



DWDM Transport Solutions

BRKBBA-2013



Russell Pretty

Cisco Networkers
2007

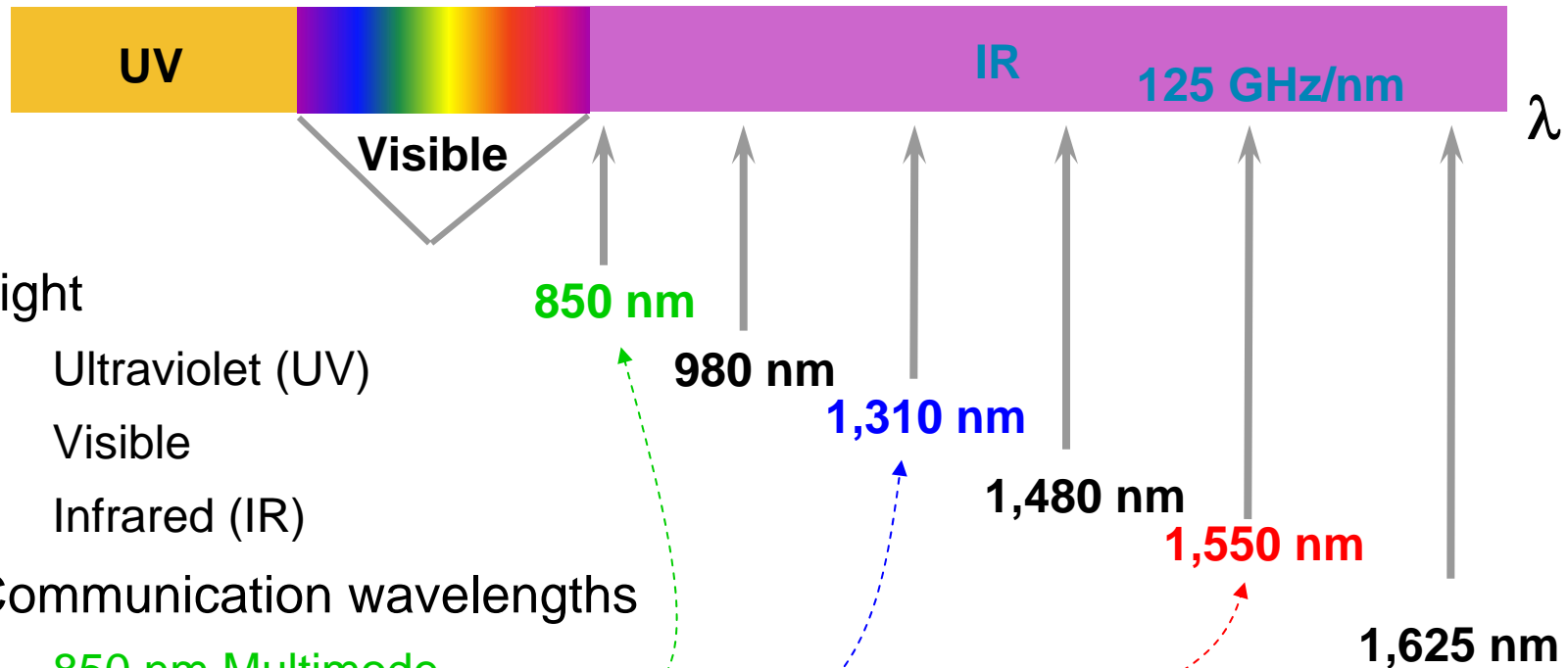
HOUSEKEEPING

- We value your feedback, don't forget to complete your online session evaluations after each session and complete the Overall Conference Evaluation which will be available online from Friday.
- Visit the World of Solutions on Level -01!
- Please remember this is a 'No Smoking' venue!
- Please switch off your mobile phones!
- Please remember to wear your badge at all times including the Party!
- Do you have a question? Feel free to ask them during the Q&A section or write your question on the Question form given to you and hand it to the Room Monitor when you see them holding up the Q&A sign.

DWDM is displacing SDH as the primary transport technology of choice

- **DWDM Technology Fundamentals**
 - Attenuation, Amplification, OSNR, FEC, Chromatic Dispersion
- **Service Flexibility**
 - Full range of Data, Storage & TDM Transport services
 - 10 to 40 Gbps per wavelength fits needs of packet switching
 - X-Ponder – Integration of L2
 - ADM on a Blade – Support of Legacy TDM
- **Dynamic Reconfigurability**
 - Reconfigurable Optical Add/Drop Multiplexors (ROADM)
 - Lasers Fully Tuneable across 80 wavelengths
 - Wavelength Cross Connects and Mesh Networking
- **Resilience**
 - Sub-50 ms protection switching
 - Automatic Gain Control
 - SDH-like performance monitoring & alarm signalling via G.709
- **Ease of Deployment**
 - Powerful Automated Design Tools
 - A-Z Provisioning

Optical Spectrum



- Light
 - Ultraviolet (UV)
 - Visible
 - Infrared (IR)
- Communication wavelengths
 - 850 nm Multimode
 - 1310 nm Singlemode
 - 1550 nm DWDM & CWDM
 - Low-loss wavelengths
- Specialty wavelengths
 - 980, 1480, 1625 nm (eg. Pump Lasers)

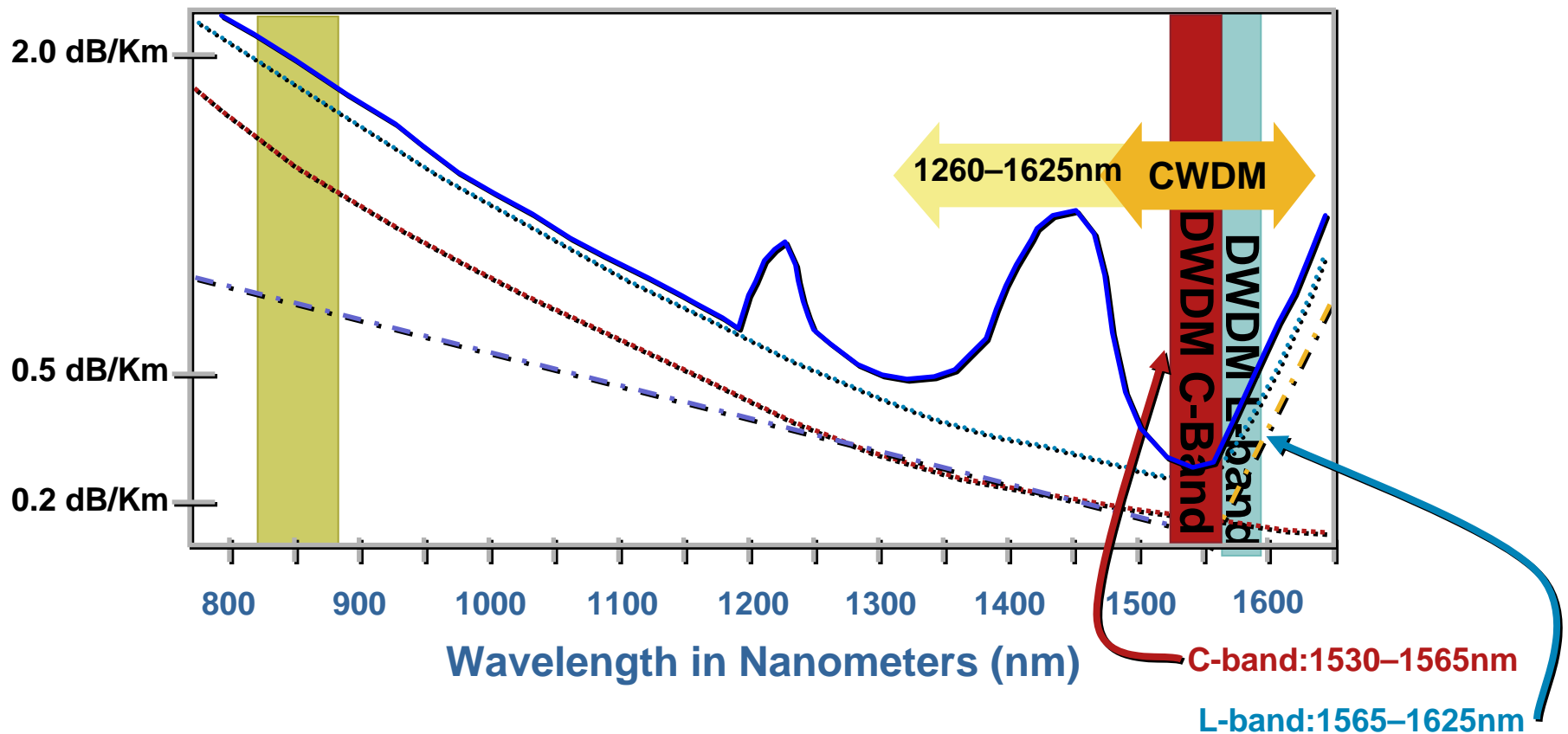
$$C = f \times \lambda$$

Wavelength: λ (Nanometers)

Frequency: f (Terahertz)

Fiber Attenuation varies with wavelength

Loss (dB)/km vs. Wavelength



DWDM has greater capacity and reach than CWDM

Dense-WDM

Optimized for

- Bandwidth
- Reach

80 DWDM Channels
spaced at 0.4 nm
(50 GHz spacing)

C band

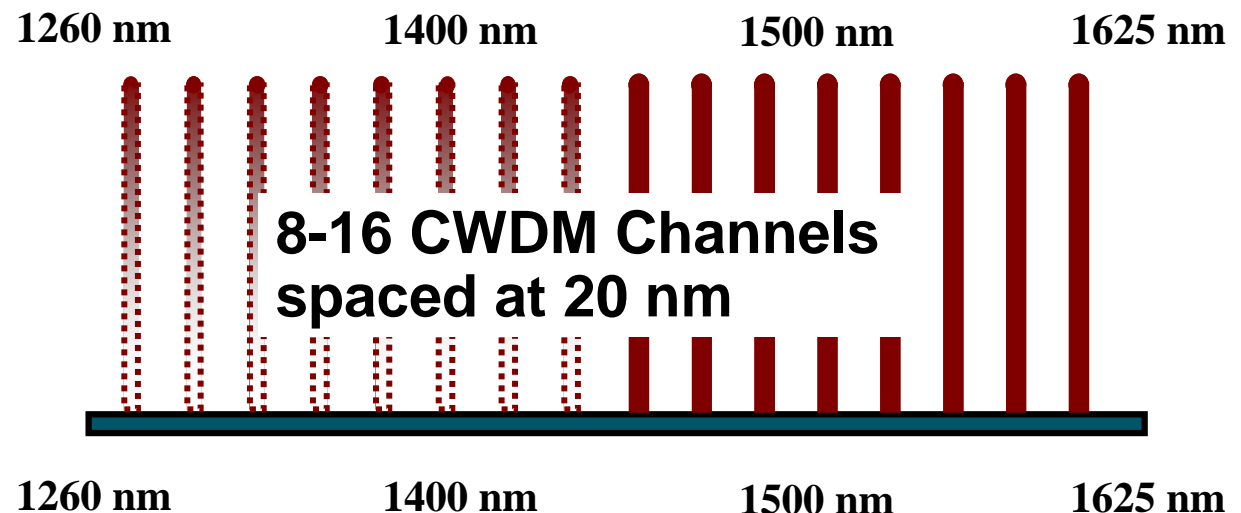


Coarse-WDM

Optimized for

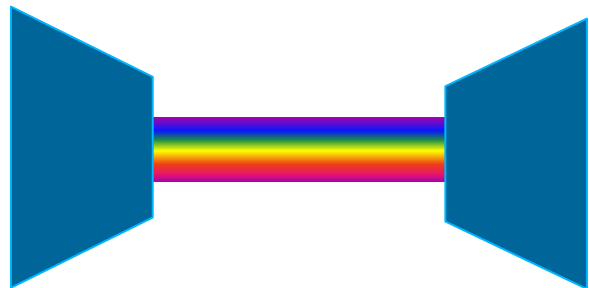
- lower cost
- Not amplifiable

8-16 CWDM Channels
spaced at 20 nm



Power Attenuation and Noise accumulation are key limiting factors in optical transmission

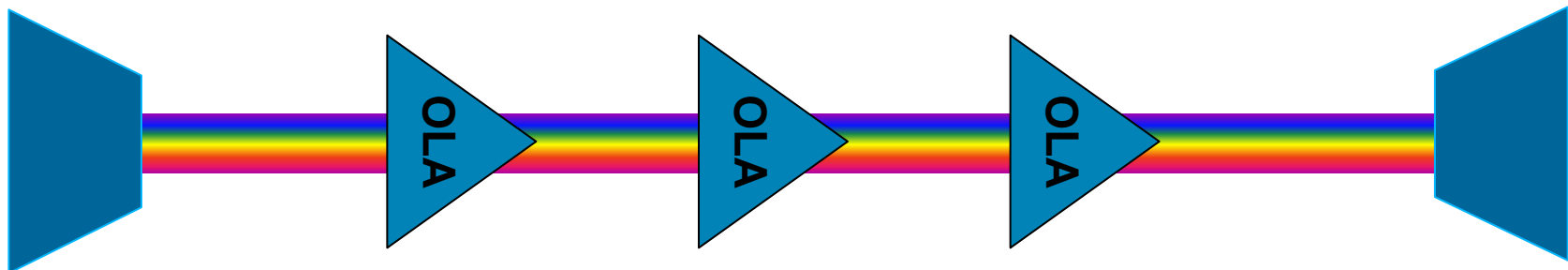
Attenuation limits reach of a dark fibre span.



0.25 dB/km typical Characteristic of Fibre

Eg. 37dB budget between Tx Power and Rx sensitivity

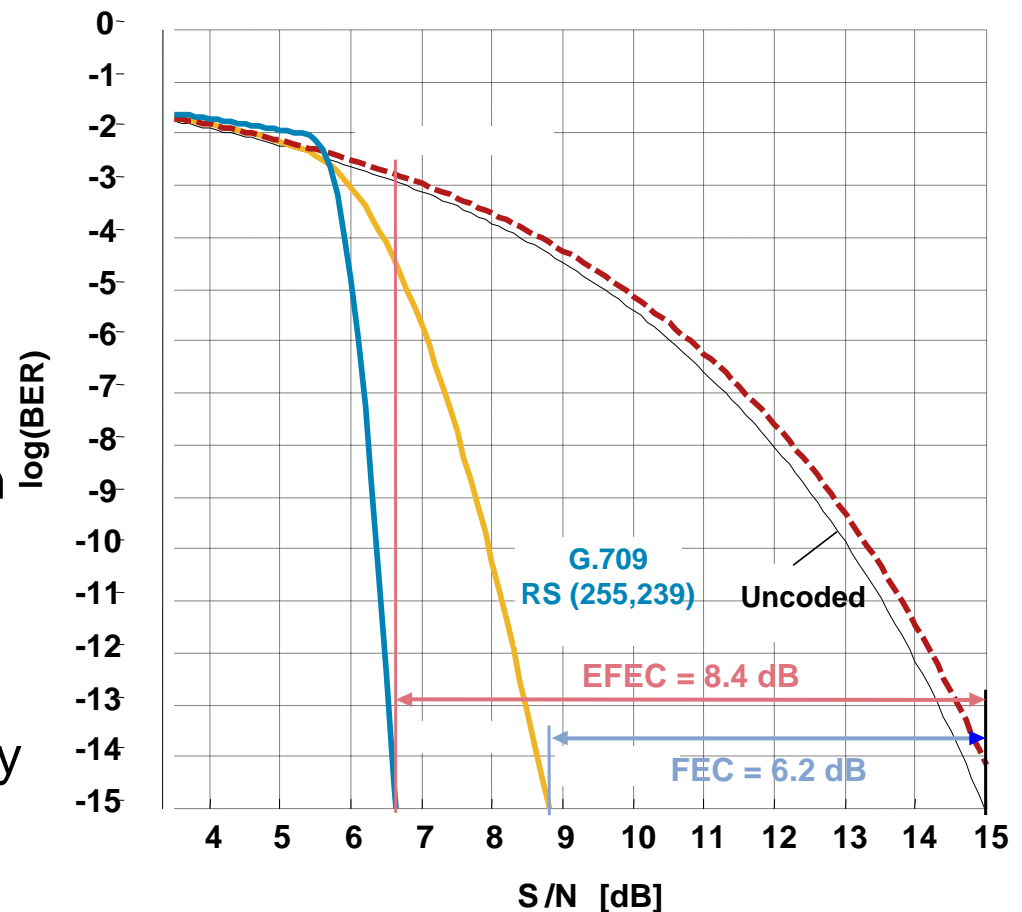
Hence spans max roughly 150km



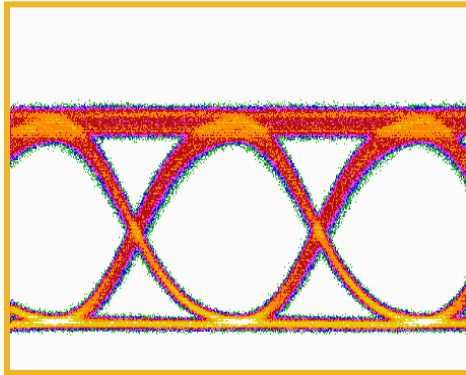
Optical Line **Amplifiers** (OLA) add more spans of reach but also **inject noise**. OSNR limits total reach.

Forward Error Correction Extends Reach

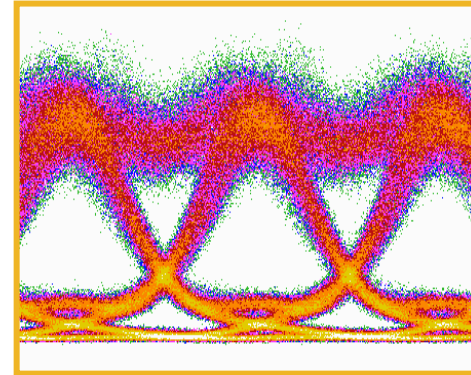
- All 15454 10G transponders/muxponders offer **software selectable** No FEC/FEC/EFEC
- 2.5G transponders offer SW Selectable No FEC/FEC
- FEC extends reach and design flexibility
- G.709 standard FEC improves OSNR tolerance by **6.2 dB** (at 10^{-15} BER) adding $5\mu\text{s}$ delay
- Enhanced FEC improves OSNR tolerance by **8.4 dB** adding $150\mu\text{s}$ delay



Chromatic Dispersion (CD) can be corrected with Dispersion Compensation Units (DCUs)

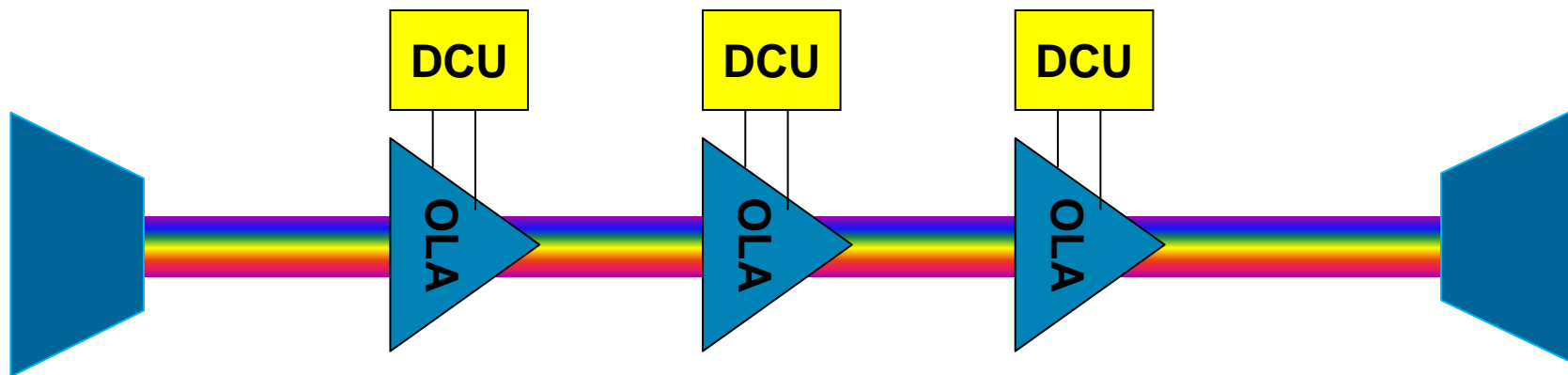


**Dispersion
= Temporal
Spreading**



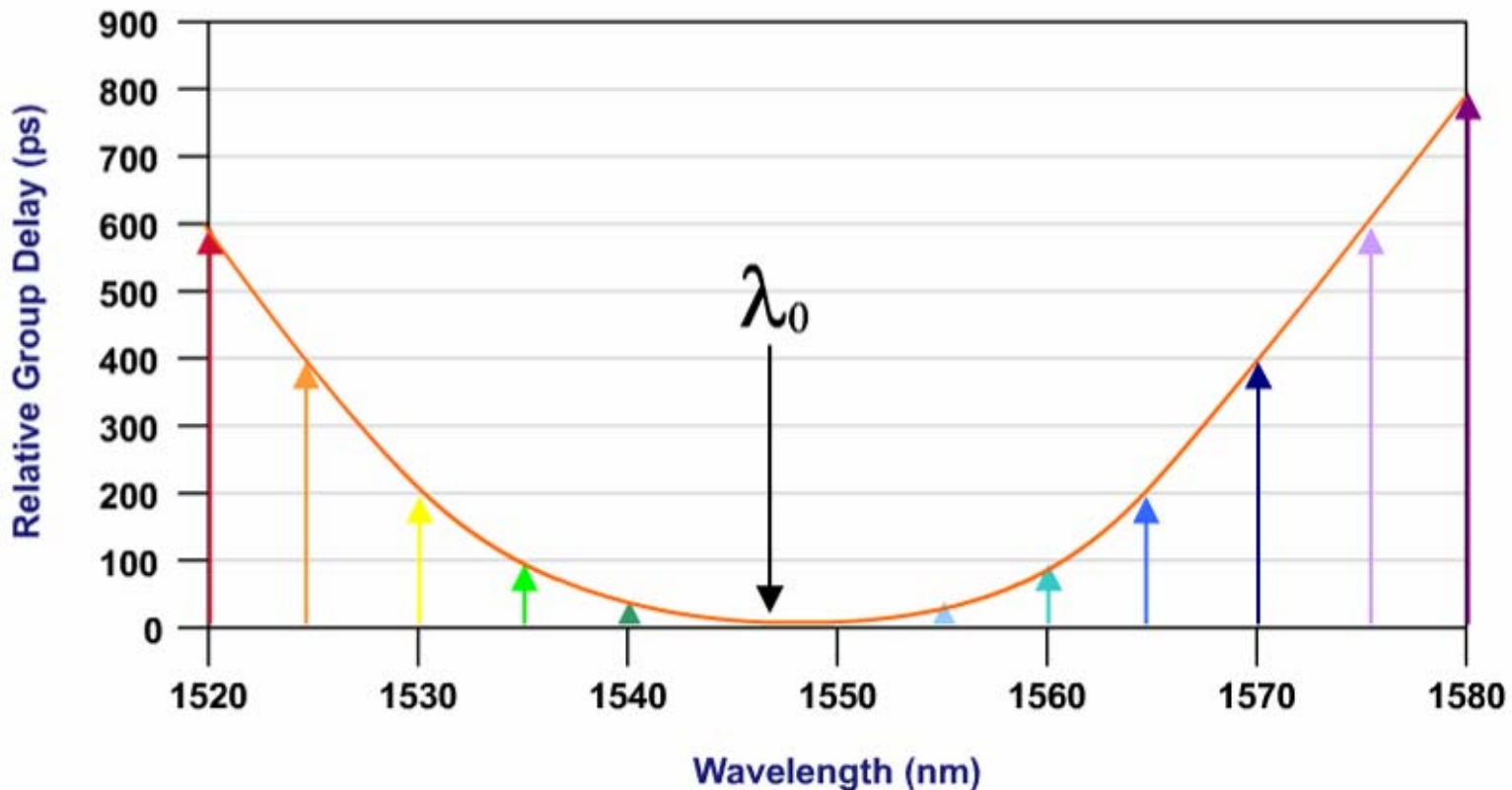
Transmitted Data Waveform

Waveform After 1000 Km



Higher bit rate signals have less tolerance to CD because bit-times are shorter

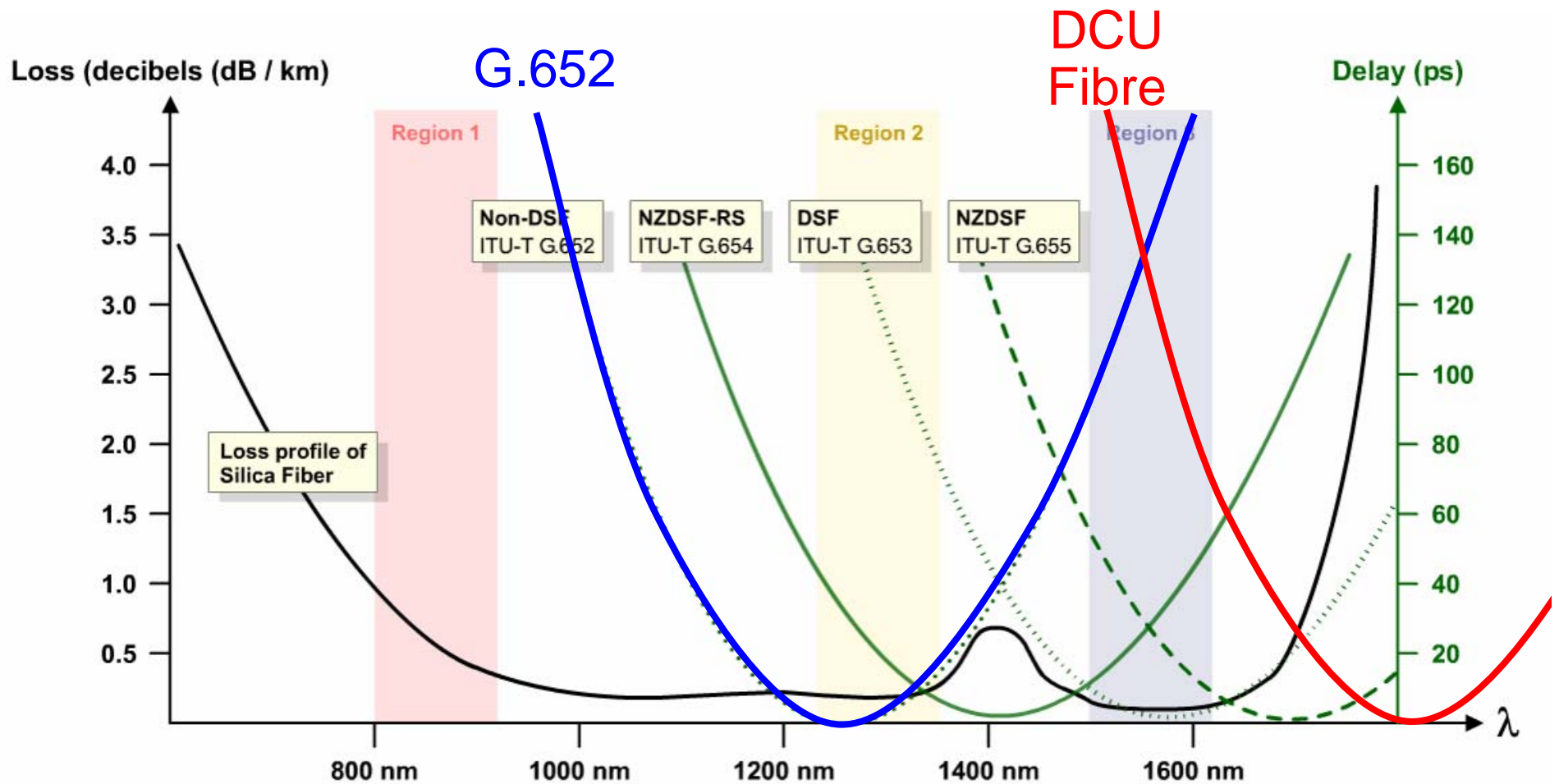
Group Delay – Different Wavelengths Travel at Different Speeds in the Fibre



Causes Chromatic Dispersion – spreading of signal in time

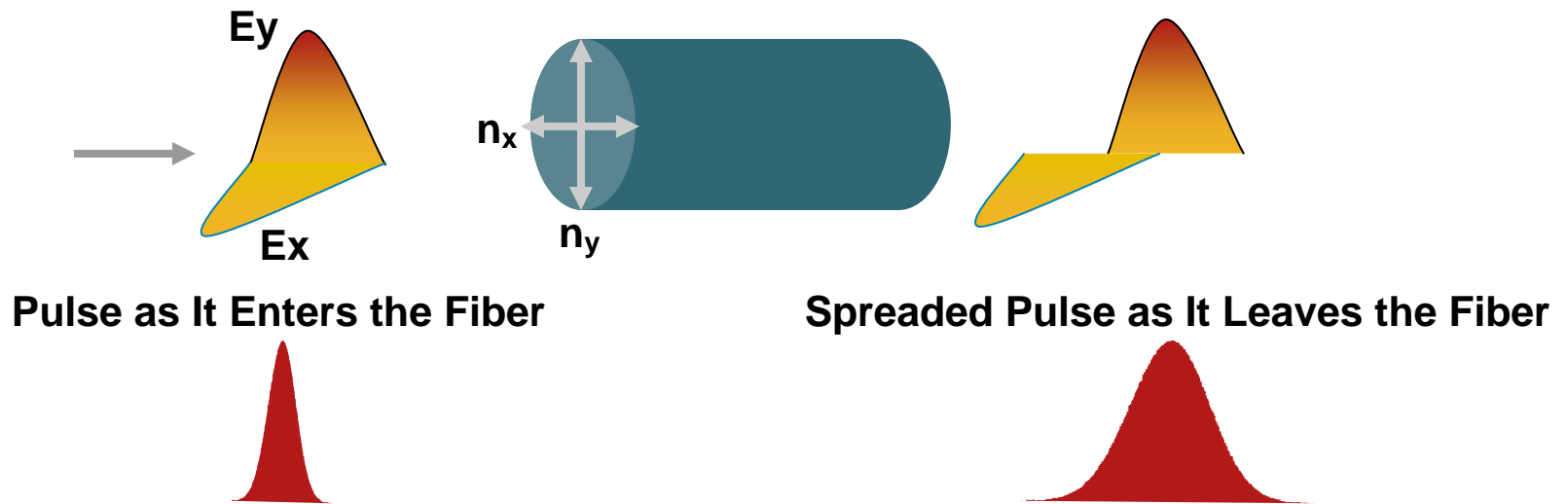
Slope of this curve is the Dispersion Coefficient

Different Fibre Types Have Different λ_0



Dispersion can be compensated for by passing the signal through fibre with a reversed slope

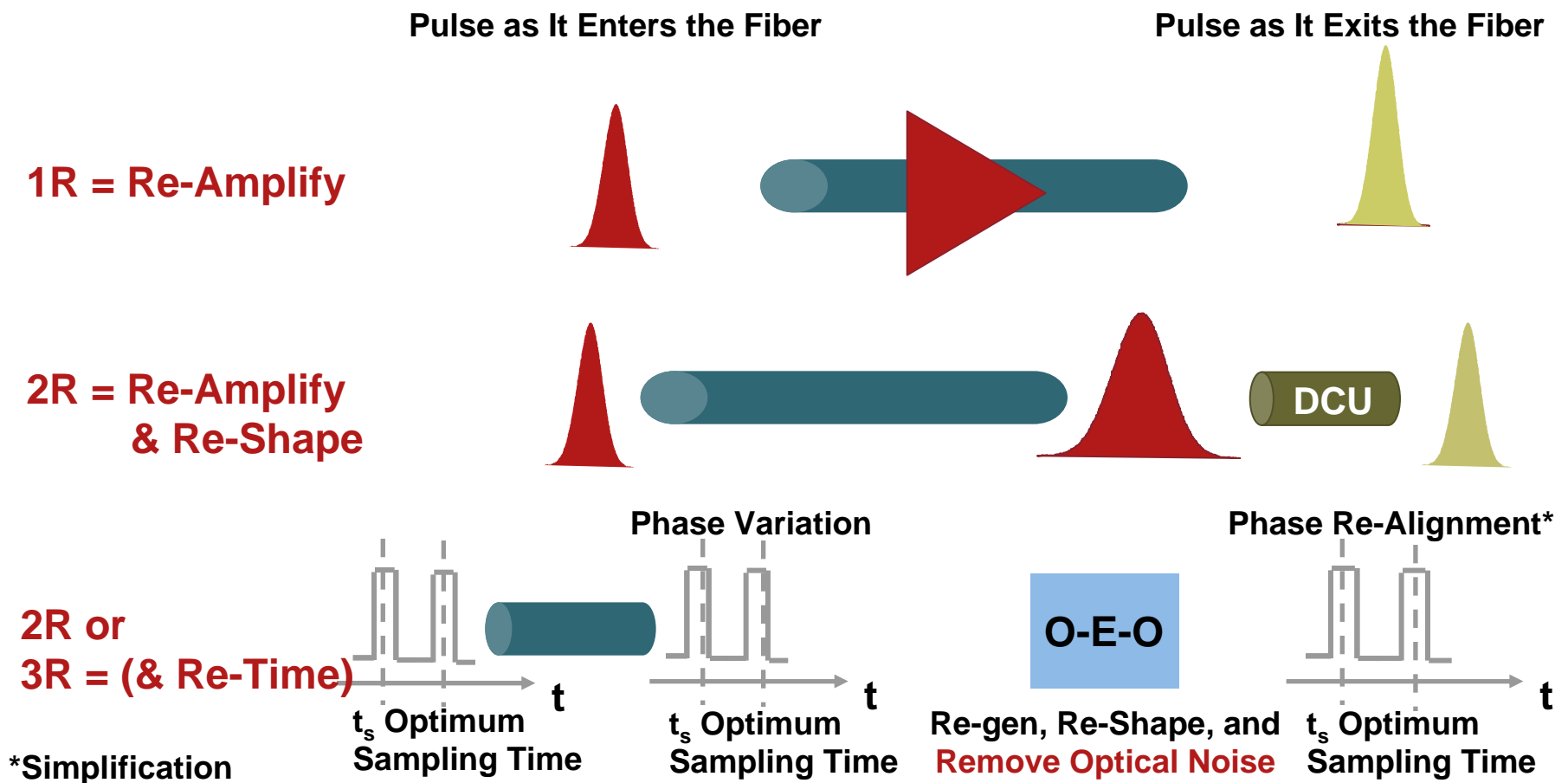
Polarization Mode Dispersion (PMD)



- Due to fibre not being perfectly round, the optical pulse broadens as it travels down the fiber
- Much weaker phenomenon than Chromatic Dispersion and doesn't limit reach at bit rates of 10Gb/s or less

Optical Regeneration – 3 R's

The Options to Recover the Signal from Attenuation/Dispersion/Jitter Degradation Are:



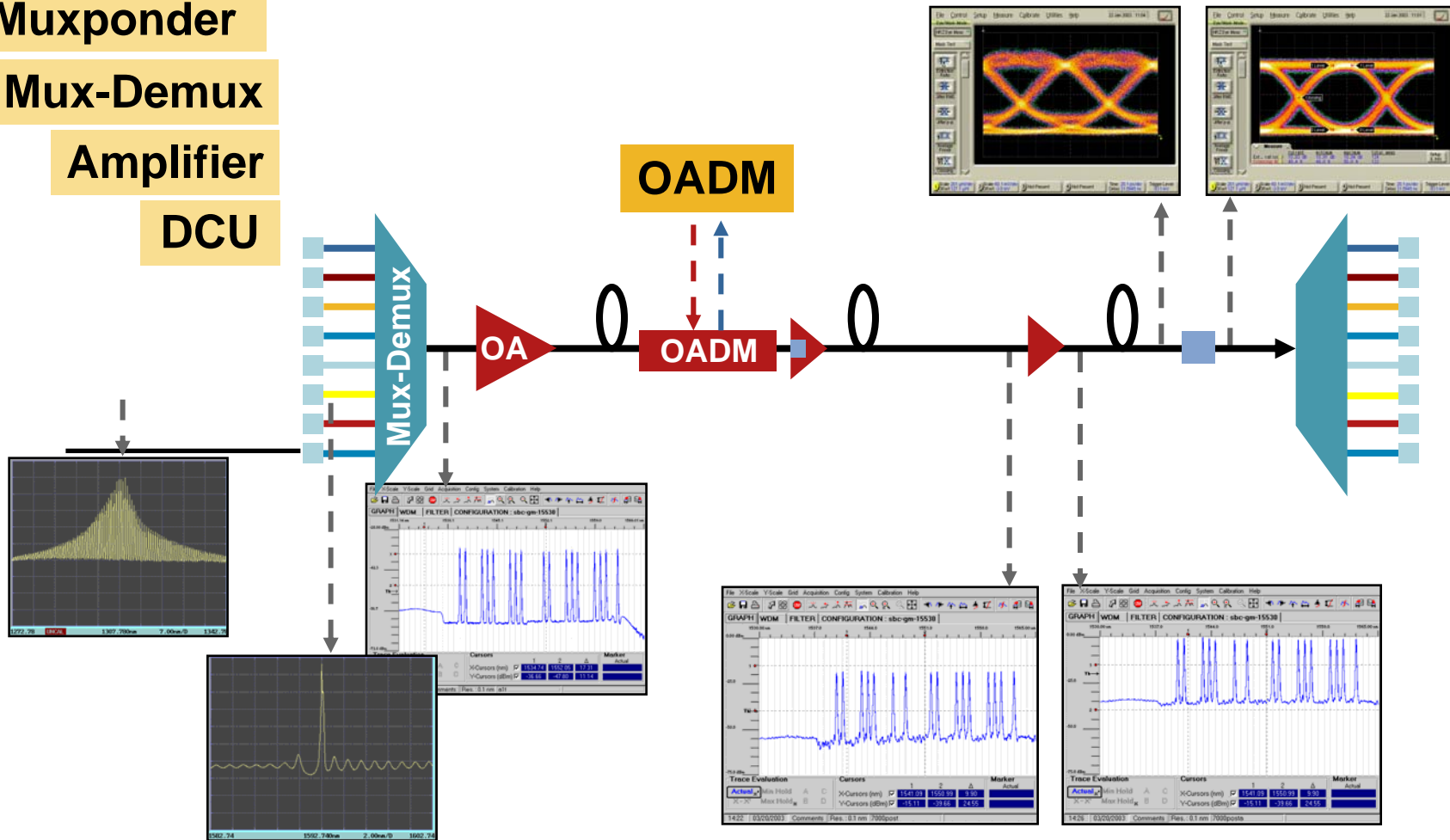
DWDM System Components

Transponder
-Muxponder

Mux-Demux

Amplifier

DCU



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DWDM Transports a Wide Range of Services

- Data

GE, 10GE LAN & WAN PHY and 40Gbit/s
 STM-1, STM-4, STM-16, STM-64 & STM-256 POS
 Integrated L2 Bridging

- Storage

Fibre Channel (1, 2, 4 and 10 Gbps)
 FICON (1, 2 & 4 Gbps)
 ISC-1, ISC-3
 ESCON
 ETR/CLO

- Video

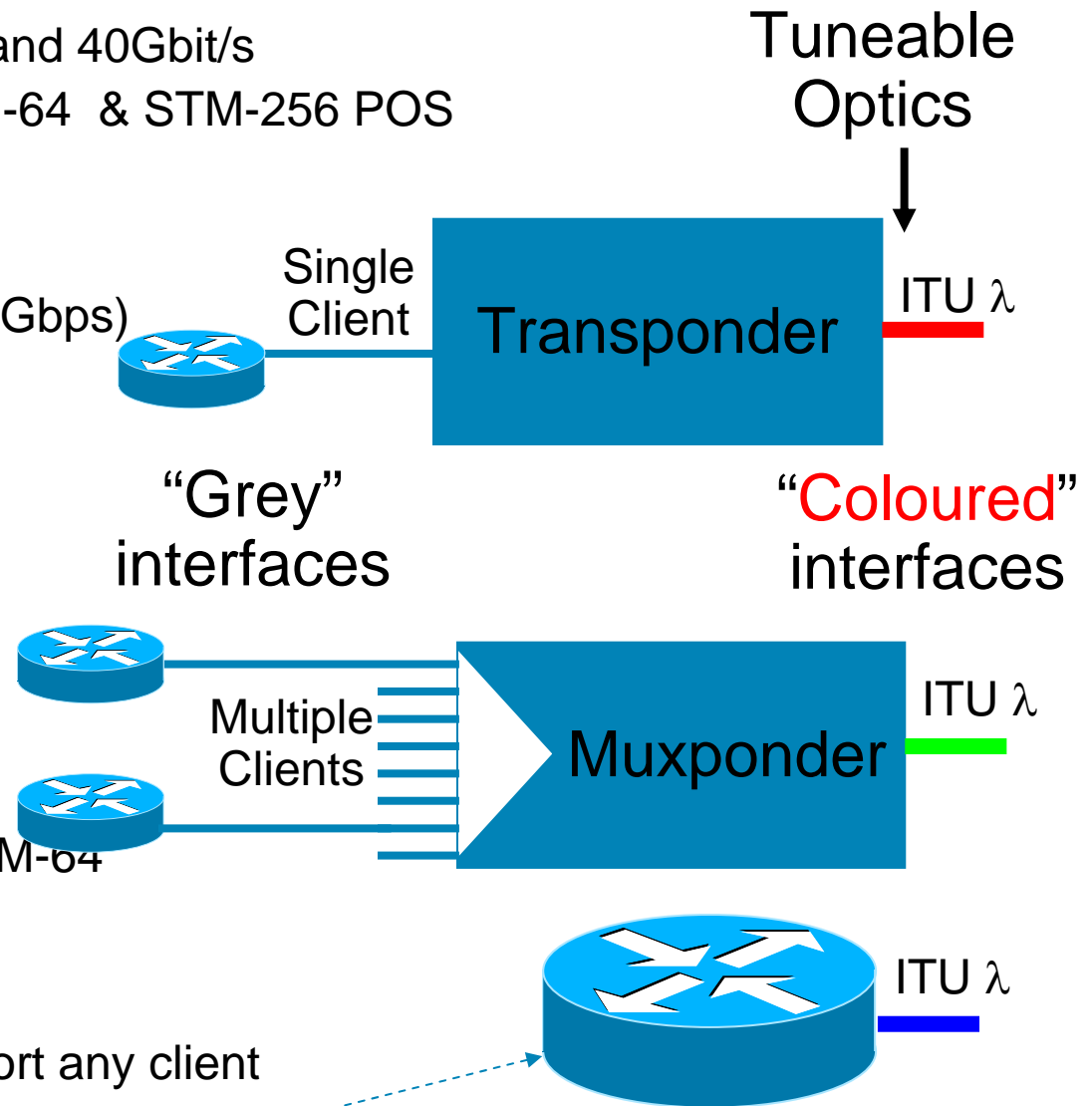
SDI, DV6000, HDTV

- TDM

STM-1, STM-4, STM-16 & STM-64
 Integrated ADM on a Blade

- Other

Multi-rate Transponders support any client
 DWDM optics in Client feed directly to OADM



DWDM Interfaces on Clients

DWDM Pluggable Optics

GBIC, SFP, XENPAKs, XFP, etc. are available on **growing list** of clients (Routers, Bridges, Storage switches, ADMs,...)

In most cases FEC and EFEC not supported, limiting amplified reach to **~ 200kms**

DWDM Client Interfaces

- The **CRS-1** had a **4x10G** DWDM interface
 - Full **tuneability** to 80λ in C-Band, based on the MSTP optical front-end
 - **G.709, FEC and EFEC** included for extended reach (**~1800 km**)
 - Initially **10GE LAN PHY**, later OC-192/STM-64 over λ
- **CRS-1** is releasing a **1x40G** DWDM interface
 - 10C769-ITU/C= 1 Port 40Gb WDMPOS Interface for the CRS-1
 - Fully 50GHz Tuneable: C-Band (80λ) and L Band,
 - EFEC, G709, **~1000km** without Regen
- **7600 & GSR** releasing a **1x10G** DWDM SPA
SPA-1X10GE-L-ITUC; 1-port 10GbE LAN-PHY SPA
Fully 50GHz Tuneable: C-Band (80λ)
G.709, FEC, EFEC,...

Cisco's ONS 15454 MSTP is Certified by all Major Storage Vendors

Service Interfaces

2.5G DataMuxponder

- 2 x GbE
- 2 x 1G FC/FICON
- 1 x 2G FC/FICON
- 8 x ESCON



10 DataMuxponder

- 8 x GbE
- 8 x 1G FC/FICON/ISC-1
- 4 x 2G FC/FICON/ISC-3
- 2 x 4G FC



2.5G MR Transponder

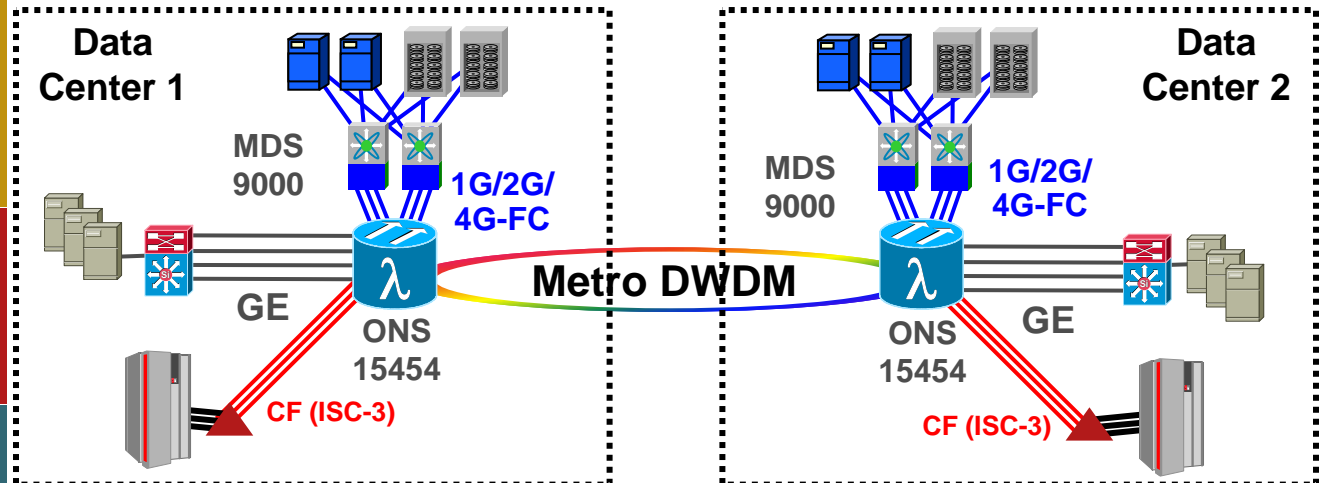
- 1 x GbE/FC/2GFC
- ETR/CLO

10G MR Transponder

- 1 x 10GbE LAN PHY
- 1 x 10G FC



- Embedded buffer to buffer credits for large DR/BC
- Real-time performance monitoring of payload (8B10B)
- Pluggable optics allow for 850nm, 1310nm, 1550nm options
- Cisco Transport Controller can launch MDS Fabric Manager



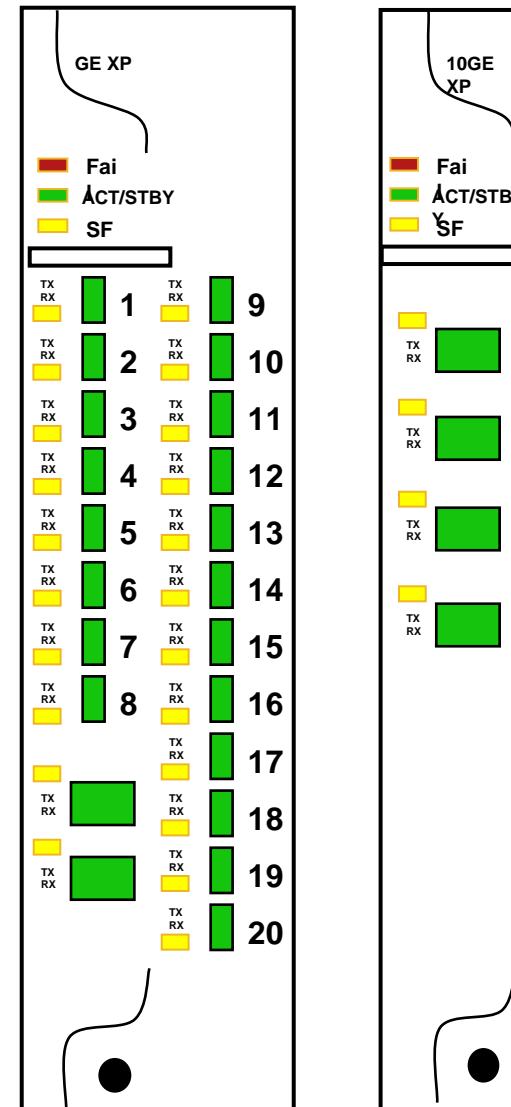
CrossPonder Integrates L2 Bridging into the DWDM network

- **GE XPonder**

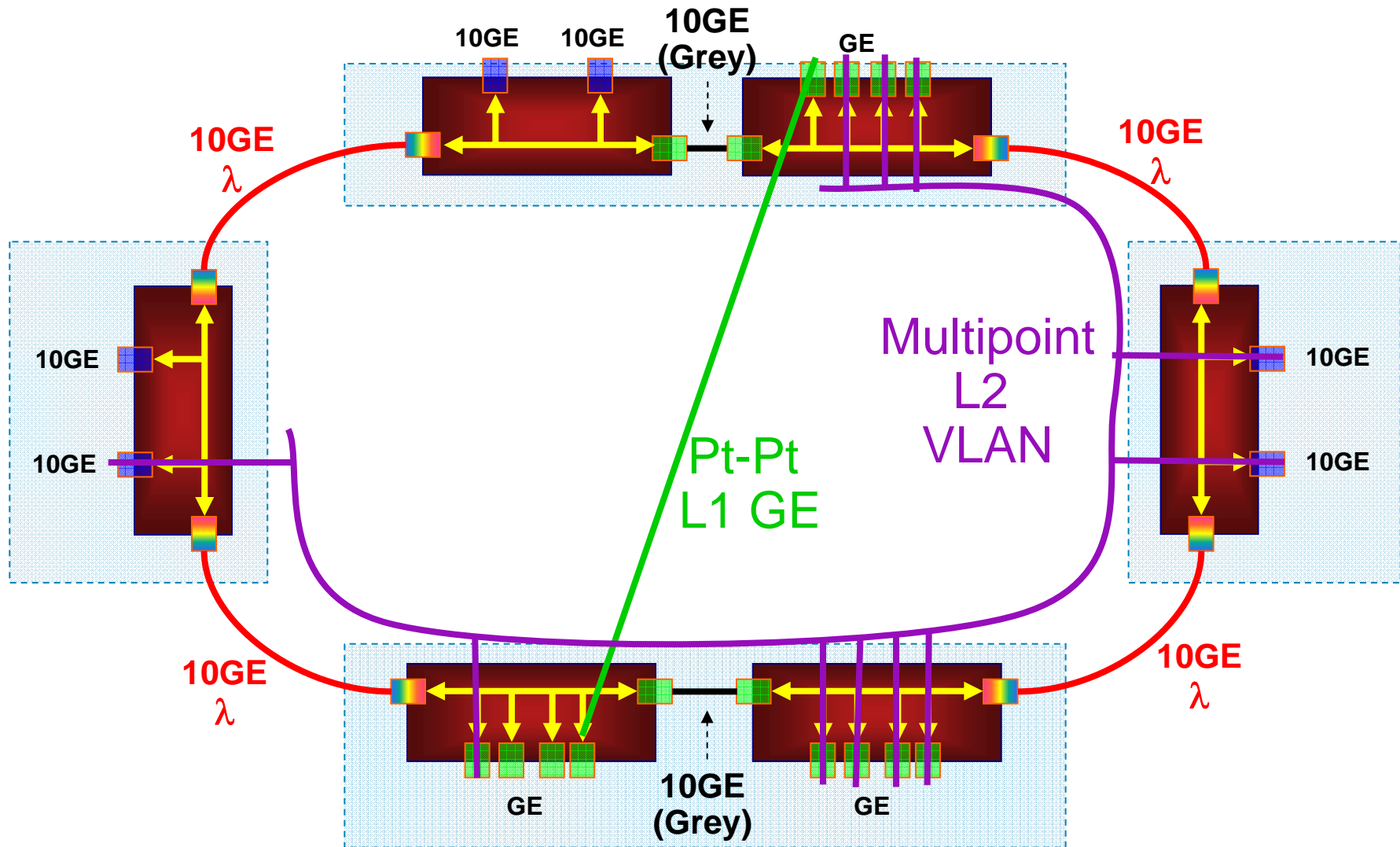
- 20 SFP Based GE Ports (High Density)
- 2 XFP Based 10GE LAN-PHY Ports
EFEC/FEC & G.709 SW Provisionable
- 50ms Ring Protection per port
- Pt-multi-pt
- Per-port Sub-rating

- **10GE XPonder**

- 4 XFP 10GE LAN PHY Ports
- 2 Ports supporting EFEC/FEC & G.709 (SW Provisionable)
- 50ms Ring Protection per port
- Pt-multi-pt
- Per-port Sub-rating

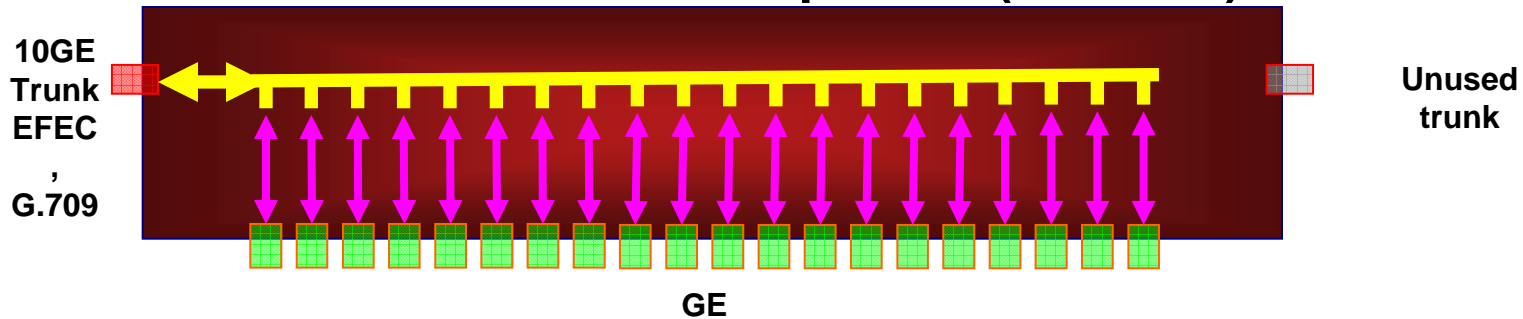


XPonder Rings Support Protected L1 and L2 Services

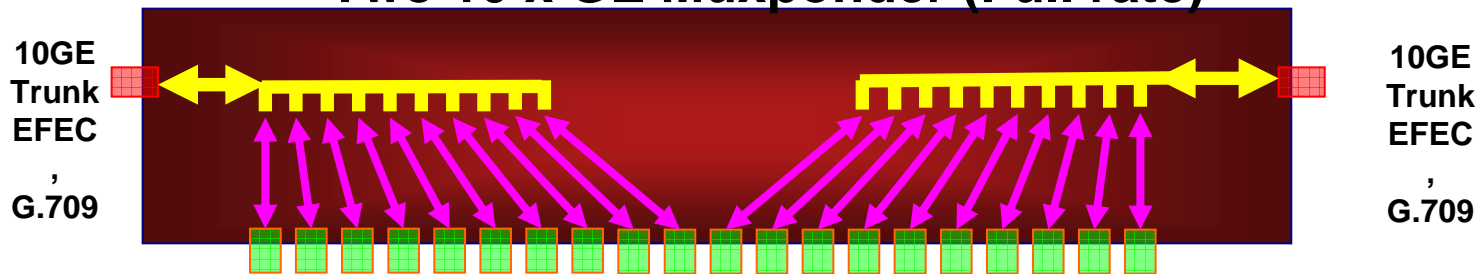


GE X-Ponder Applications - Muxponder

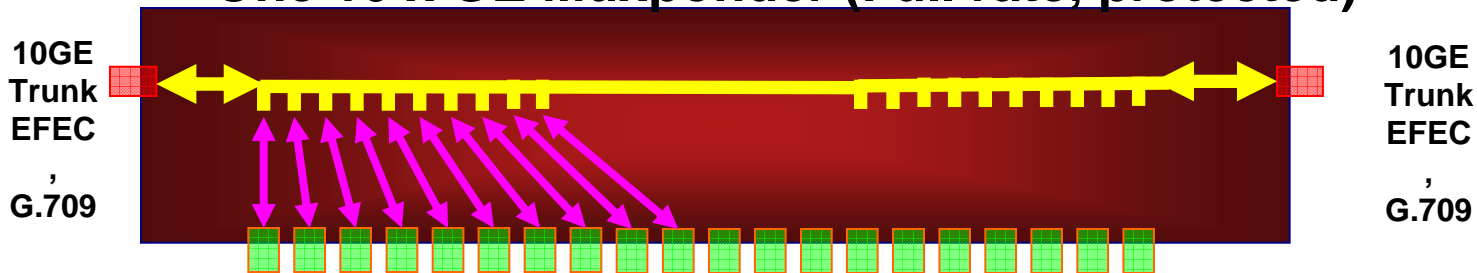
One 20 X GE Muxponder (Half rate)



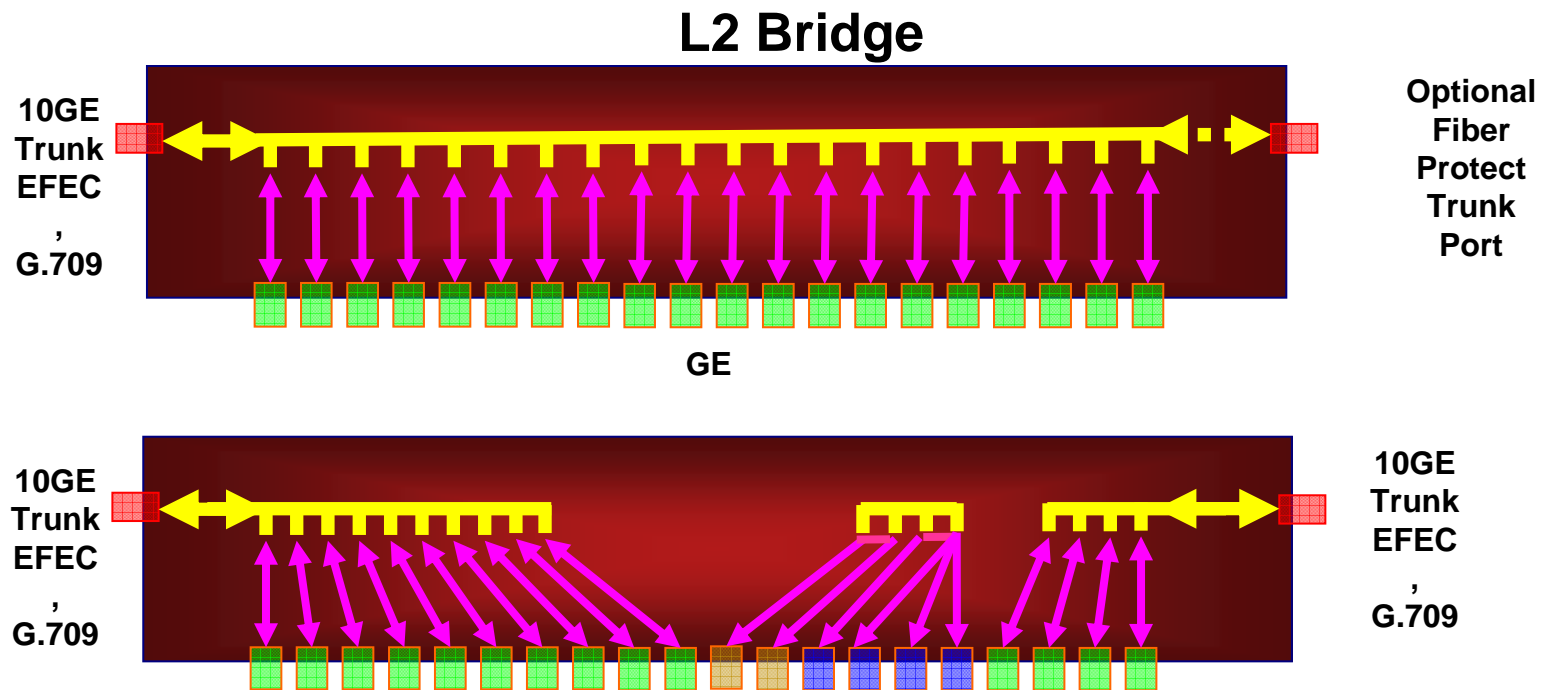
Two 10 x GE Muxponder (Full rate)



One 10 x GE Muxponder (Full rate, protected)



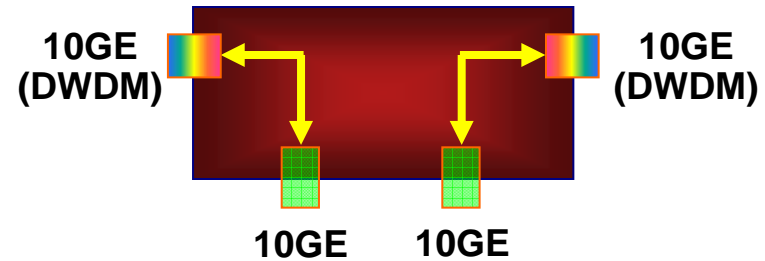
GE X-Ponder Applications - Bridging



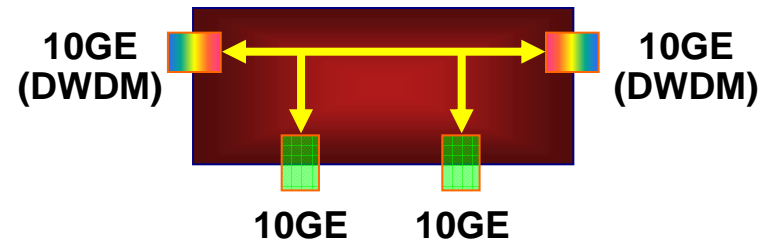
- 802.1Q and Q-in-Q support
- VLAN Translation
- Ingress 3-colour policing
- WRR Egress Queuing
- 50ms Ring Protection

10GE XPonder Operating Modes

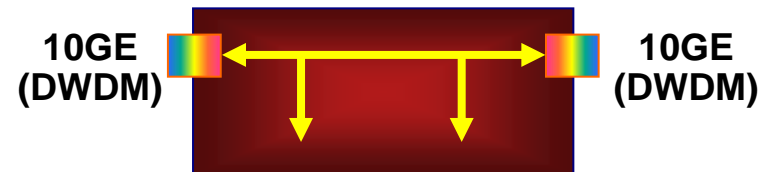
- 2x 10GE Transponder



- Layer 2 Bridge



- 10GE DWDM Regenerator



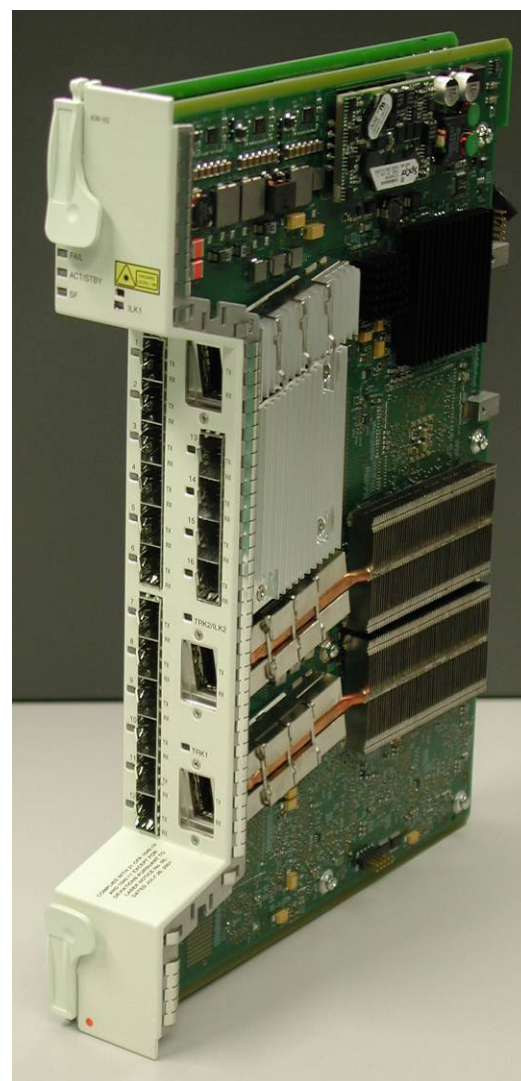
10G ADM On A Blade: Unit Details

HW Features

- 16 SFP Based Client (Grey and CWDM optics available)
- Support of OC3/OC12/OC48/GE client signals
- 1 Trunk XFP Based supporting E-FEC/FEC and G.709
- 2 SR XFP supporting redundancy connection with protection board and Pass-through Traffic
- GFP-F Mapping

SW features

- SONET Operation mode
- OTN PM on Trunk
- A to Z Circuit provisioning (STS layer)
- SONET PM (B1, B2 on Trunk and aggregate) and Alarm Management (Line, Section and Path)
- Ethernet RMON statistics
- UPSR Protection on Trunk
- 1+1 APS on Client
- Dual card only supported



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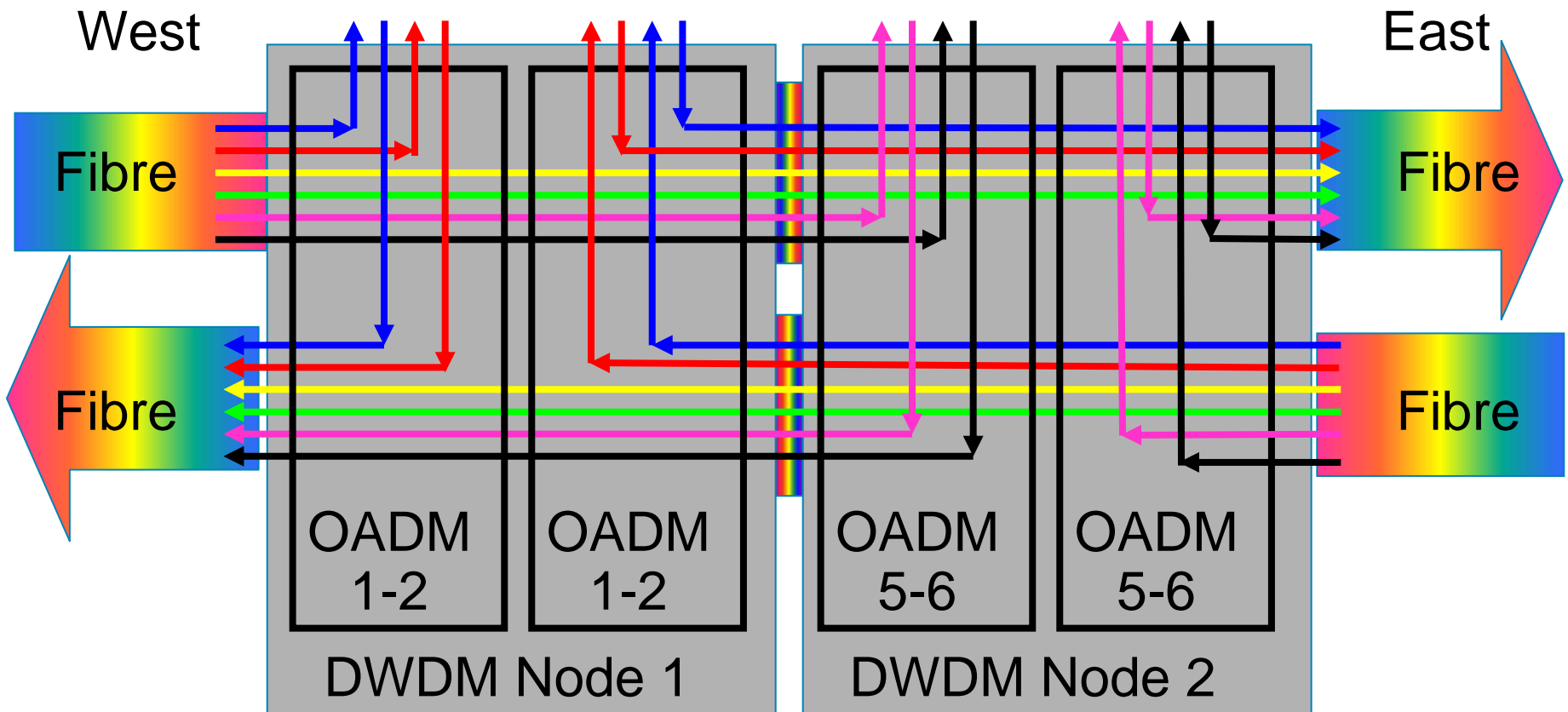
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- **Ease of Deployment**

 - Powerful Automated Design Tools

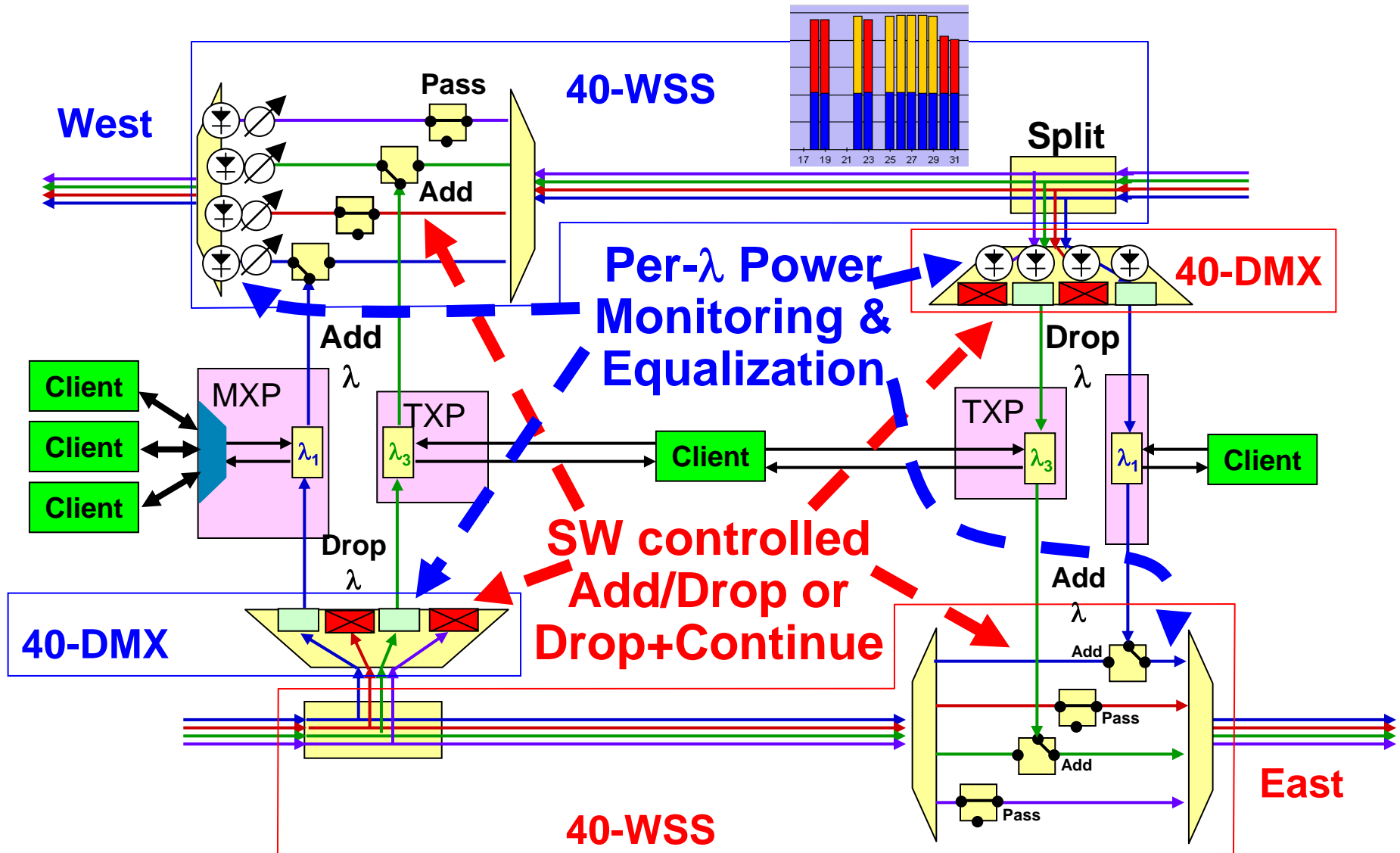
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Fixed Optical Add Drop Multiplexer - OADM

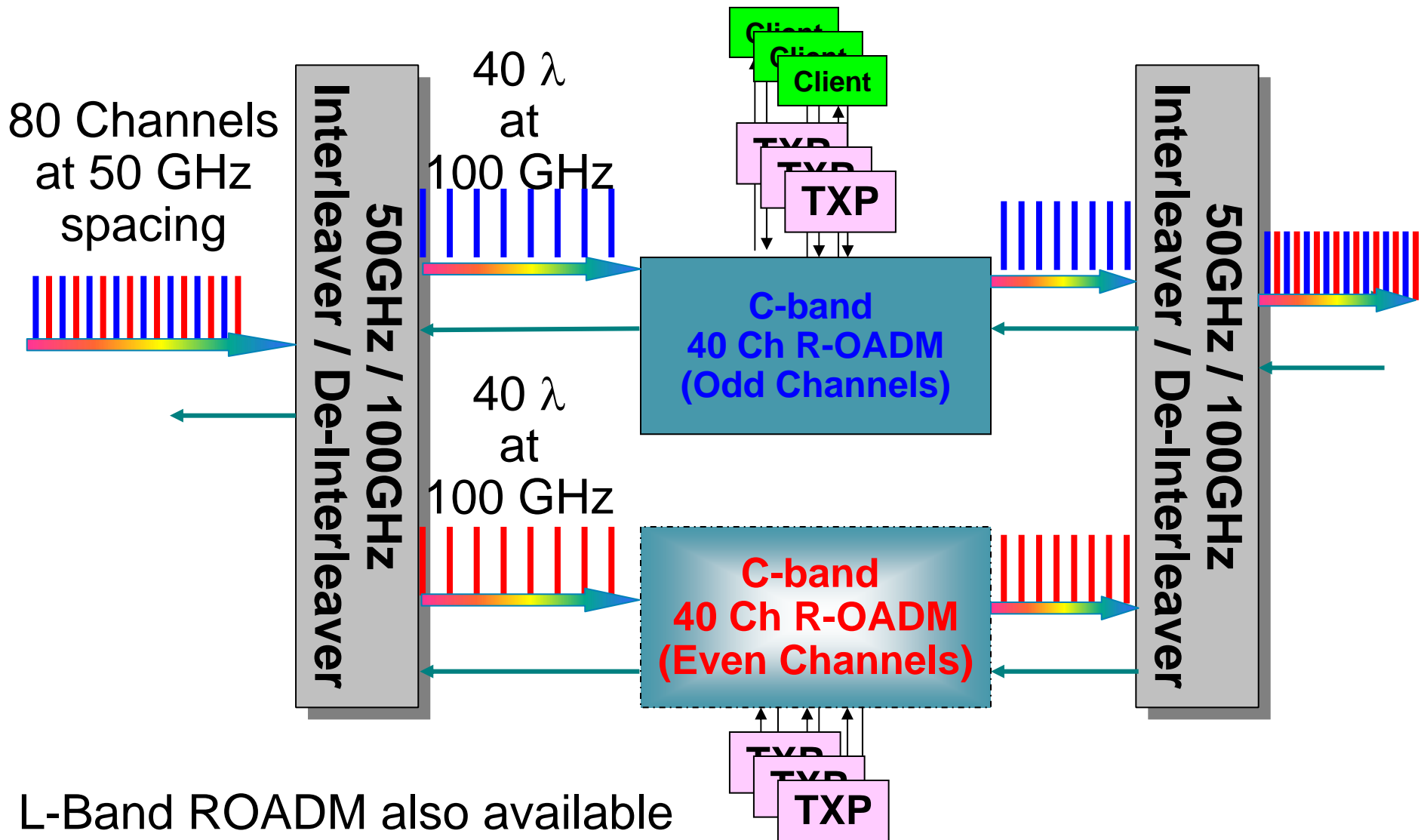


- Different parts (OADMs) are needed to add/drop different wavelengths
- Requires careful planning & future service growth forecasting
- High requirement for spares

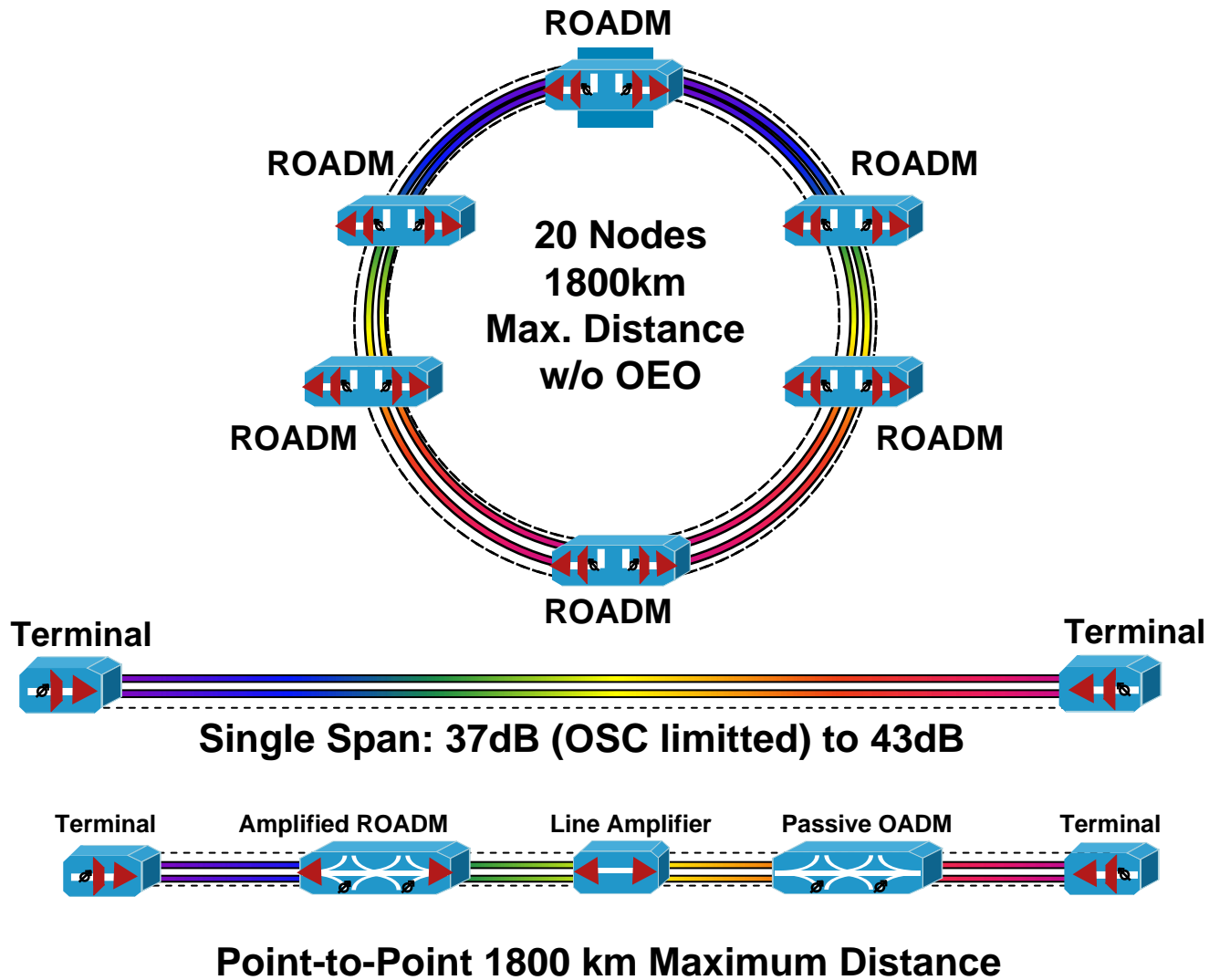
R-OADMs Add Flexibility & Control



C-band Scalability to 80 Wavelengths

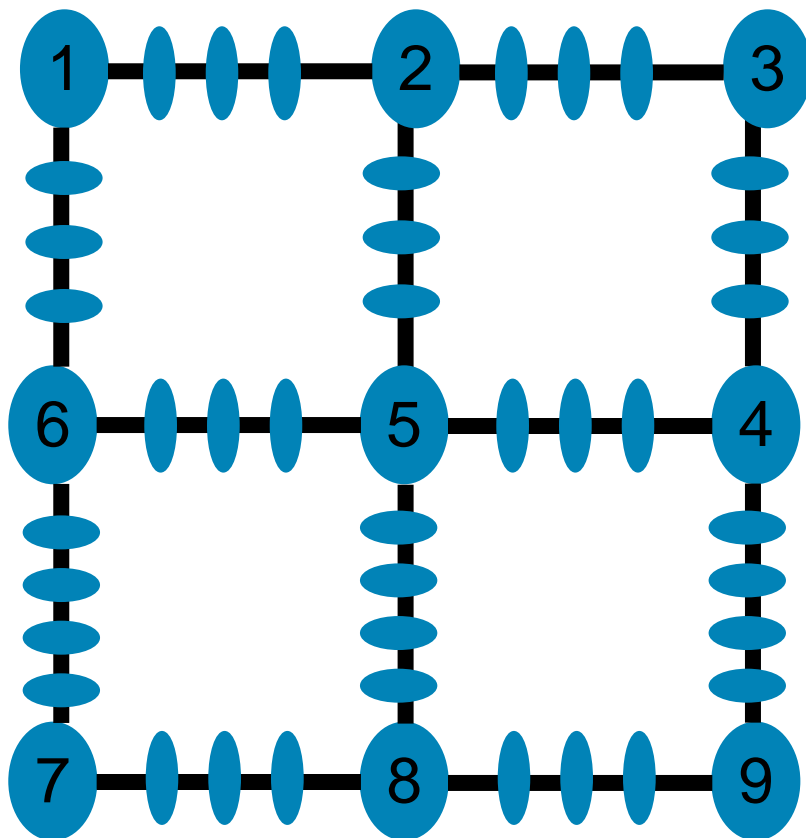


A 2-degree ROADM supports Point-to-point, Linear Bus and Ring Topologies

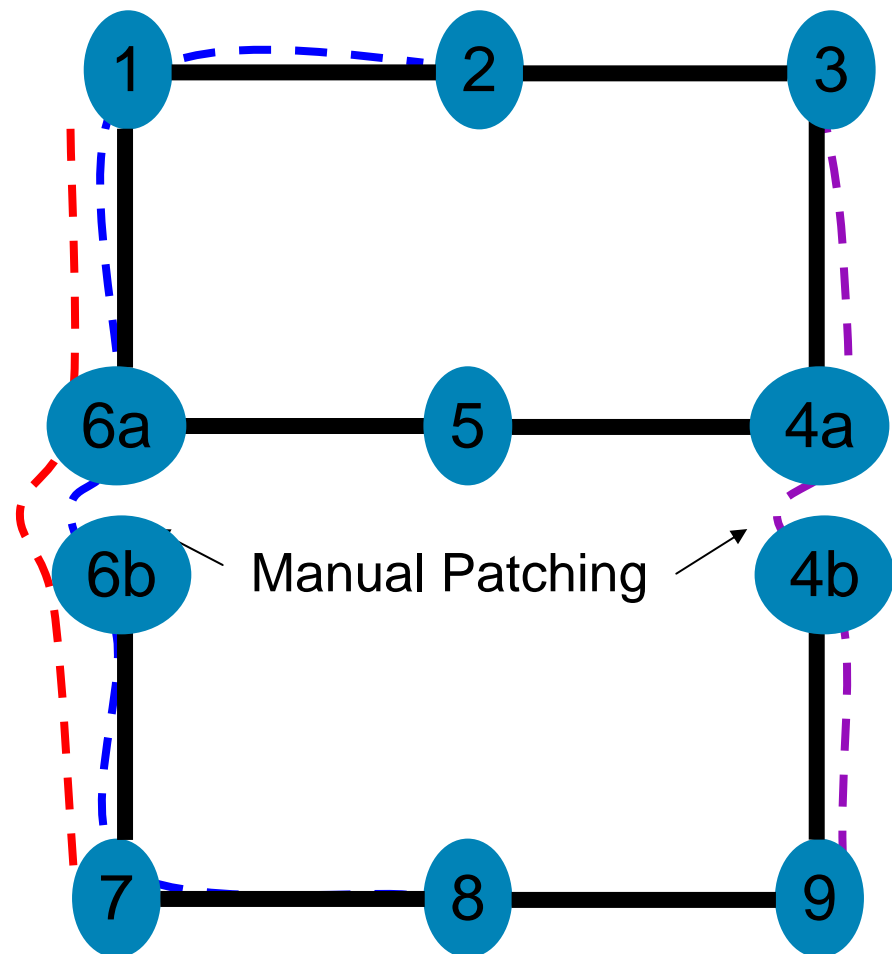


Constructing Mesh networks with 2-degree ROADMs requires careful planning and manual patching

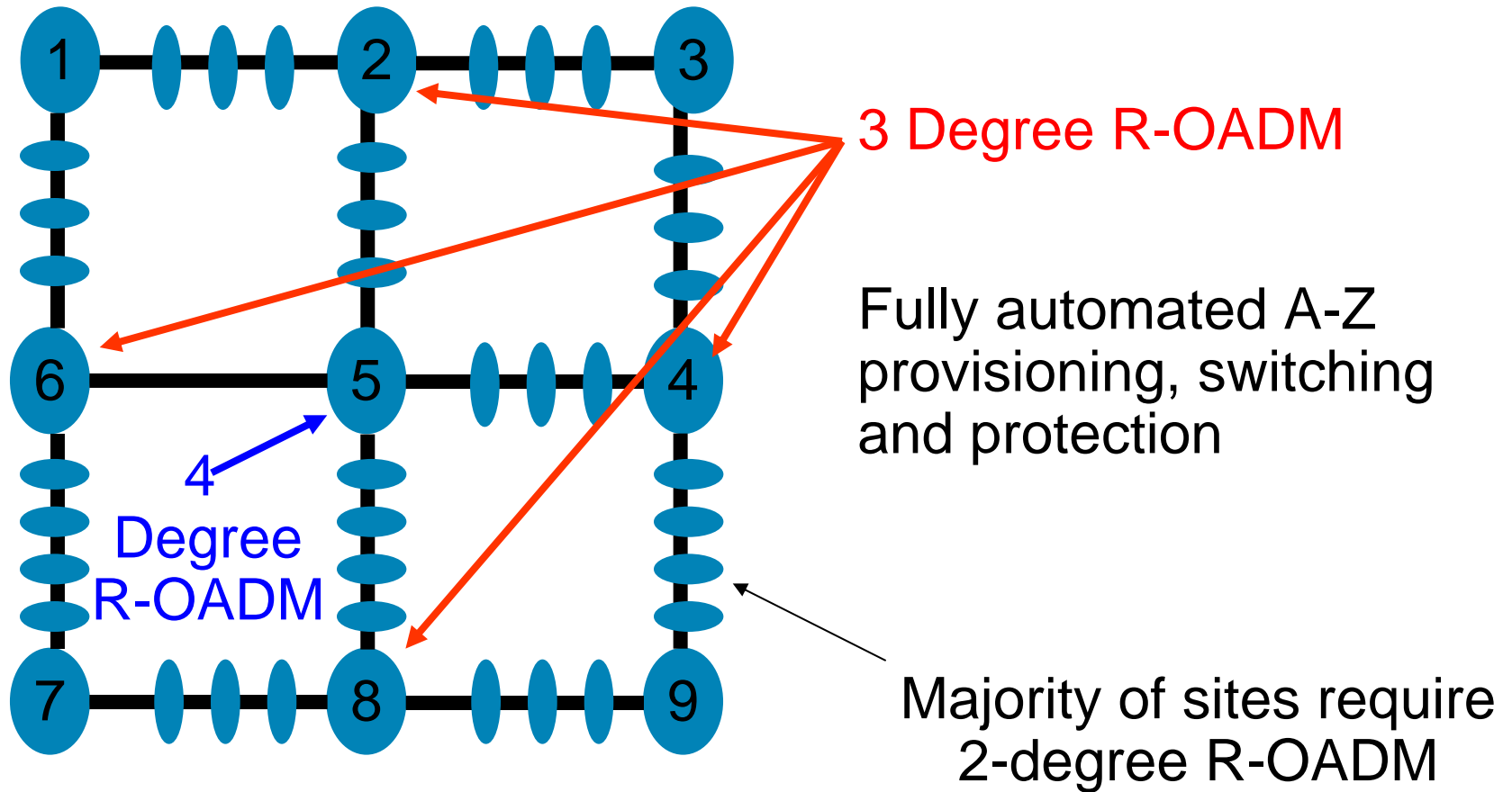
Fibre Topology



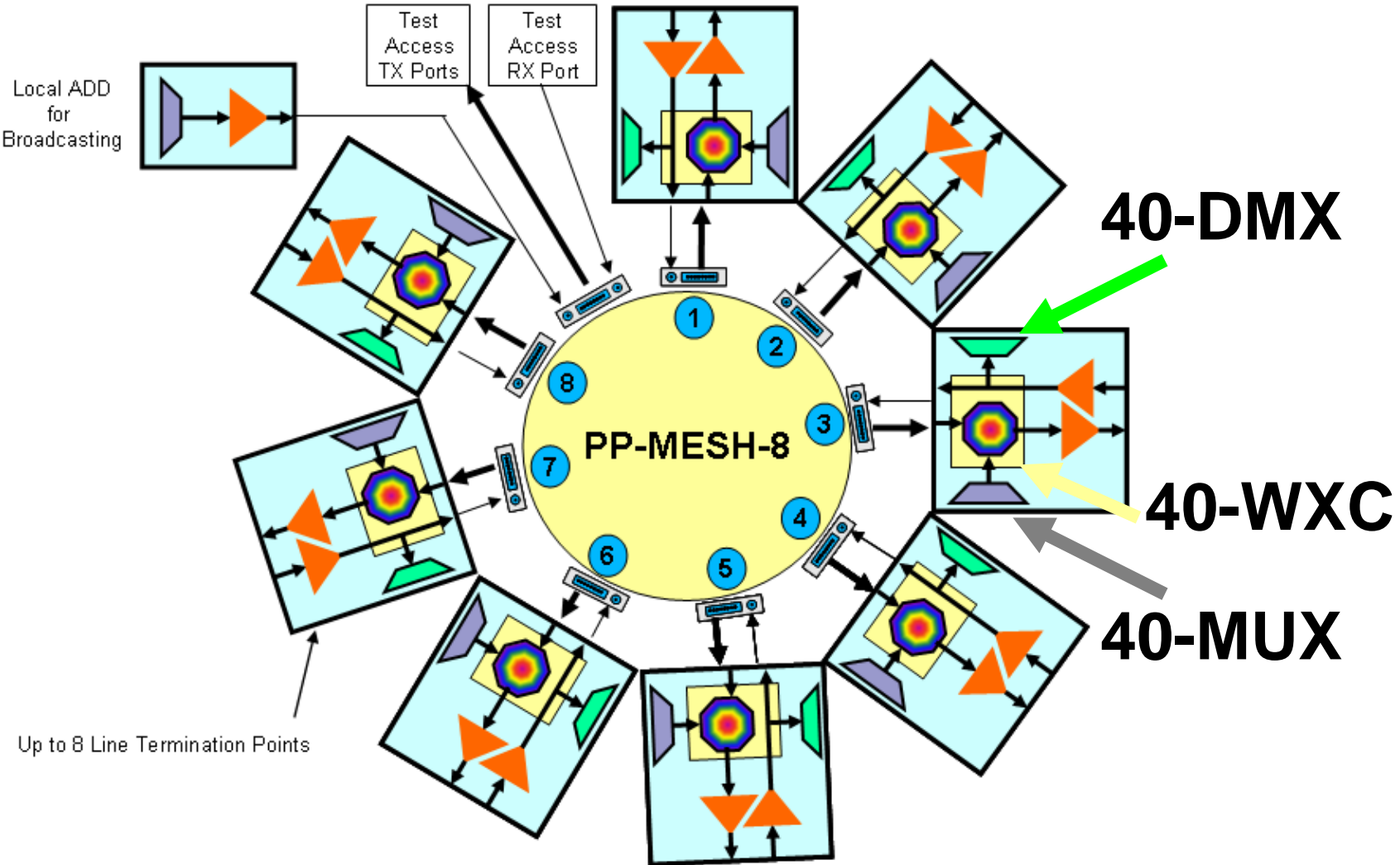
2-Degree ROADM solution



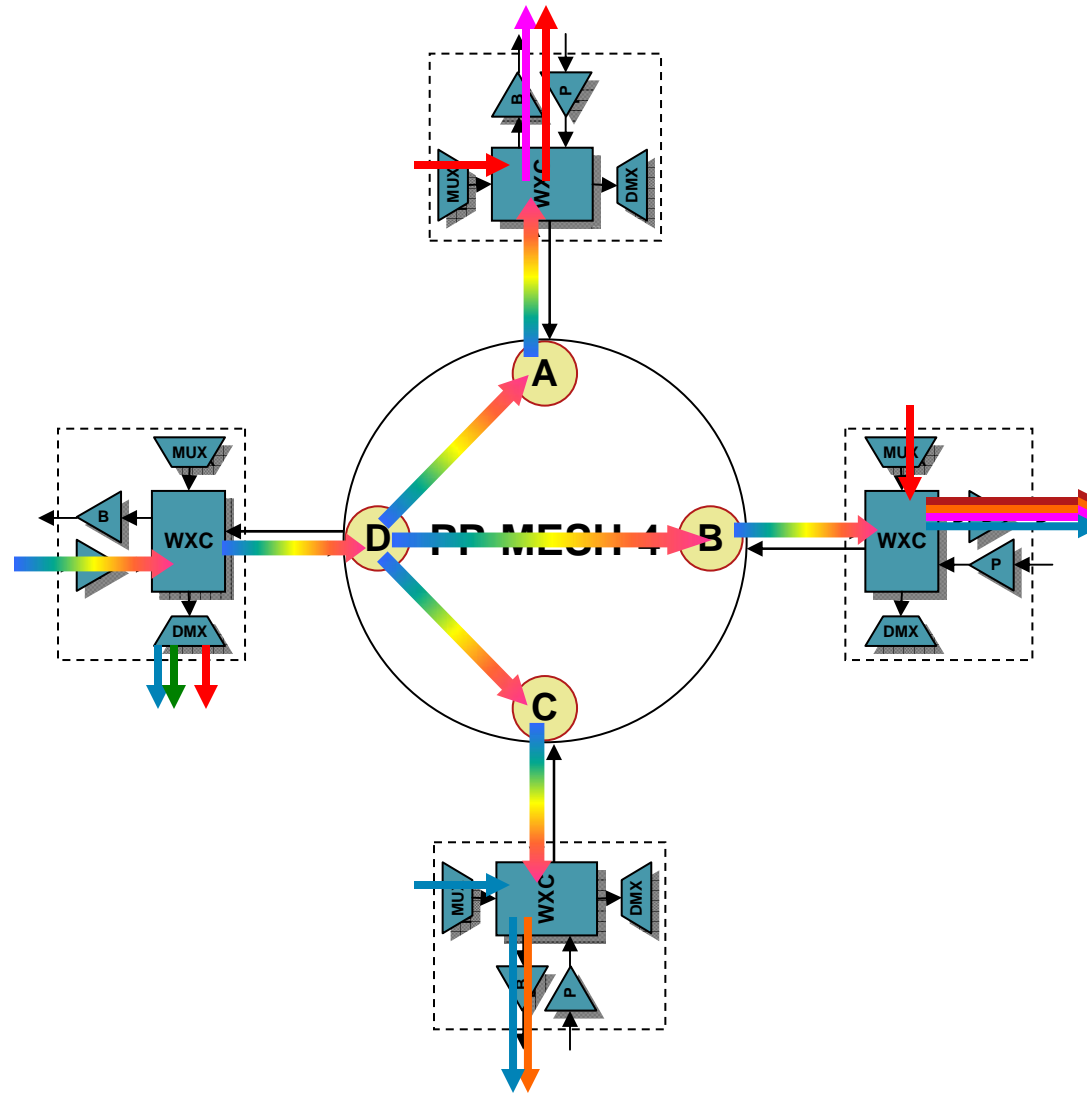
Multi-degree ROADMs are required to support Mesh networks



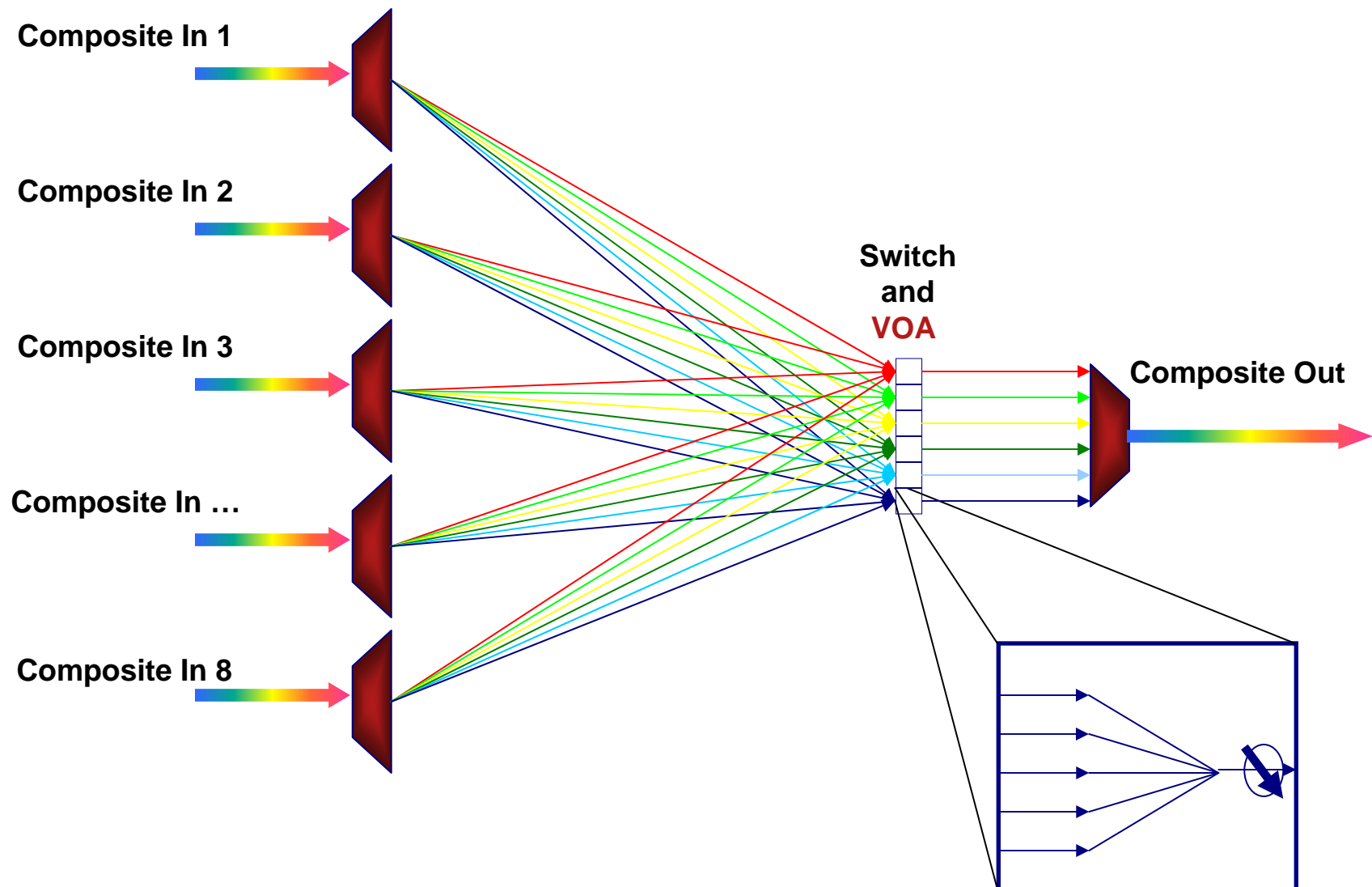
MEMS-based Wavelength Cross Connect supports up to 8-Degree ROADMs



Degree-4 ROADM Node Block Diagram



40-WXC Functional Block Diagram



ROADM & Mesh Summary

- ROADMs, combined with transponders which are **fully tuneable** to 80 wavelengths, provide dramatic **operational simplification**
- **Most** sites (~80%) require only **2-degree** ROADMs
- Only sites requiring 3 or more degrees require MEMS-based **WXC**
- **Cisco Transport Planner** design tool crucial to complex designs

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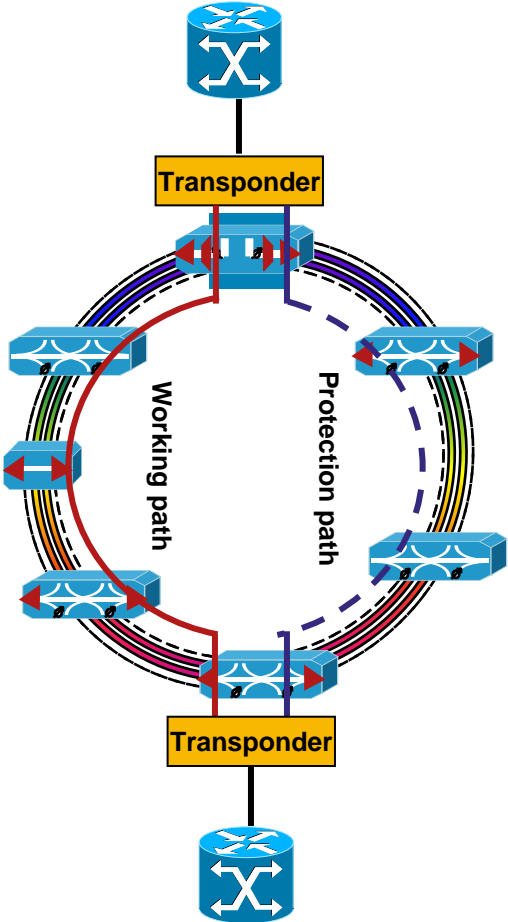
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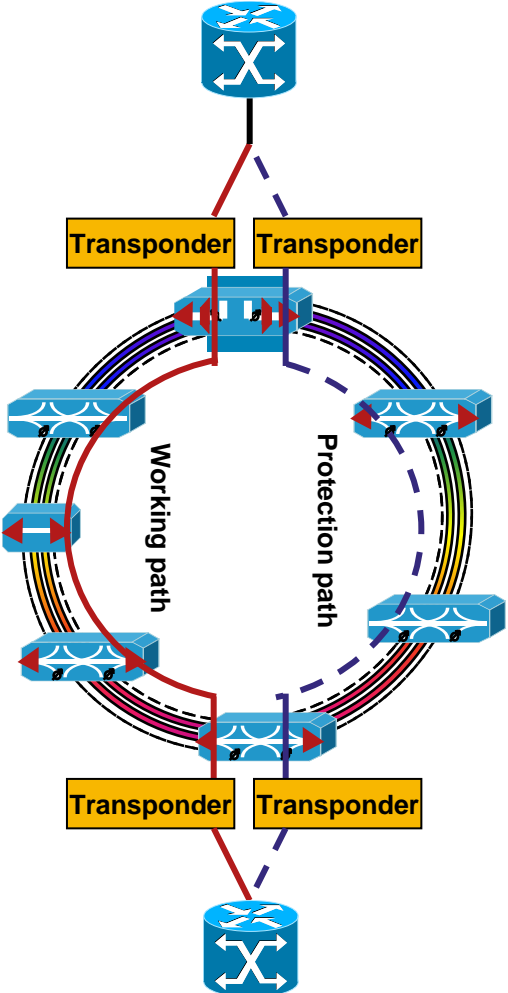
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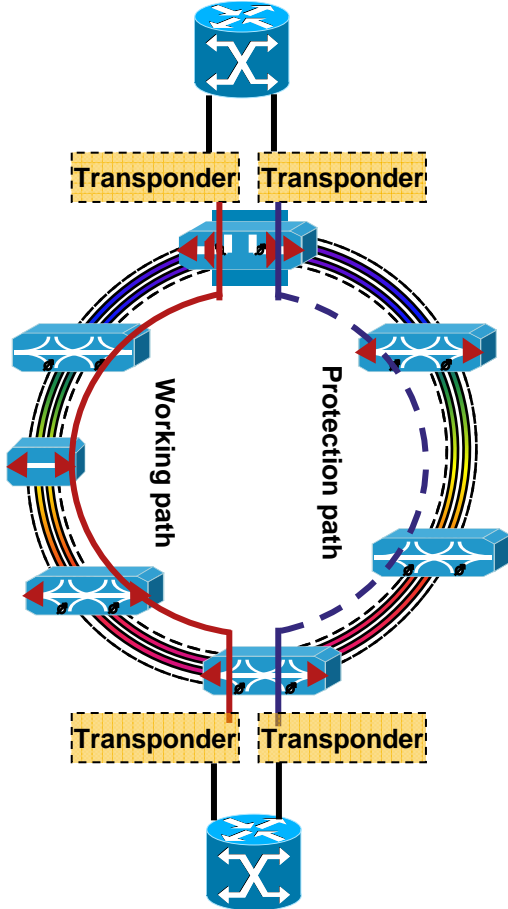
3 types of Optical Layer Protection are supported



Splitter Protection



Y-Cable Protection

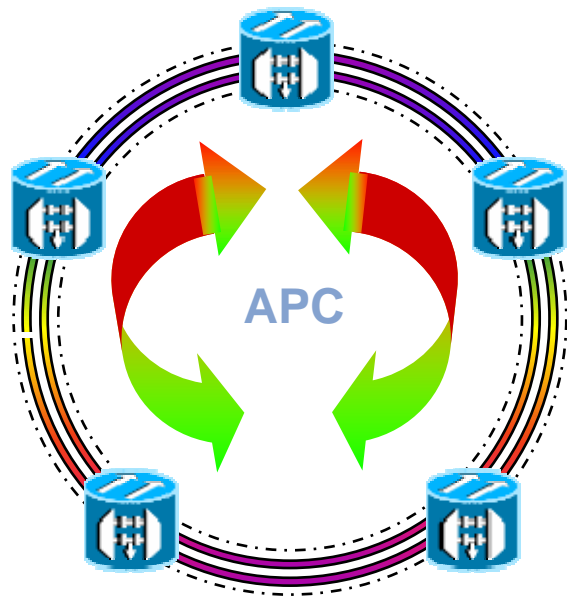


Diverse Path Protection (Client 1+1)



Automatic Power Control maintains service performance

No Human Intervention Required



- **Automatically** corrects amplifier power/gain for capacity change, ageing effects, operating conditions
- **Keep traffic working** after network failures
- **Prevent BER** increase due to network degrade
- **Keep constant** either power or gain on each amplifier
- No truck rolls
- No troubleshooting required
- No operation complexity

OTN G.709 on Transponders Enables Signaling, Performance Monitoring and FEC

- All 10Gb transponders and muxponders have **SW selectable** OTN and GCC ON/OFF
- 2.5G MR transponder has SW Selectable OTN and GCC ON/OFF



- OTN is ITU **standard** for mapping and managing WDM network
- Allows for **interoperability** of equipment at wavelength layer
- Provides payload and signal **performance monitoring**
- “Digital wrapper” allows **FEC** to be applied in non-proprietary fashion



- Client Signal
- OPU_k—Optical Channel Payload Unit
- ODU_k—Optical Channel Data Unit
- OTU_k—Optical Channel Transport Unit
- Alignment

k Indicates the Order:
 1 2.5G
 2 10G
 3 40G

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ONS 15454 MSTP Management Applications

- **Cisco Metro Planner →
Cisco Transport Planner**

Network design
Network modelling
Computer-aided installation: from
network design straight to installation



- **Cisco Transport Controller
(CTC)**

Installation and setup
Full node/ring management capability

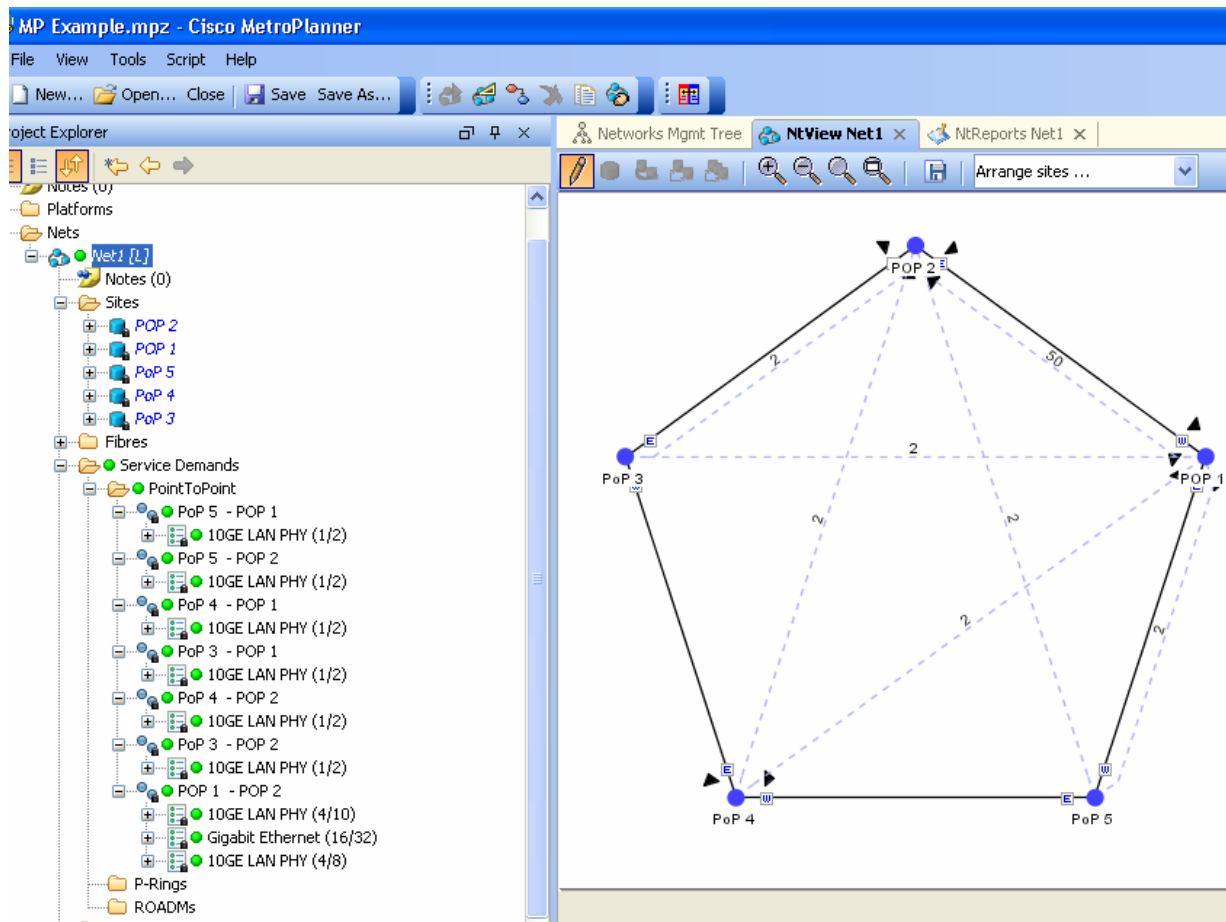


- **Cisco Transport Manager
(CTM)**

EMS/NMS layer applications for
advanced optical management
CORBA/TL1 and SNMP NBI available
for OOS integration



Cisco Transport Planner – CTP MSTP Design Tool



- GUI-based network design
- Ring or linear topologies, fibre types and lengths
- Service demands:
 - point-to-point
 - ring
 - mesh (any-to-any ROADM)
 - Protection type

Transport Planner Analyses all services and places Amplifiers and DCUs

Group = ROADM 1 :: Demand = ROADM Demand 1 :: Connectivity = any :: P/F = only present

#	SOL	EOL	Traffic Group Label	Srv. Circuit Label	P/F	Source	Dest.	Side	Protect	Wavelength	Span (km)	TX Type
1	●	●	ROADM 1	ROADM Demand 1	P/F	Site 1	Site 2	East	Y-Cable, Client 1+1	30.3	20.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 2	Site 1	West		30.3	20.00	
1	●	●		ROADM Demand 1	P/F	Site 2	Site 1	East		30.3	80.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 1	Site 2	West		30.3	80.00	
1	●	●	ROADM 1	ROADM Demand 1	P/F	Site 1	Site 2	East	Y-Cable, Client 1+1	31.1	20.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 2	Site 1	West		31.1	20.00	
1	●	●		ROADM Demand 1	P/F	Site 2	Site 1	East		31.1	80.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 1	Site 2	West		31.1	80.00	
1	●	●	ROADM 1	ROADM Demand 1	P/F	Site 1	Site 2	East	Y-Cable, Client 1+1	31.9	20.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 2	Site 1	West		31.9	20.00	
1	●	●		ROADM Demand 1	P/F	Site 2	Site 1	East		31.9	80.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 1	Site 2	West		31.9	80.00	
1	●	●	ROADM 1	ROADM Demand 1	P/F	Site 1	Site 2	East	Y-Cable, Client 1+1	32.6	20.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 2	Site 1	West		32.6	20.00	
1	●	●		ROADM Demand 1	P/F	Site 2	Site 1	East		32.6	80.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 1	Site 2	West		32.6	80.00	
1	●	●	ROADM 1	ROADM Demand 1	P/F	Site 1	Site 2	East	Y-Cable, Client 1+1	34.2	20.00	2.5G MR TXP w/FEC
	●	●			P/F	Site 2	Site 1	West		34.2	20.00	
1	●	●		ROADM Demand 1	P/F	Site 2	Site 1	East		34.2	80.00	2.5G MR TXP w/FEC

Analyzed

- **Comprehensive analysis = first-time success!**
- **Tool chooses transponders & filters, places amplifiers and DCUs and analyses optical performance**

Transport Planner provides Bill of Materials and numerous reports

2.5.0(7)
 Design Description:
 Design Version:
 Customer Name:
 Prepared by: bfield
 Last Price Alignment Date: 08-20-04 at 11:45:04 via CCO Update

Network Total Discounted Price: \$1,775,690.00
 Global Discount Percentage:

Product ID	Description	Quantity	Unit Price	Network Unit Discount	Total Price	Discou Total F
15216-DCU-SA=	Mechanical shelf (housing 2 DCM)	5	\$700.00	0 %	\$3,500.00	
15454-AIR-RAMP=	ONS 15454 Air Ramp / Baffle for th...	5	\$120.00	0 %	\$600.00	
15454-FBR-STRG=	Fiber Storage Shelf	5	\$800.00	0 %	\$4,000.00	
15454-PP-64-LC=	Patch Panel Shelf - 64 Connectors...	10	\$3,000.00	0 %	\$30,000.00	\$
15454-SA-HD=	15454 SA HD NEBS3 ANSI w/ RC...	6	\$2,700.00	0 %	\$16,200.00	\$
15454-BLANK	Empty slot Filler Panel	30	\$225.00	0 %	\$6,750.00	
15454-TCC2	Timing Communications Control ...	12	\$4,500.00	0 %	\$54,000.00	\$
15454-FTA3-T	Shelf Fan Tray Assembly,ANSI,15...	6	\$720.00	0 %	\$4,320.00	
15454-MSTP-4.7SW=	Rel. 4.7.0 MSTP Feature Pkg., CD,...	6	\$1,995.00	0 %	\$11,970.00	\$
SF15454-MSTP-4.7	Rel. 4.7.0 SW, MSTP, Pre-loaded ...	12	\$0.00	0 %	\$0.00	
15216-DCU-350=	DCF of -350 ps/nm and 4dB loss	10	\$11,275.00	0 %	\$112,750.00	\$1
15454-LC-LC-2=	Fiber patchcord - LC to LC - 2m	38	\$90.00	0 %	\$3,420.00	
15454-OSC-CSM=	ONS 15454 Combiner and Separ...	10	\$9,000.00	0 %	\$90,000.00	\$
15454-OPT-PRE=	ONS 15454 Optical Pre-Amplifier ...	10	\$40,000.00	0 %	\$400,000.00	\$4
15454-32-DMX=	32 Ch DMUX 100 GHz (for use wit...	10	\$21,000.00	0 %	\$210,000.00	\$2

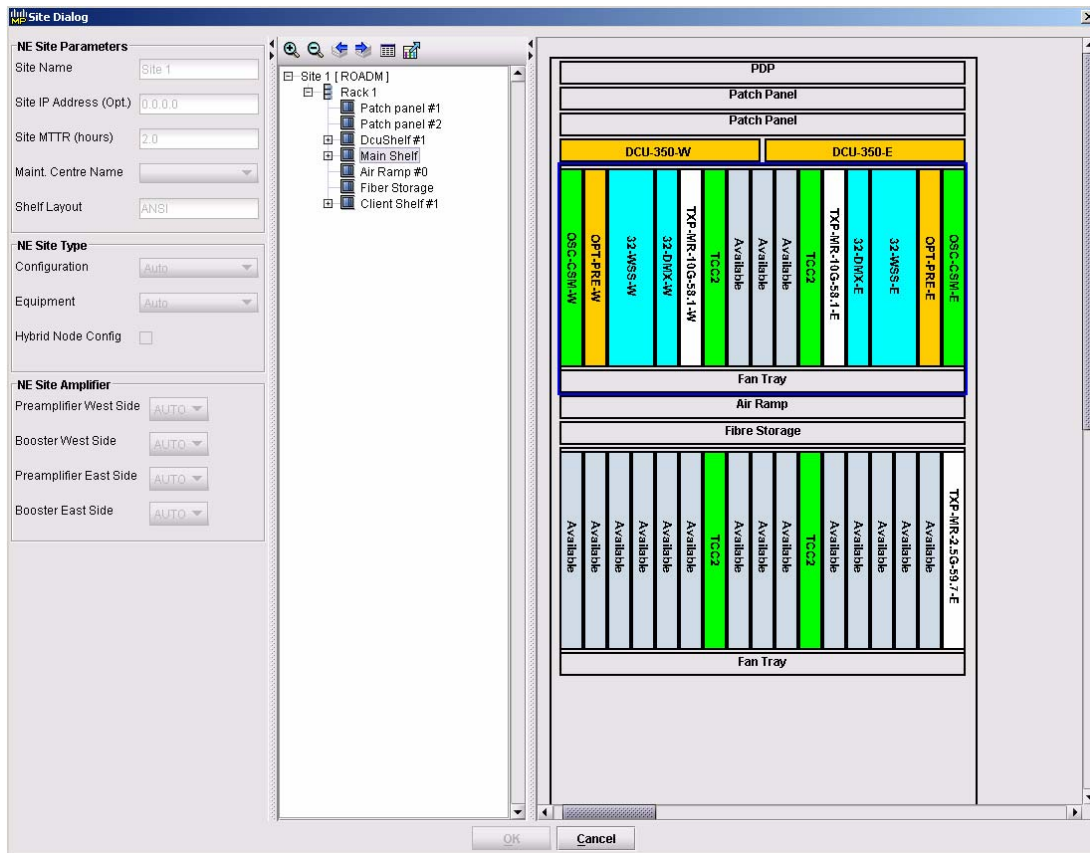
Analyzed

- Smooth transition from design to implementation

Bill of materials

Power Requirements

Concept to Creation Easier: Transport Planner



- Smooth transition from design to implementation

Bill of materials

Power Requirements

Rack diagrams

Concept to Creation Easier: Transport Planner

Site	IP Address	Position-1	Unit-1	Port #-1	Port ID-1	Port Label-1	Attenuator	Patchcord Type
Site 1	0.0.0.0	Rack #1.DcuShelf #1.01	15216-DCU-350	<undef>	<undef>1	RX		
Site 1	0.0.0.0	Rack #1.DcuShelf #1.01	15216-DCU-350	<undef>	<undef>1	TX		
Site 1	0.0.0.0	Rack #1.DcuShelf #1.02	15216-DCU-350	<undef>	<undef>2	RX		
Site 1	0.0.0.0	Rack #1.DcuShelf #1.02	15216-DCU-350	<undef>	<undef>2	TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.02	15454-OPT-PRE	1	LINE-2-1-RX	COM-RX		
Site 1	0.0.0.0	Rack #1.Main Shelf.02	15454-OPT-PRE	2	LINE-2-1-TX	COM-TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.17	15454-OSC-CSM	1	LINE-17-1-RX	COM-RX		
Site 1	0.0.0.0	Rack #1.Main Shelf.17	15454-OSC-CSM	2	LINE-17-1-TX	COM-TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.16	15454-OPT-PRE	2	LINE-16-1-TX	COM-TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.01	15454-OSC-CSM	1	LINE-1-1-RX	COM-RX		
Site 1	0.0.0.0	Rack #1.Main Shelf.14	15454-32-WSS	66	LINE-14-1-RX	EXP-RX		
Site 1	0.0.0.0	Rack #1.Main Shelf.14	15454-32-WSS	65	LINE-14-1-TX	EXP-TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.14	15454-32-WSS	69	LINE-14-3-TX	DROP-TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.14	15454-32-WSS	29	CHAN-14-29-RX	RX-54.1 - 60.6 [5]		
Site 1	0.0.0.0	Rack #1.Main Shelf.14	15454-32-WSS	31	CHAN-14-31-RX	RX-54.1 - 60.6 [7]		
Site 1	0.0.0.0	Rack #1.Main Shelf.03	15454-32-WSS	69	LINE-3-3-TX	DROP-TX		
Site 1	0.0.0.0	Rack #1.Main Shelf.03	15454-32-WSS	29	CHAN-3-29-RX	RX-54.1 - 60.6 [5]		
Site 1	0.0.0.0	Rack #1.Main Shelf.13	15454-32-DMX	29	CHAN-13-29-TX	TX-54.1 - 60.6 [5]		
Site 1	0.0.0.0	Rack #1.Main Shelf.13	15454-32-DMX	31	CHAN-13-31-TX	TX-54.1 - 60.6 [7]		
Site 1	0.0.0.0	Rack #1.Main Shelf.05	15454-32-DMX	29	CHAN-5-29-TX	TX-54.1 - 60.6 [5]		
Site 2	0.0.0.0	Rack #1.DcuShelf #1.01	15216-DCU-350	<undef>	<undef>1	RX		
Site 2	0.0.0.0	Rack #1.DcuShelf #1.01	15216-DCU-350	<undef>	<undef>1	TX		
Site 2	0.0.0.0	Rack #1.DcuShelf #1.02	15216-DCU-350	<undef>	<undef>2	RX		
Site 2	0.0.0.0	Rack #1.DcuShelf #1.02	15216-DCU-350	<undef>	<undef>2	TX		
Site 2	0.0.0.0	Rack #1.Main Shelf.02	15454-OPT-PRE	1	LINE-2-1-RX	COM-RX		
Site 2	0.0.0.0	Rack #1.Main Shelf.02	15454-OPT-PRE	2	LINE-2-1-TX	COM-TX		
Site 2	0.0.0.0	Rack #1.Main Shelf.17	15454-OSC-CSM	1	LINE-17-1-RX	COM-RX		

- **Smooth transition from design to implementation**

Bill of materials

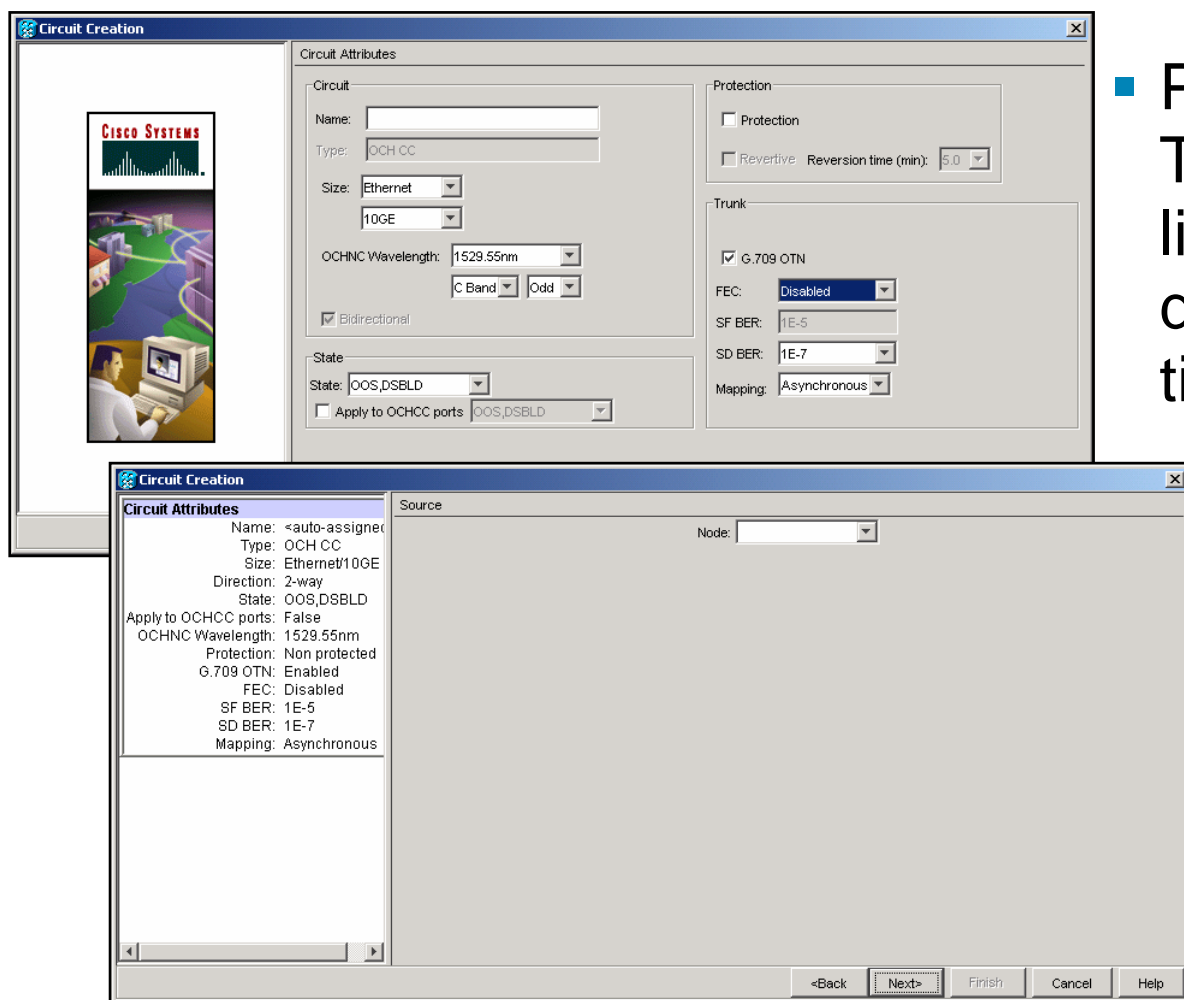
Power Requirements

Rack diagrams

Step-by-step interconnect

System Config Files

CTM & CTC: A-Z Wavelength Provisioning



- Provisioning of TXP/MXP/ITU linecard and OCH done at the same time

Client provisioning (PPM)

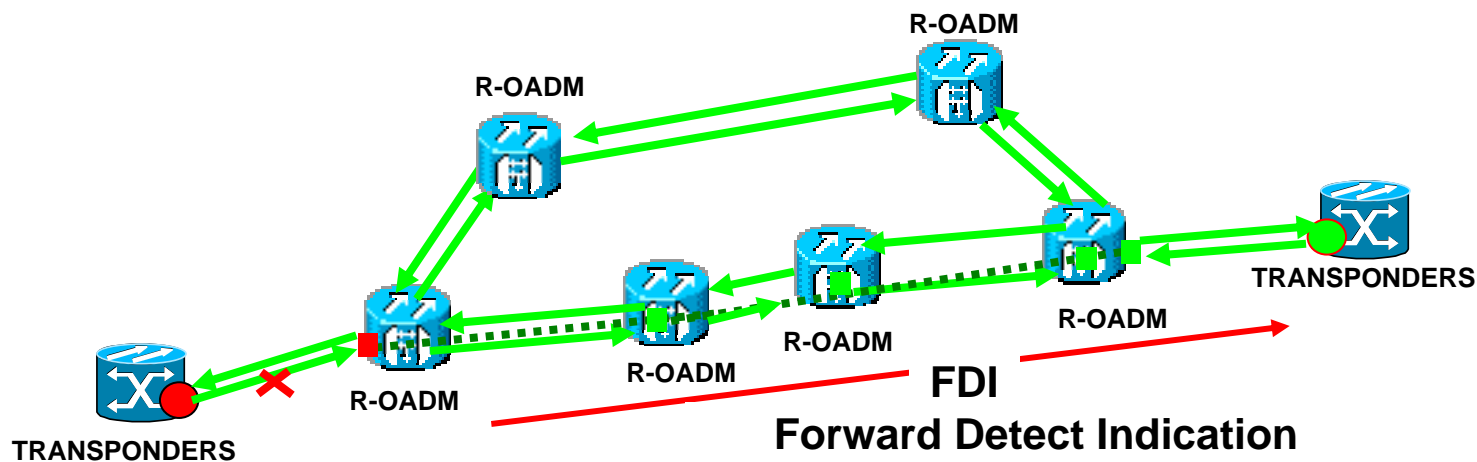
Wavelength selection (C- vs. L-band)

Protection configuration

G.709 and FEC provisioning

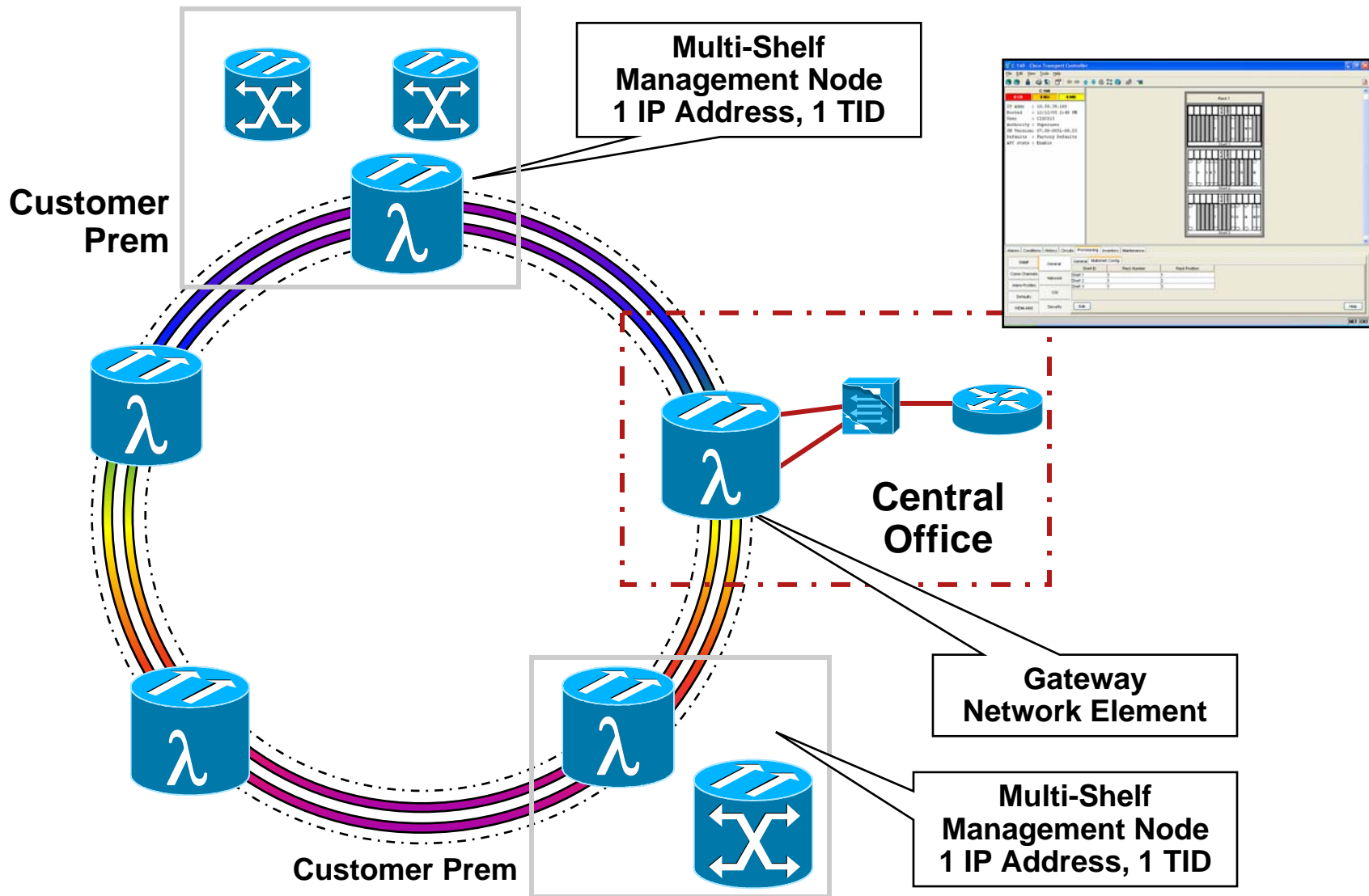
Circuit direction selection as per OCHNC

Network Level Alarm Correlation (NLAC)



- Reporting relevant fault notifications to management interfaces
- Suppressing/demoting irrelevant symptoms
- Makes troubleshooting easier
- Save DCN bandwidth
- Avoid Alarm flooding/storms in case of dramatic events
- Avoid the “Christmas tree effect” on the Video Wall at NOC
- Based on standard ITU-T G.798 atomic function definition

MSTP Multi-Shelf Management



DWDM is displacing SDH as the primary transport technology of choice

- **Service Flexibility**

 - Full range of Data, Storage & TDM Transport services

 - Bit-Rate & Protocol Agnostic

 - 10 to 40 Gbps per wavelength fits needs of packet switching

 - Increased reach through Forward Error Correction

- **Dynamic Reconfigurability**

 - Reconfigurable Optical Add/Drop Multiplexors (ROADM)

 - Lasers Fully Tuneable across 80 wavelengths

 - Wavelength Cross Connects and Mesh Networking

- **Resilience**

 - Full Optical Monitoring & Automatic Gain Control for each wavelength

 - SDH-like performance monitoring & alarm signaling via G.709

 - Sub-50 ms protection switching

- **Ease of Deployment**

 - Powerful Automated Design Tools

 - A-Z Provisioning

ONS 15454 MSTP Market Analysis



- #1 Worldwide WDM Market Share (12%)
- #1 North American WDM Market Share (23%)
- #1 Worldwide ROADM Market Share (37%)
- #1 North American ROADM Market Share (49%)



“Cisco dominates ROADM Market share, ...”

“Undeniable Market Power”, “and a solution based on the *hugely successful 15454 platform*”...

“What is very interesting to note here is that Cisco is claiming **ROADM wins in market segments not targeted by other pure-play ROADM vendors**, including enterprise/government and metro access networks”



Momentum: “Very Positive”

Current Prospective “Very Threatening”

Only Vendor In North America to achieve Highest Ratings

Cisco ONS 15454 MSTP

- ROADM technology (iPLC) very cost effective compared to competition (MEMS)
- Wide service breadth up to 40 Gbps/ λ
- Fully tuneable transponders (80 λ)
- Carrier Class resilience
- Proven product excellence –
>520 ONS 15454 MSTP Customers since Aug 03
- Significant roadmap planned to extend capabilities

More Information

- MSTP Product Information
<http://www.cisco.com/en/US/products/hw/optical/ps2006/ps5320/index.html>
- Networkers Breakout Session
Data Center Optical Infrastructure for the Enterprise
07-FR1-BRKDCT-2007-BRKDCT-2007
- Cisco Press
DWDM Network Designs and Engineering Solutions
<http://www.ciscopress.com/bookstore/product.asp?isbn=1587050749&rl=1>
Optical Network Design and Implementation
<http://www.ciscopress.com/bookstore/product.asp?isbn=1587051052&rl=1>
Tech Focus: Optical/Metro
<http://www.ciscopress.com/markets/detail.asp?st=44712&rl=1>

Meet the Experts

IP NGN Architectures and Technologies

- Oliver Boehmer
Network Consulting Engineer
- Moustafa Kattan
Consulting Systems Engineer
- Yves Hertoghs
Distinguished System Engineer
- Ed Draiss
Product Manager



Recommended Reading

BRKBBA -2013

- Continue your Networkers learning experience with further reading from Cisco Press.
- Visit the on-site Cisco company store, where the full range of Cisco Press books is available for you to browse.



Q and A

