Routers and “Advanced Optical Modulation”

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Overall Traffic Growth Is Straining All Known Network Architectures

For Perspective:

1 Exabyte = 5 X All the World’s Printed Matter

5 Exabytes = All Words ever Spoken

Global IP Traffic—By Segment

Traffic grows to 11 Exabytes per Month by 2009

15 Exabytes by 2010

*Source: Cisco Estimates, Ovum, Gartner, IDC, Merrill Lynch, MRG, MPA, Public Company Data
Growth is driven exclusively by Data

- Legacy applications moving to IP
  Video – SD, HD, Broadcast Cable
  Voice

- New applications exclusively IP
  Video - On Demand, DVRs, Switched Digital, Video conferencing ...
  Audio – Streaming audio, Internet radio, Digital juke boxes, etc....
  High-Speed Data, Internet
  Over-the-Top Content providers—i.e., YouTube

- Household Bandwidth Needs in 2010 (U.S.):
  Applications: HDTV + SDTV + PVRs + HSD + VoIP-Phones
  Twenty such homes would generate more traffic than traveled the entire Internet backbone in 1995
Where does this take us?

- **Higher bandwidths** are needed to address this growth:
  - 10 Gig networks beginning to feel the strain
  - Cannot rely on L2/L3 aggregation: `LAG 4 X 10G ≠ 40G`
  - Cannot rely on L1 aggregation: `DWDM ports are not unlimited`

- **Increase wavelength** capacity as soon as viable:
  - Move to higher data rates per lambda, i.e. 40G and 100G
  - BUT must operate over existing infrastructure
  - AND ideally with equivalent performance to 10G
  - Requires advanced optical modulation schemes

- **Remove** all unnecessary network layers leaving only:
  - Service layer (IP)
  - Transport layer (DWDM)

- **Integrate** DWDM technology on Router: IPoDWDM
IPoDWDM

- IPoDWDM vs. PMO
  - IPoDWDM reduces CAP EX
    - Less components, shelves, processor cards, etc…
  - IPoDWDM reduces OP EX
    - Less shelves, less rack space, less power, simplifies trouble shooting, etc…
  - IPoDWDM enhances Resiliency
    - Less Opto Electonic Components, enhanced fault recovery features, etc…
IPoDWDM - Integration

Three Key Levels of Integration

1. Hardware Integration
   - 40G and 10G serial interfaces on Cisco CRS-1
   - Serial 40Gig over existing 10Gig networks
   - Links of up to 900+km deployed

2. Control Integration
   - A to Z provisioning of services across entire network, both L1 and L3
   - Multiple standards defined

3. Management Integration
   - Management as two models:
     - Separate (respect PMO)
     - Integrated (IP+Transport)
40Gb/s Interfaces

- Routers Prefer single serial 40Gb/s interface
  LAG / Load Balancing limitations

- Customers prefer single 40Gb/s interfaces
  DWDM transport gear do not have unlimited ports
  DWDM is view as fixed (and sunk) asset
  1 X 40Gb/s Port is better then 4 X 10Gb/s Port
  Network capacity becomes 80ch X 40Gb/s = \(3.2\text{Tb/s}\)

- Modulation technology is advancing rapidly
  ODB > DPSK > Coherent (DP-QPSK)
  40 Gb/s can be run over existing DWDM infrastructure
  40Gb/s approaching 10Gb/s performance

40 Gb/s DWDM Technology can be integrated on the Router
100Gb/s Interfaces

- 100Gb/s is Real!
  - Customers Requesting Today!!
- IEEE and ITU have taken up the standard
- Routers Prefer single serial 100Gb/s interface
  - LAG / Load Balancing limitations
- Customers prefer single 100Gb/s interfaces
  - DWDM transport gear are not unlimited ports
    - 1 X 100Gb/s Port is better then 10 X 10Gb/s Port
    - Network capacity becomes 80ch X 100Gb/s = 8.0Tb/s
- 100Gb/s must operate over existing 10Gb/s infrastructures
  - Advanced modulation schemes will achieve this level of performance
  - Leverage the work started on 40Gb/s

100 GB/s DWDM Technology can be integrated on the Router
Summary

- **IP Traffic Continues to Grow**
  All applications converging on IP
  15 Exabytes per month by 2010

- **Need fatter pipes, not more pipes**
  Service Layer (IP) - Router - overcome LAG / Load Balancing limitation
  Transport Layer (DWDM) - DWDM systems do not have unlimited ports

- **Advanced modulation required**
  Fatter Pipe (40G, 100G, etc..) needs to match performance of Skinny Pipe (10G)

- **Network is consolidating into two layers**
  Service (IP) & Transport (DWDM)
  IPoDWDM is the next obvious step in Network Evolution

- **Advanced Modulation Technology can be integrated on Router**
  CRS-1 has integrated 10G and 40G DWDM interfaces on the router