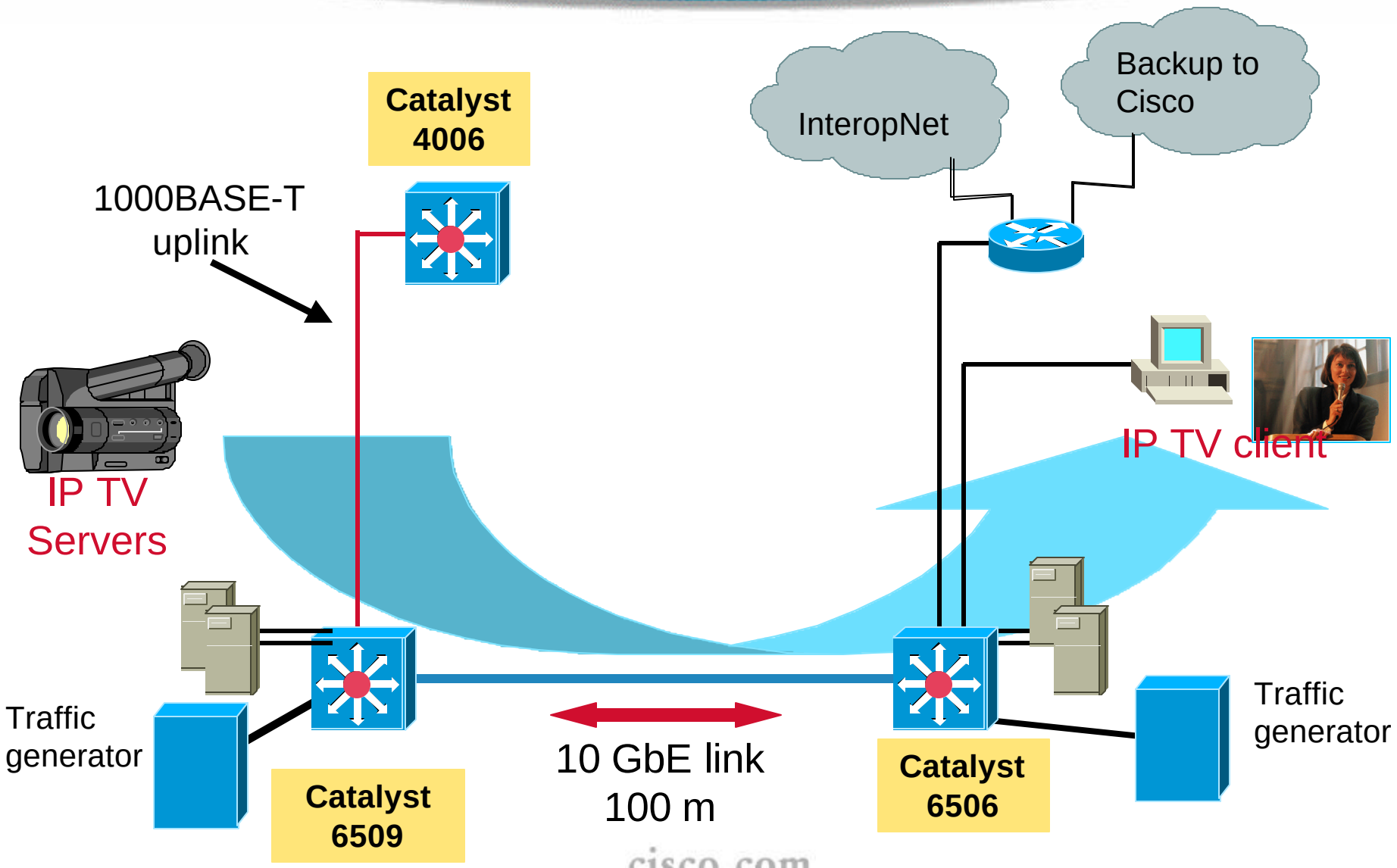
- Cost-effective bandwidth for the LAN, Switch-to-Switch
- Aggregate multiple Gigabit Ethernet segments
- 10 GigaEtherChannel will enable 20 to 80 Gbps (future)

10 GbE over WAN

- Attachment to the optical cloud with WAN physical layer (WAN PHY)
- Compatibility with the installed base of SONET OC-192
- Interfaces and links between SP to IXC networks can be co-located
- No need for protocol conversion, traffic remains IP/Ethernet



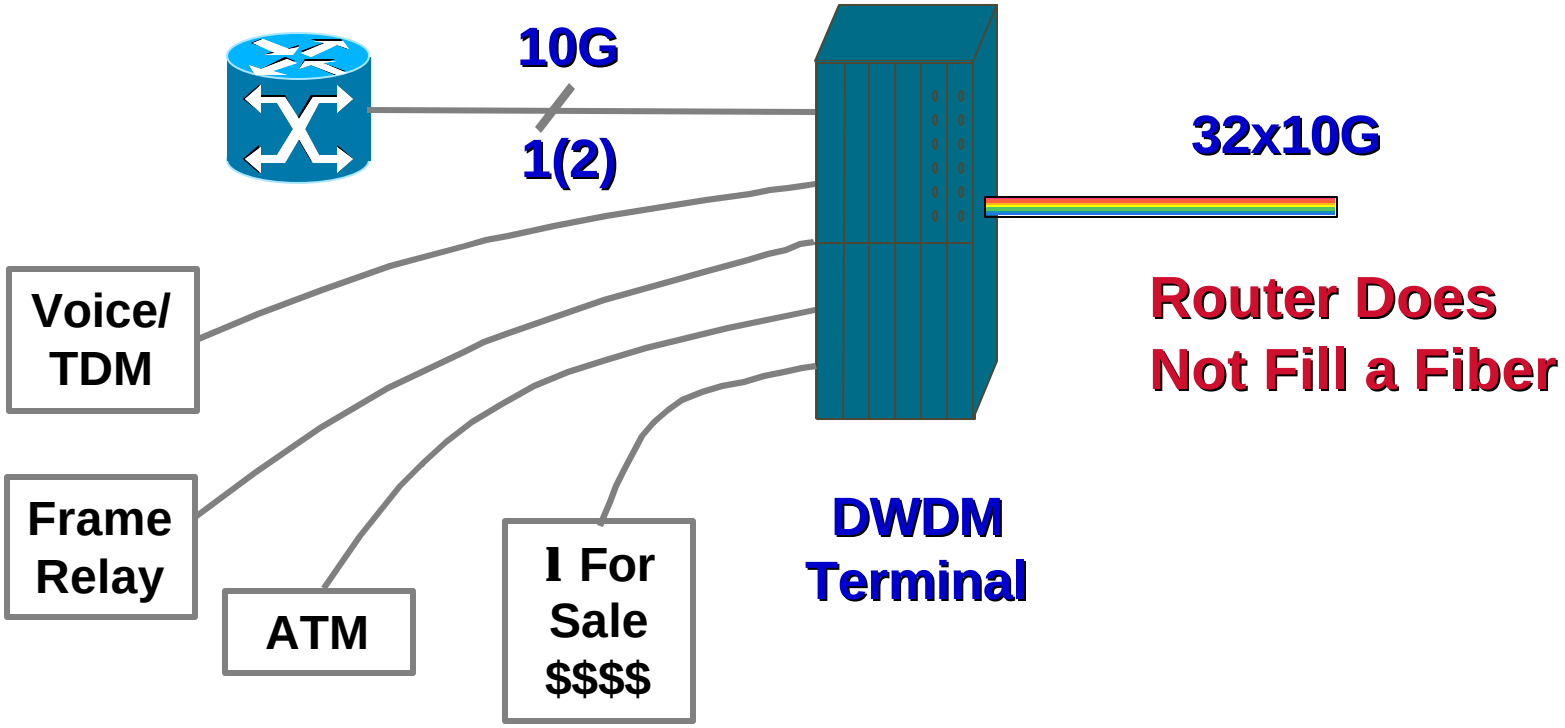
Cisco 10 GbE Demo at Interop Las Vegas



Future Trends

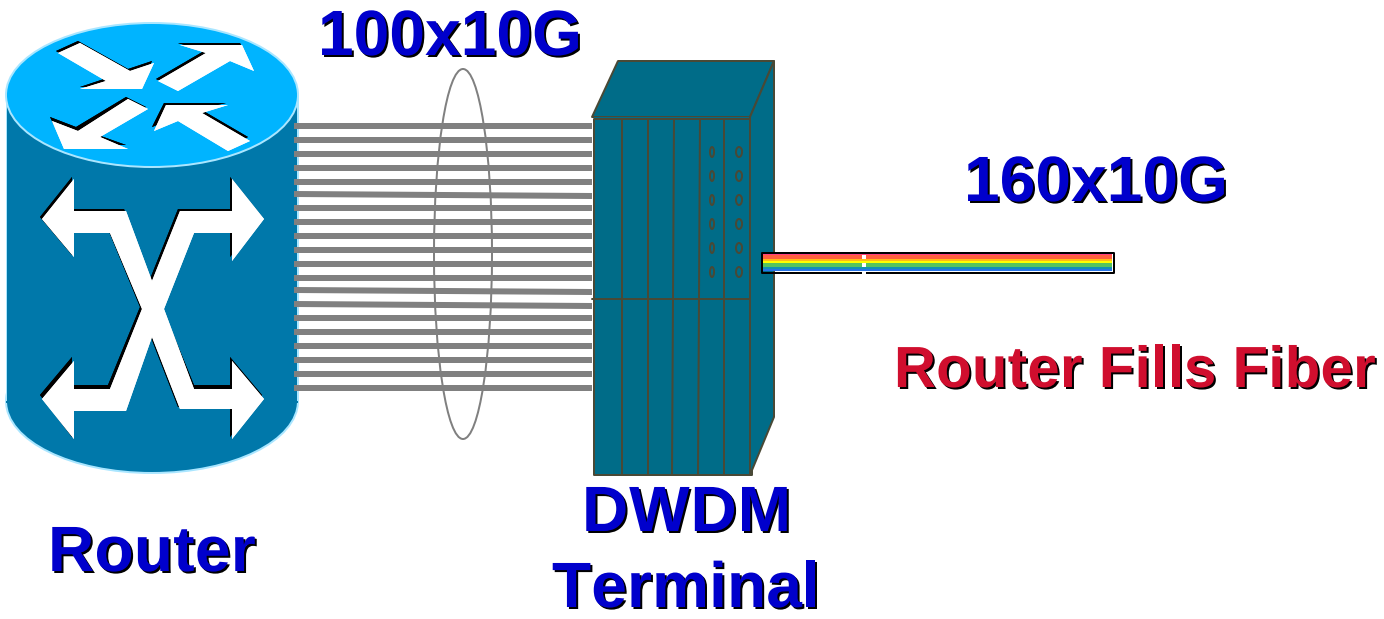
What Comes Next?

Router and DWDM—Today



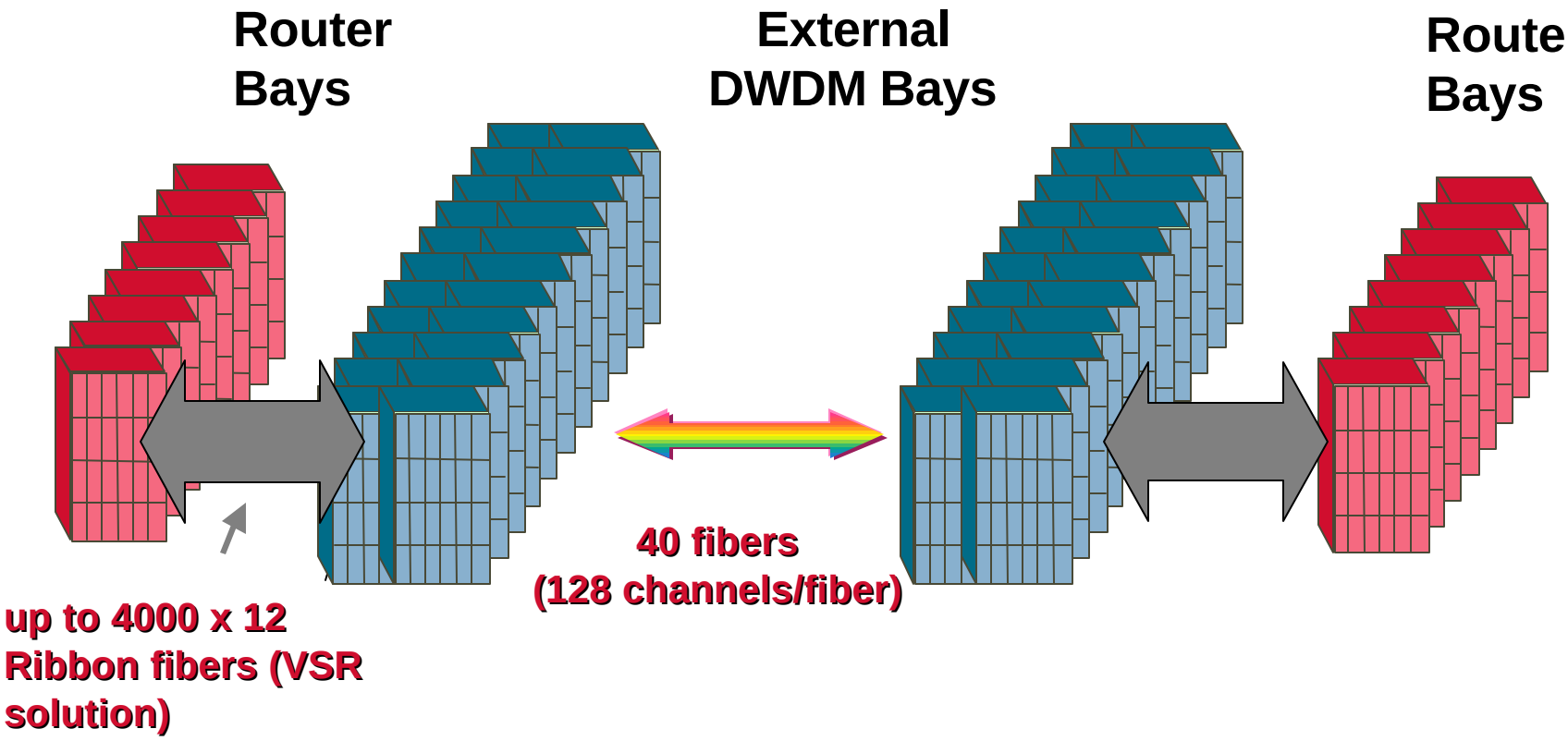
- **Paradigm shift in how IP Routers and DWDM are used, as routers get larger**

Routers and DWDM—Future



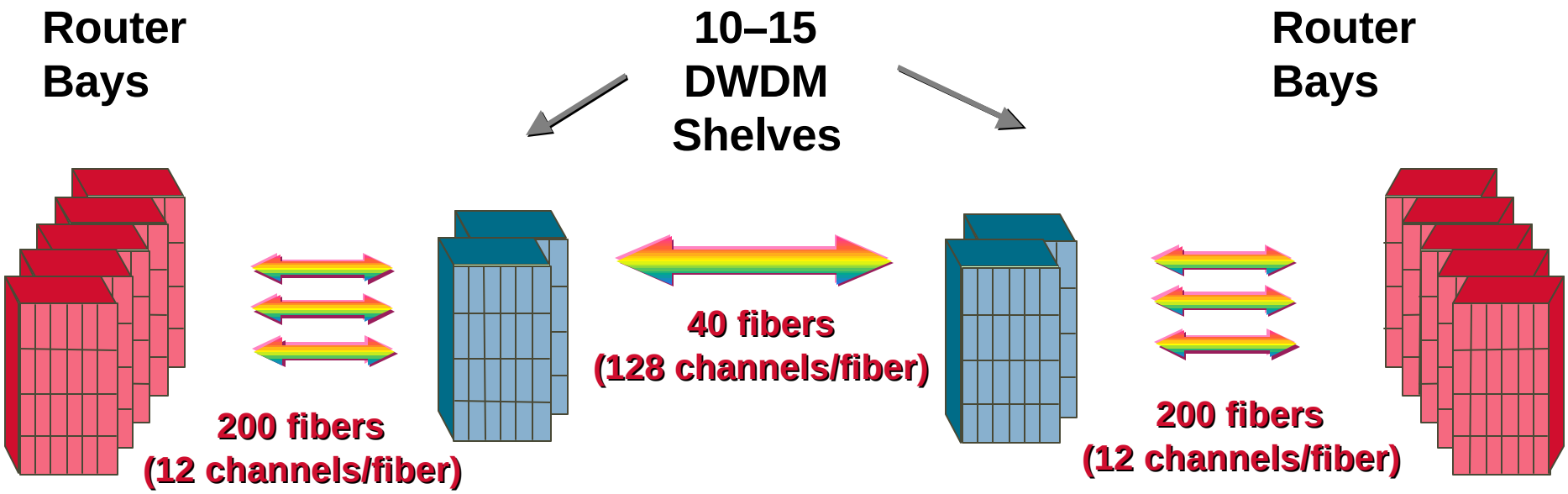
- Fiber interconnect/management is a big issue
- Consider Router and DWDM as one system

External DWDM Problem: Density



- **External DWDM Does Not Scale**

Density Solution



- DWDM optics on router line cards
- First level WDM multiplexing on line card

  20 x reduction in DWDM equipment
  200 x reduction in fiber interconnect

Conclusion

- **‘Quiet Revolution’ is taking place**
- **Datacomm community is driving the industry towards standard, plug and play, multivendor, optical interface modules:**
  - **Promote competition**
  - **Drive up volumes**
  - **Drive down cost**
  - **Enable ‘optics for the masses’**

Conclusion (Cont.)

- **Low cost OC-48 modules have been shipping from multiple suppliers for over 1 year. Work starting on ITU versions**
- **Industry converging on a common OC-192 module. Support distances from 300m to 500 km**
- **Gigabit Ethernet transceivers provide lowest cost/bit optics available today**

Conclusion (Cont.)

- Ethernet pioneered the concept of multivendor, high volume, low cost optical transceivers
- 10 Gigabit Ethernet is following the same model
- 10 Gigabit Ethernet Will be the lowest cost 10 Gbps optics solution