



SANOG

South Asian Network Operators Group

Know Your Backbone : **DWDM**

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SANOG 23, Bhutan 2013



Introduction of the Topic

Introduction with WDM network

Grooming DWDM Network

Case Study : 441 km DWDM Network

SECTION

1

Introduction of the TOPIC

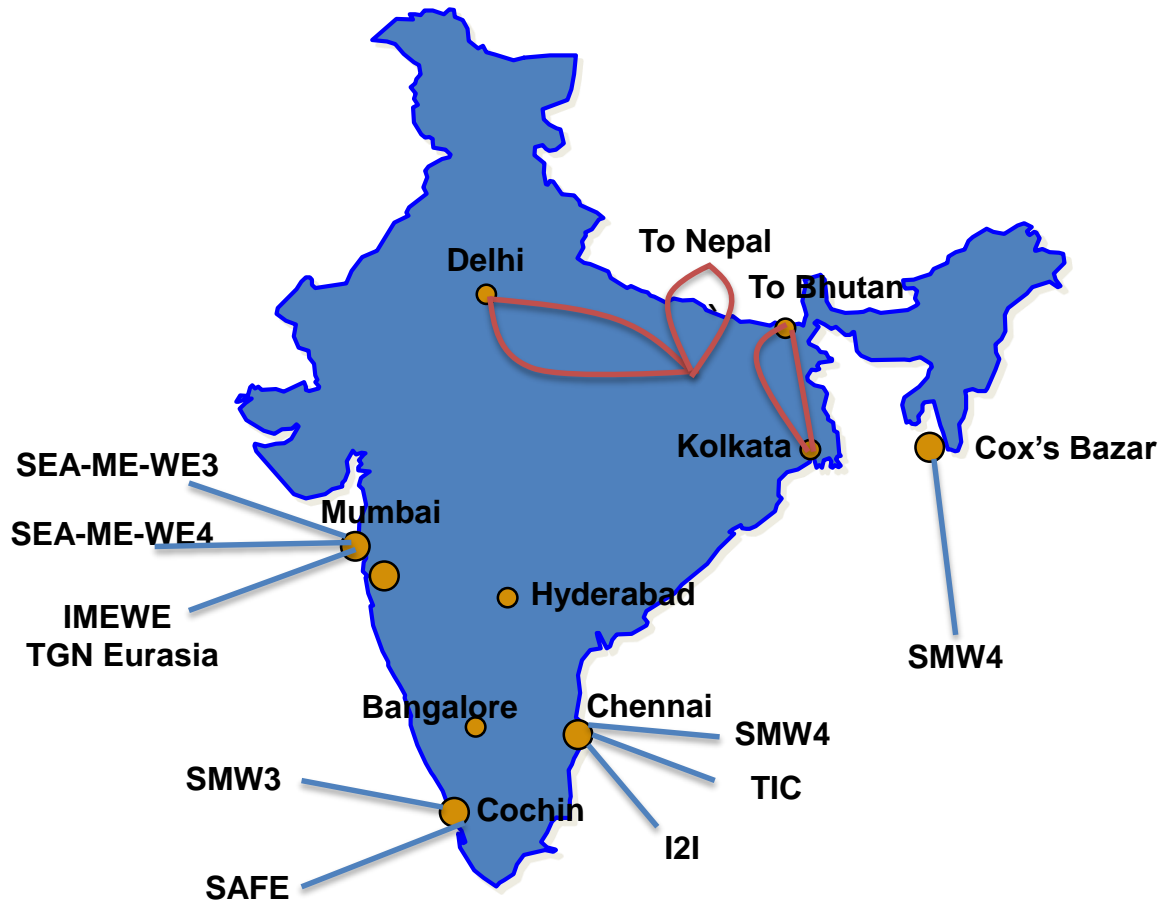


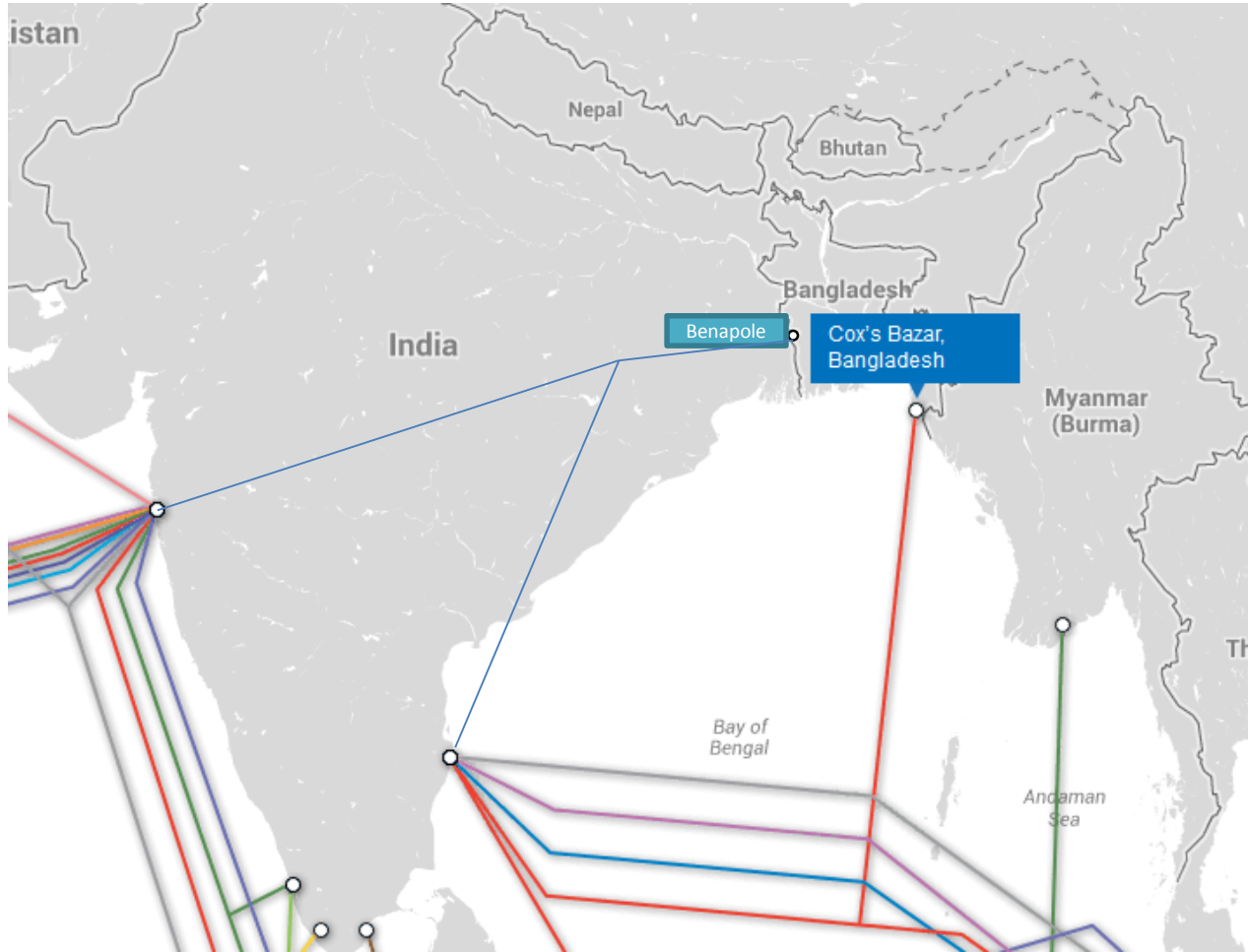
How South-Asia Connected with Rest of World

How you ISP/IIG is connected

What is the result and Soltuion

The Solution : WDM

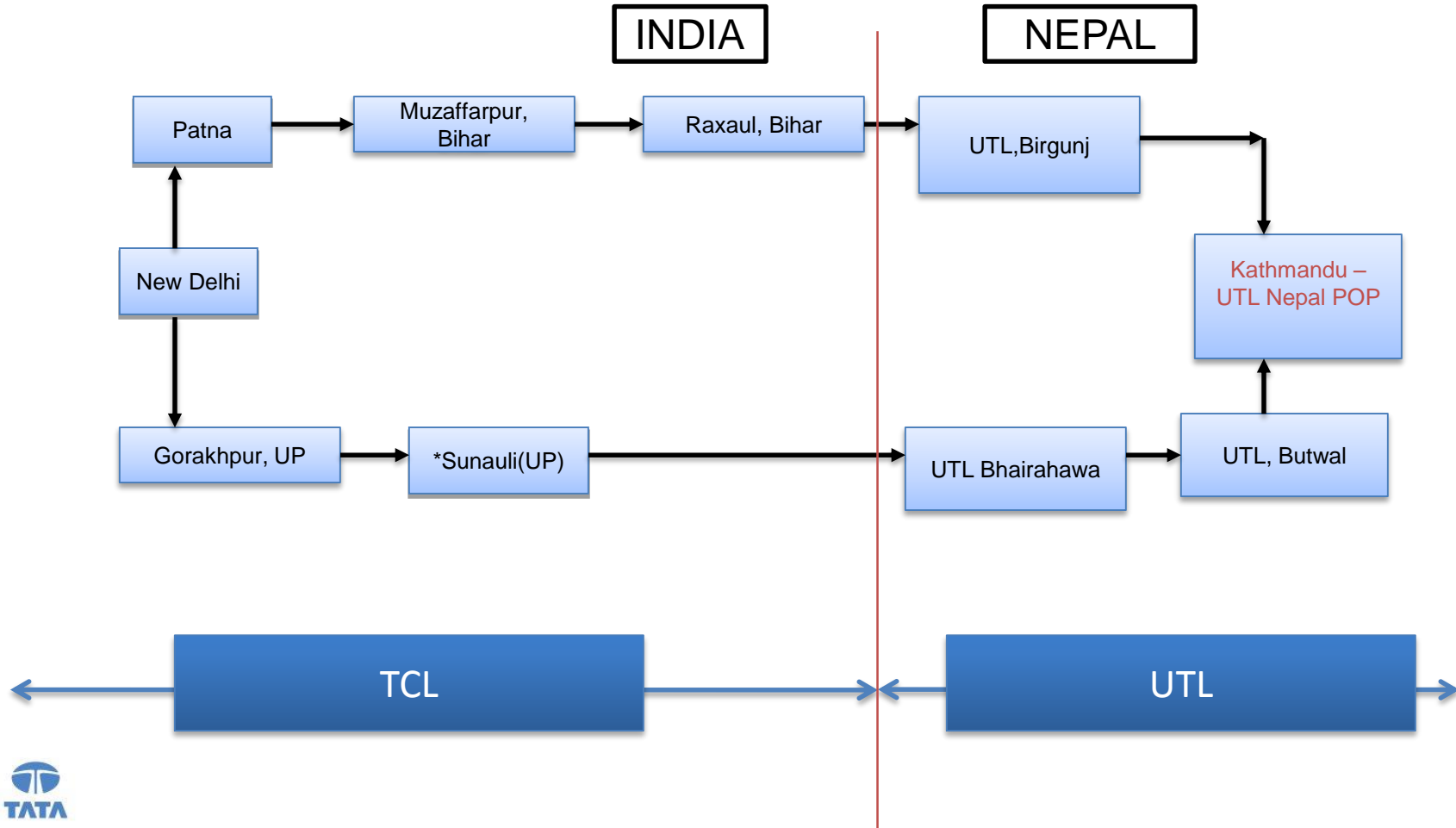


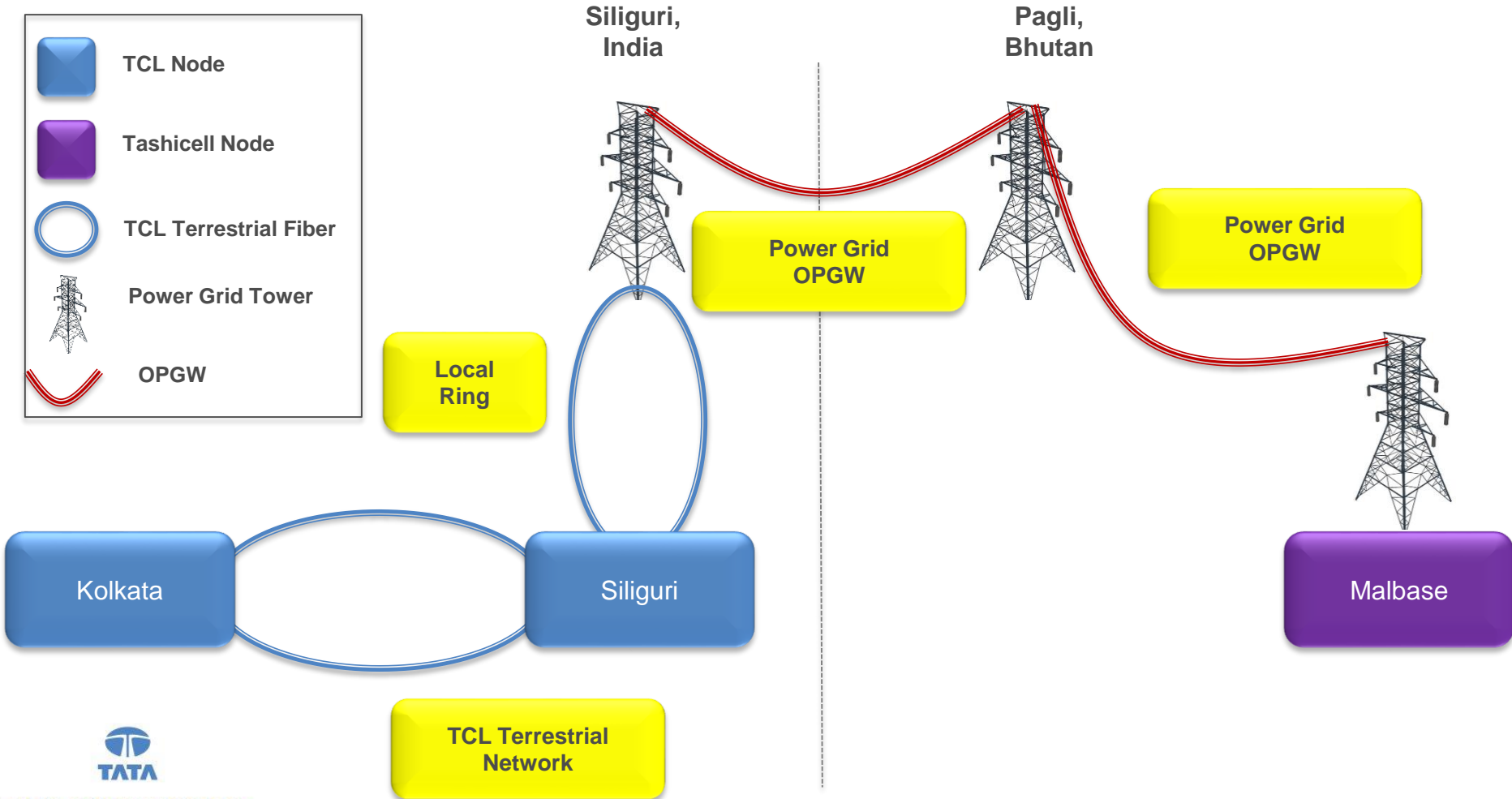
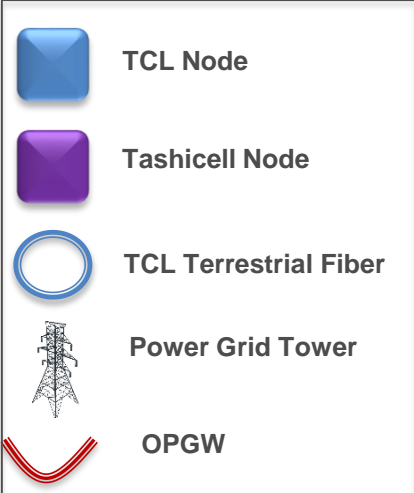


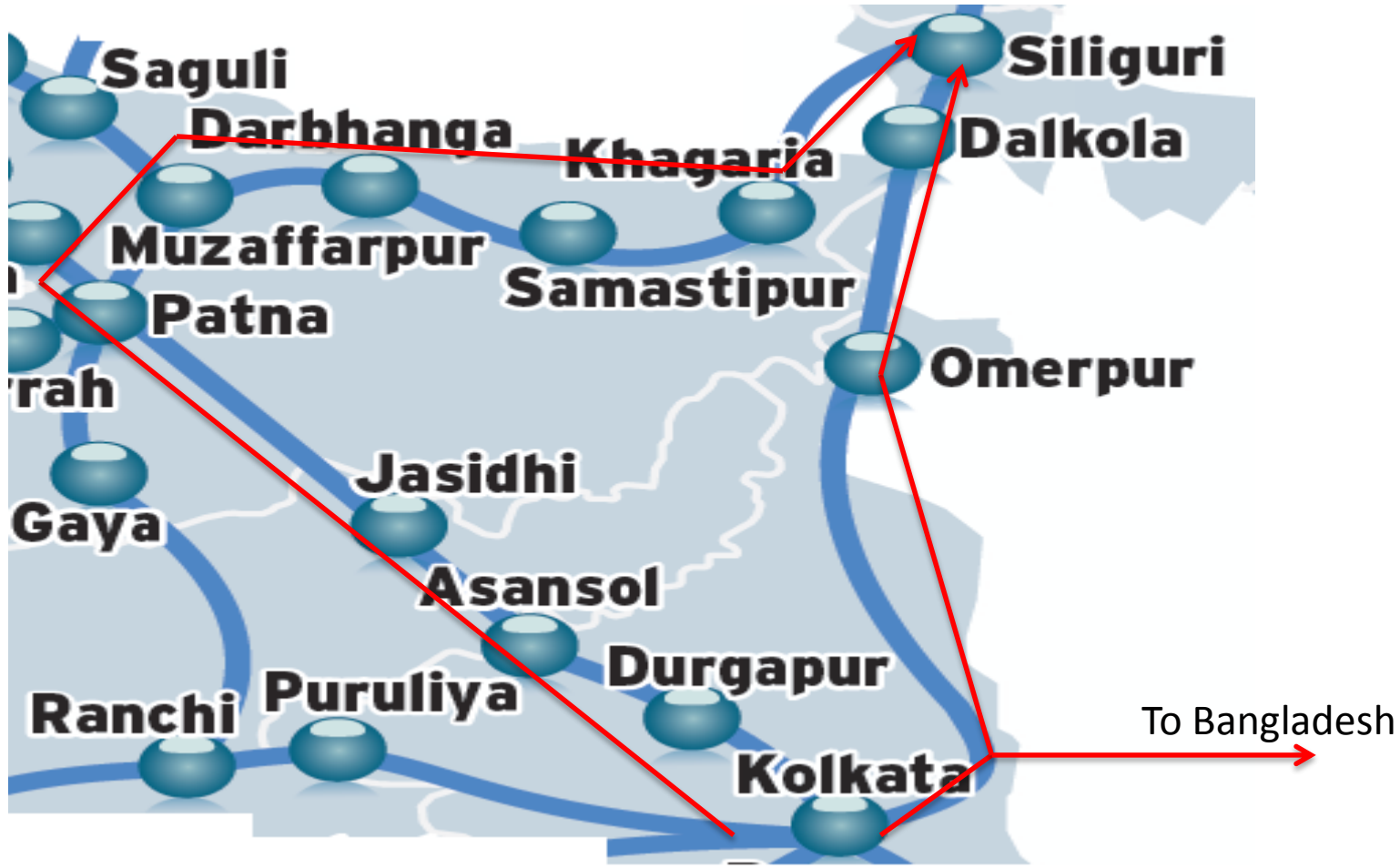
Cable Name :
Sea-Me-We 4

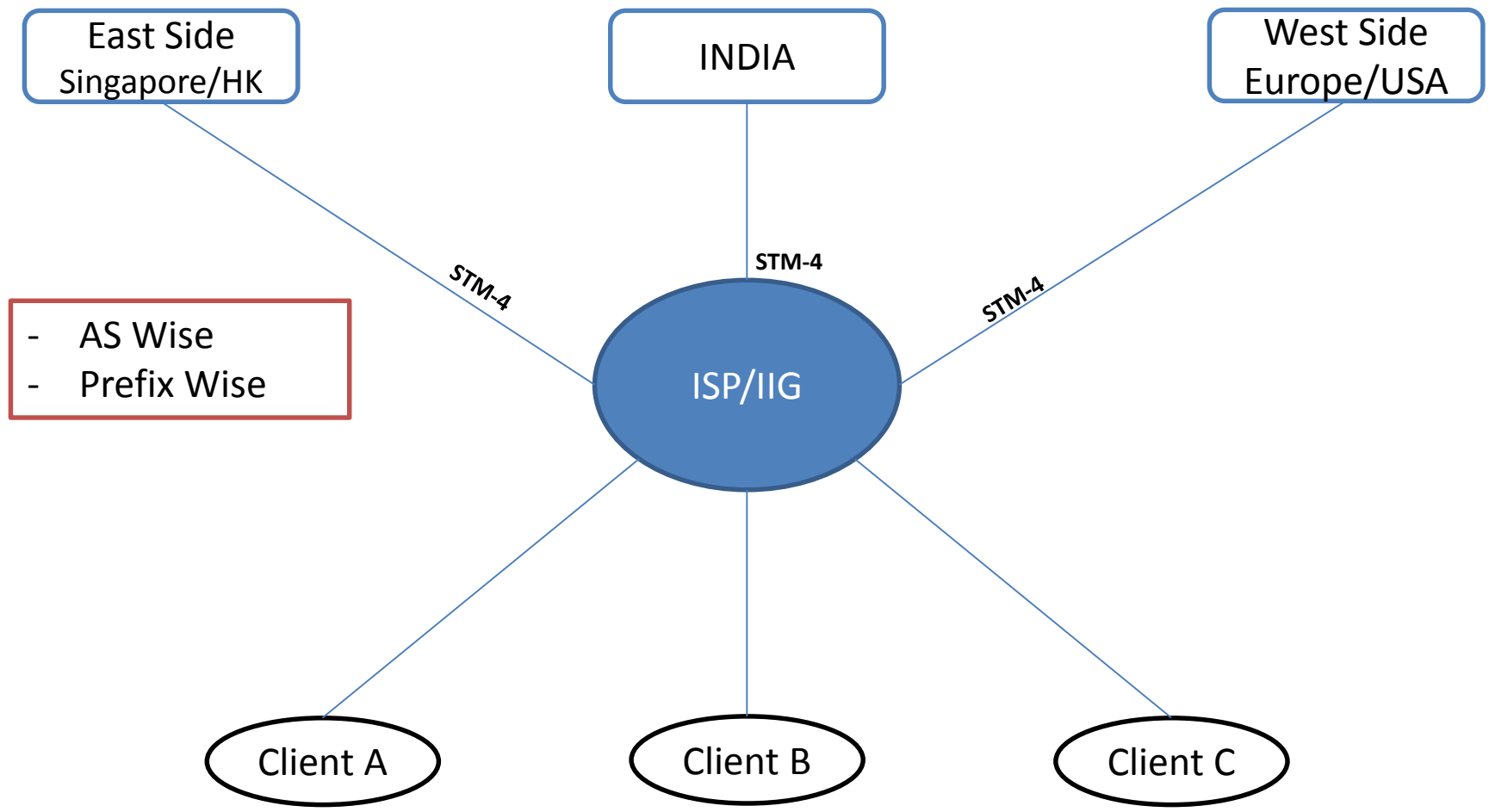
Operator :
Bangladesh Submarine
Cable Company Limited
(BSCCL)

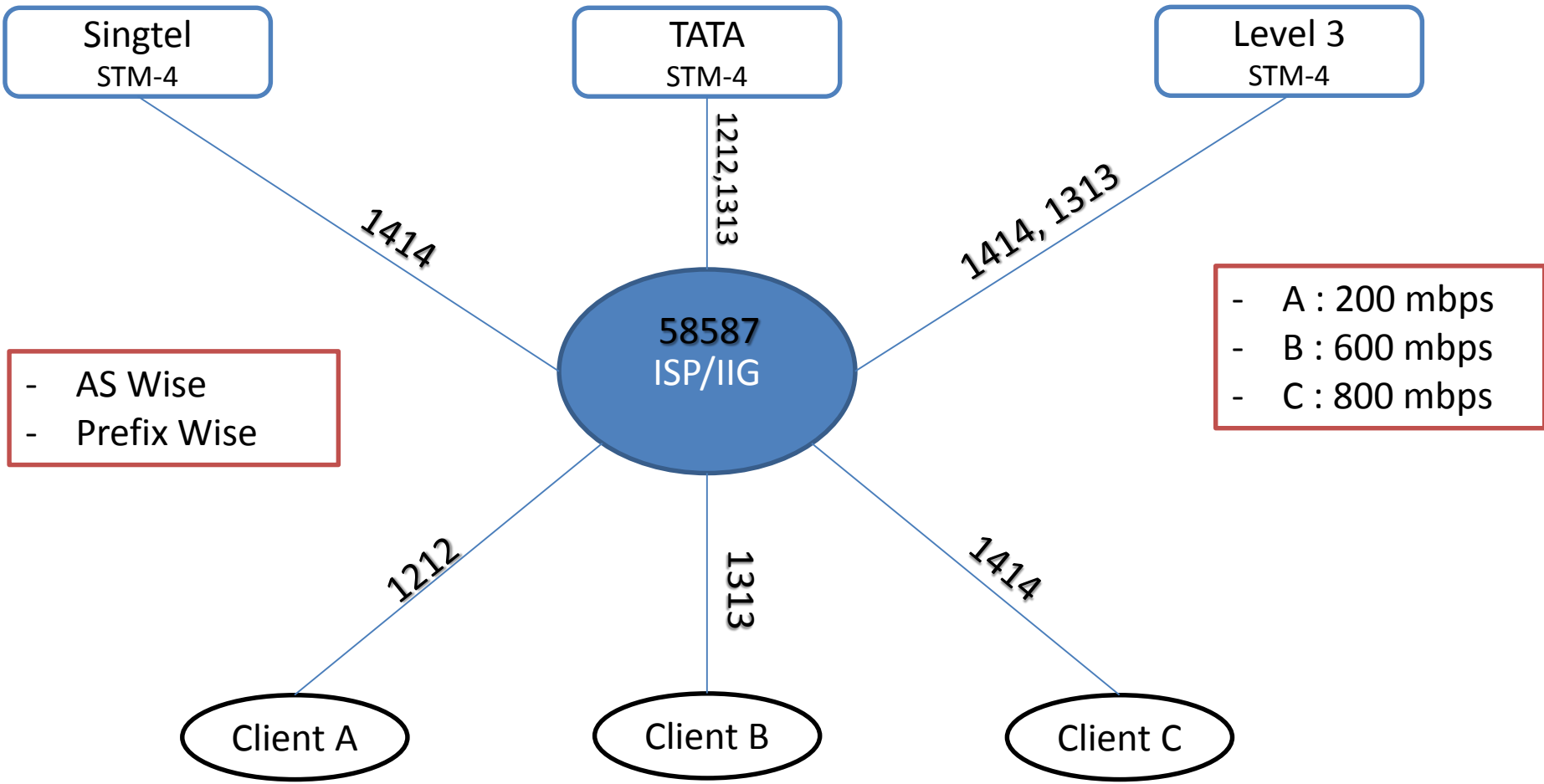




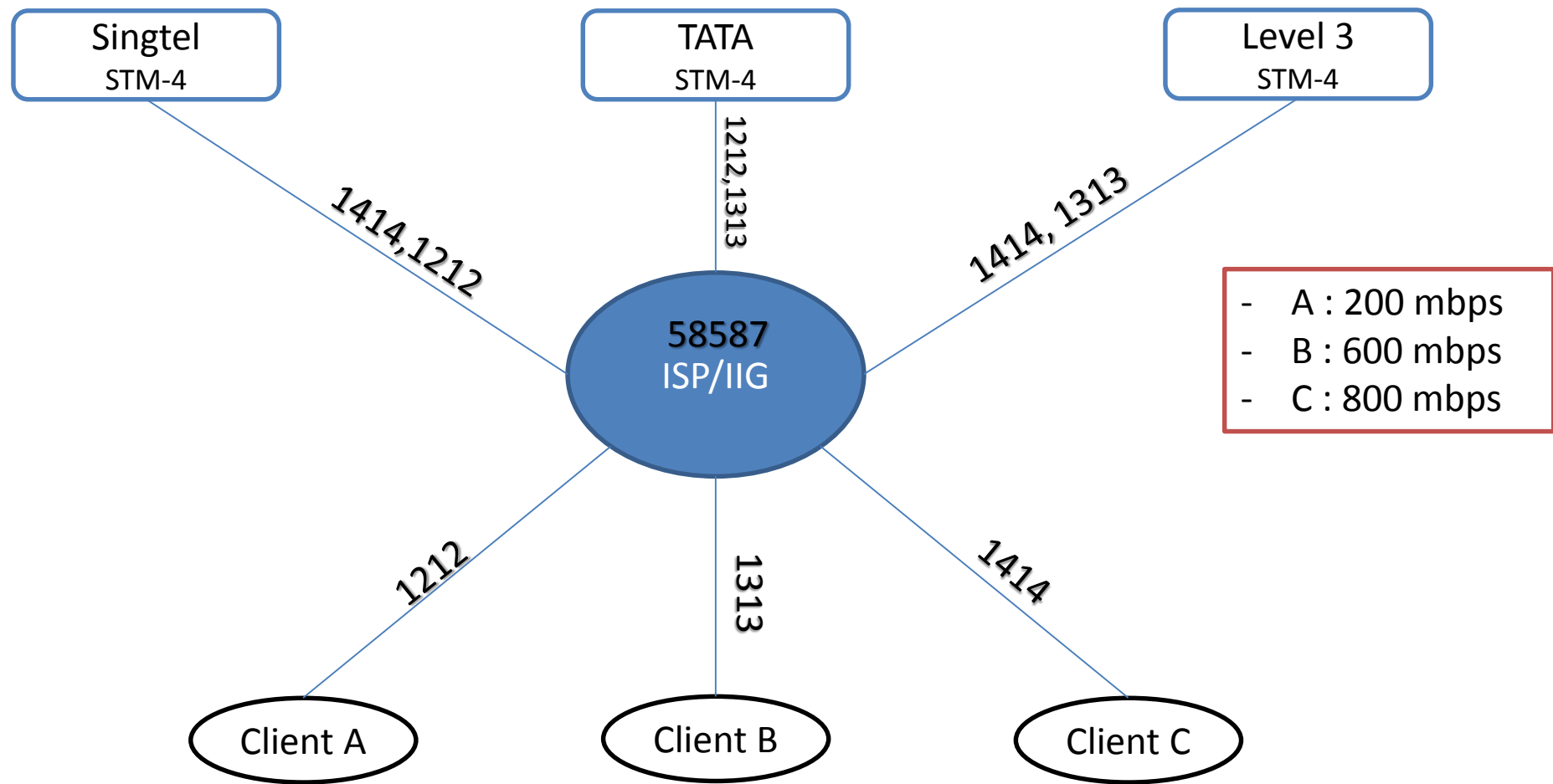




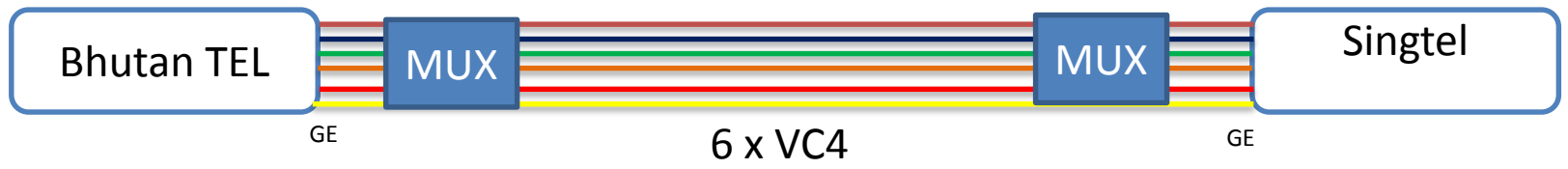
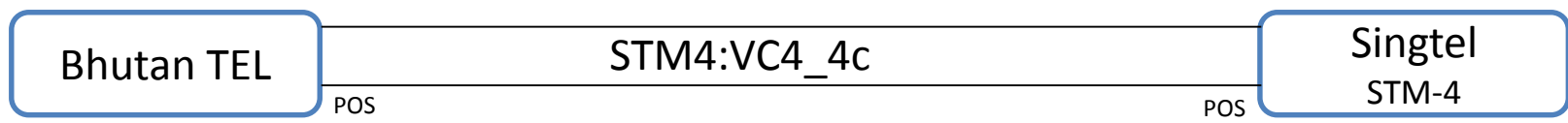


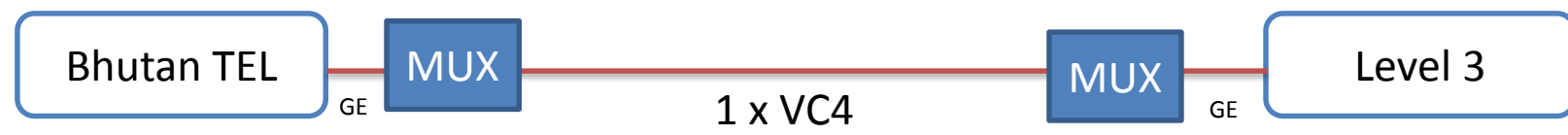
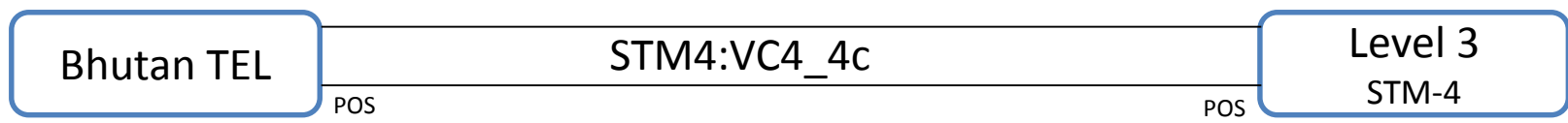


Congestion

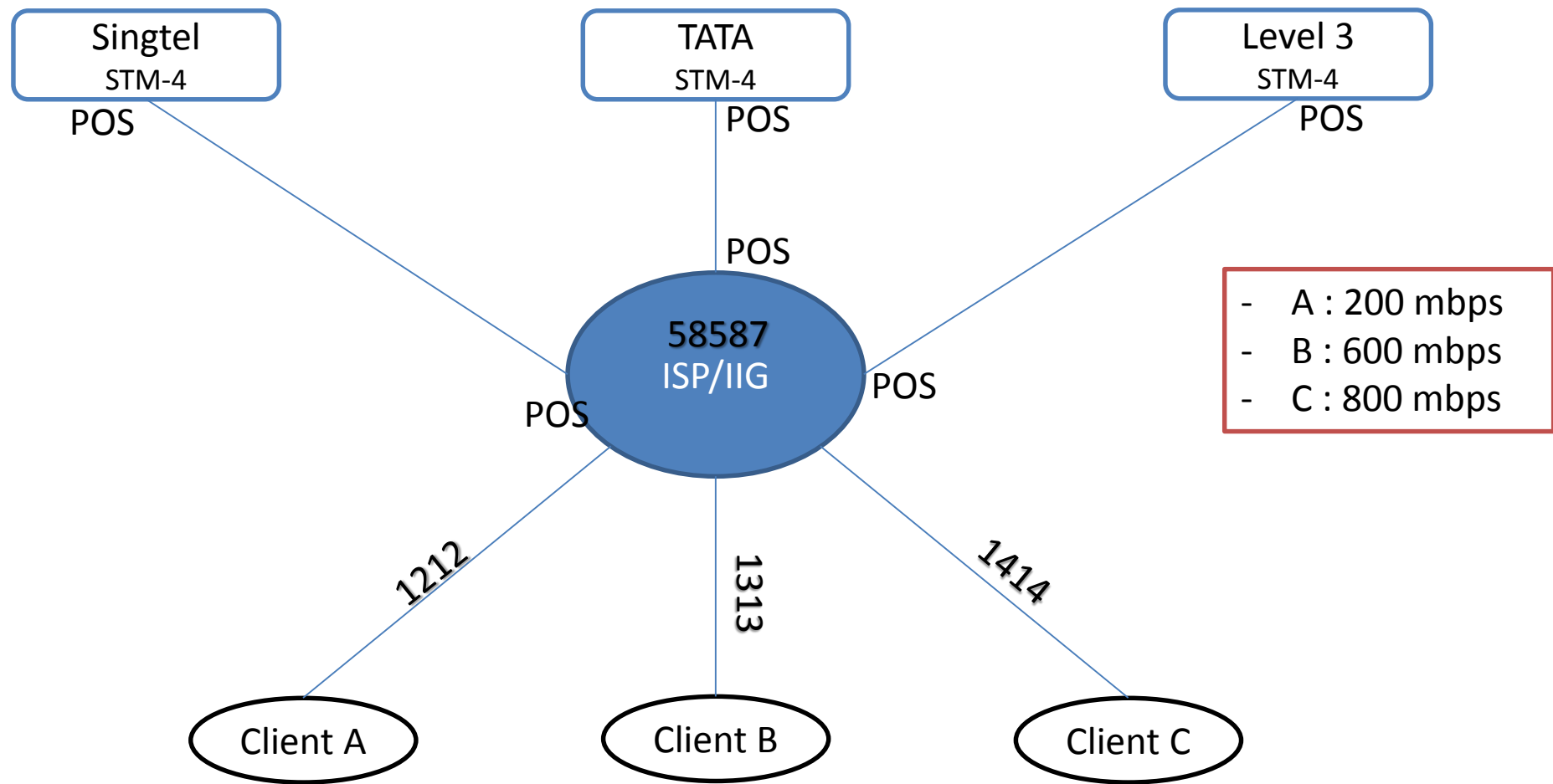


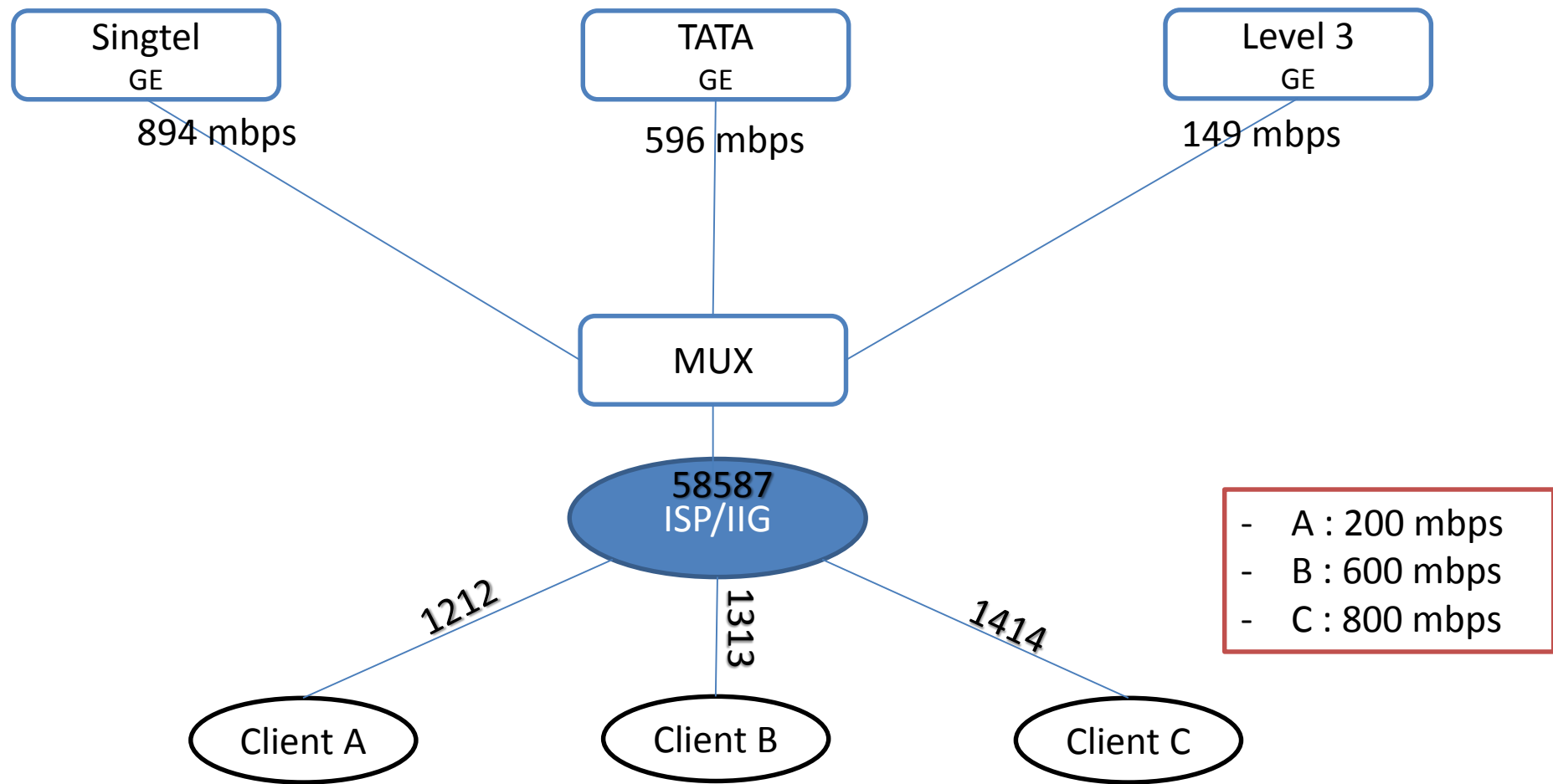
- Singapore Route become congested.
- Traffic Engineering is not working.
- Need bigger port of STM-16 or GE.
- POS STM-16 is too much Expensive.





Congestion





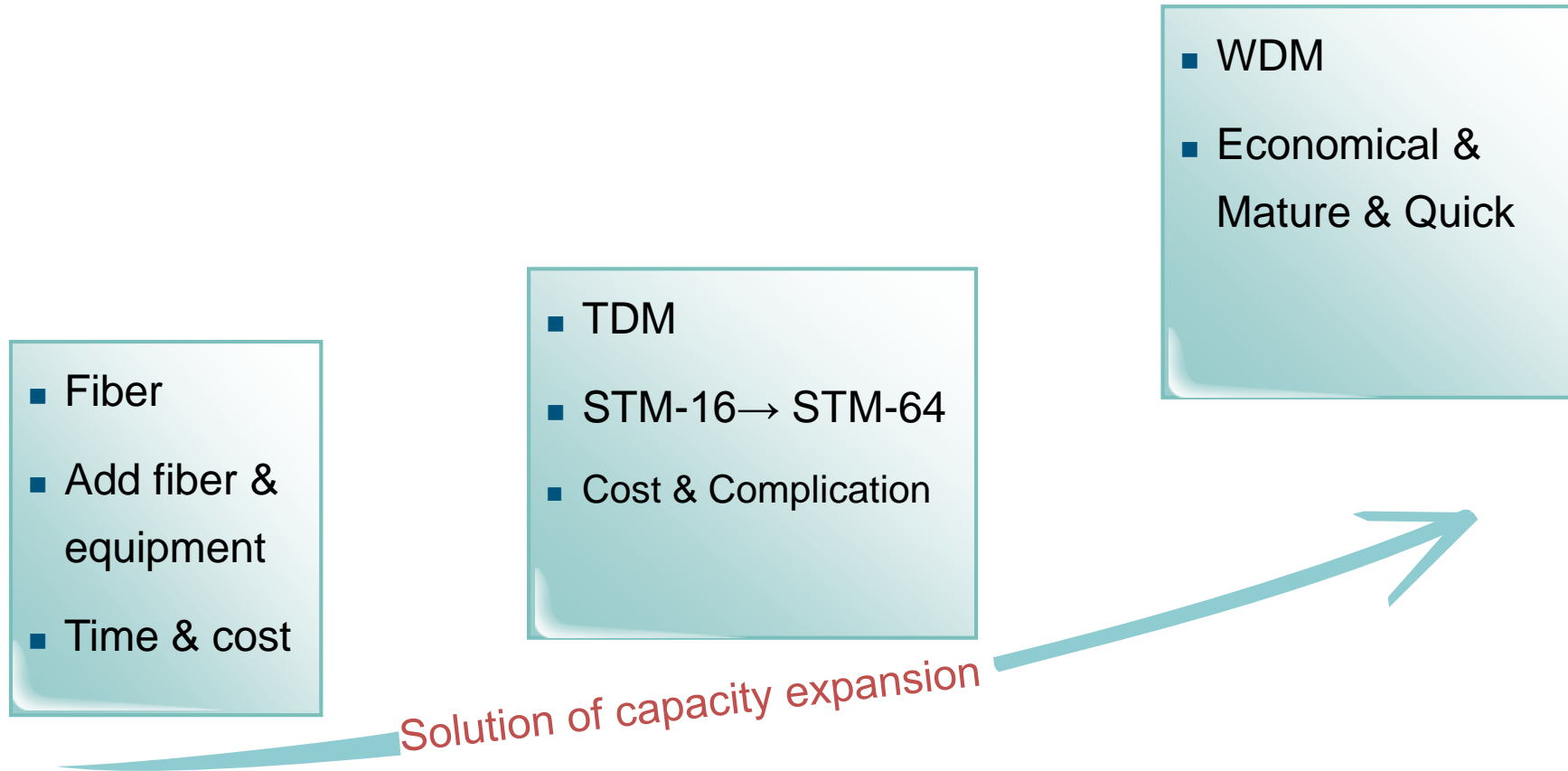
- Singapore Route got expanded.
- Level3 Route became small
- Traffic Engineering is now working evenly.
- Opex same or reduced as Singapore is near.
- Capex reduced, as POS cards are really expensive.
- Router is routing and Transmission Equipment is Transmitting.

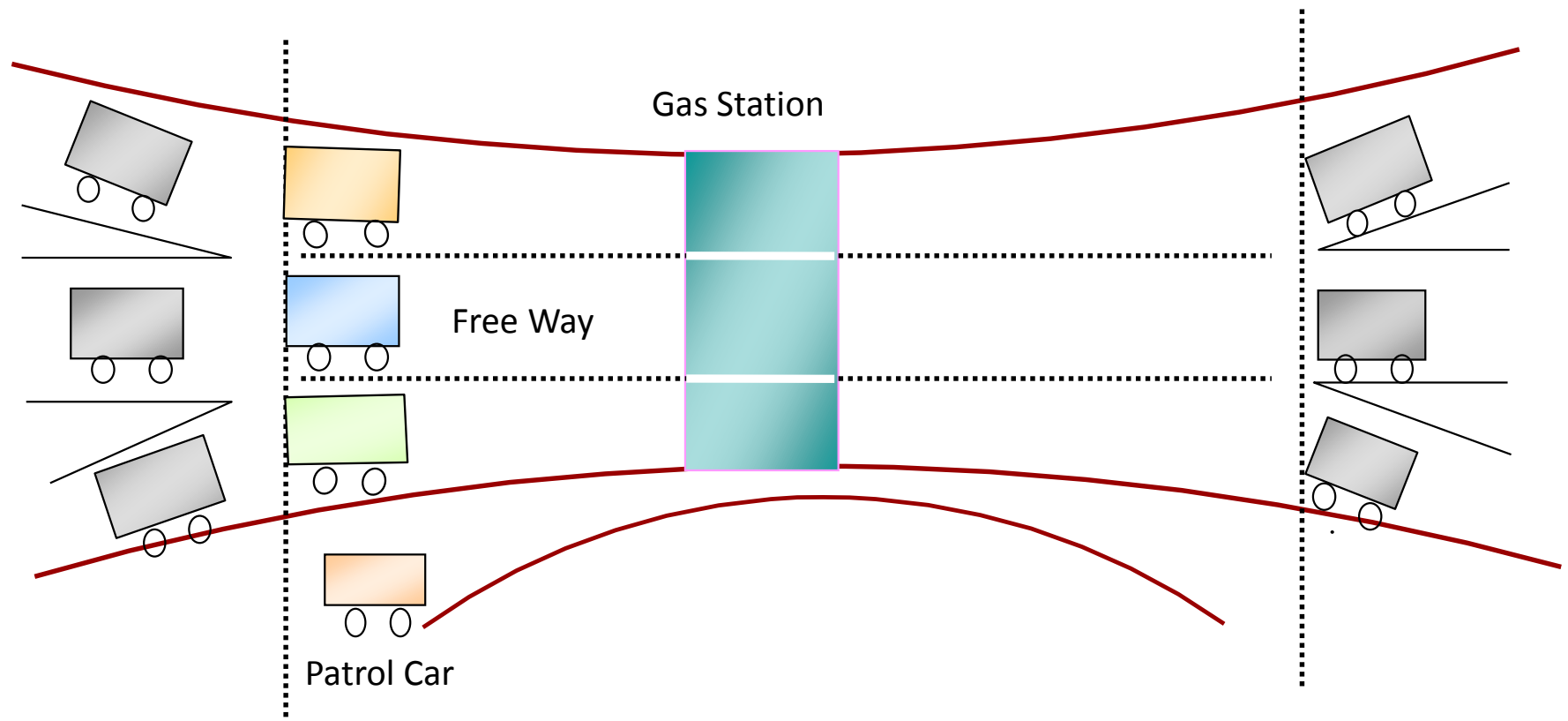
*Need a Future-proof Transmission
Backbone*

SECTION

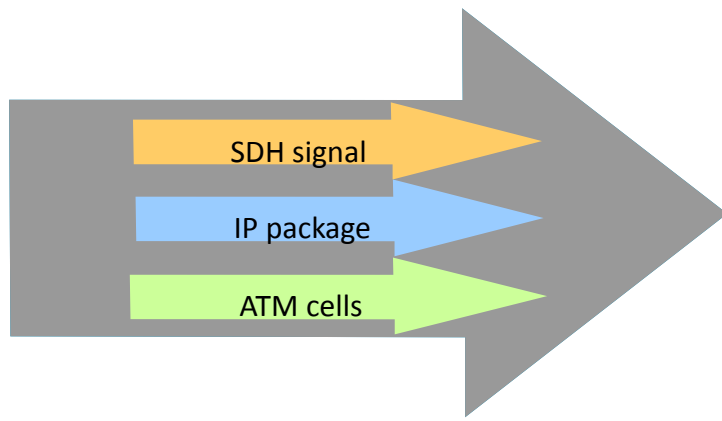
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Introduction to WDM Network

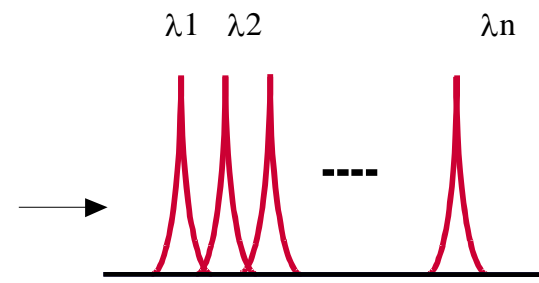


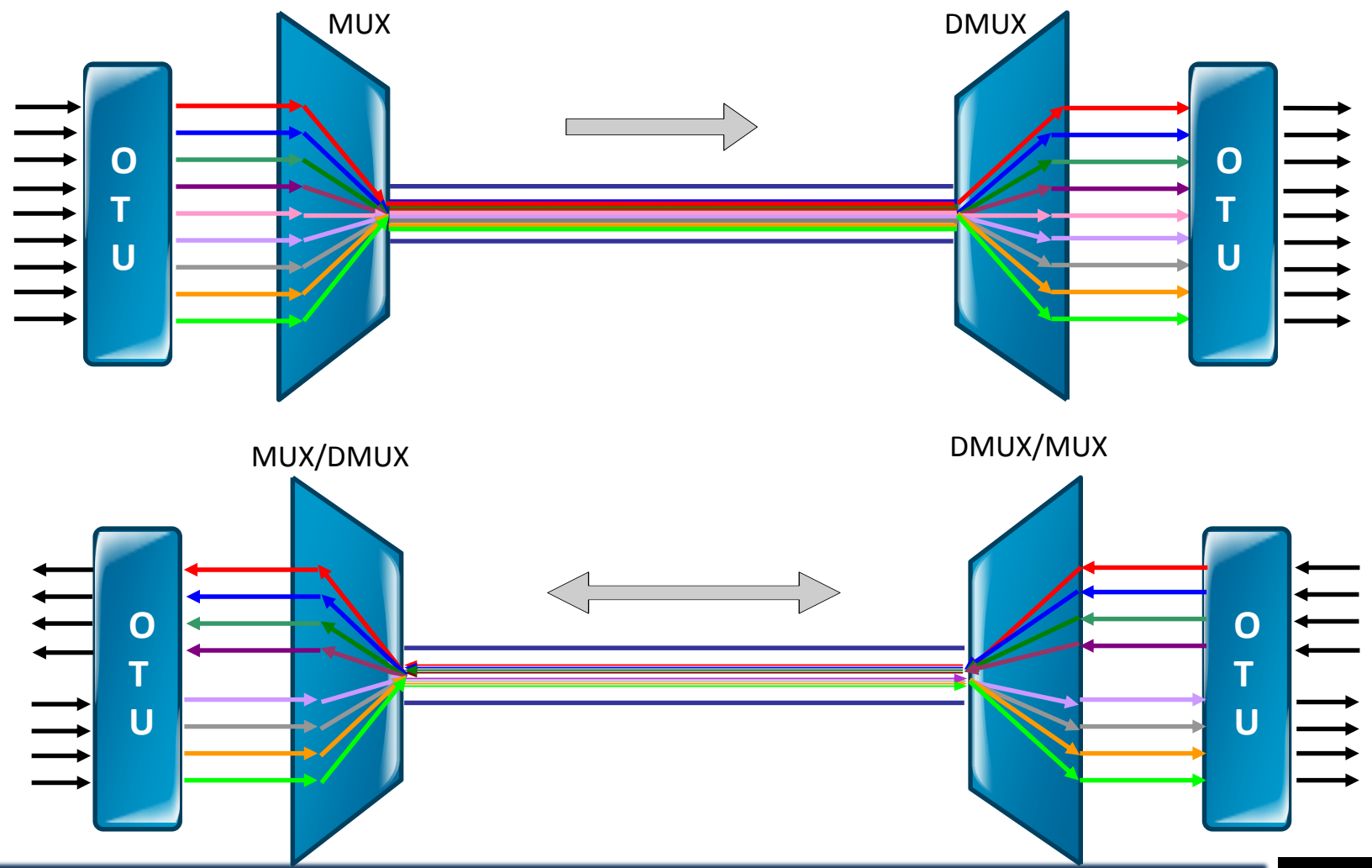


Different signals with specific wavelength are multiplexed into a fiber for transmission.



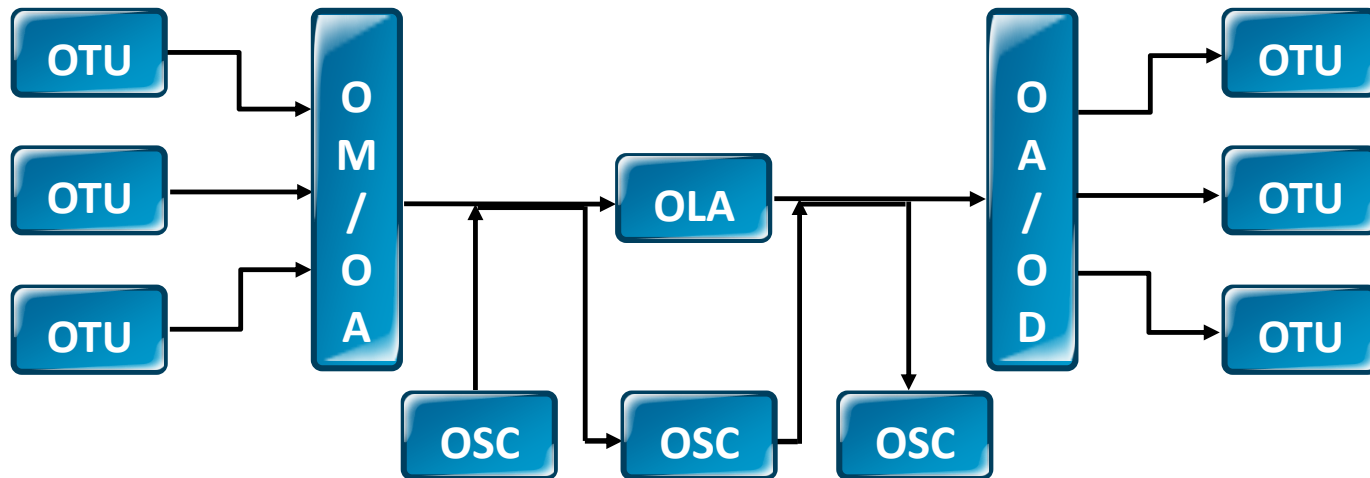
λ λ_1
 λ λ_2
 λ \vdots
 λ λ_n

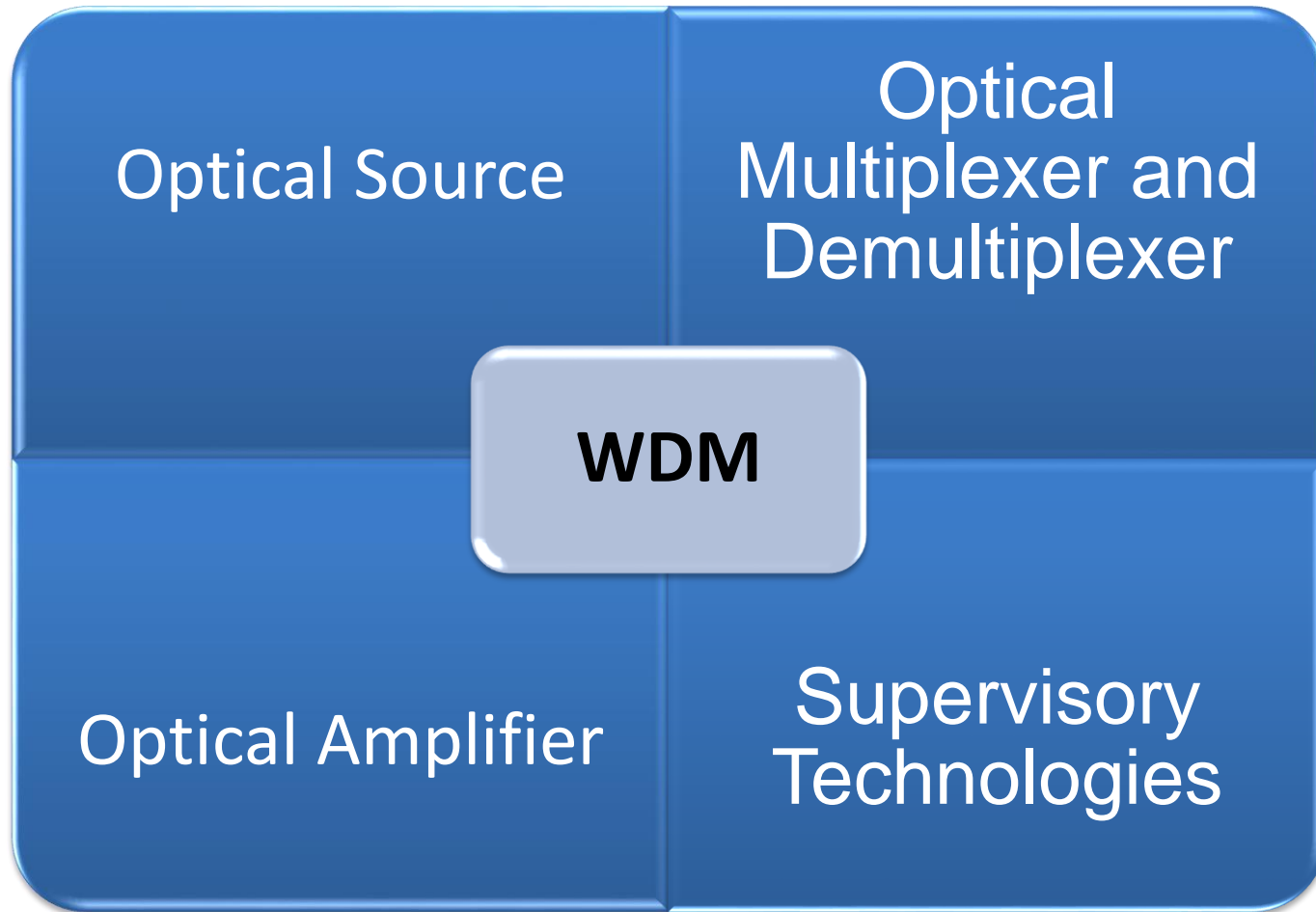




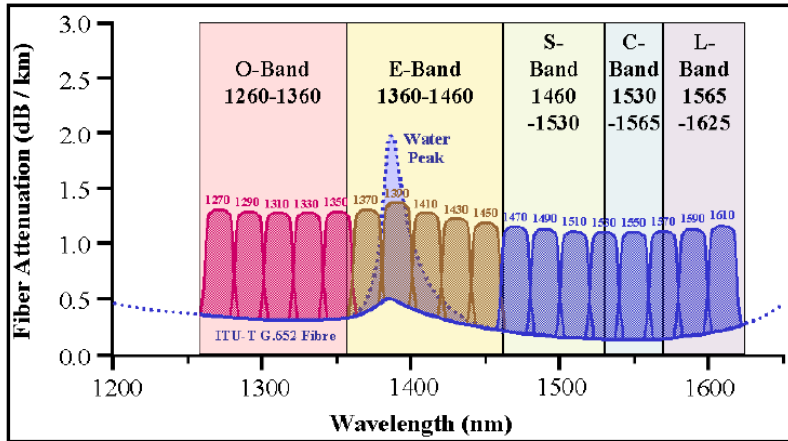
The overall structure of the WDM system of N-path wavelength:

- Optical Transponder Unit (OTU)
- Optical Multiplexer Unit / Optical De-multiplexer Unit (OMU/ODU)
- Optical Amplifier (OA)
- Supervisory Channel (OSC/ESC)



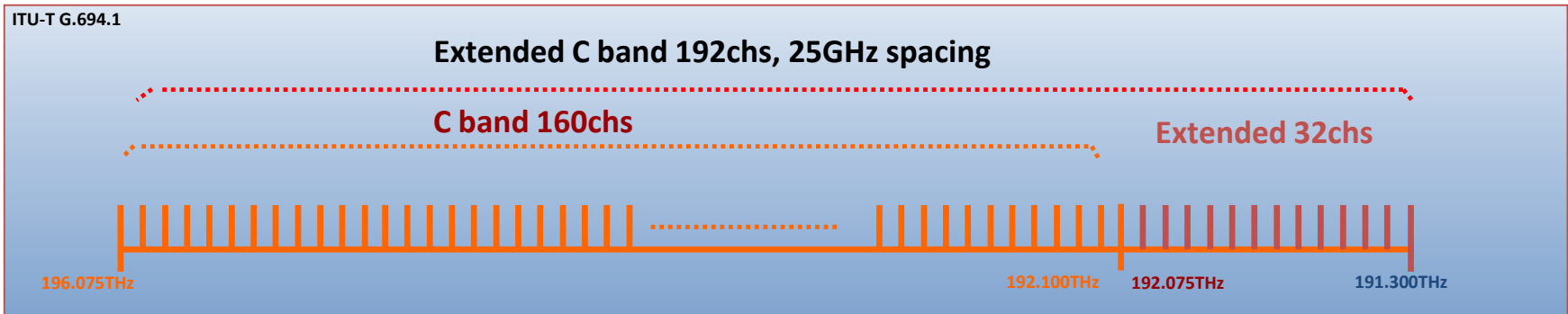


- Ultra high capacity
- Data transparency transmission
- Long haul transmission
- Compatible with existing optical fibers
- High performance-to-cost ratio
- High networking flexibility, economy and reliability
- Smooth expansion



CWDM: Coarse Wavelength Division Multiplex

DWDM: Dense Wavelength Division Multiplex



CWDM

- Defined by wavelengths
- Short-range communications
- Uses wide-range frequencies
- Wavelengths spread far apart
- Wavelength drift is possible
- Breaks the spectrum into big chunks
- Light signal isn't amplified

DWDM

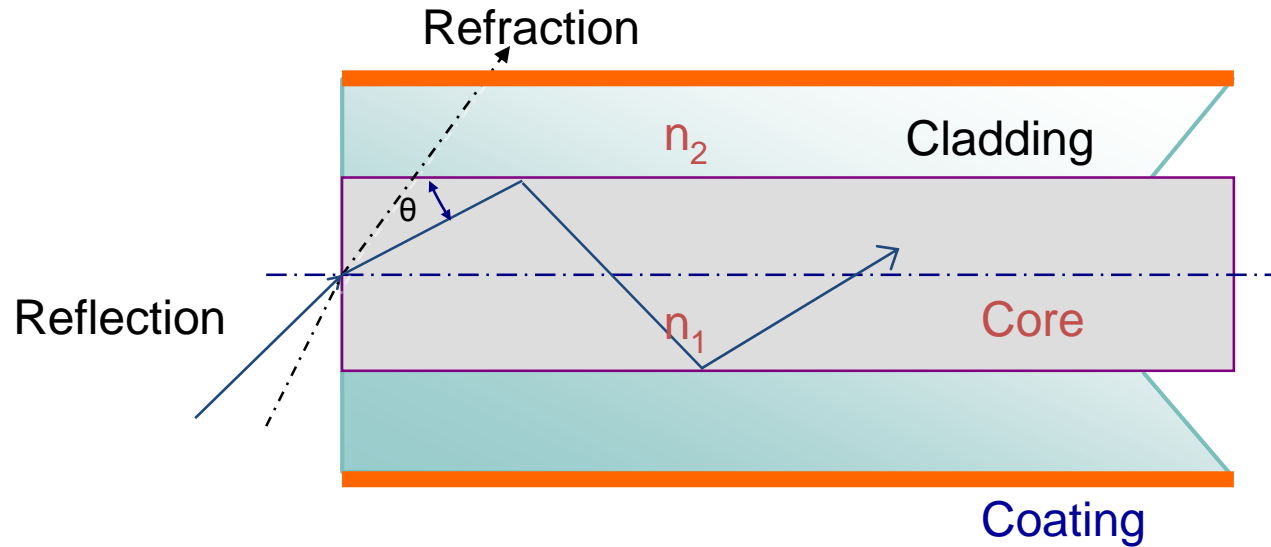
- Defined by frequencies
- Long-haul transmissions
- Narrow frequencies
- Tightly packed wavelengths
- Precision lasers required to keep channels on target
- Dices the spectrum into small pieces
- Signal amplification maybe used

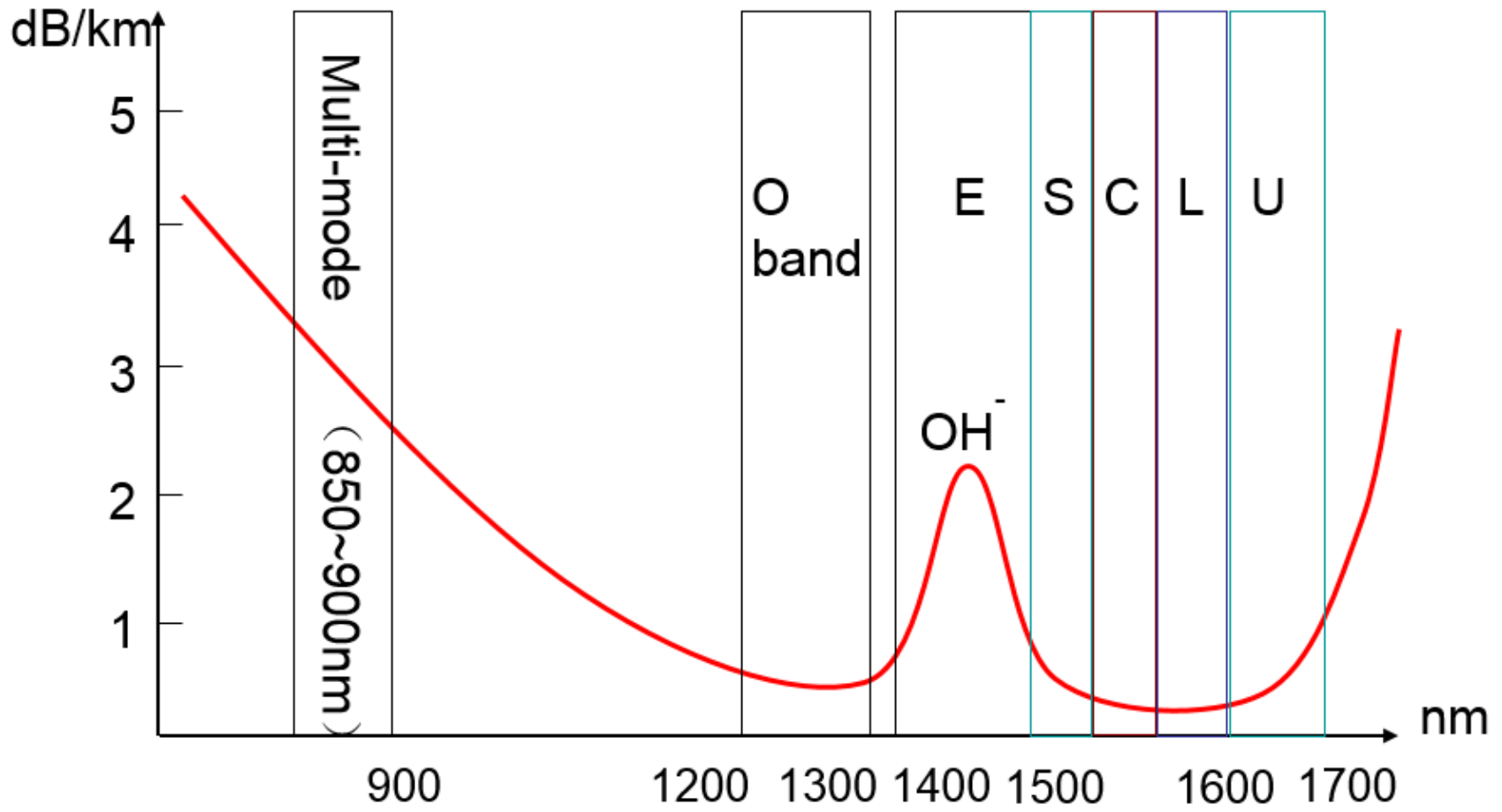
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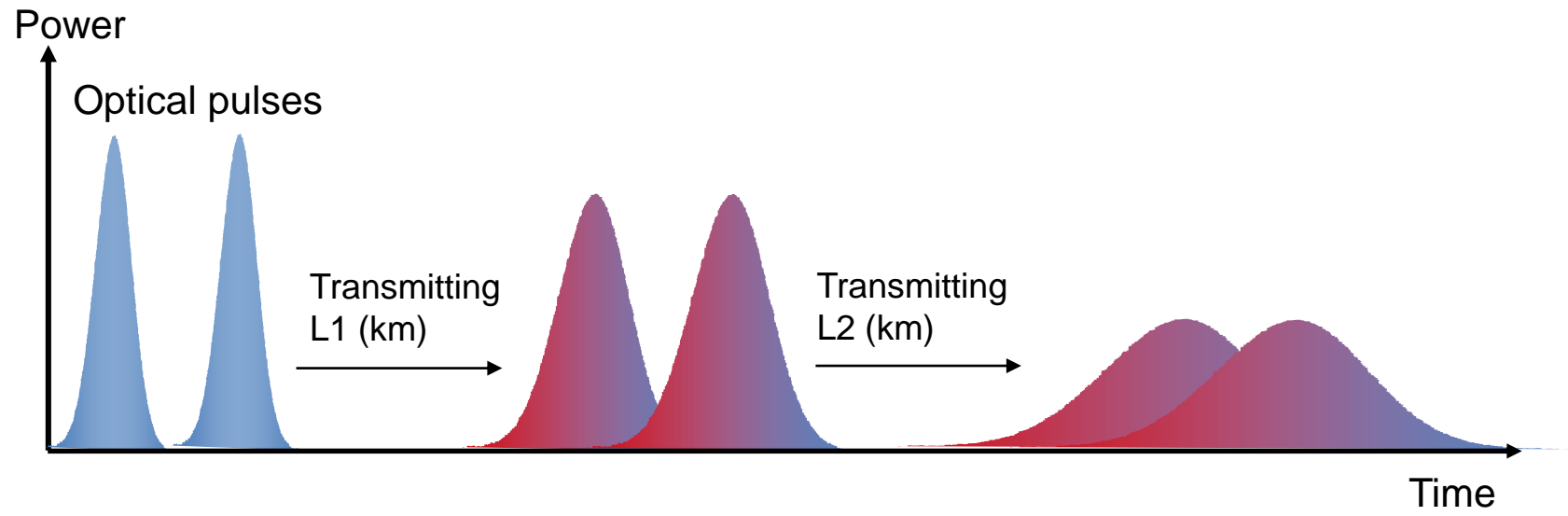
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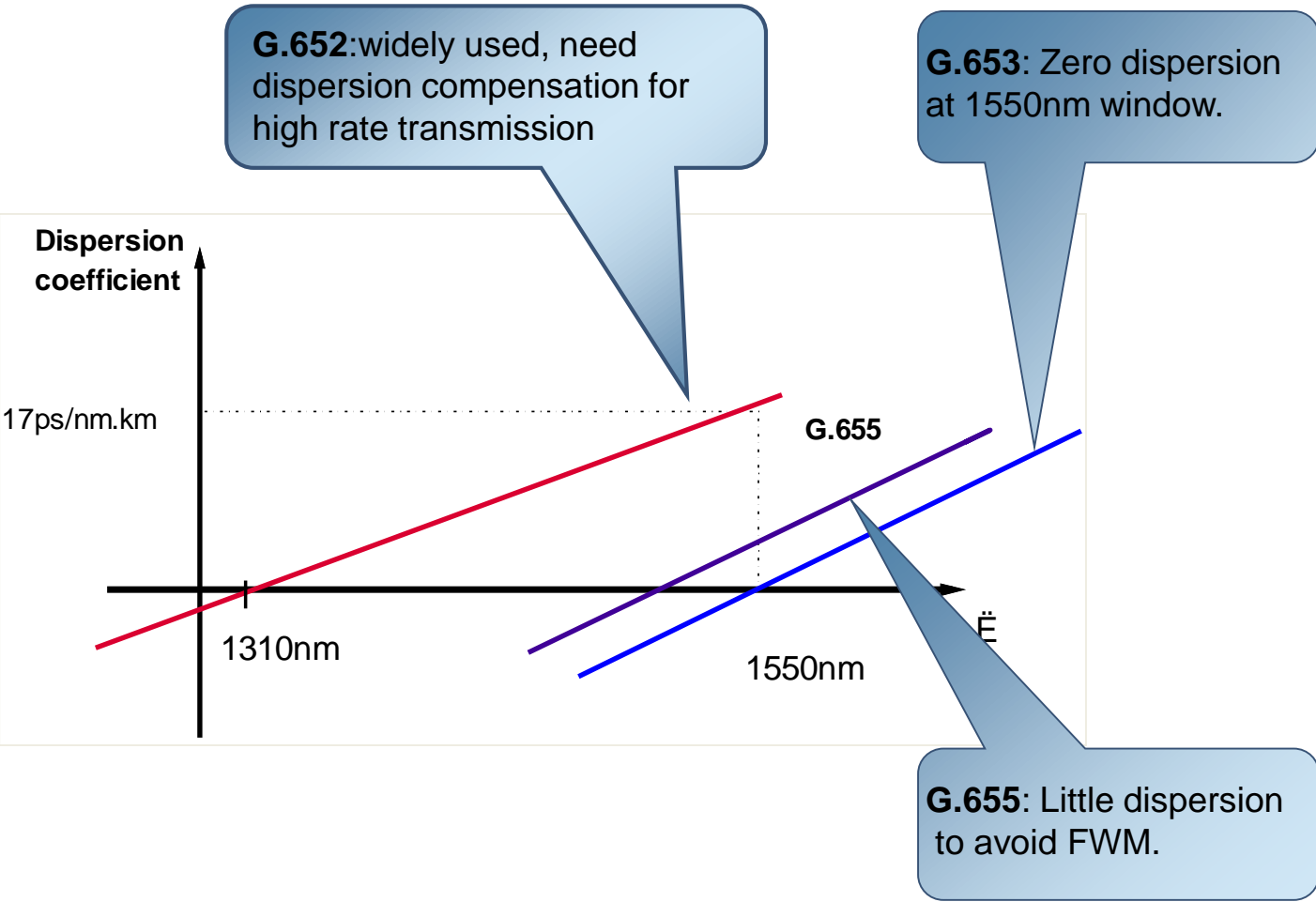
Some Theory of Fiber and Light for WDM Network

Consists of a cylindrical glass core, a glass cladding and a plastic wear-resisting coating.

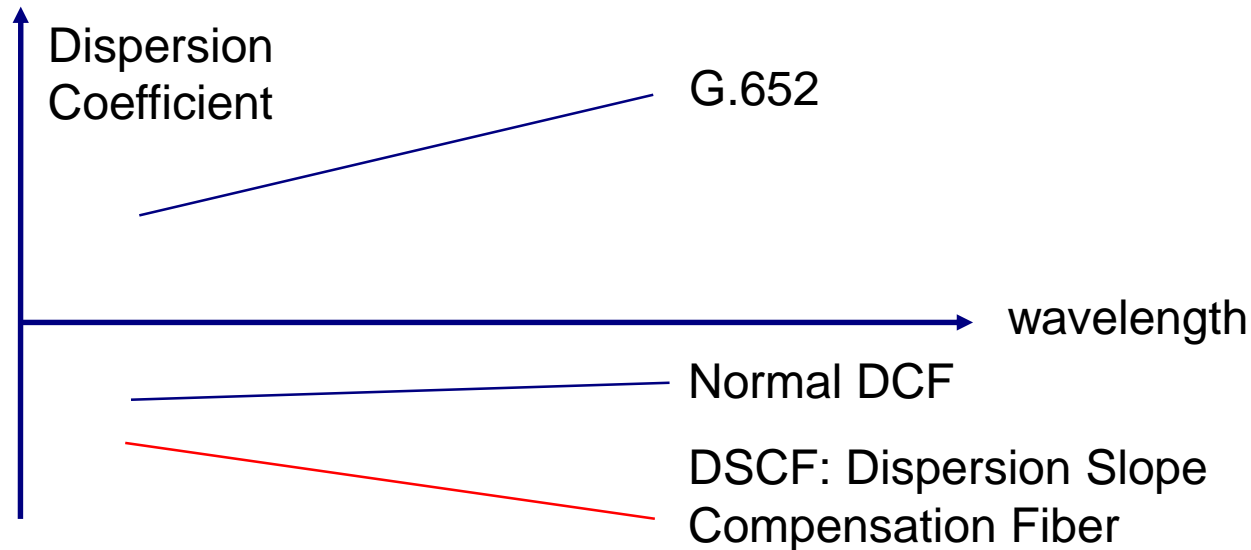








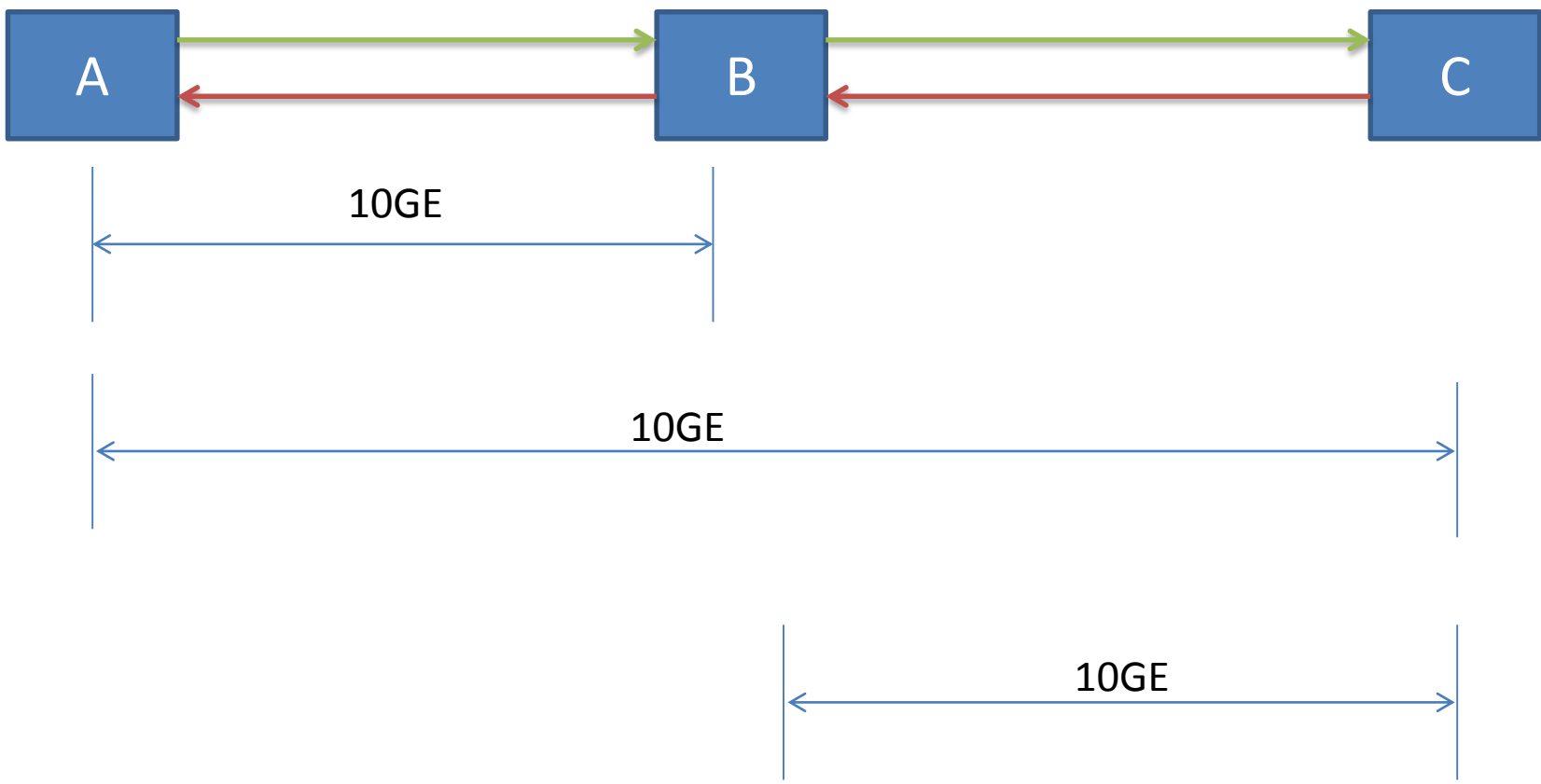
- The pulse will be broadened because of
 - Positive dispersion coefficient at 1550nm window
- DCF has negative dispersion coefficient and can counteract positive dispersion in transmission.

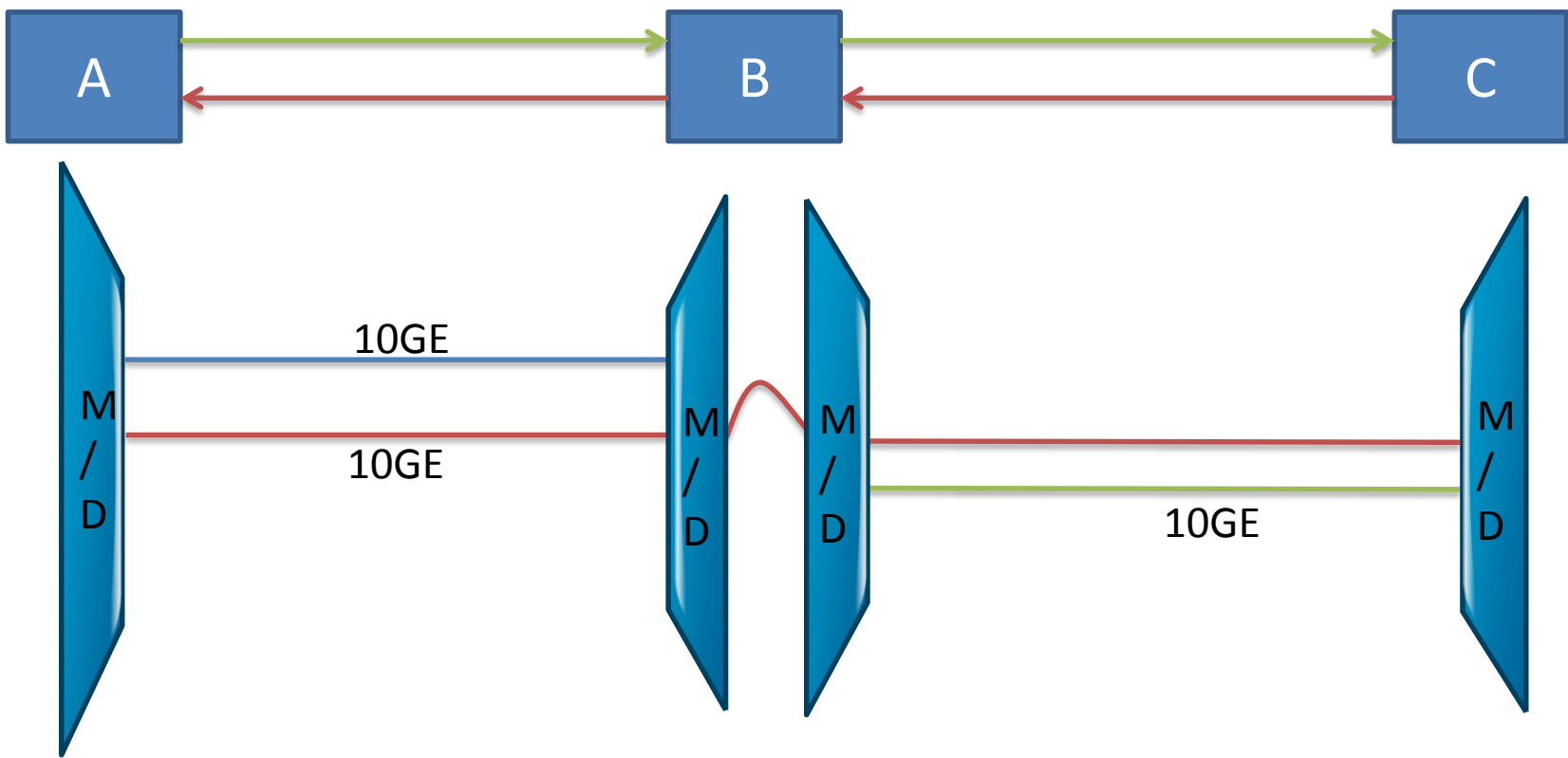


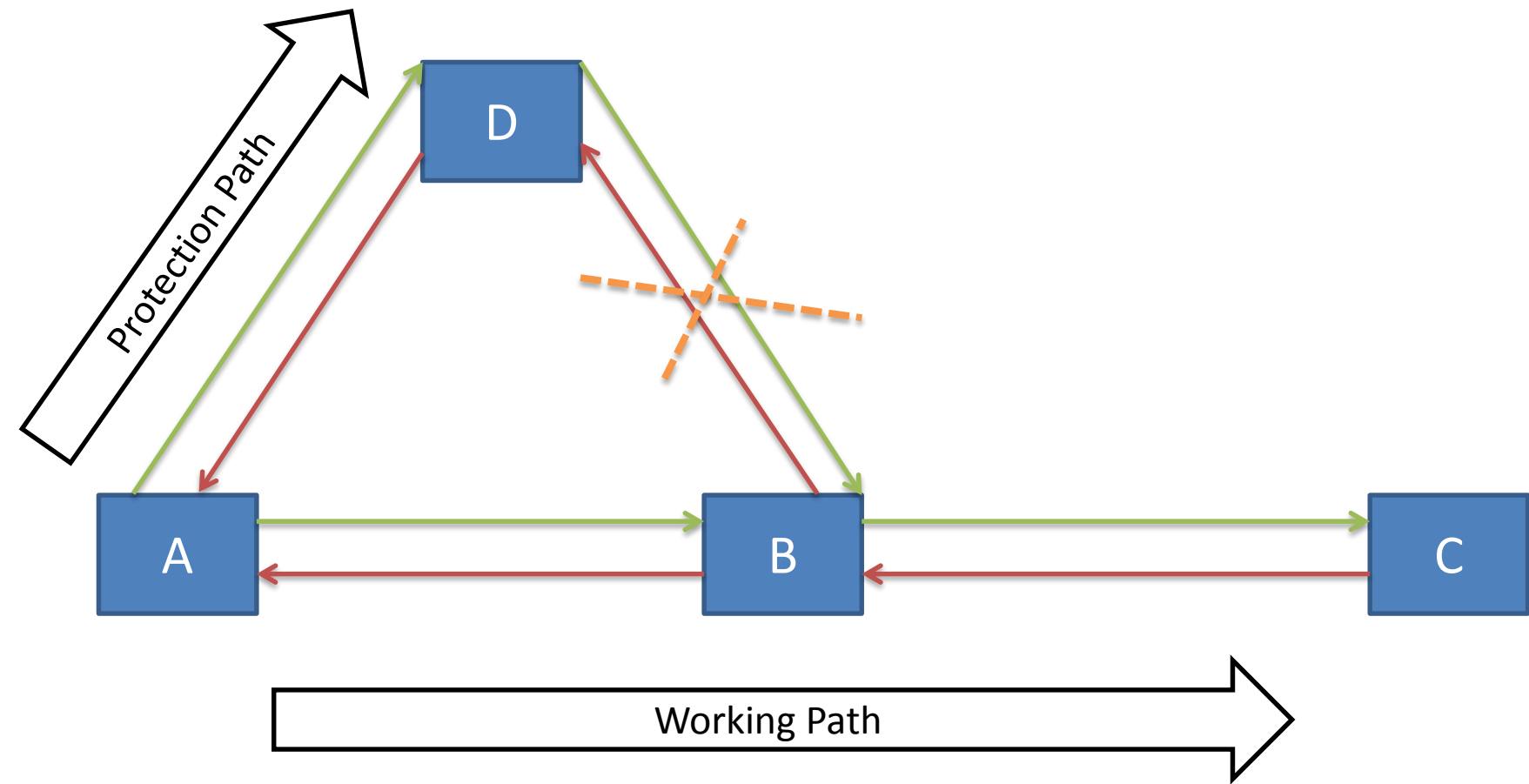
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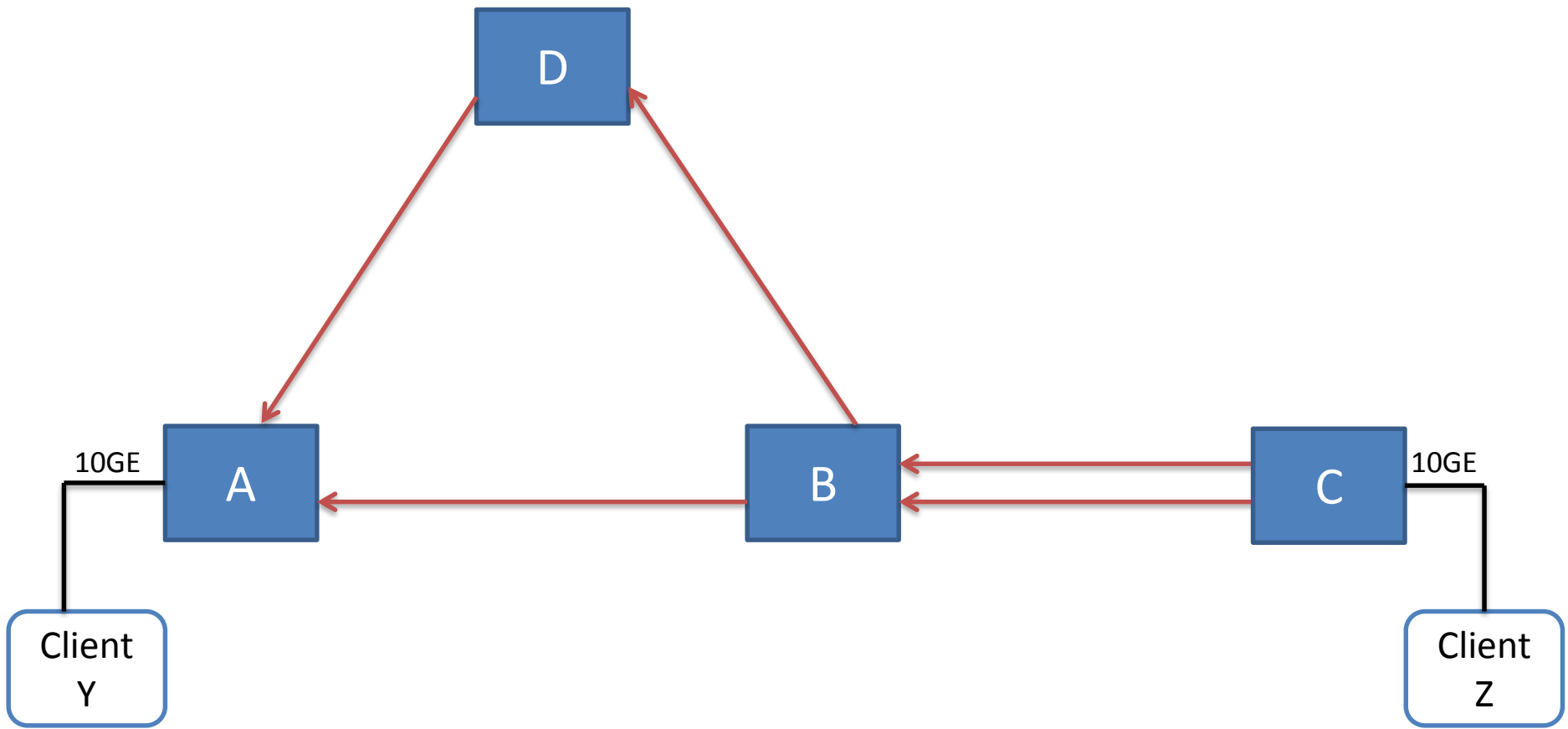
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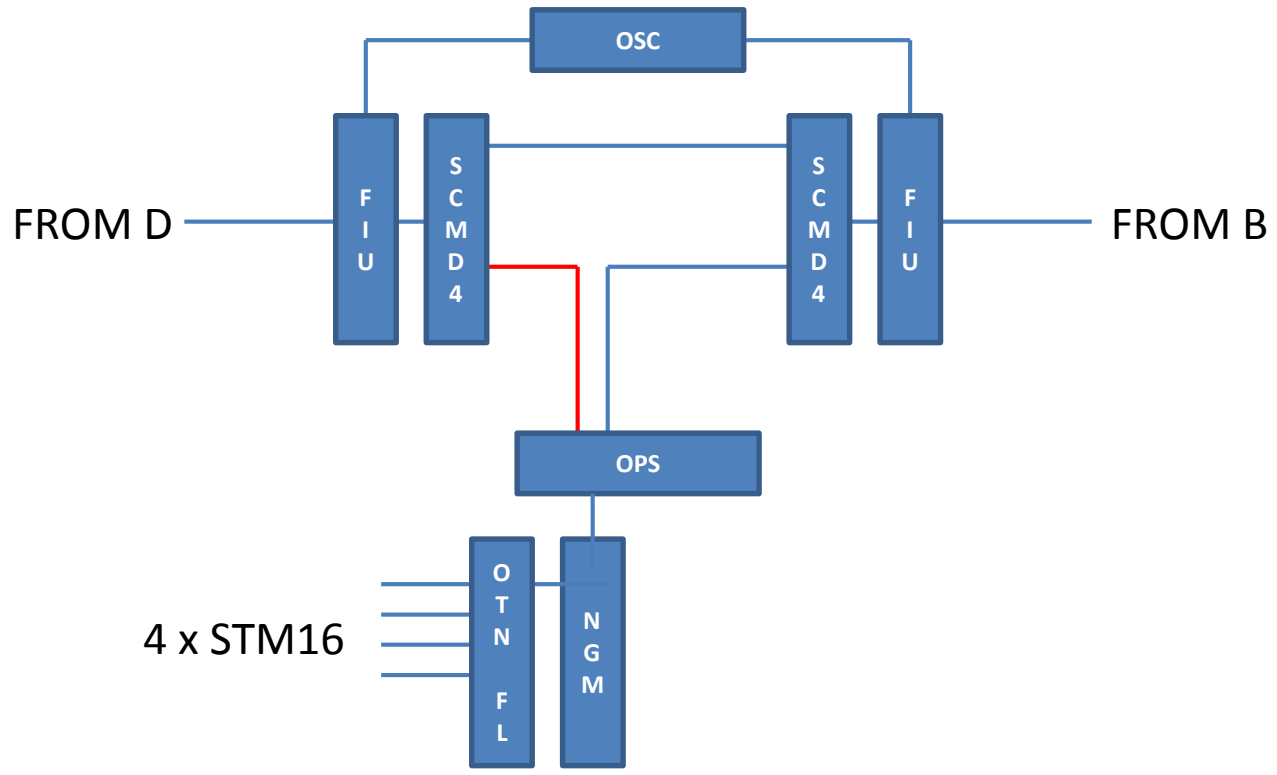
WDM Optical Layer Grooming







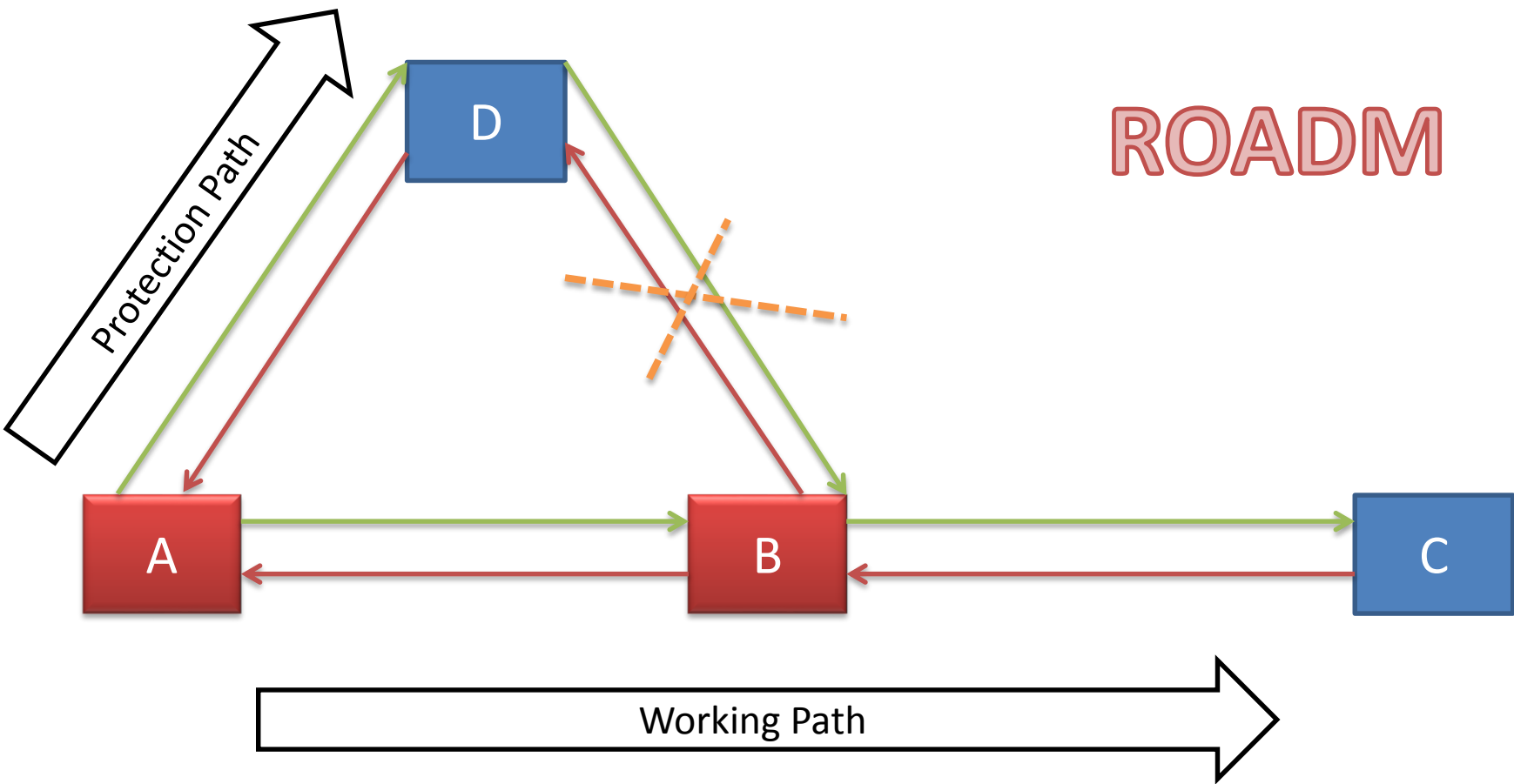


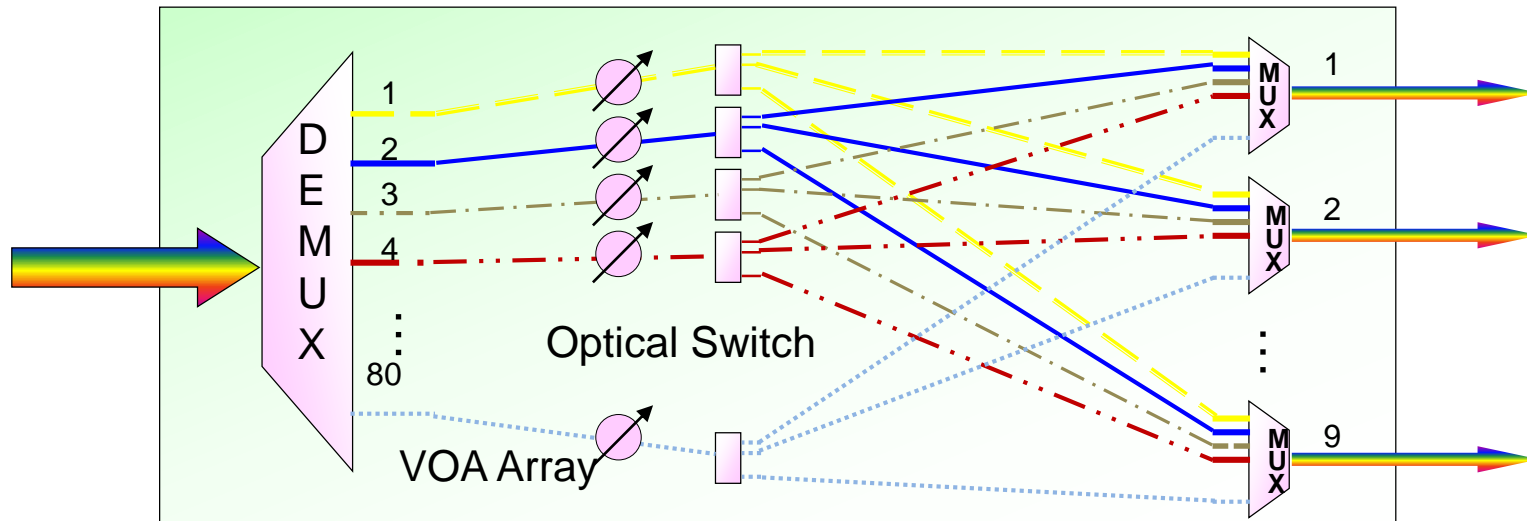


SITE B : With OPS Card

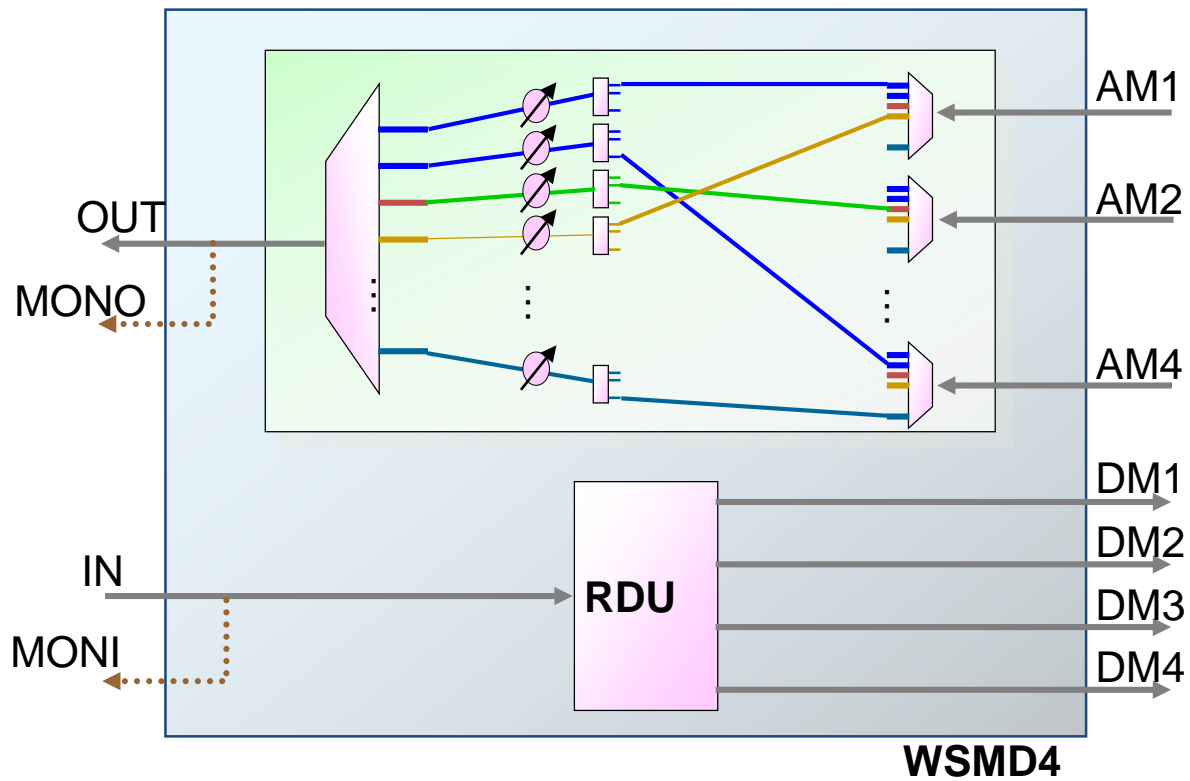


ROADM



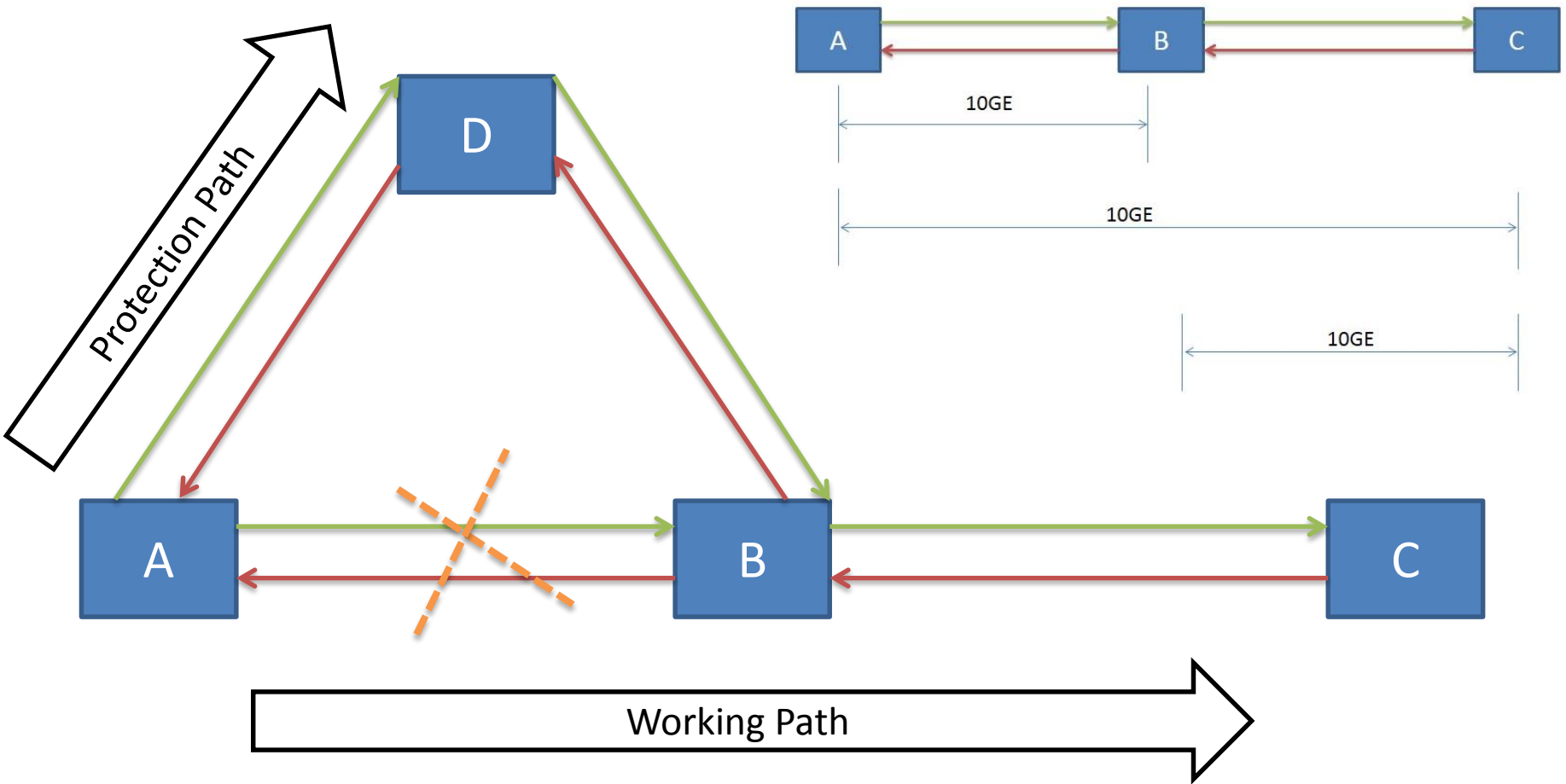


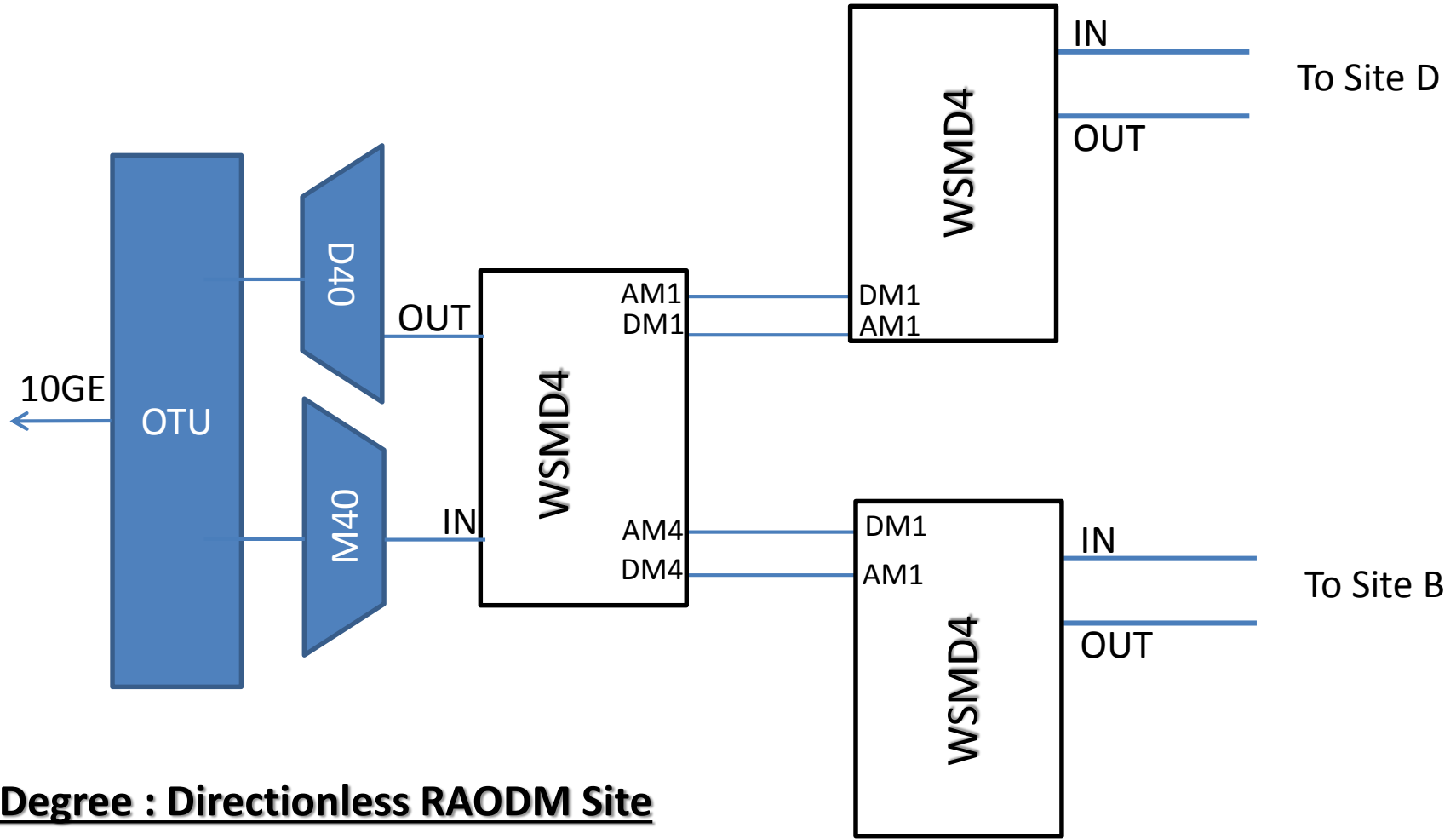
- WSS (Taking WSD9 as example):
 - Chromatic optical signal is de-multiplexed to monochromatic optical signals.
 - VOAs adjust the power of each monochromatic optical signal.
 - Then guide each of the monochromatic signals to different optical multiplexer by controlling the 1 x N (that is N=9 in the figure) optical switch array.
 - Finally transmit any monochromatic optical signal to any output port.



- WSMD4: 4-port wavelength selective switching multiplexer and demultiplexer board.
- RDU is 1 x 4 coupler to separate the optical signal into four parts.







3 Degree : Directionless ROADM Site



- ROADM is really Expensive
- Per Degree we need one ROADM Card
- ROADM is not good for
 - Heavy Fiber CUT in the network
 - Overhead Cable – Where fiber change the characters
- Optical Protection Switching is available and getting very smart everyday.
- 40G/100G Technology is available and getting cheaper
- Electrical Grooming via OTN

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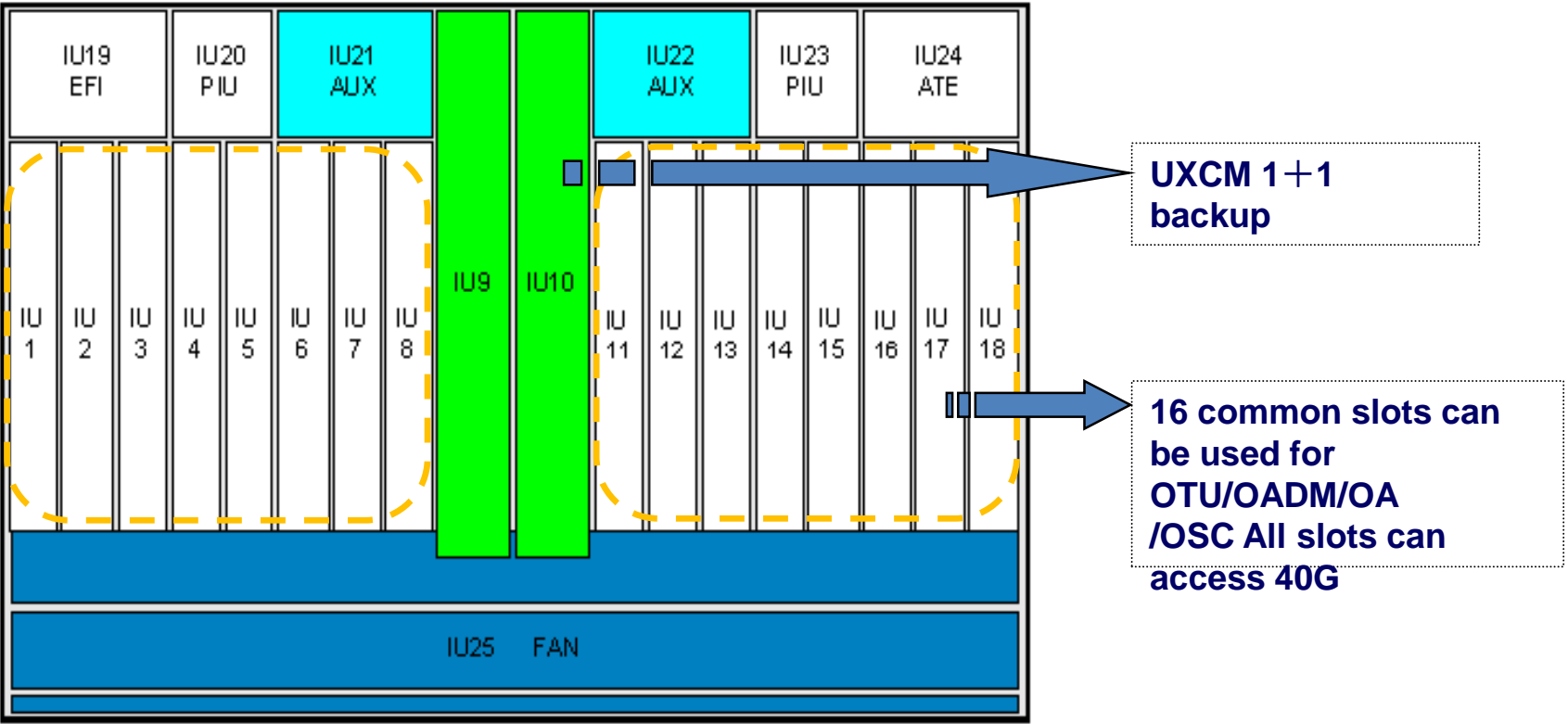
5

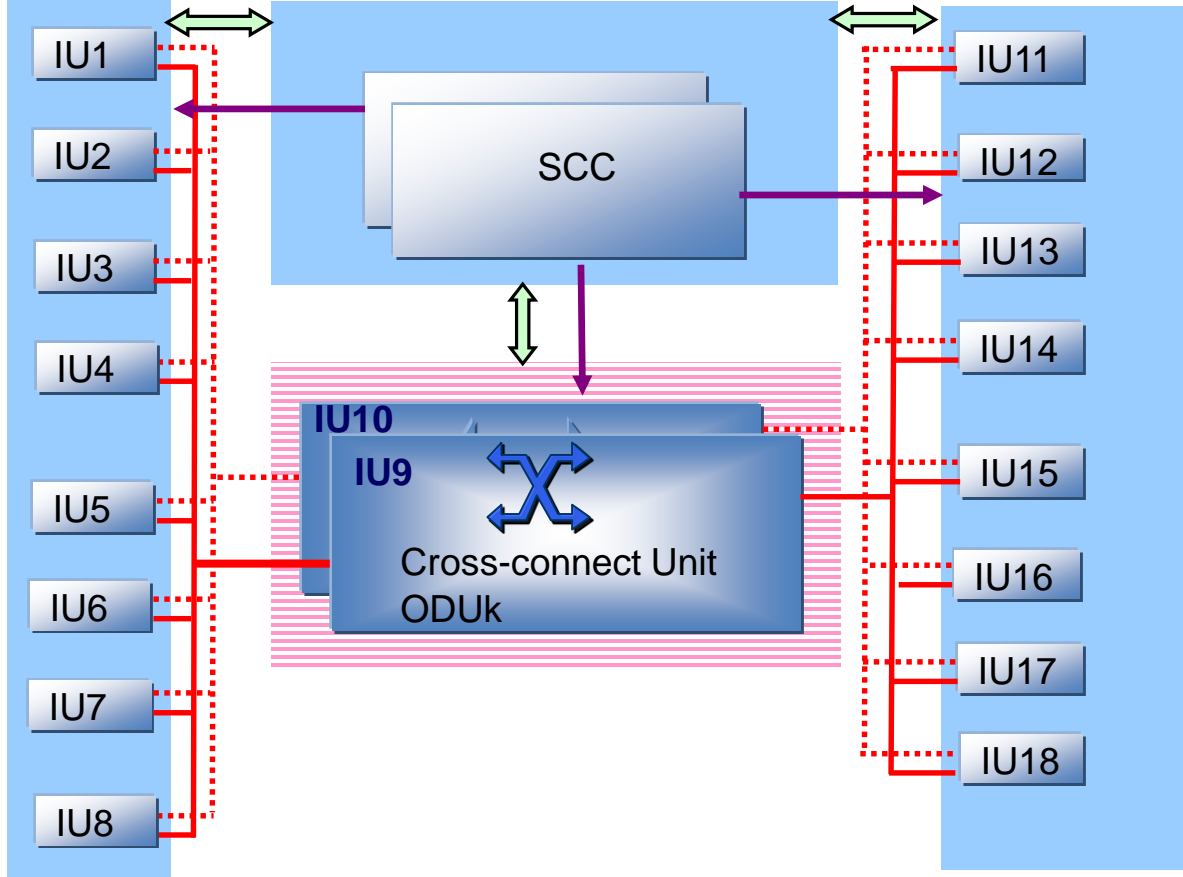
WDM Electrical Layer Grooming

An Optical Transport Network (OTN) is composed of a set of Optical Network Elements connected by optical fiber links, able to provide functionality of transport, multiplexing, routing, management, supervision and survivability of client signals.

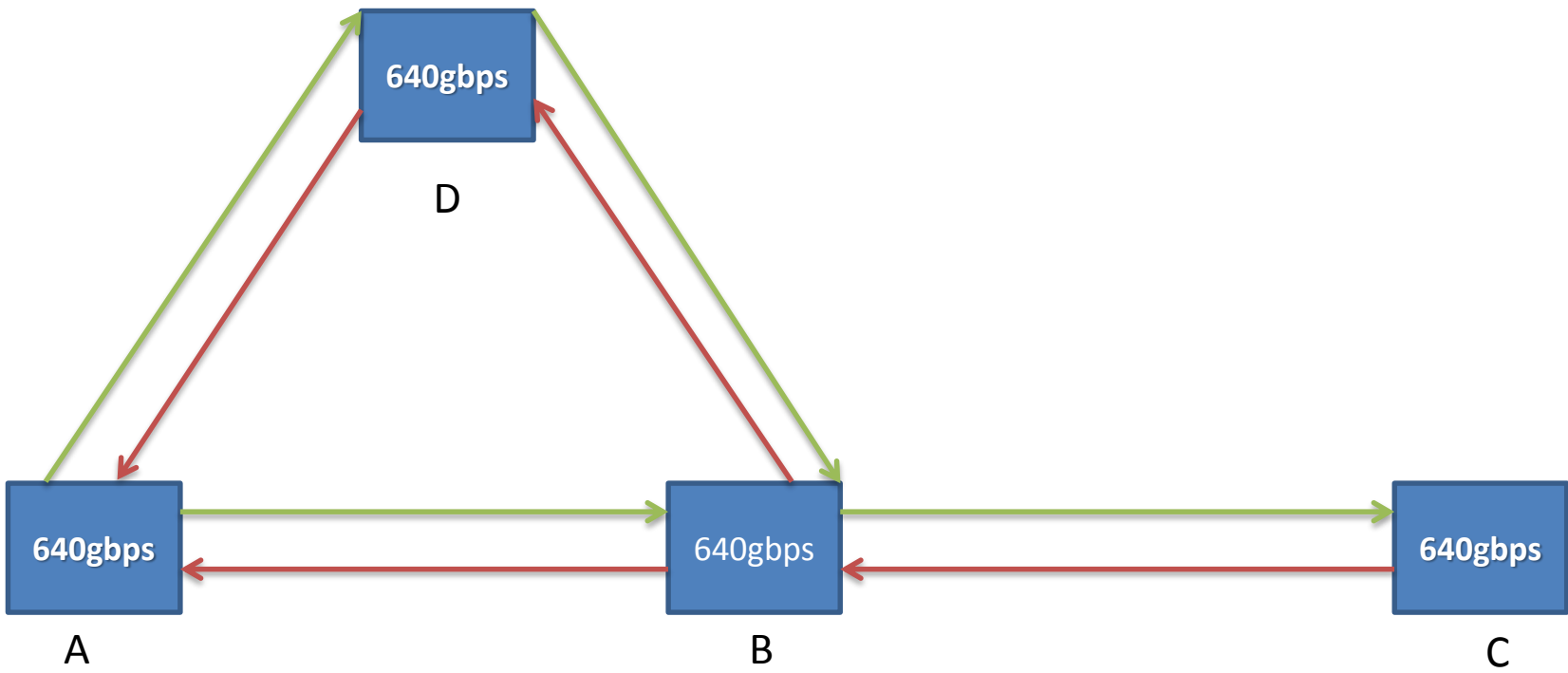
- Compared with SDH and SONET :
 - Ultra capacity with high accuracy, Terabit/second per fiber via DWDM lines
 - Service transparency for client signals
 - Asynchronous mapping, powerful FEC function, predigest network design and reduce the cost

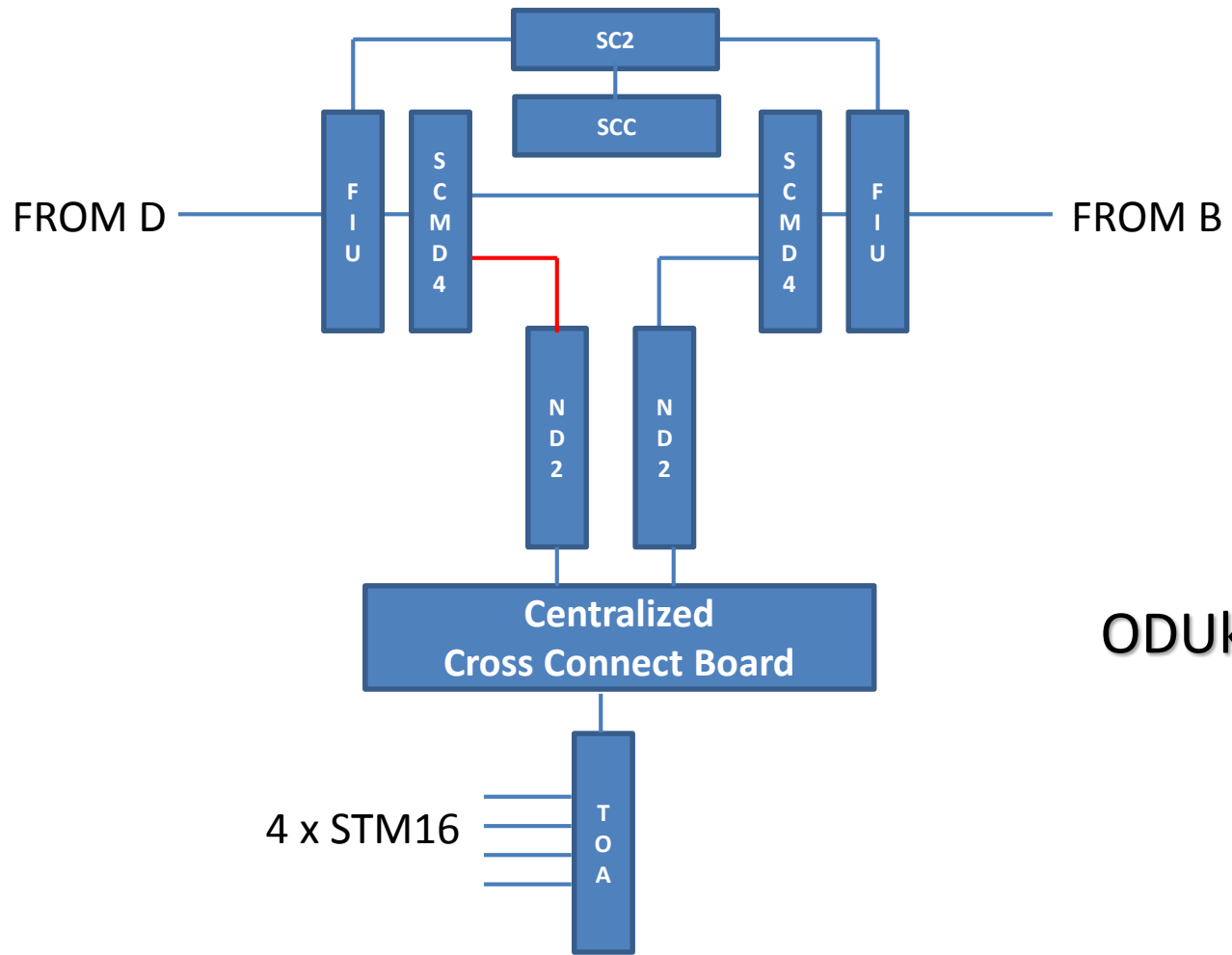
- Compared with traditional WDM
 - Enhanced OAM & networking functionality for all services
 - Dynamically electrical/optical layer grooming





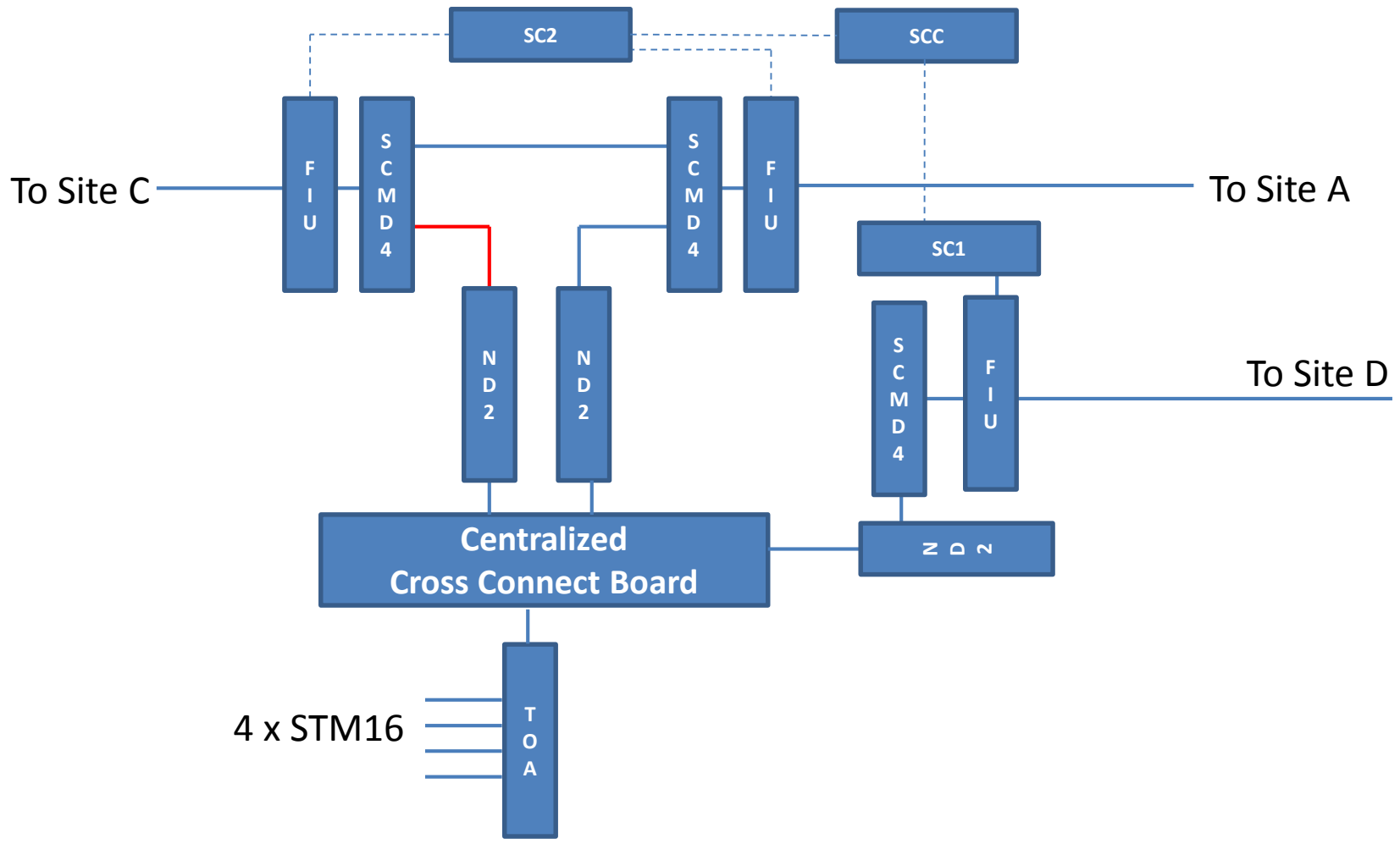
- Centralized cross-connect bus (**active**)
- Centralized cross-connect bus (**standby**)

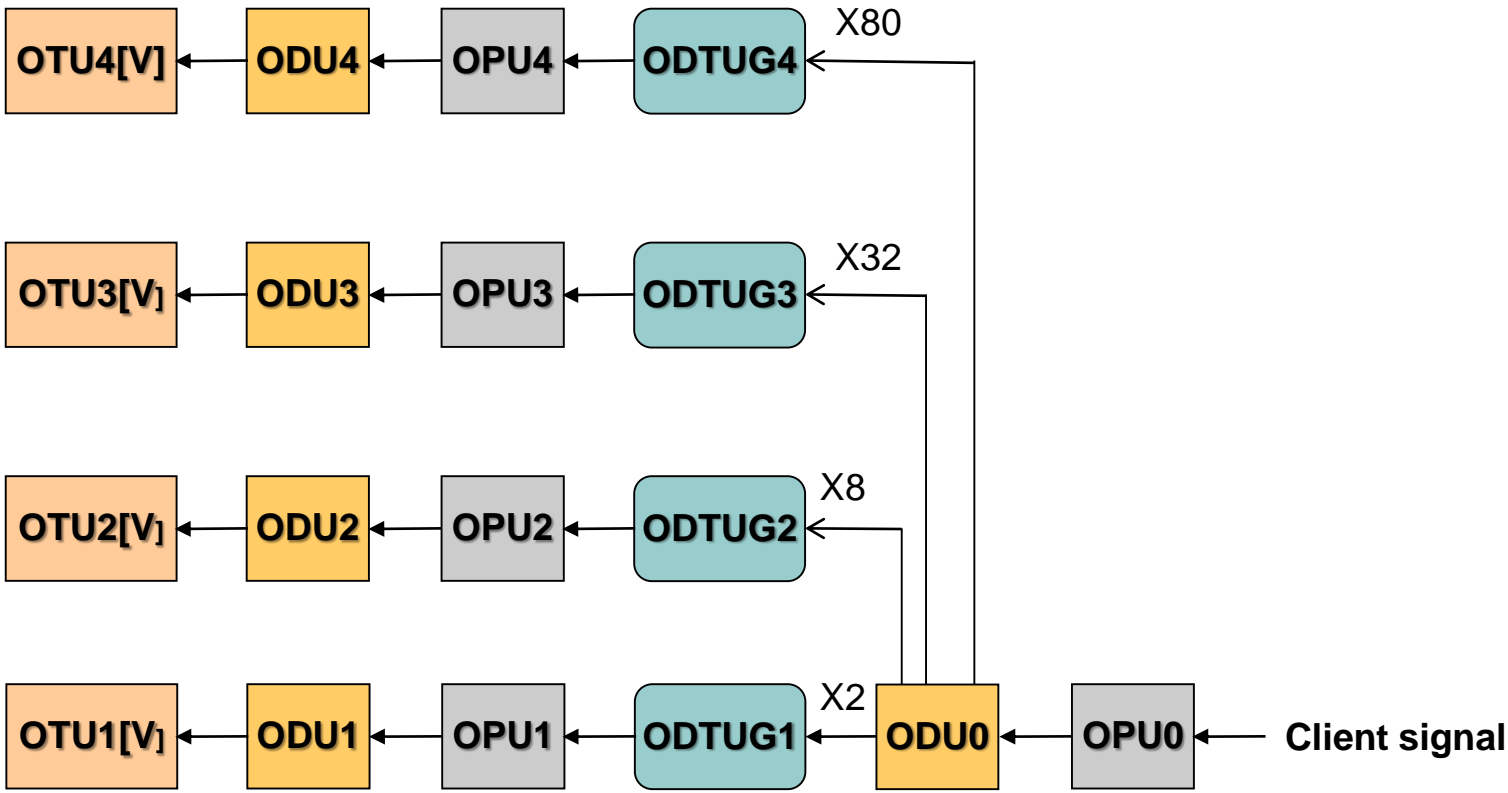




ODUk Protection







○ Multiplexing
□ Mapping



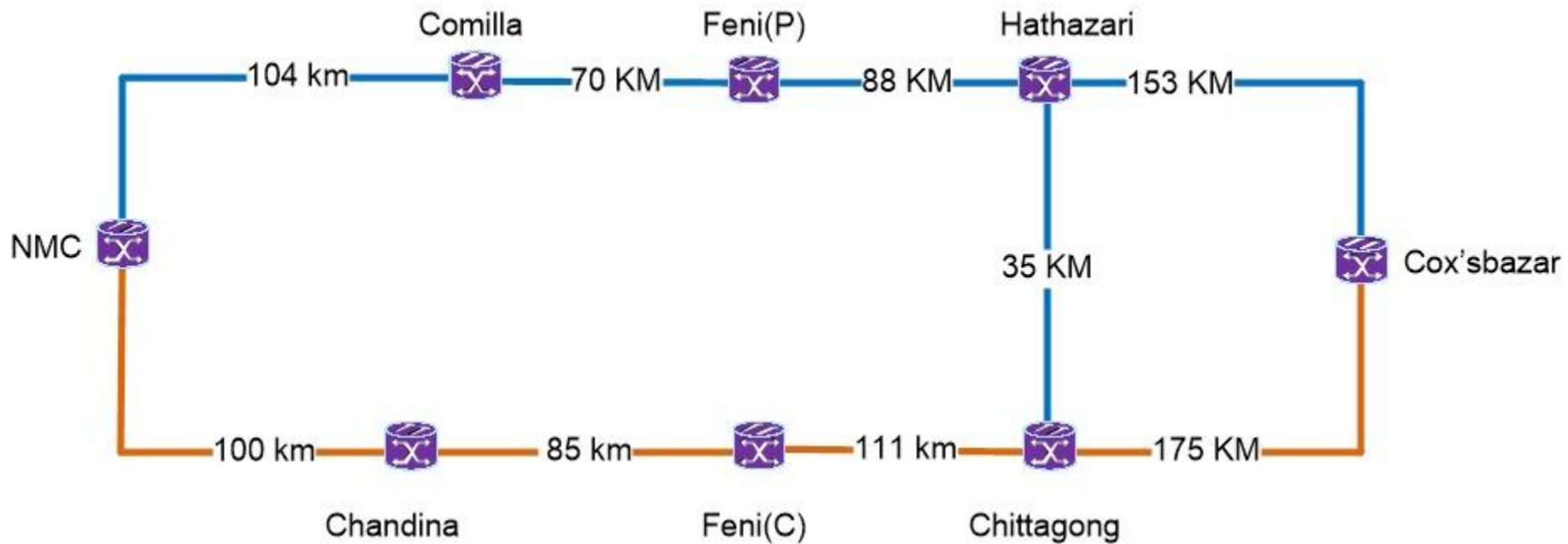
SECTION

6

Case Study : Dhaka to Cox's
Bazar DWDM Link to Connect
Sea-Me-We-4 Submarine
Cable

- Area
 - Hilly-Rough Terrain
 - Flat
- Fiber Characteristics
 - Underground
 - Over Head
 - Power Grid Cable
- Need Backup or Not
- Future Forecasting
- Technology Trend – 10G/40G/100G

Think Today – Not Tomorrow !!!



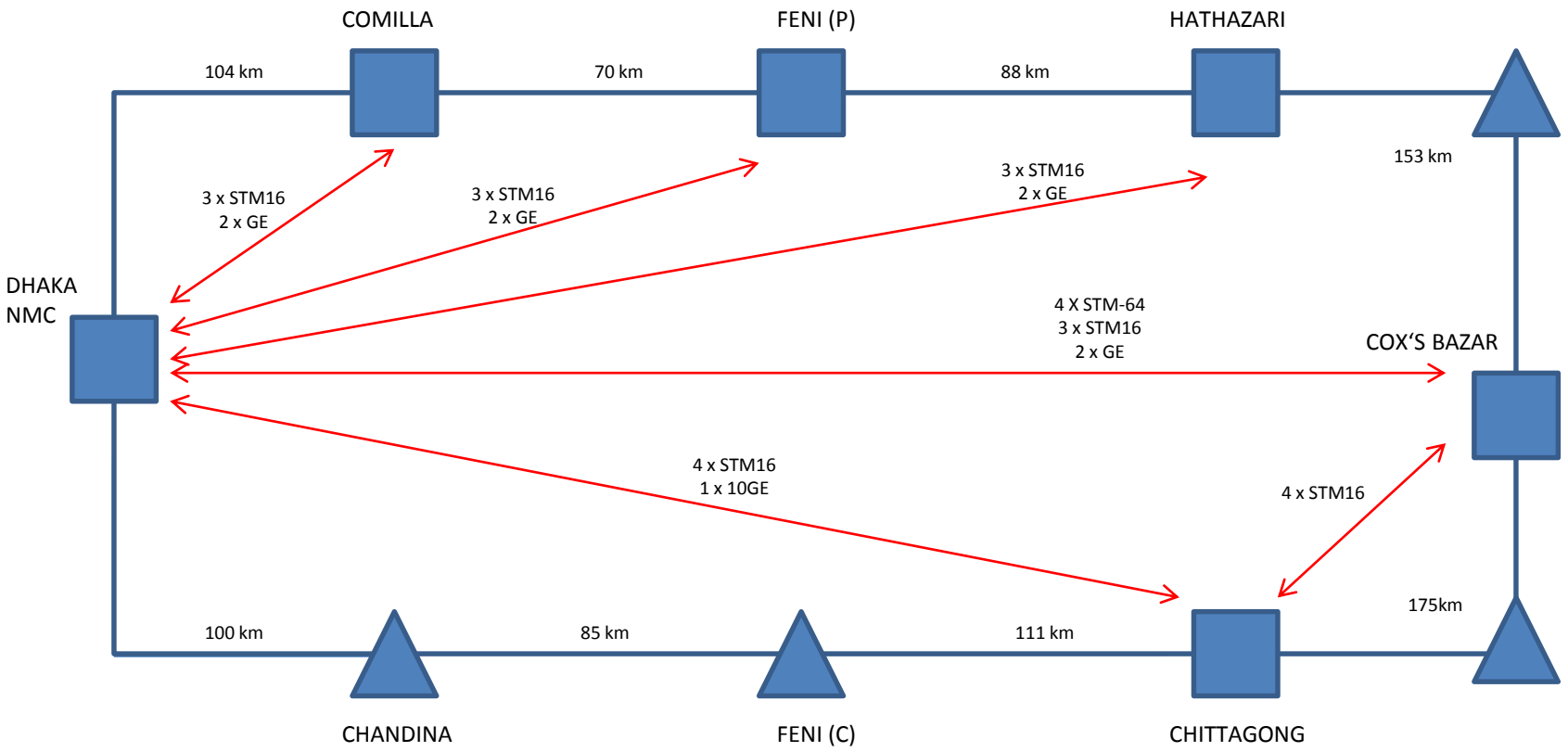
- Area : Flat
- Fiber Characteristics
 - Underground : Yellow Line
 - Power Grid Cable : Blue Line
- Protection : Ring Network

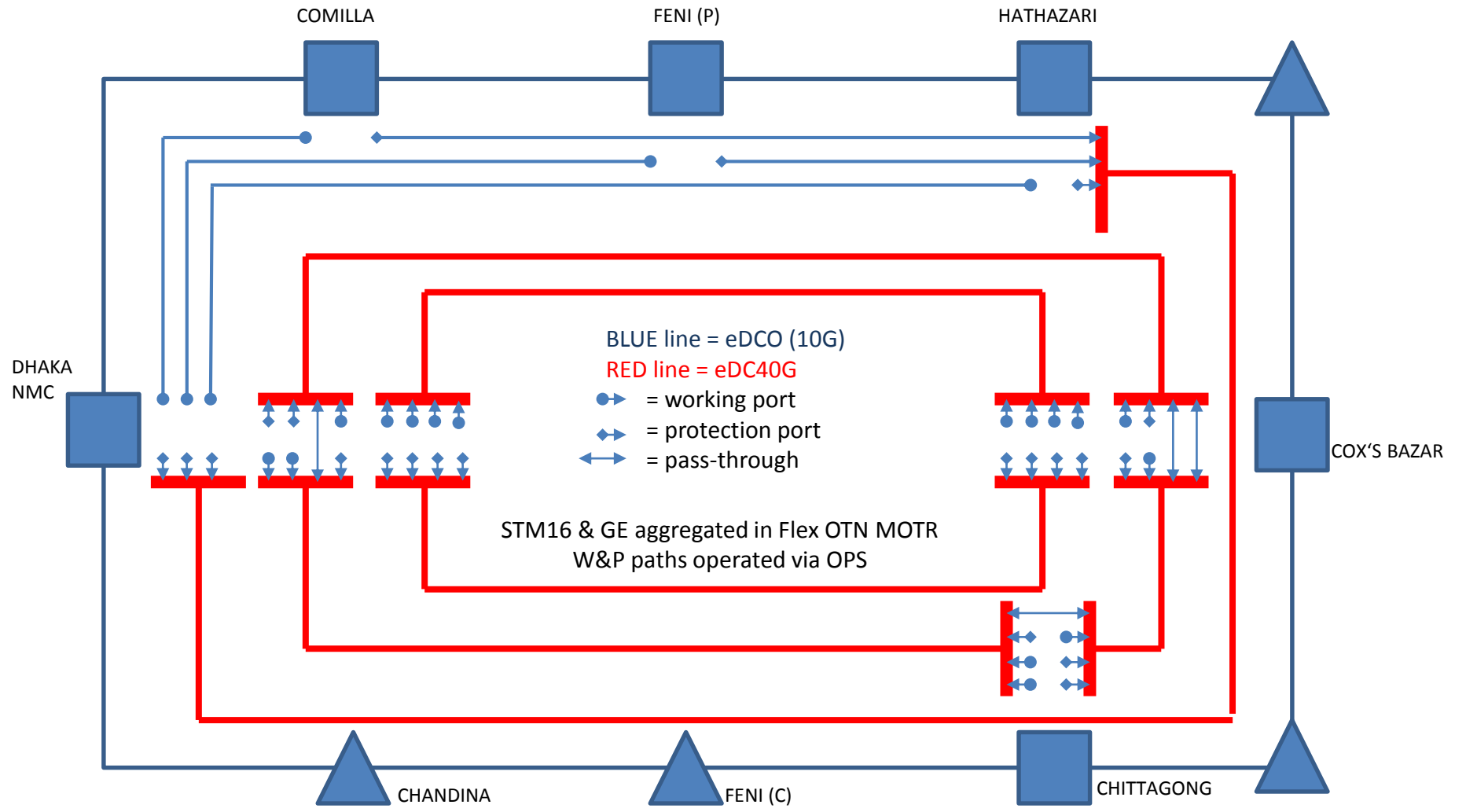
	NMC	Comilla	Feni (P)	Chittagong	Hathazari	Cox's Bazar	
NMC	0	4xSTM-16 2xGE	4xSTM-16 2xGE	4xSTM-16 1x10GE	4xSTM-16 2xGE	4 x STM-64 4xSTM-16 2xGE	
Comilla	4xSTM-16 2xGE	0					
Feni (P)	4xSTM-16 2xGE		0				
Chittagong	4xSTM-16 1x10GE			0		4 x STM-16	
Hathazari	4xSTM-16 2xGE				0		
Cox's Bazar	4 x STM-64 4xSTM-16 2xGE			4 x STM-16		0	
Chandina	OLA Site	Fiber Loss 0.25 per km					
Feni (C)	OLA Site						



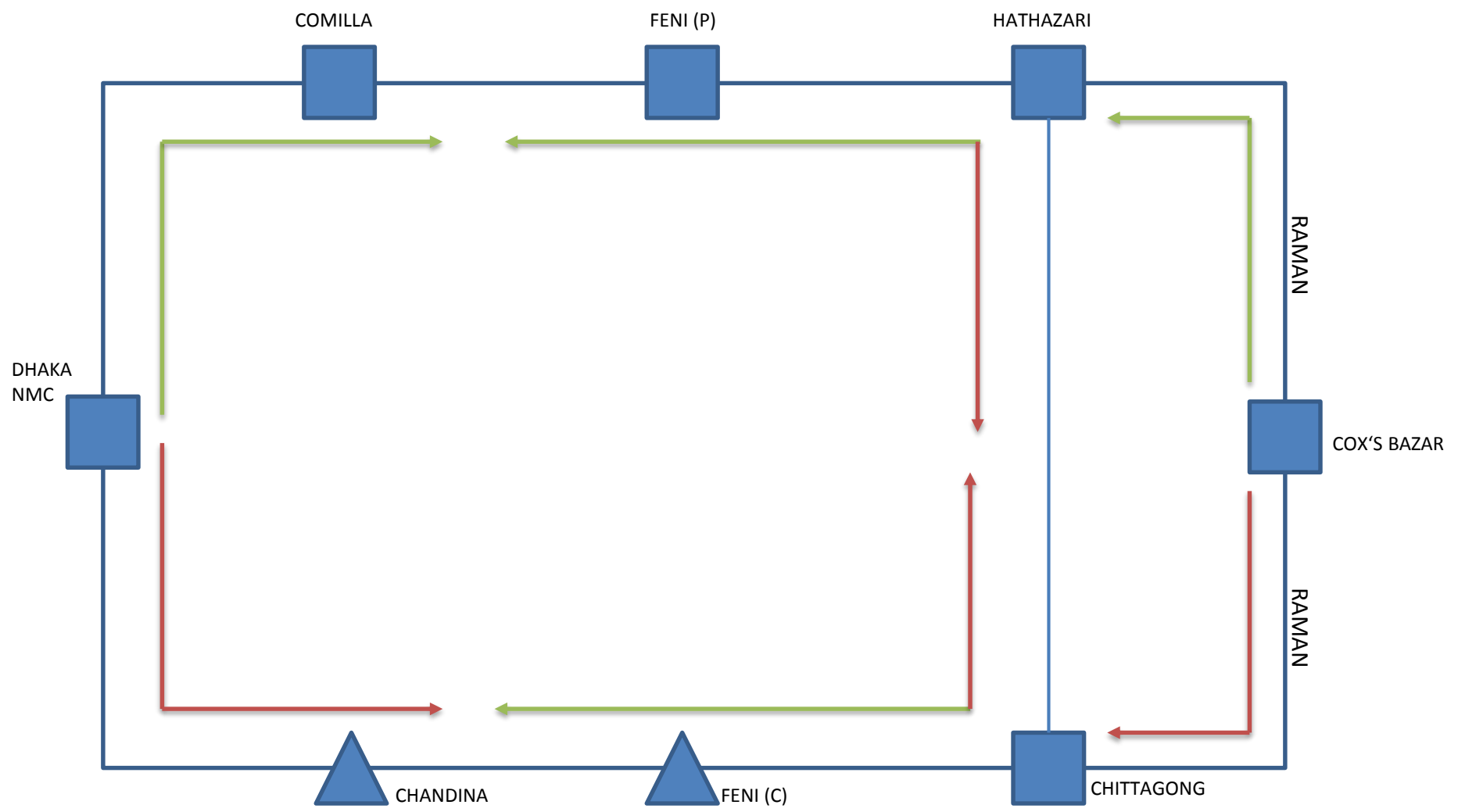
	NMC	Comilla	Feni (P)	Chittagong	Hathazari	Cox's Bazar	
NMC	0	3xSTM-16 2xGE	3xSTM-16 2xGE	4xSTM-16 1x10GE	3xSTM-16 2xGE	4 x STM-64 3xSTM-16 2xGE	
Comilla	3xSTM-16 2xGE	0					
Feni (P)	3xSTM-16 2xGE		0				
Chittagong	4xSTM-16 1x10GE			0		4 x STM-16	
Hathazari	3xSTM-16 2xGE				0		
Cox's Bazar	4 x STM-64 3xSTM-16 2xGE			4 x STM-16		0	
Chandina	OLA Site	Fiber Loss 0.25 per km					
Feni (C)	OLA Site						





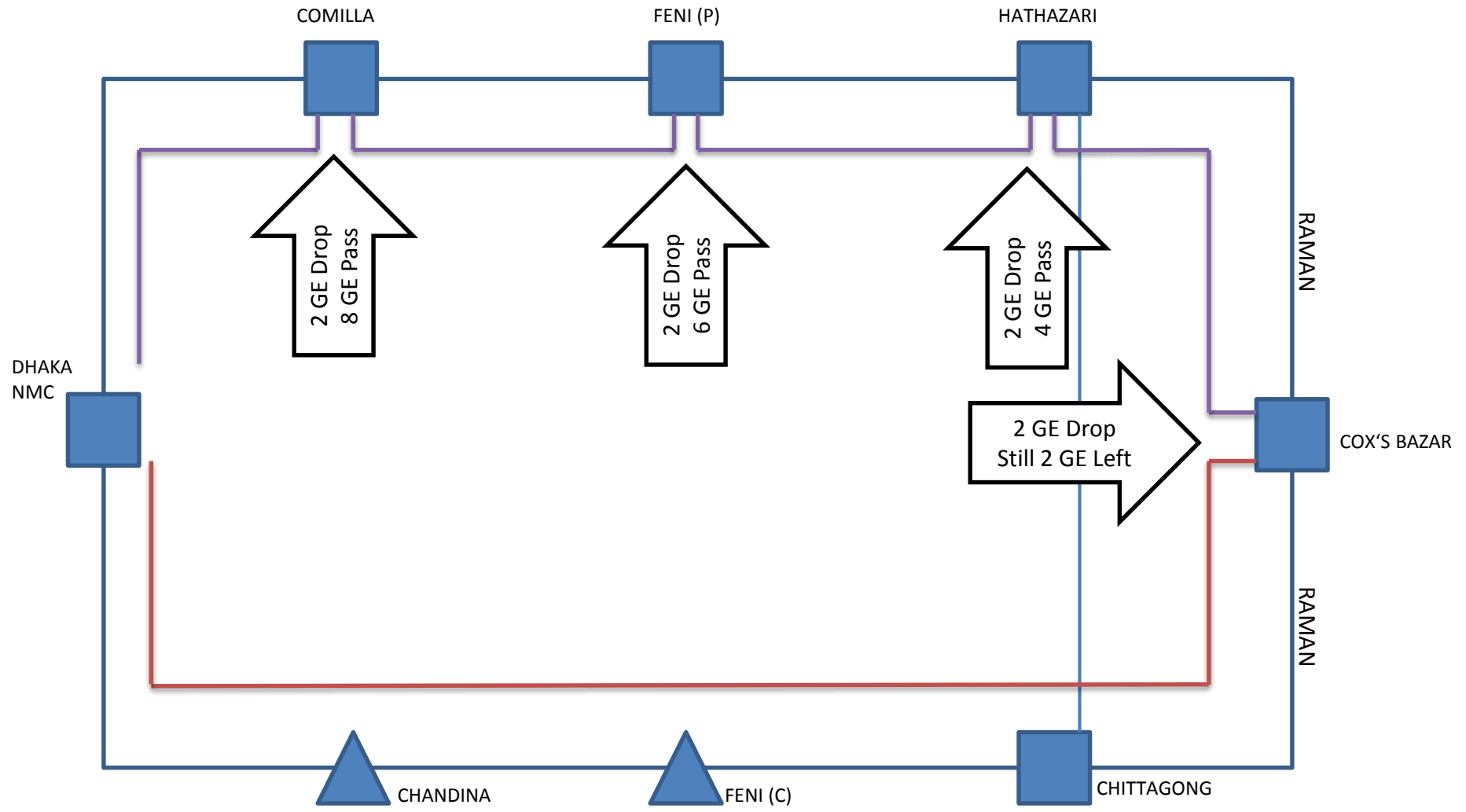


- Traffic Matrix
 - CIENA dropped one 10G channel to every point
 - One STM-16 is reduced to make the use for one 10G.
 - $3 \times 2.5 \text{ (STM-16)} + 2 \text{ GE} = 10 \text{ G}$
- To Reduce the cost Hathazari to Chittagong link was dropped.
- OTN Services were used in single card
- No Centralized cross connect board were used here

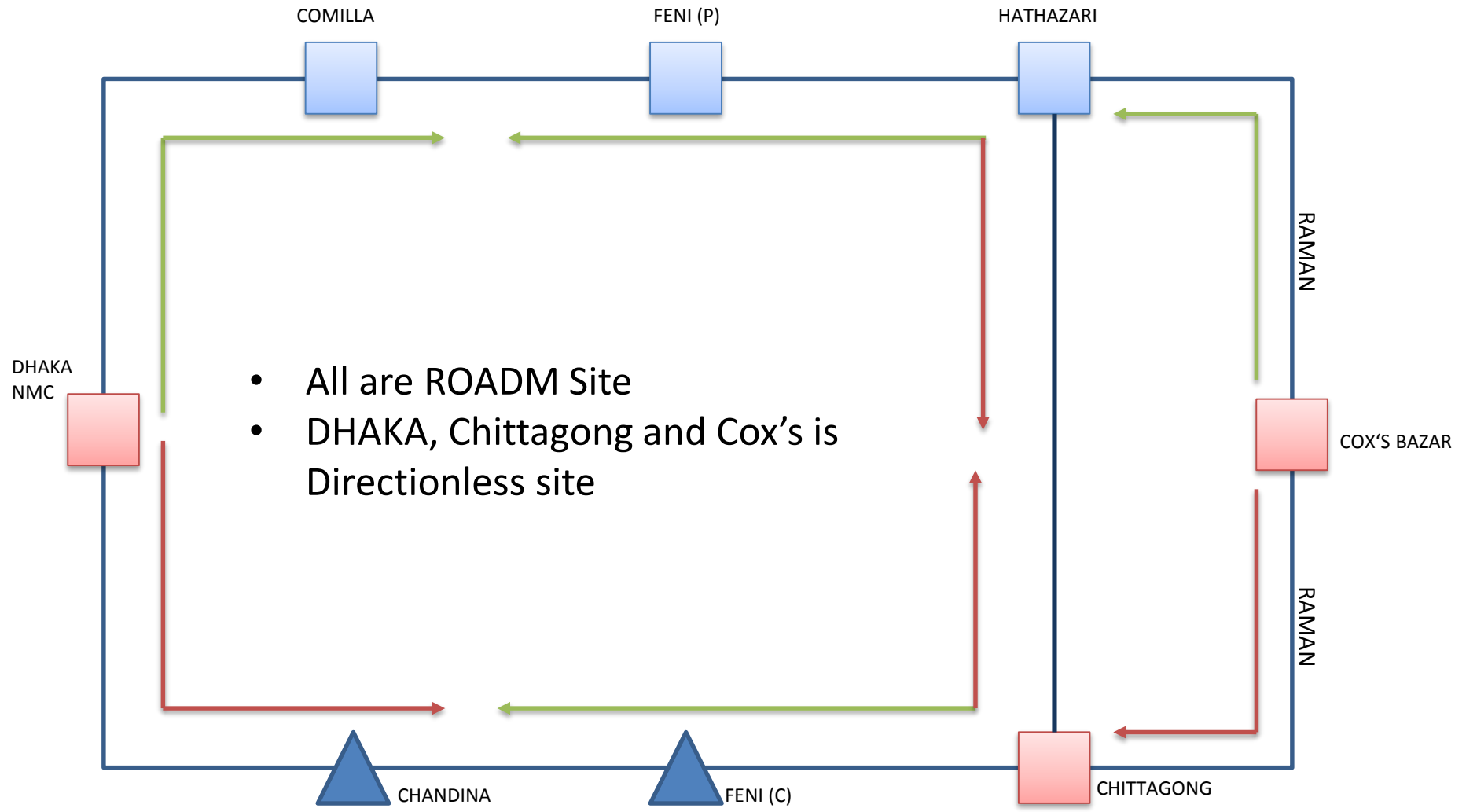


	NMC	Comilla	Feni (P)	Chittagong	Hathazari	Cox's Bazar
NMC	0	4xSTM-16 2xGE	4xSTM-16 2xGE	4xSTM-16 1x10GE	4xSTM-16 2xGE	4 x STM-64 4xSTM-16 2xGE
Comilla	4xSTM-16 2xGE	0				
Feni (P)	4xSTM-16 2xGE		0			
Chittagong	4xSTM-16 1x10GE			0		4 x STM-16
Hathazari	4xSTM-16 2xGE				0	
Cox's Bazar	4 x STM-64 4xSTM-16 2xGE			4 x STM-16		0





- Traffic Matrix
 - Full traffic was dropped according to requirement
- A big bypass link was crated between Hathazari and Chittagong.
- OTN Services were used in Centralized cross connect borad with 360 gbps license.
- HUAWEI used RAMAN Amplifier, which is expensive and crucial to handle the power of that card.



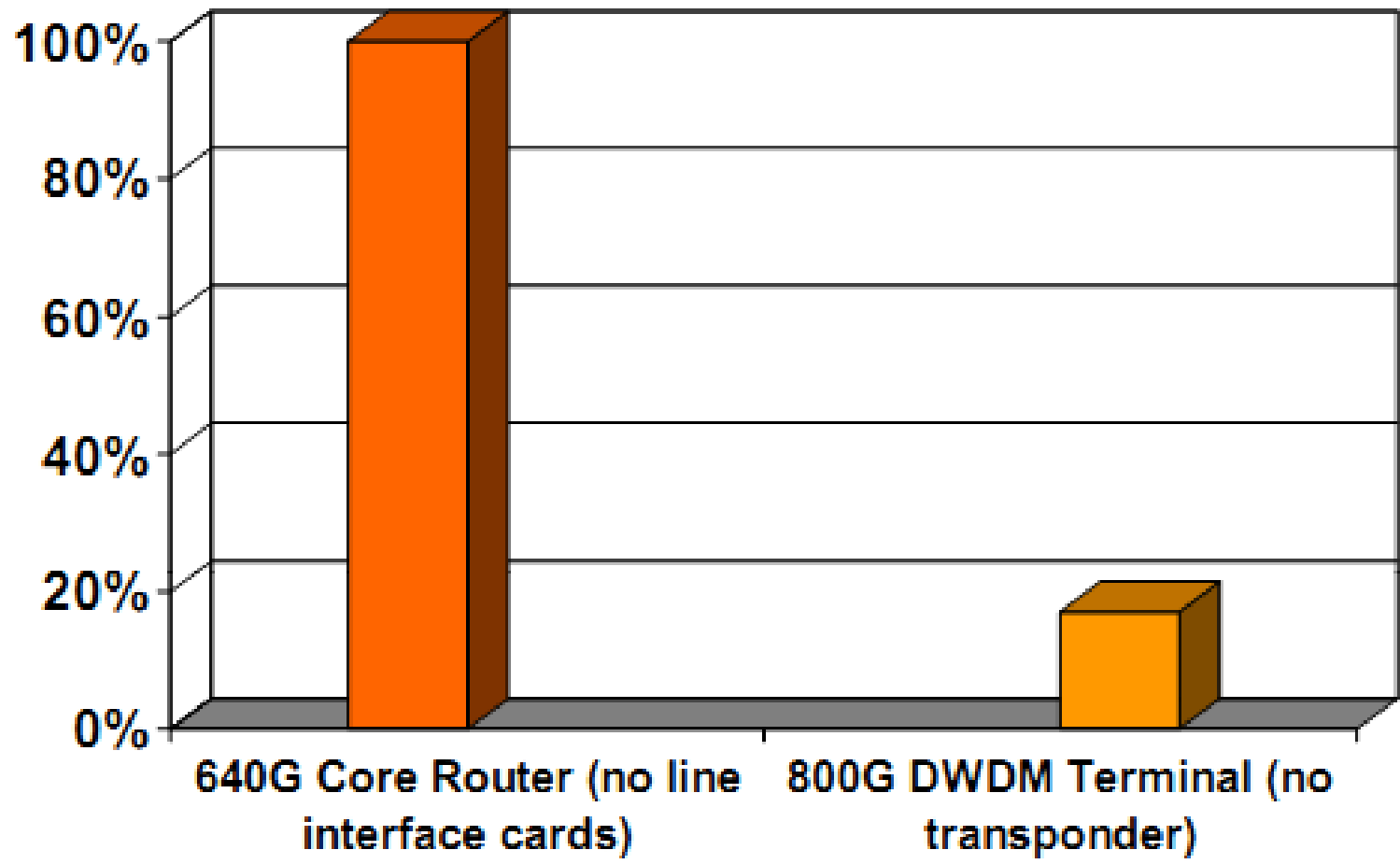
- Traffic Matrix
 - Full traffic was dropped according to requirement
 - 2x10G channel dropped every site
- Under-utilized Lambda
- A big bypass link was crated between Hathazari and Chittagong.
- ROADM Card is used everywhere and 3 are directionless site.
- As, this road faces to much fiber cut, ROADM and Fixed DCM is not suitable.

SECTION



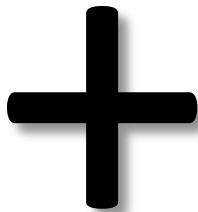
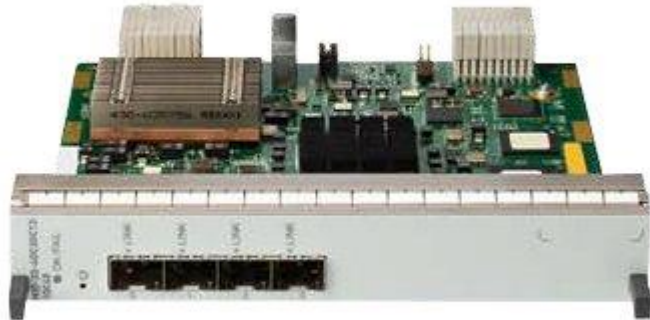
Conclusion

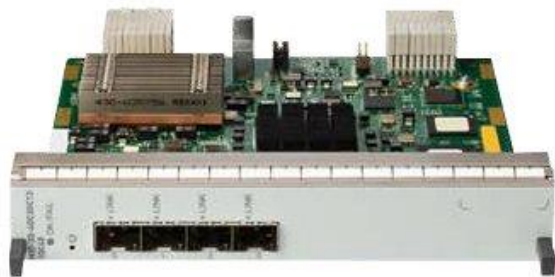
- Length – more than 120 km.
- Convergence : LFA/FRR/TE/RSVP
- Legacy Router Doesn't Support Above Protocols
- Service Independent Convergence
- LFA/FRR/TE is a CPU hungry Process, so quality degrades
- Fiber Characteristics Through NMS without further investment



POS : MIC-3D-4OC3OC12-1OC48 (By Juniper)

Description : Low density multirate MIC, 4 port non-channelized OC3-OC12 / 1 port non-channelized OC48 MIC, (Requires a pluggable SFP optics module)





Ports at the Base :
2 x STM-64
4 x STM-16
4 x GE

- Plan your network according to your & Future need, not by limitation.
- Effective use of expensive IP Transit Bandwidth.
- Traffic Engineering at Layer-1.
- DWDM Backbone is Service Independent – So Future Prof.
- Reduce Capex
- Simple Configuration - Reduce Opex

Thank You.



South Asian Network Operators Group

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