Trendy v oblasti vysokorychlostních přenosů dat

SP4/L2
David Jakl – Cisco
Program

• Need for >10GE
• 40GE/100GE Standards & Transceivers
• 40GE/100GE Cisco Portfolio
• Cisco DWDM
• Cisco IP+Optical
• Summary
Need for >10GE
Internet Market Dynamics
Video, Mobile, Cloud Dominate Growth

Global IP Traffic Growth

Source: Cisco Visual Networking Index—Forecast, 2010-2015
Why 100GE?

- **10G clients**
  
  ...are becoming everywhere
  
  Increasing likelihood of individual traffic flows approaching 10Gb/s
  
  Core networks need from 4x to 10x highest user interface speed

- **Bandwidth Optimization**
  
  Aggregated links can lead to less than optimal link utilization
  
  N x 10G LAG results in less than N x 10G in truly usable bandwidth

- **Simplicity**
  
  Implementing features such as QoS is simpler and more robust with a serial interface vs. an aggregated interface
  
  Fewer interfaces to inventory, manage, and cable

- **Need for more faceplate bandwidth**
  
  Bandwidth per slot is starting to exceed 10G port capacity
### 30x 10GE bundle in a live network in 2010

**Bundle-Ether1111**

<table>
<thead>
<tr>
<th>B/W (Kbps)</th>
<th>MAC address</th>
<th>Minimum active Links</th>
<th>B/W (Kbps)</th>
<th>Maximum active Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>300000000</td>
<td>0024.14c5.ba83</td>
<td>1</td>
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</table>

<table>
<thead>
<tr>
<th>Port</th>
<th>State</th>
<th>Port ID</th>
<th>B/W (Kbps)</th>
<th>MAC address</th>
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<tbody>
<tr>
<td>Te2/6/0/0</td>
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<td>Tel/12/0/0</td>
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<td>0x8000, 0x000c</td>
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<td>10000000</td>
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</tr>
</tbody>
</table>

**YES**
Why is 100G Transport Significant?

- 100G in the packet world = a better way to interface with a router
- 100G in DWDM transport = a major leap in density

Legacy 10G
80 x 10G = 800 Gb/s

Migration of Legacy
72 x 10G = 720 Gb/s
+ 8 x 100G = 800 Gb/s
Total = 1.52 Tb/s

Greenfield NGN
80 x 100G = 8 Tb/s
100G – A Coordinated Standards Effort

- 100G standardization coordinated among ITU, IEEE, and OIF
- Proactively eliminate interop issues encountered with 10G and 40G
40GE/100GE Standards & Transceivers
High Speed Ethernet Standard Interfaces

### Proposed PMD’s

<table>
<thead>
<tr>
<th>PMD</th>
<th>Reach</th>
<th>Media / Cabling</th>
<th>Standard Status</th>
<th>Publication</th>
<th>Electrical I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>100GBASE-CR4</td>
<td>&lt;5 m</td>
<td>Copper, TwinAx</td>
<td>Task Force, 802.3bj</td>
<td>2013 – 2014</td>
<td>4x25G</td>
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<tr>
<td>100GBASE-SR4</td>
<td>&lt;50 m ?</td>
<td>OM-3/4 MMF, Ribbon 12</td>
<td>Study Group</td>
<td>2014 ?</td>
<td>4x25G</td>
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<tr>
<td>100GBASE-FRx</td>
<td>&lt; 500 m – 2 km?</td>
<td>SMF, Duplex</td>
<td>Study Group</td>
<td>2014 ?</td>
<td>4x25G</td>
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<tr>
<td>40GBASE-ER4</td>
<td>&lt; 40 km</td>
<td>SMF, Duplex</td>
<td>Study Group</td>
<td>2014 ?</td>
<td>4x25G</td>
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</tbody>
</table>

10x10 100GE 2km, 10km, 40km SMF - Founders: Google, Brocade, Santur, JDSU - [www.10x10msa.org](http://www.10x10msa.org)
10GE/40GE/100GE Transceivers

<table>
<thead>
<tr>
<th>XENPAK</th>
<th>X2</th>
<th>XFP</th>
<th>SFP+</th>
<th>40G</th>
<th>100G</th>
<th>40G/100G</th>
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<tr>
<td></td>
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<td></td>
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<tr>
<td>121</td>
<td>70</td>
<td>30</td>
<td>56</td>
<td>18</td>
<td>13</td>
<td>~24</td>
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<tr>
<td>70 pins 4x3.125G</td>
<td>70 pins 1x10G</td>
<td>20 pins 1x10G</td>
<td>38 pins 4x10G</td>
<td>~114</td>
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<td>36</td>
<td>18</td>
<td>56</td>
<td>18</td>
<td>13</td>
<td>~24</td>
</tr>
<tr>
<td>70 pins 4x3.125G</td>
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<td>36</td>
<td>13</td>
<td>13</td>
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<td>~24</td>
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<tr>
<td>4x3.125G</td>
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<tr>
<td>148 pins 4x10G (XLAUI)</td>
<td>148 pins 4x10G (CAUI)</td>
<td>84 pins Tx: 12x10G Rx: 12x10G</td>
<td>84 pins Tx: 12x10G Rx: 12x10G</td>
<td>84 pins Tx: 12x10G Rx: 12x10G</td>
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<tr>
<td>~16</td>
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<td>~16</td>
<td>~16</td>
<td>~16</td>
<td>~16</td>
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<tr>
<td>&lt; 8 W</td>
<td>&lt; 4 W</td>
<td>&lt; 3.5 W</td>
<td>&lt; 1.5 W</td>
<td>&lt; 3.5 W</td>
<td>&lt; 3.5 W</td>
<td>&lt; 8 W CFP40G</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt; 24 W CFP100G</td>
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All units are in rounded to millimeters.
40GE/100GE Cables & Transceivers

40GE-SR4
12-fiber MPO to CFP/QSFP

100GE-SR10
24-fiber MPO to CFP/CXP

40GE QSFP SR4

40GE/100GE CFP SC

40GE-SR4
100GE-SR10 MPO

40GE/100GE LR4/ER4 CFP SC

100GE-SR10 CXP

40GE-100GE QSFP to 4x10GE SFP+

40GE CFP to 4x10GE SFP+

Cisco Proprietary

40GE QSFP to 4x10GE SR LC

10GE SFP+ SR
Future 100GE Transceivers

- CXP → CXP AOC
- CFP → CFP2 → CFP4
- 40GE QSFP+ → 100GE QSFP28
40GE/100GE
Cisco Portfolio
Cisco 40GE Portfolio 2012

- CRS-3 4x40GE CFP PLIM
- ASR 9000 1x/2x 40GE MPA QSFP
- Nexus 7000 M2 2x40GE CFP
- Nexus 7000 M2 6x40GE QSFP
- Catalyst 6500 2:1 4x40GE CFP
- Nexus 3016 16x40GE QSFP
- Nexus 3064 4x40GE Uplink QSFP
- Catalyst 4500-X 2x40GE Uplink Module QSPF
Cisco 100GE Portfolio 2012

- CRS-1 1x100GE CFP PLIM
- ASR 9000 2x100GE CFP
- Nexus 7000 M2 2x100GE CFP
# Cisco 40GE/100GE Transceiver Form-factor by Platform

<table>
<thead>
<tr>
<th></th>
<th>CFP 40G</th>
<th>QSFP 40G</th>
<th>CFP 100G</th>
<th>CXP 100G</th>
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<tbody>
<tr>
<td>Nexus 3000</td>
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<tr>
<td>Nexus 7000</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Cat 6500</td>
<td>✓</td>
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<td></td>
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<tr>
<td>Cat 4500-X</td>
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<td>✓</td>
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<tr>
<td>ASR 9000</td>
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<tr>
<td>CRS-3</td>
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<tr>
<td>ONS 15454</td>
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</table>

Transceiver form factors for *released and/or announced* 40G/100G platforms
## Cisco TMG 40GE Transceiver Roadmap

*Roadmap (not committed)*

<table>
<thead>
<tr>
<th></th>
<th>CY11</th>
<th>CY12</th>
<th>&gt;= CY13*</th>
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<tbody>
<tr>
<td><strong>CFP 40G</strong></td>
<td></td>
<td><strong>SR4</strong> (100m MMF ribbon)</td>
<td>ER4* (40km SMF duplex)</td>
</tr>
<tr>
<td><strong>Optics</strong></td>
<td><strong>SR4</strong> (100m MMF ribbon)</td>
<td><strong>LR4</strong> (10km SMF duplex)</td>
<td></td>
</tr>
<tr>
<td><strong>FourX Adapter</strong></td>
<td>(4 SFP+ in a CFP)</td>
<td><strong>FourX Adapter</strong> (4 SFP+ in a CFP)</td>
<td></td>
</tr>
<tr>
<td><strong>FR</strong> (2km SMF duplex)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>QSFP 40G</strong></td>
<td><strong>SR4</strong> (100m MMF ribbon)</td>
<td><strong>LR4</strong> (10km SMF duplex)</td>
<td></td>
</tr>
<tr>
<td><strong>Optics</strong></td>
<td></td>
<td><strong>4x10G SR-300</strong> (300m MMF ribbon)</td>
<td></td>
</tr>
<tr>
<td><strong>Cables (Q-Q)</strong></td>
<td><strong>Passive Copper Cables 1M, 3M, 5M</strong></td>
<td><strong>Active Copper Cables 7M, 10M</strong></td>
<td></td>
</tr>
<tr>
<td><strong>QSFP Octopus/Breakout cables</strong></td>
<td><strong>Passive Copper Cables 1M, 3M, 5M</strong></td>
<td><strong>Active Copper Cables 7M, 10M</strong></td>
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</tr>
</tbody>
</table>

There is no available standard for 300m 40GE.

**4x10G SR-300** is being specified at Cisco to interoperate with 10GBASE-SR over 300m OM3.

But can also be used in a 40GE mode over 300m, in a Cisco to Cisco link.
## Cisco TMA 100GE Transceiver Roadmap

<table>
<thead>
<tr>
<th></th>
<th>&lt;CY11</th>
<th>CY12</th>
<th>&gt;= CY13*</th>
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<tr>
<td><strong>CFP 100G</strong></td>
<td><strong>LR4</strong> (10km SMF duplex)</td>
<td><strong>SR10</strong> (100m MMF ribbon)</td>
<td><strong>ER4</strong>* (40km SMF duplex)</td>
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<tr>
<td><strong>Optics</strong></td>
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<td></td>
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</tr>
<tr>
<td><strong>CXP 100G</strong></td>
<td></td>
<td><strong>SR10</strong> (100m MMF ribbon)</td>
<td></td>
</tr>
<tr>
<td><strong>Optics &amp; Cables</strong></td>
<td></td>
<td><em>AOC</em>* Active Optical Cables (Various reaches)</td>
<td></td>
</tr>
</tbody>
</table>
Cisco Acquires Lightwire

• March 2012 – Cisco closes on Lightwire acquisition

• Lightwire – pioneer in CMOS Photonics

• Lightwire’s CMOS photonics technology integrates multiple optical and digital functions onto a small silicon chip

• CMOS Photonics will:
  • enable Cisco to develop high-speed optical interconnects while reducing size, cost, power and footprint
  • accelerate time to market and will augment Cisco’s next-generation 40G, 100G and beyond optical transceiver portfolio
Cisco DWDM
ONS 15454 MSTP
State of the Art DWDM Transport

15454 M6 & M2 Chassis
TNC & TSC Processors

WSON Intelligence
R9.4 – Q4 2011

80ch, 8-Degree WXC
R9.2 – Q1 2010

15216 Edge OADMs
R9.2 – Q1 2010

Single Module ROADM(s)
R9.1 - Q4 2009

Enhanced Ethernet Xponder
R9.0 – Q1 2009

AnyRate Xponder
R 9.4 – Q4 2011

OTU2 Transponder
R 9.0 – Q1 2009

Co-Propagating Raman
R 9.3 – Q3 2011

96 Channel MAL-less EDFA’s
R 9.4 – Q4 2011

40G Coherent
R9.2.1 – Q1 2011

100G
R 9.6 – Q2 2012

AnyRate Xponder
R 9.4 – Q4 2011

State of the Art DWDM Transport

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Agile DWDM

- **Tunable Laser** – Transmit laser can be provisioned to any frequency in the C-Band.
- **Colorless** – ROADM add ports provisioned in software and rejects any other wavelengths.
- **Tunable Receiver** – Coherent Detection accepts provisioned wavelength and rejects all others.
- **Omni-Directional** – Wavelength can be routed from any Add/Drop port to any direction in software.
- **Restoration** – Ability to reroute a dangling resource to another path after protection switch.
- **Flex Spectrum** – Ability to provision the amount of spectrum allocated to each Wavelength allowing for 400G and 1T bandwidths.
- **Contention-less** – In the same Add/Drop device you can add and drop the same frequency to multiple ports.
**Touchless Optical Layer**  
Foundation for Optical Control Plane

- Complete Control in Software
- No Manual Movement of Fibers
- Control Plane automates Provisioning, Restoration, Migration, Maintenance

**Tunable Laser** — Transmit laser can be provisioned to any frequency in the C-band (96 channels)

**Colorless** — ROADM ports are not frequency specific (re-tuned laser does not require fiber move)

**Tunable Receiver** — Coherent receiver can select one wavelength among a composite signal (no demux needed, re-tune does not require fiber move)

**Flex Spectrum** — Ability to provision the amount of spectrum allocated to each Wavelength allowing for 400G and 1T bandwidths.

**Omni-Directional** — ROADM ports are not direction specific (re-route does not require fiber move)

**Contension-less** — Same frequency can be added/dropped from multiple ports on same device.

**Dynamic Optical Restoration** — Re-route a dangling resource

**WSON**

**15454 MSTP**

**CY 2013**
Cisco WSON
Foundation for Multi-layer Information Exchange

Embedded Optical Layer Intelligence

Linear impairments
- Power Loss
- Chromatic Dispersion (CD)
- Polarisation Mode Dispersion (PMD)
- Optical Signal to Noise Ratio (OSNR)

Non linear Optical impairments:
- Self-Phase Modulation (SPM)
- Cross-Phase Modulation (XPM)
- Four-Wave Mixing (FWM)

Topology
- Lambda assignment
- Route choices (C-SPF)

Interface Characteristics
- Bit rate
- FEC
- Modulation format

Regeneration Capability
# MPLS-TE vs. G-MPLS

<table>
<thead>
<tr>
<th><strong>MPLS-TE</strong></th>
<th><strong>G-MPLS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Plane</strong></td>
<td><strong>Data Plane</strong></td>
</tr>
<tr>
<td>IGP Topology</td>
<td>Link Mgmt Protocol</td>
</tr>
<tr>
<td>Packet Specific (b/w)</td>
<td>Out of band Non packet forwarding</td>
</tr>
<tr>
<td>Traffic Engineering Data Base Network Graph</td>
<td></td>
</tr>
<tr>
<td>Constrained Shortest Path First (CSPF) Path Calculation</td>
<td>Data Plane Specific</td>
</tr>
<tr>
<td>RSVP-TE</td>
<td>Traffic Engineering Data Base Network Graph</td>
</tr>
<tr>
<td>Path signaling and maintenance</td>
<td>Constrained Shortest Path First (CSPF) Path Calculation</td>
</tr>
<tr>
<td>Head-End function</td>
<td>RSVP-GMPLS or CE-LDP</td>
</tr>
<tr>
<td>What’s goes in tunnel (L2 and L3)</td>
<td>Path signaling and maintenance</td>
</tr>
</tbody>
</table>

**Packet based MPLS Label Switching**

**Data Plane specific**

**Variable – Data Plane specific**
Cisco 100G DWDM Technology

- Coherent Polarized Differential Quadrature Phase-Shift Keying (CP-DQPSK, DP-DQSK, PM-DQPSK)
- SW-configurable FEC algorithm to optimize Bandwidth vs. Reach:
  - 7% based on Standard G.975 ReedSolomon FEC
  - 20% based on Standard G.975.1 I.7 EFEC
  - 7% based on 3rd Generation EFEC (1xE^-2 Pre-FEC BER)
- Baud rate: 28 to 32 Gbaud
- 96 channels Full C-band 50GHz tunable DWDM Trunk
- SW-Configurable CD Robustness up to 70,000ps/nm, adjustable to 40,000ps/nm to operate with 1dB more of OSNR and operate @ Lower Power Consumption
- PMD Robustness up to 30ps (100ps of DGD)
- B2B OSNR: 14.5dB (0.1nm RBW)
- Receiver Dynamic Range (Noise Limited): +0dBm to -18dBm
CP-DQPSK 100G

- DP-QPSK Modulator
- Mux/Precoder
- Driver
- Laser
- Coherent Signal Processor
- Integrated receiver
- TX Out
- RX In
- ~5 inch
- ~7 inch
ONS 15454 MSTP

100G Suite of Line Cards

100G Tunable Line Card

10x10G Muxponder

2 x 100G CFP Client
2 x 40G CFP Muxponder
6x 100G Transponders in 6 RU
EANTC/Lightreading Validation
Cisco 100G Optical Innovations

**FEC & 100Gbit/s Ultra Long-Haul**

- 3000km SMF-28 ULL fiber max 0.18dB/km
- 28x EDFA (no RAMAN), 3x DGE
- 70 100Gbit/s CP-DQPSK channels
- No CD/PMD compensation
- Pre-FEC ~2.2E-03

How to Increase Transport Capacity?

- **Increase capacity (bit rate) per wavelength**
- **Increase the number of wavelengths**

**Feasible ADC bandwidth**

**50 GHz ITU Grid Infrastructures**

**Increase Modulation Efficiency**

**400G & Terabit Superchannels**

**Triple System Capacity**

**Flexible Spectrum Allocation**
DWDM System Capacity

Capacity per Fiber Pair

- **CP-DQPSK**: 100G per carrier, 96 chs at 50GHz
- **CP-16QAM**: 200G per carrier, 96 chs at 50GHz
- **CP-16QAM**: 200G per carrier, Flex Spectrum

Terabits per Second

- 9.6
- 19.2
- 28.8
What is a Flex Spectrum ROADM?

- **Standard ROADM**s support wavelengths on the 50GHz ITU Grid
  
  Bit Rates or Modulation Formats not fitting on the ITU grid cannot pass through the ROADM

- **Flex Spectrum ROADM** removes any restrictions with respect to:
  
  **Channel Spacing**
  - Allows creation of Superchannels
  - Allows maximum flexibility in controlling non-linear effects due to wavelengths interaction

  **Modulation formats**
  - Mix wavelengths with different Bit Rates
  - Scale to higher per-channel Bit Rates
EANTC/Lightreading Validation
Cisco 100G Optical Innovations
Super Channel Demo

- 500km, EDFA, No CD/PMD compensation
- 2x 1Tbit/s Super Channel = 10x 100Gbit/s 16QAM
- 1x 400Gbit/s Super Channel = 4x 100Gbit/s 16QAM
- 64x 100Gbit/s
- Pre-FEC ~1.2E-02

Cisco 100G Competitive Differentiators

• **Performance**
  Multiple field trials over existing infrastructure
  **3000 km** lab demonstration, verified by EANTC.

• **Compatibility with existing Infrastructure**
  No guard band *typically* required between adjacent channels – 10G, 40G, 100G
  High PMD robustness allows installation over ageing fiber plants

• **Density**
  When using CXP (SR10), **six transponders per M6, one per RU, 42 per bay**
  Lowest power 100G in industry

• **Price Flexibility**
  10G → 100G Muxponding **Pay-As-You-Grow**
  Metro and Long Haul price / performance flexibility

• **IP / Optical Integration**
  Pre-FEC Proactive FRR including regeneration
  **Same module** used in 15454 100G trunk card, CRS-3 IPoDWDM line card, and future converged platforms
## Cisco DWDM Customers

### Global Customer Acceptance Across All Market Segments

<table>
<thead>
<tr>
<th>SP</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NCNI</strong></td>
<td>Beijing Broadcasting Institute, BBI</td>
</tr>
<tr>
<td><strong>aarnet</strong></td>
<td>Xiamen University</td>
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<tr>
<td><strong>CESNET</strong></td>
<td>Wake Forest University</td>
</tr>
<tr>
<td><strong>TIREN</strong></td>
<td>The George Washington University</td>
</tr>
<tr>
<td><strong>Cable/MSO’s</strong></td>
<td><strong>COGEO</strong></td>
</tr>
<tr>
<td><strong>COX</strong></td>
<td><strong>OCM</strong></td>
</tr>
<tr>
<td><strong>CABLEVISION</strong></td>
<td><strong>DTE Energy</strong></td>
</tr>
<tr>
<td><strong>VIDEOTRON</strong></td>
<td><strong>CHARTER COMMUNICATIONS</strong></td>
</tr>
<tr>
<td><strong>ROGERS</strong></td>
<td><strong>COMCAST</strong></td>
</tr>
<tr>
<td><strong>TIME WARNER CABLE</strong></td>
<td><strong>EASTLINK</strong></td>
</tr>
<tr>
<td><strong>COMCAST</strong></td>
<td><strong>C&amp;M cablecom</strong></td>
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<tr>
<td><strong>EXON</strong></td>
<td><strong>SHANGHAI ELECTRIC POWER CO., LTD.</strong></td>
</tr>
<tr>
<td><strong>SAKHALIN ENERGY</strong></td>
<td><strong>DTE Energy</strong></td>
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<tr>
<td><strong>Qatar Petroleum</strong></td>
<td><strong>Manitoba Hydro</strong></td>
</tr>
<tr>
<td><strong>IndianOil</strong></td>
<td><strong>Philadelphia Stock Exchange</strong></td>
</tr>
<tr>
<td><strong>BANKTHAI</strong></td>
<td><strong>JPMorgan Chase &amp; Co.</strong></td>
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<tr>
<td><strong>London Stock Exchange</strong></td>
<td><strong>First Boston</strong></td>
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<tr>
<td><strong>Northern Trust</strong></td>
<td><strong>Citi</strong></td>
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<tr>
<td><strong>TD</strong></td>
<td><strong>China Construction Bank</strong></td>
</tr>
<tr>
<td><strong>Barclays</strong></td>
<td><strong>BANK OF CHINA</strong></td>
</tr>
</tbody>
</table>
Cisco IP+Optical
What is IP-over-DWDM?

All the benefits of a transponder integrated into the packet platform

IPoDWDM vs. WDM Pluggables

- High performance optics
- Fully tunable
- G.709 and FEC/EFEC
- Integrated Management and Performance Monitoring

CRS
ASR 9000
12000
7600

ONS 15454 MSTP ROADM
IP-over-DWDM Solution Benefits

• Lower CapEx
  Elimination of client optics

• Lower OpEx
  Space, power, management

• Enhanced resiliency
  Fewer active components

• Multi-Layer Interaction
  Proactive FRR, …
CRS-3 100G IP over DWDM PLIM

- **Ultra Long Haul Performance**
  - CP-DQPSK, 96 channel tunable DWDM interface
  - 3000 km, unregenerated, without Raman
  - Over X customer trials completed

- **End-to-End Compatibility**
  - ONS 15454 MSTP Virtual Transponder management
  - Two slot regenerator with ONS 15454 100G line card
  - Same DWDM module as ONS 15454 100G transponder

- **IP over DWDM Benefits**
  - Pre-FEC proactive fast reroute – hitless failover
  - Space, Power, and Capex savings
  - Fewer network elements – improved resiliency

- **CRS Flexibility**
  - Multi-Service, Thin Core, and Lean Core
  - 4, 8, 16 slot chassis plus multi-chassis
  - 100G IP-over-DWDM and gray CFP based PLIM
Pre-FEC Proactive Protection

Reactive Protection

- Gray Port On Router
- Transponder
- FEC
- DWDM / ROADM

![Reactive Protection Diagram]

Proactive Protection

- Gray Port On Router
- DWDM Router Interface
- Trigger Enabled Transponder
- FEC
- DWDM / ROADM

![Proactive Protection Diagram]
Transport Interface Virtualization

“Virtual Transponder”

Router Interface Virtualization

“MSTP Satellite”

MSTP has visibility into and control of the DWDM interface on the router.

Router L1 interface controlled and monitored by CTC.

Control Plane interaction

Router has visibility into and control of the DWDM interface on the MSTP.

DWDM interface controlled and monitored by router CLI.

Control Plane interaction
iOverlay – Convergence Control Plane

- iOverlay can provide the network knowledge of peering while providing greater scale
- Provide Multi Layer Support while Respecting Organizational Boundaries
- Leverage Expertise across layers
- Share and leverage information across layers
iOverlay Architecture

- Overlay client uses service from Server layer
- The two layers are independent and decoupled
- I for Information: all the required information is flowing between the two layers
iOverlay - Intelligent Information Exchange

**Multi-Layer Interaction**

**Packet Layer** (master)
- IGP
- QoS
- SLA’s
- Peering
- Addressing

**Layer 0 Information**
- Circuit ID, Wavelength path
- Wavelength Latency
- Shared Risk Link Groups
- Wavelength Margin (yellow, green, red)
- Available wavelength capacity
- L0 Network Topology
- Dynamic Optical Restoration
- L0 Maintenance

**Packet Layer Requests**
- Sub-50ms Protection (Proactive FRR)
- Hardware Integration
- IP over DWDM
- GMPLS

- a circuit with the same path as X
- a circuit with disjoint path as X
- a circuit with max latency Y
- a circuit that avoids XYZ risk
- a circuit that has best optical margin
- a protected circuit, with restoration
- an unprotected circuit, with restoration
- Coordinated Maintenance

**DWDM Layer** (slave)
- OSNR
- CD / PMD
- power levels
- non-linear impairments
- physical topology

**Segmented**
- GMPLS

**Un-Overlay**
- UNI

**Overlay**
- UNI
Layer Interaction - Provisioning

- Low Latency / Disjoint / Matching / SRLG Circuit
  
  Today → **Months**
  L3 requests circuit of L0 team
  Ingress and Egress may be different
  L0 verifies available path
  L0 verifies performance and resources
  L0 / L3 Coordinate Circuit Turn up

iOverlay → **Minutes**

Client Signals circuit request
Disjointed from other circuit ID
L0 signals wavelength or path error message
Automatically updating SRLG data
Dynamic Optical Restoration

0+1+R
Eliminate Wasteful Dual Layer protection

1+1+R
Enhanced Protection for Critical Circuits

Dynamic Optical Restoration <1 minute

FRF: Traffic Restore
FRR: Fault Recovery
Pre-FEC
Dangling
Resources
Over-provisioning
Oversubscription
FRR Traffic Restore
Omni-Directional Add/Drop
Summary
Summary

• 40GE/100GE Standards
• Transceivers continue evolving
• Cisco strong R&S 40GE/100GE Portfolio
• Market leading 100G DWDM Solution (Distance, Density, Power)
• 1Tbit/s Super Channel Demo
• Cisco investments in optical
• IP+Optical – Layer convergence – iOverlay
Cisco Expo 2012
100GE HW & Demo

CRS-3/4
1x100GE

ASR 9006
2x100GE

100GBASE-LR4

100GBASE-LR4

Nexus 7009
2x100GE

Spirent TestCenter
Odkazy


• EANTC/Lightreading Report:

• Optical Impairment-Aware WSON Control Plane for Cisco ONS 15454 MSTP:

• CFP MSA: http://cfp-msa.org/