

Network Resiliency with WSON

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Global IP Traffic

- Compound Annual Growth Rate is 26%, as per Cisco Visual Networking Index
- Annual global IP traffic will reach 4.8 ZB per year by 2022, or 396 exabytes (EB) per month.
- In 2017, the annual run rate for global IP traffic was 1.5 ZB per year, or 122 EB per month.

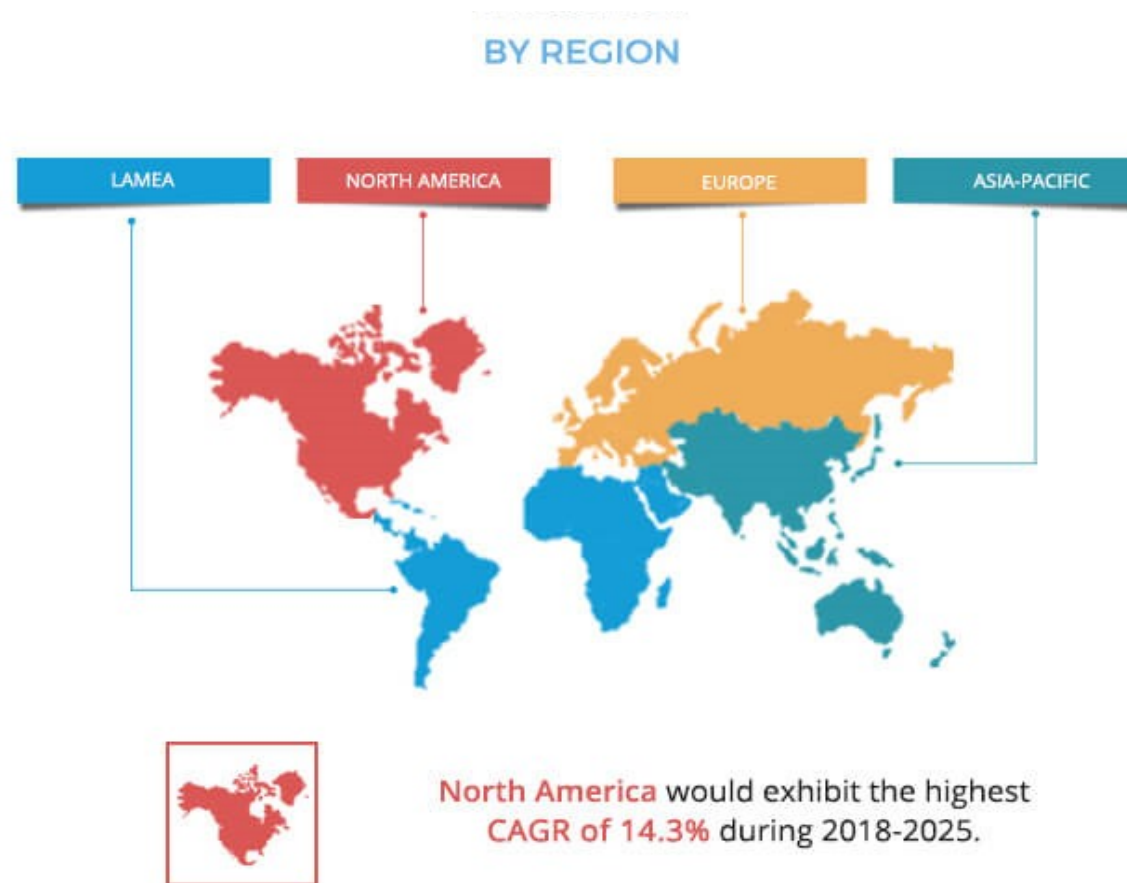


Source: Cisco VNI Global IP Traffic Forecast, 2017-2022

- <https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html>

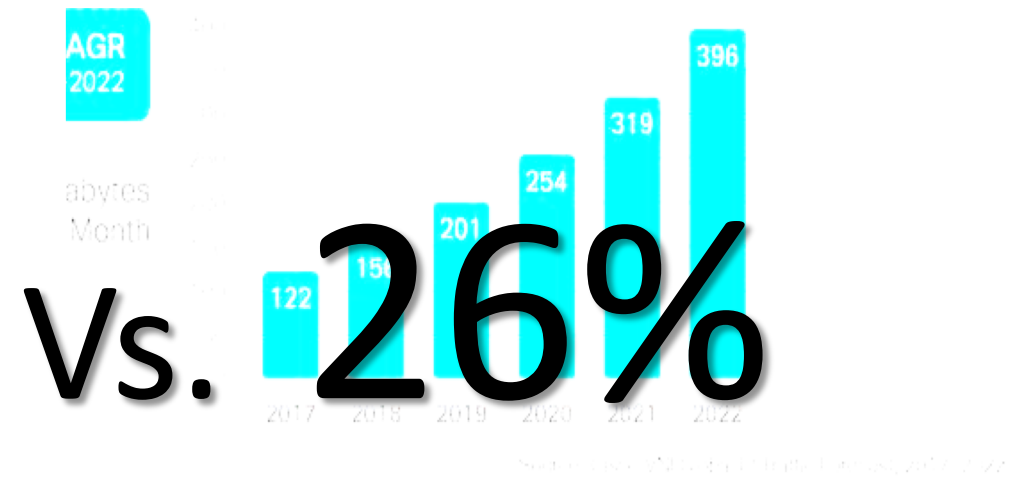
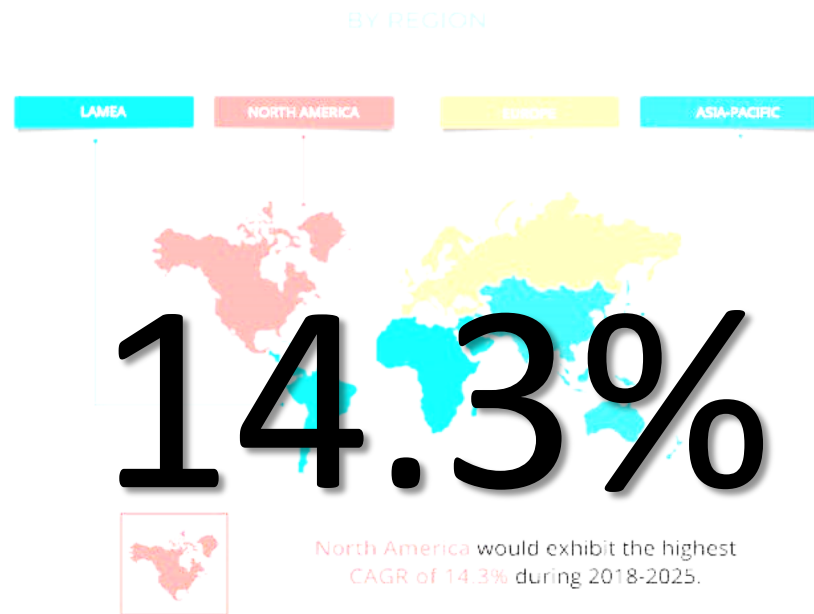
Global Optical Fiber Market

- Compound Annual Growth Rate is 14.3%, the highest in North America, as per 3rd party market research.



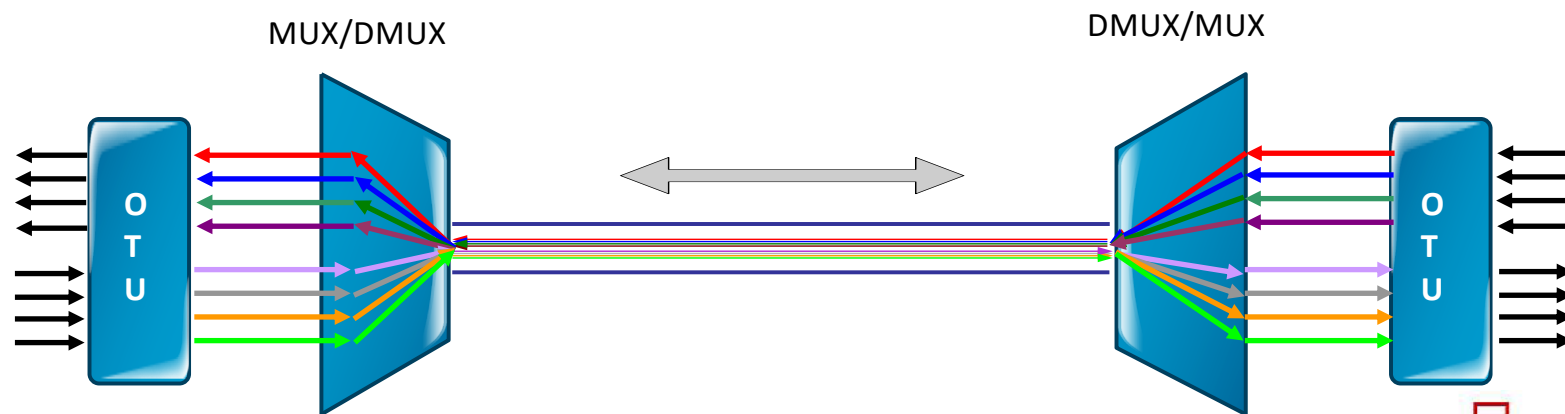
- <https://www.alliedmarketresearch.com/optical-fiber-market>

Growth Comparison



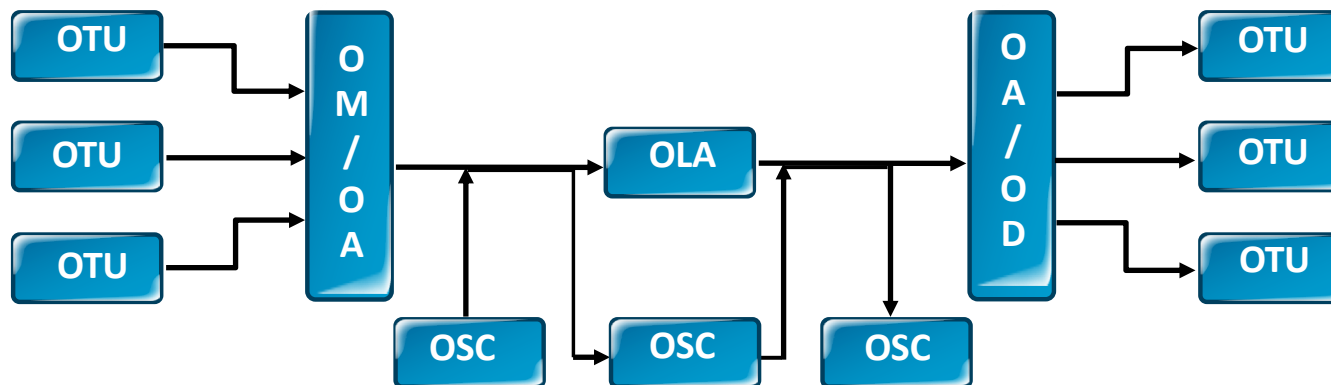
DWDM

- Dense Wavelength Division Multiplexing
- An Optical Transport Technology to facilitate large bandwidth transmission
- Optical level dynamic protection & restoration
- One physical link can carry 96 channels
- Channel can be configured as 100/200/400 Gbps per Channel

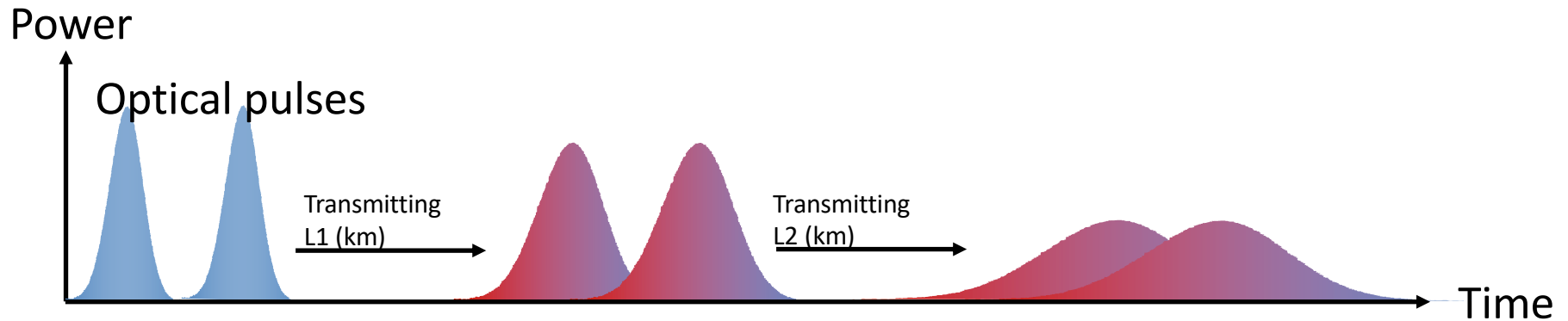


Basic Structure

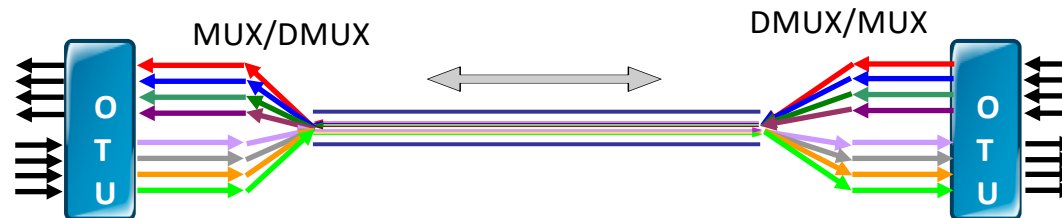
- The overall structure of the WDM system of N-path wavelength:
 - Optical Transponder Unit (OTU)
 - Optical Multiplexer Unit / Optical De-multiplexer Unit (OMU/ODU)
 - Optical Amplifier (OA)
 - Supervisory Channel (OSC/ESC)



Dispersion

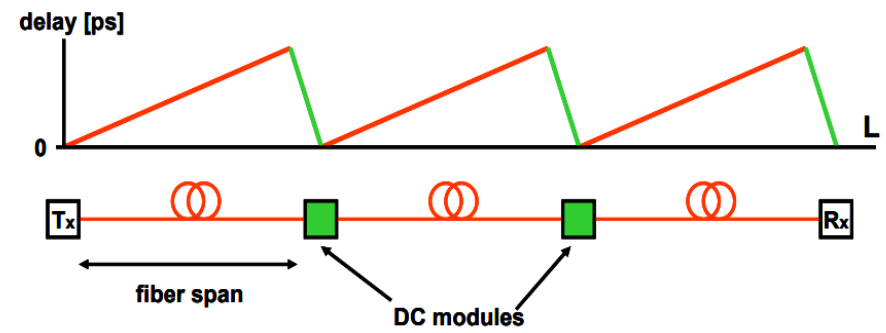
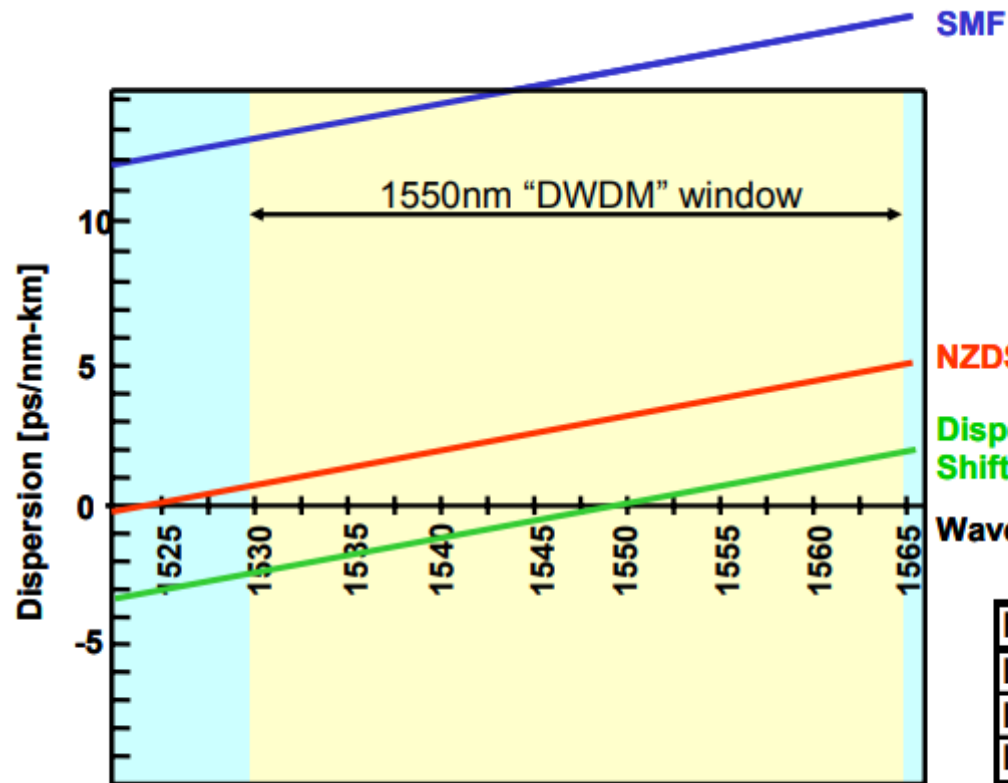


Dispersion in fiber refers to a physical phenomenon of signal distortion caused when various modes carrying signal energy or different frequencies of the signal have different group velocity and disperse from each other during propagation.



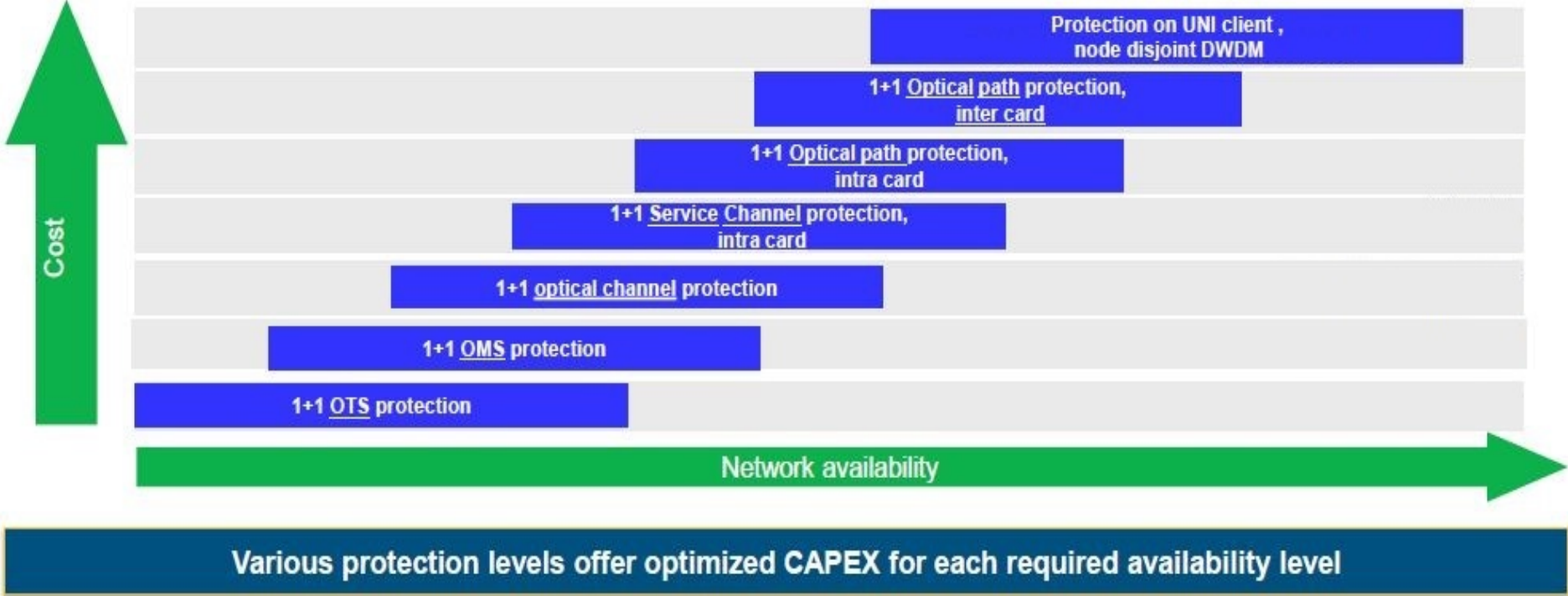
CD(Chromatic Dispersion): Since different frequency (wavelength) components of the light source have different group velocities and light beams with different frequencies have different time delays in transmission, dispersion arising from which is called chromatic dispersion.

Dispersion Compensation



Fiber Type	Chromatic Dispersion ps / (nm * km)	
	1310 nm	1550 nm
ITU G.652 conventional	0	17
ITU G.653 DSF	-15	0
ITU G.655 NZDSF	-12	3

Protection : (1+1)



Protection : (1+1)

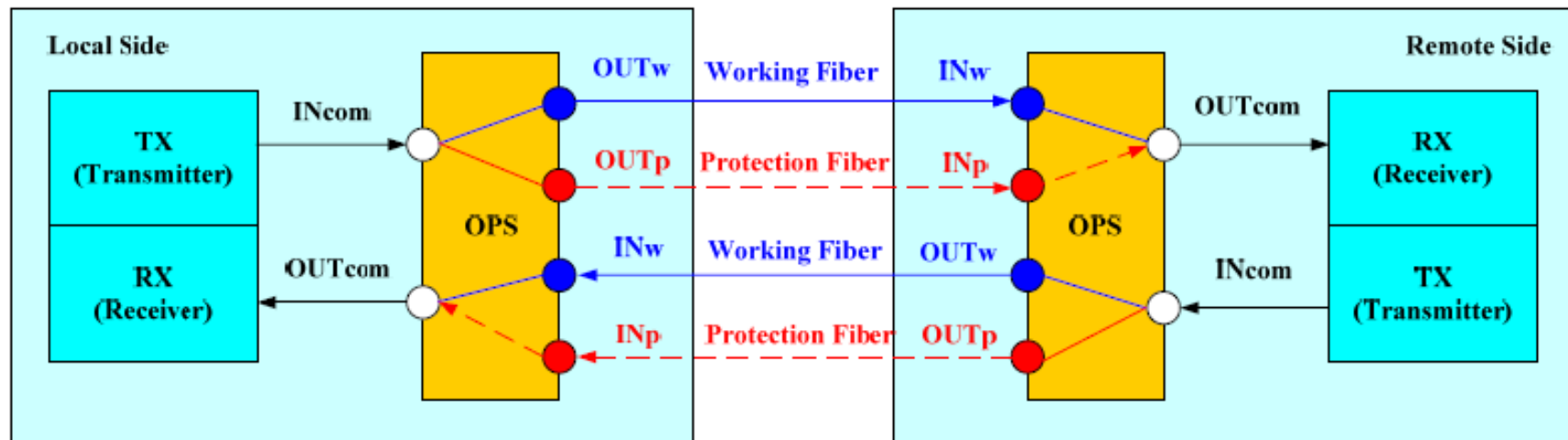
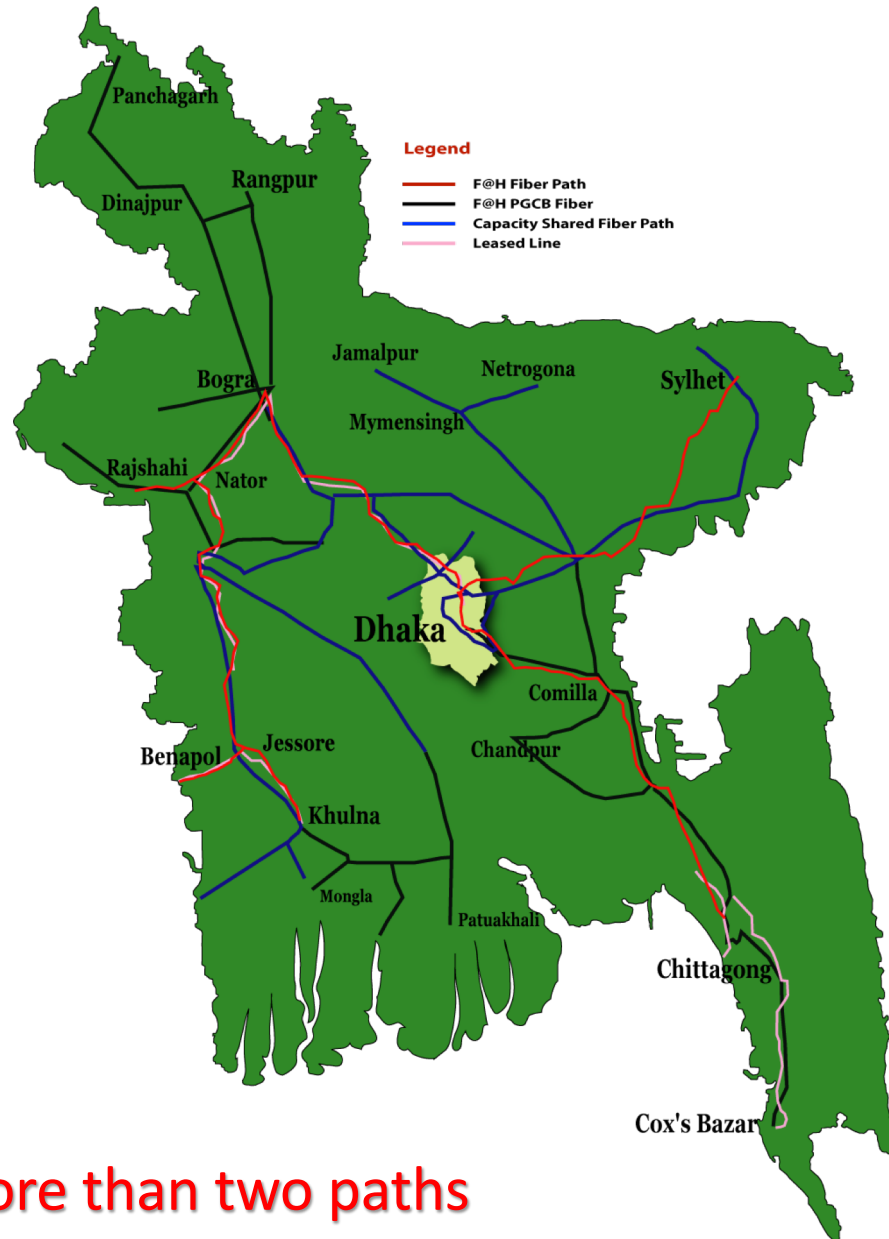


Fig : Using two fiber pair with different paths.

Protection & Restoration : (1+1+R)



Restoration with more than two paths

ASON/WSON by GMPLS :

ASON (Automatically Switched Optical Network)

- Architecture for transport networks enabling distributed connection control
- Requirement and architecture documents have been approved by ITU-T

WSON (Wavelength Switched Optical Network)

- ASON networks based on WDM switching technology (photonic layer)
- Framework and specific ASON extension under definition by IETF

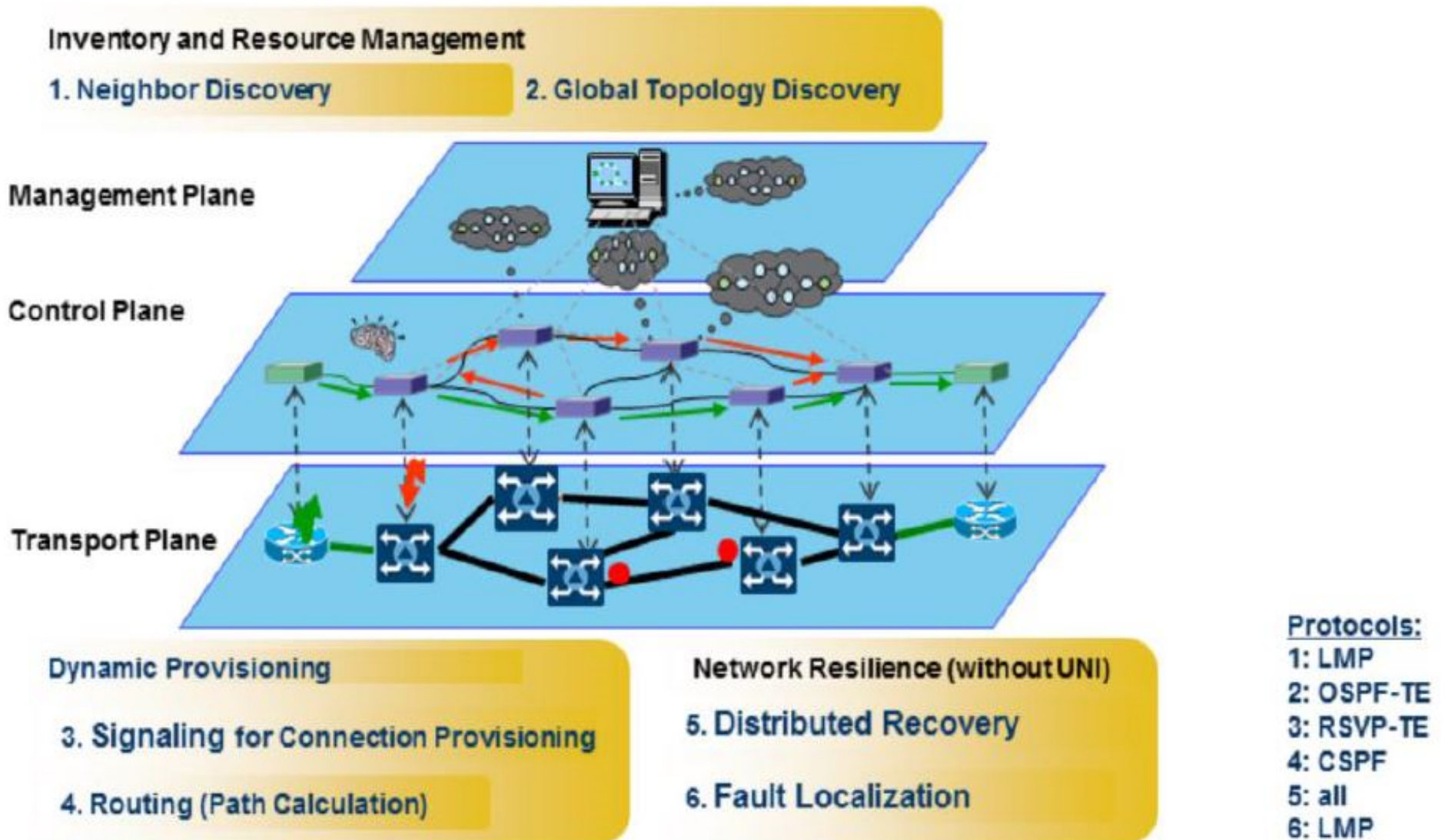
GMPLS (Generalized Multi-Protocol Label Switching)

- Defines a suite of protocols to implement ASON/WSON functionality
- GMPLS protocol standards are defined at the IETF

Advantages of ASON/WSON :

- Automated topology/resource discovery
- Automated end-to-end service provisioning
- Multi-layer/domain networking
- Multiple failure network recovery
- Bandwidth efficiency by sharing of restoration capacity
- Bandwidth on demand
- Class of services at transport layer
- Traffic engineering

GMPLS Control Plane Functions



GMPLS Control Plane Protocols

LMP: Link management protocol

Manage and maintain the health of control and data planes between two neighboring nodes

OSPF-TE: Open shortest path first-Traffic Engineering

Routing protocols for the auto-discovery of network topology, advertise resource availability (e.g bandwidth or protection type)

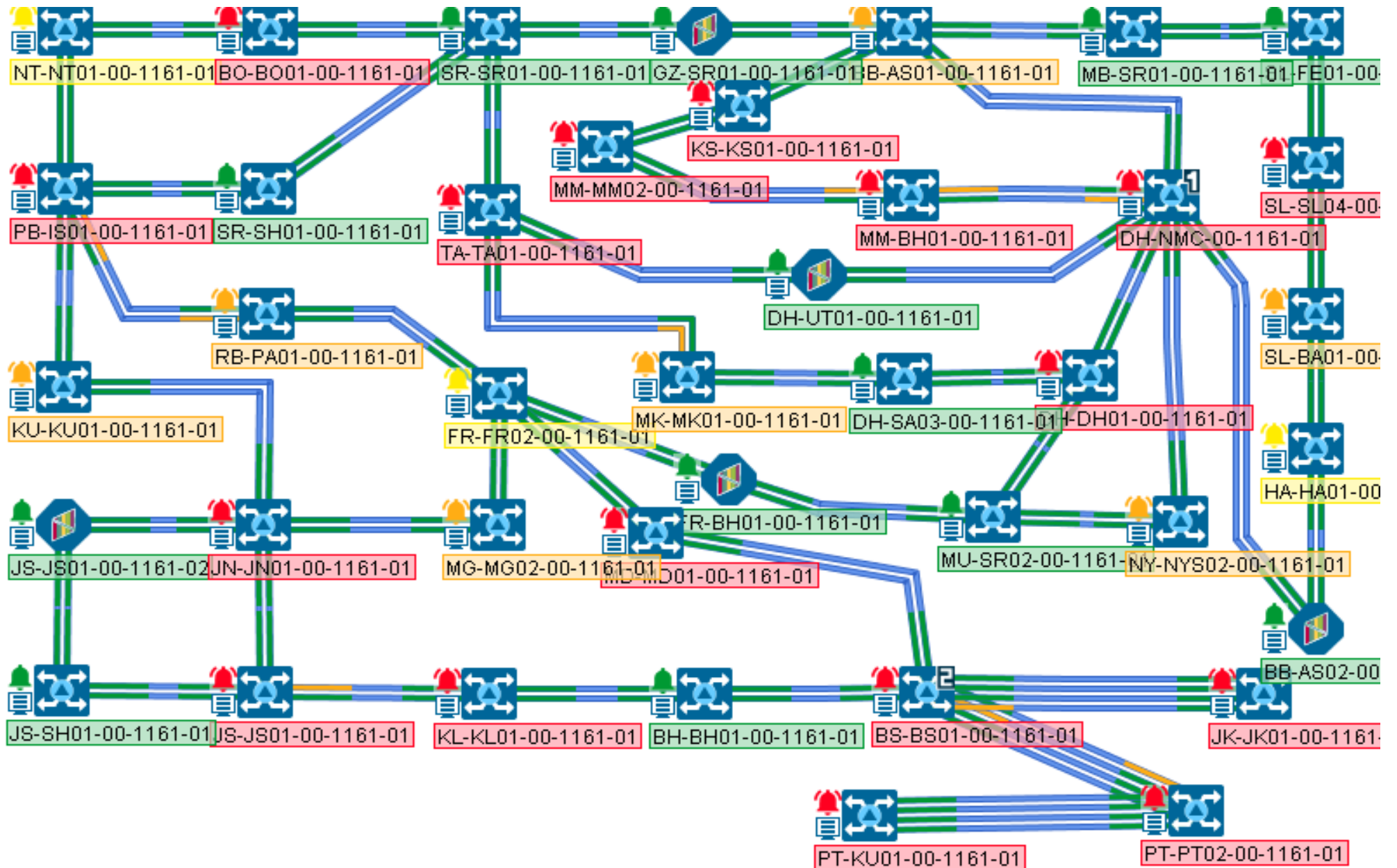
CSPF: Constraint Shortest Path First

Based on OSPF route information, calculated the path for tunnel

RSVP-TE: Resource reservation protocol for traffic engineering

Based on CSPF's result, send message to create the tunnel hop-by-hop.

NMS-View



Nuts & Bolts

- Installed & Commissioned Nodes – 41
- Prime Feature – WSON
- Capacity Provisioned – 250 x 10G (1+1+R)
- Project Deployment Time – 3 Months

Project Hurdles

- Alien Lambda Provision
- Around 500G of Live Traffic Migration from Previous Network
- New PoP Readiness (Infrastructure, Power, Fiber)
- Fiber Readiness
- Leasing Fiber from 3rd Parties
- Proper Passive Protection Path Plan
- Last Mile Security
- Overhead Manageability
- National Transport Infrastructure Development Work

Major Challenge

- Switching Hits were generating Circuit Flaps

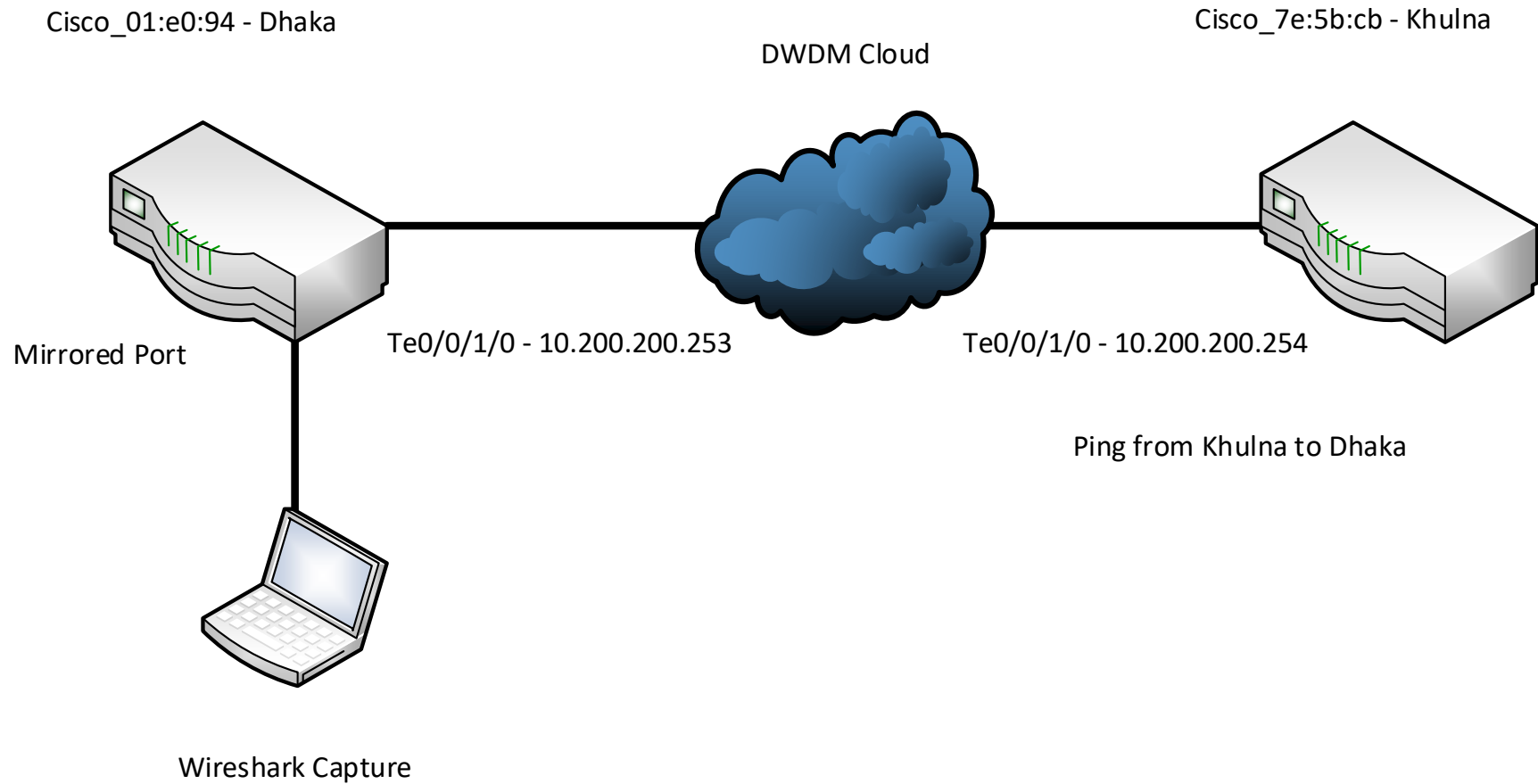
```
RP/0/RSP0/CPU0:NMC-ASR9K-NATIONWIDE-PE01#sho logging start march 22 15:30:00 end Mar 22 16:52:00 LC/0/4/CPU0:2019 Mar 22 15:32:54.143 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.7.90 on interface FortyGigE0/4/0/0.1962 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:32:54.144 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.7.86 on interface FortyGigE0/4/0/0.1961 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:32:54.144 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.7.94 on interface FortyGigE0/4/0/0.1963 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:32:54.144 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.6.181 on interface FortyGigE0/4/0/0.1960 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:33:08.869 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.6.181 on interface FortyGigE0/4/0/0.1960 is up LC/0/4/CPU0:2019 Mar 22 15:33:10.154 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.7.86 on interface FortyGigE0/4/0/0.1961 is up LC/0/4/CPU0:2019 Mar 22 15:33:10.155 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.7.94 on interface FortyGigE0/4/0/0.1963 is up LC/0/4/CPU0:2019 Mar 22 15:33:10.155 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.7.90 on interface FortyGigE0/4/0/0.1962 is up LC/0/4/CPU0:2019 Mar 22 15:52:14.124 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.6.181 on interface FortyGigE0/4/0/0.1960 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:52:14.125 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.7.86 on interface FortyGigE0/4/0/0.1961 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:52:14.125 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.7.94 on interface FortyGigE0/4/0/0.1963 has gone down. Reason: Control timer expired LC/0/4/CPU0:2019 Mar 22 15:52:14.125 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_DOWN : BFD session to neighbor 10.0.7.90 on interface FortyGigE0/4/0/0.1962 is up LC/0/4/CPU0:2019 Mar 22 15:52:28.269 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.7.86 on interface FortyGigE0/4/0/0.1961 is up LC/0/4/CPU0:2019 Mar 22 15:52:28.270 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.7.90 on interface FortyGigE0/4/0/0.1962 is up LC/0/4/CPU0:2019 Mar 22 15:52:28.270 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.7.94 on interface FortyGigE0/4/0/0.1963 is up LC/0/4/CPU0:2019 Mar 22 15:52:28.270 Dhaka: bfd_agent[126]: %L2-BFD-6-SESSION_STATE_UP : BFD session to neighbor 10.0.6.181 on interface FortyGigE0/4/0/0.1960 is up
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<NMC-NW-H6320_L3SW01_251_0_254>display log 2019-3-22 15:32:16.998.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[87]:Interface XGigabitEthernet0/0/15 has turned into DOWN state. 2019-3-22 15:32:16.998.3+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01LACP/3/LAG_DOWN_REASON_EVENT(1)[86]:The member of the LACP mode Eth-Trunk interface went down. (TrunkName=Eth-Trunk107, PortName=XGigabitEthernet0/0/15, Reason=PortDown) 2019-3-22 15:32:16.998.9+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[85]:Interface XGigabitEthernet0/0/20 has turned into DOWN state. 2019-3-22 15:32:16.998.10+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01LACP/3/LAG_DOWN_REASON_EVENT(1)[84]:The member of the LACP mode Eth-Trunk interface went down. (TrunkName=Eth-Trunk107, PortName=XGigabitEthernet0/0/20, Reason=PortDown) 2019-3-22 15:32:17.38.1+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFNET/4/IF_STATE(1)[83]:Interface Eth-Trunk107 has turned into DOWN state. 2019-3-22 15:32:17.978.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[82]:Interface XGigabitEthernet0/0/15 has turned into UP state. 2019-3-22 15:32:18.88.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[81]:Interface XGigabitEthernet0/0/20 has turned into UP state. 2019-3-22 15:32:20.108.1+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFNET/4/IF_STATE(1)[80]:Interface Eth-Trunk107 has turned into UP state. 2019-3-22 15:51:36.908.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[79]:Interface XGigabitEthernet0/0/20 has turned into DOWN state. 2019-3-22 15:51:36.908.3+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01LACP/3/LAG_DOWN_REASON_EVENT(1)[78]:The member of the LACP mode Eth-Trunk interface went down. (TrunkName=Eth-Trunk107, PortName=XGigabitEthernet0/0/20, Reason=PortDown) 2019-3-22 15:51:37.88.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[77]:Interface XGigabitEthernet0/0/15 has turned into DOWN state. 2019-3-22 15:51:37.88.3+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01LACP/3/LAG_DOWN_REASON_EVENT(1)[76]:The member of the LACP mode Eth-Trunk interface went down. (TrunkName=Eth-Trunk107, PortName=XGigabitEthernet0/0/15, Reason=PortDown) 2019-3-22 15:51:37.98.1+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFNET/4/IF_STATE(1)[75]:Interface Eth-Trunk107 has turned into DOWN state. 2019-3-22 15:51:37.718.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[74]:Interface XGigabitEthernet0/0/15 has turned into UP state. 2019-3-22 15:51:37.758.1+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFNET/4/IF_STATE(1)[73]:Interface Eth-Trunk107 has turned into UP state. 2019-3-22 15:51:37.828.2+06:00 NMC-NW-H6320_L3SW01_251_0_254 %%01IFPDT/4/IF_STATE(1)[72]:Interface XGigabitEthernet0/0/20 has turned into UP state.
```


Our Findings

- Wireshark Report
- Ethernet Analyzer Report
- Cisco TAC Analysis

Wireshark Report



Wireshark Report – Before Switching

before failover.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

eth.src == 00:c1:64:01:e0:94

No.	Time	Source	Destination	Protocol	Length	Info
105	46.994721	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
151	107.010746	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
174	167.026876	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
183	227.042956	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
192	287.061911	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
206	347.075322	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
218	407.091445	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
236	467.109320	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
268	527.123595	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
281	587.139830	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
290	647.155152	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
299	707.171953	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
320	767.187947	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
335	827.204126	Cisco_01:e0:94	CDP/VTP/DTP/PAGP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0

Length: 18
Sent through Interface: TenGigE0/0/1/0

- Addresses
 - Type: Addresses (0x0002)
Length: 17
Number of addresses: 1
 - IP address: 10.200.200.253
- Capabilities
 - Type: Capabilities (0x0004)
Length: 8
 - Capabilities: 0x00000001
- Software Version
- Platform: cisco ASR9K Series
 - Type: Platform (0x0006)
Length: 22
Platform: cisco ASR9K Series
- Native VLAN: 0

0050 01 01 01 cc 00 04 0a c8 c8 fd 00 04 00 08 00 00
0060 00 01 00 05 00 5b 43 69 73 63 6f 20 49 4f 53 20[Cisco IOS

Text item (text), 9 bytes

Packets: 341 · Displayed: 14 (4.1%) · Load time: 0:0.10 | Profile: Default

Before switching, we saw that Dhaka Cisco router was sending CDP messages to Khulna Neighbor

Wireshark Report – After Switching

after failover.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

eth.src == 00:c1:64:01:e0:94

No.	Time	Source	Destination	Protocol	Length	Info
28	34.290034	Cisco_01:e0:94	Broadcast	ARP	60	Who has 10.200.200.254? Tell 10.200.200.253
29	41.879528	Cisco_01:e0:94	CDP/VTP/DTP/PagP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
30	48.825235	Cisco_01:e0:94	Broadcast	ARP	60	Who has 10.200.200.254? Tell 10.200.200.253
31	49.294588	Cisco_01:e0:94	CDP/VTP/DTP/PagP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
32	49.294590	Cisco_01:e0:94	Broadcast	ARP	60	Gratuitous ARP for 10.200.200.253 (Reply)
33	49.764395	Cisco_01:e0:94	Broadcast	ARP	60	Who has 10.200.200.254? Tell 10.200.200.253
34	50.295517	Cisco_01:e0:94	CDP/VTP/DTP/PagP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
35	51.296517	Cisco_01:e0:94	CDP/VTP/DTP/PagP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0
58	105.646607	Cisco_01:e0:94	CDP/VTP/DTP/PagP/UDLD	CDP	251	Device ID: NMC-ASR9K-NATIONWIDE-PE01 Port ID: TenGigE0/0/1/0

> Frame 33: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
> Ethernet II, Src: Cisco_01:e0:94 (00:c1:64:01:e0:94), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
v Address Resolution Protocol (request)
 Hardware type: Ethernet (1)
 Protocol type: IPv4 (0x0800)
 Hardware size: 6
 Protocol size: 4
 Opcode: request (1)
 Sender MAC address: Cisco_01:e0:94 (00:c1:64:01:e0:94)
 Sender IP address: 10.200.200.253
 Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
 Target IP address: 10.200.200.254

0020 00 00 00 00 00 00 0a c8 c8 fe 00 00 00 00 00 00
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
.....

Target MAC address (arp.dst.hw_mac), 6 bytes

Packets: 65 · Displayed: 9 (13.8%) · Load time: 0:0.4

Profile: Default

After switching, we saw that Dhaka Cisco Router lost ARP of its Khulna Neighbor

Wireshark Report – After Switching

The screenshot displays the Wireshark interface with a capture file named 'After_Failover_Test.pcapng'. The main packet list pane shows 36 ICMP Echo (ping) requests from source 10.200.200.254 to destination 10.200.200.253. All requests are marked as 'no response found!'. The filter applied is 'ip.src == 10.200.200.254'. The packet details pane for the selected packet (No. 36) shows the following structure:

- Destination: Cisco_01:e0:94 (00:c1:64:01:e0:94)
- Source: Cisco_7e:5b:cb (08:96:ad:7e:5b:cb)
- Type: IPv4 (0x0800)
- Internet Protocol Version 4, Src: 10.200.200.254, Dst: 10.200.200.253
 - 0100 = Version: 4
 - 0101 = Header Length: 20 bytes (5)
 - > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
 - Total Length: 100
 - Identification: 0x0000 (0)
 - > Flags: 0x00
 - Fragment offset: 0
 - Time to live: 255
 - Protocol: ICMP (1)
 - Header checksum: 0x140d [validation disabled]
 - [Header checksum status: Unverified]
 - Source: 10.200.200.254

The packet bytes pane shows the raw data for the destination hardware address (eth.dst), 6 bytes: 00 c1 64 01 e0 94.

Packets: 68 · Displayed: 30 (44.1%) · Load time: 0:0.2 | Profile: Default

After switching, also the ping from Khulna to Dhaka was interrupted & vice versa

Analyzer Report

NMC Analyzer connected 5-13-12 (Switching Time: 29.89 ms)

The screenshot shows the NMC Analyzer interface with the following details:

- Device: base-8000-8364-0
- Test: P1: 10GigE LAN Layer 2 Traffic Term
- Module 1 Messages logged. Click to see...
- Level (dBm): -5.1
- Freq Dev (ppm): 1.2
- Frame Size: Jumbo 9500
- Summary table (red background):

Summary	Status	Ethernet
Sync Loss Seconds	1	Rx Pause Length (ms) +
Local Fault Seconds	1	Frame Rate +
Code Violations	38	Frame Size +
Jabbers	1	Rx Mbps, Cur L1 9,999.0
Errored Frames	1	Rx Mbps, Cur L2 9,978.2
Lost Frames	3,815	Tx Mbps, Cur L1 9,999.6
CoS Frames	1	Tx Mbps, Cur L2 8,978.8
Errored Blocks (PCS)	32	Round Trip Delay (us) +
Block Sync Losses (PCS)	2	Packet Jitter (us) +

Additional interface elements include a left sidebar with status indicators (Signal Present, Sync Acquired, Link Active, etc.), a bottom toolbar with buttons like Laser, Actions, Errors, Faults, Traffic Started, Loop Up, Loop Down, LLB, Pause Frame Insert, and Reset Service Disruption Test, and a right sidebar with SAM-Complete, Enhanced RFC 2544, and Toolkit buttons.

But analyzer showed that lambda was switched from Dhaka end in 29.89ms

Analyzer Report

Khulna Analyzer connected 1-12-6 (Switching Time: 12.75 ms)

The screenshot shows a network analyzer interface with the following components:

- System:** mts5000-92ddb:0
- Tests:** JUMBO BERT
- Fiber Optics:** Select Test, Port 2: 10GigE LAN Layer 2 Traffic Term
- Running:** 3m:10s, No messages
- Level (dBm):** -4.2
- Freq Dev (ppm):** -0.1
- Summary:** Ethernet
- Summary Results:** ALL SUMMARY RESULTS OK
- Ethernet Parameters:**

Parameter	Status
Max Average Peak	Instantaneous 0
VLAN ID	Unavailable
VLAN User Priority	Unavailable
SVLAN1 ID, PRI, DEI	Unavailable
Preceding SVLANs	
SVLAN2 ID, PRI, DEI	Unavailable
SVLAN3 ID, PRI, DEI	Unavailable
SVLAN4 ID, PRI, DEI	Unavailable
SVLAN5 ID, PRI, DEI	Unavailable
SVLAN6 ID, PRI, DEI	Unavailable
SVLAN7 ID, PRI, DEI	Unavailable
Svc Disruption (us)	12757.63
- Bottom Panel:** Laser, Actions, Service Disruption, Errors, Faults, OAM, Reset Service Disruption Test, Decouple Tx and Rx

But analyzer showed that lambda was switched from Khulna end in 12.75ms

Big Confusion :

**Wireshark report shows
there is an interruption
during switching**

**Analyzer report shows there
is no interruption**

Cisco TAC

- Apr 10 14:39:14.876 gether/1/main 0/0/CPU0 t4 ETH_TRACE: ethernet_link_event_handler: Interface Te0/0/1/0 (0x000000c0), hw event link **down <<<<< Link flapped on the DWDM end, after which ethernet trace is informing router that HW link is down.**
- Apr 10 14:39:14.876 gether/1/main 0/0/CPU0 t4 ETH_IM: ethernet_im_hw_event_handler: Interface Te0/0/1/0 (0x000000c0), state down
- Apr 10 14:39:14.876 gether/1/main 0/0/CPU0 t4 ETH_EVENTS: FSM event (1, 0, None): HW link state (DOWN): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw **link:UP <<<<< Ethernet event is not tearing down the Link. Physical link is still UP.**
- Apr 10 14:39:14.876 gether/1/main 0/0/CPU0 t4 ETH_EVENTS: FSM action: Carrier delay timer started for Te0/0/1/0 (0x000000c0), sec=1, nsec=500000000 **<<<<< Carrier delay timer started**
- Apr 10 14:39:14.876 gether/1/main 0/0/CPU0 t4 ETH_EVENTS: FSM event processed for (1, 0, None): HW link state (no IM state update): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw **link:UP <<<<< Physical link is still up.**
- Apr 10 14:39:14.876 gether/1/main 0/0/CPU0 t4 ETH_INFO: ethernet_link_event_handler: Interface Te0/0/1/0 (0x000000c0), hw event link down, retval Success
- Apr 10 14:39:16.377 gether/1/fast 0/0/CPU0 t11 ETH_TRACE: Ethernet timer handler **invoked <<<<<< Carrier delay timer expired after 1500msec**
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM event (1, 0, None): Cardelay timer (DOWN): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:UP
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM action: PFI protect down for Te0/0/1/0 (0x000000c0)
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM action: Carrier delay timer stopped for Te0/0/1/0 (0x000000c0)
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM action: state pulse to owner thread for Te0/0/1/0 (0x000000c0), state down immediate
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM event processed for (1, 0, None): Cardelay timer (no IM state update): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw **link:DOWN<<<<< Physical link teared down after carrier delay timer expired**
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t12 ETH_EVENTS: FSM event (1, 0, None): State pulse (DOWN): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:DOWN
- Apr 10 14:39:16.377 gether/1/main 0/0/CPU0 t12 ETH_EVENTS: FSM event processed for (1, 0, None): State pulse (update IM with down immediate): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:DOWN

Cisco TAC

- Apr 10 14:39:16.378 gether/1/main 0/0/CPU0 t12 ETH_EVENTS: FSM action: IM state update for Te0/0/1/0 (0x000000c0), state down immediate
- Apr 10 14:39:16.382 gether/1/fast 0/0/CPU0 t12 ETH_INFO: Processed attribute Mcast address set request on Te0/0/1/0 (0x000000c0)
- Apr 10 14:39:16.382 gether/1/fast 0/0/CPU0 t12 ETH_INFO: Processed attribute Mcast address set request on Te0/0/1/0 (0x000000c0)
- Apr 10 14:39:17.933 gether/1/main 0/0/CPU0 t4 ETH_TRACE: ethernet_link_event_handler: Interface Te0/0/1/0 (0x000000c0), hw event link up <<<< Physical Link came back up again
- Apr 10 14:39:17.933 gether/1/main 0/0/CPU0 t4 ETH_IM: ethernet_im_hw_event_handler: Interface Te0/0/1/0 (0x000000c0), state up
- Apr 10 14:39:17.933 gether/1/main 0/0/CPU0 t4 ETH_EVENTS: FSM event (1, 0, None): HW link state (UP): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:DOWN
- Apr 10 14:39:17.933 gether/1/main 0/0/CPU0 t4 ETH_EVENTS: FSM action: Carrier delay timer started for Te0/0/1/0 (0x000000c0), sec=1, nsec=500000000 <<<<<< **Carrier delay timer started again and will wait for 1500msec before bringing the physical interface up.**
- Apr 10 14:39:17.933 gether/1/main 0/0/CPU0 t4 ETH_EVENTS: FSM event processed for (1, 0, None): HW link state (no IM state update): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:DOWN
- Apr 10 14:39:17.933 gether/1/main 0/0/CPU0 t4 ETH_INFO: ethernet_link_event_handler: Interface Te0/0/1/0 (0x000000c0), hw event link up, retval Success
- Apr 10 14:39:19.434 gether/1/fast 0/0/CPU0 t11 ETH_TRACE: Ethernet timer handler invoked
- Apr 10 14:39:19.434 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM event (1, 0, None): Cardelay timer (UP): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw **link:DOWN <<<<< Carrier delay timer expired exactly after 1500msec**
- Apr 10 14:39:19.434 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM action: Carrier delay timer stopped for Te0/0/1/0 (0x000000c0)
- Apr 10 14:39:19.434 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM action: state pulse to owner thread for Te0/0/1/0 (0x000000c0), state up
- Apr 10 14:39:19.434 gether/1/main 0/0/CPU0 t11 ETH_EVENTS: FSM event processed for (1, 0, None): Cardelay timer (no IM state update): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw **link:UP <<<<< Physical interface came back up**
- Apr 10 14:39:19.434 gether/1/main 0/0/CPU0 t12 ETH_EVENTS: FSM event (1, 0, None): State pulse (UP): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:UP
- Apr 10 14:39:19.434 gether/1/main 0/0/CPU0 t12 ETH_EVENTS: FSM event processed for (1, 0, None): State pulse (update IM with up): [admin:UP client admin:UP client admin tx: UP port:ENABLED port tx:ENABLED hw link:UP

Cisco TAC

- **Apr 10 14:39:14.876** gether/1/main 0/0/CPU0 t4 ETH_TRACE:
ethernet_link_event_handler: Interface Te0/0/1/0 (0x000000c0), **hw event link down <<<<< Link flapped on the DWDM end, after which ethernet trace is informing router that HW link is down.**
- **Apr 10 14:39:17.933** gether/1/main 0/0/CPU0 t4 ETH_TRACE:
ethernet_link_event_handler: Interface Te0/0/1/0 (0x000000c0), **hw event link up <<<< Link came back up again**
- **As a workaround, increase the carrier-delay timer anything above 3056msec.**

Initial Findings

- Ethernet Interface Carrier Delay value was changed
 - For Router interfaces, it was changed to 4000ms
 - For Switch interfaces, it was changed to 2000ms

- Chromatic Dispersion Search Value in Lambda Cards was reduced
 - Previous CD Value : -280,000 ps/nm to +280,000 ps/nm
 - After Change CD Value : -2,000 ps/nm to +40,000 ps/nm

Initial Findings

005-014.02 I02L200G-1 [34]:194.450 THz Line Traffic Configuration

Optical Channel | OTU4 | ODU4

Operational state:

Modulation format:

Encoding type:

Sink

Supervision mode:

Received signal input BER:

Input power

Optical input power: dBm

Power thresholds

Rx input power too low: dBm

Rx input power too high: dBm

QPSK

CD: ps/nm

DGD: ps

Estimated OSNR: dB

Chromatic dispersion search low: ps/nm [-280000 ... -1000]

Chromatic dispersion search high: ps/nm [1000 ... 280000]

Source

Transmitter parameters

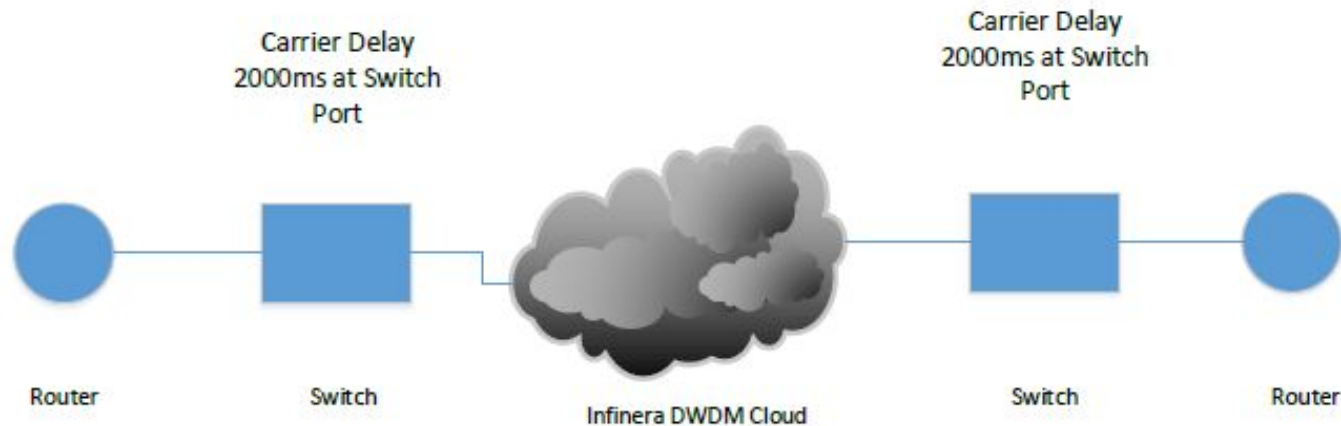
Required output power: dBm [-2.0 ... 4.5]

Current output power: dBm

AnyDesk

Observation : Switch Topology

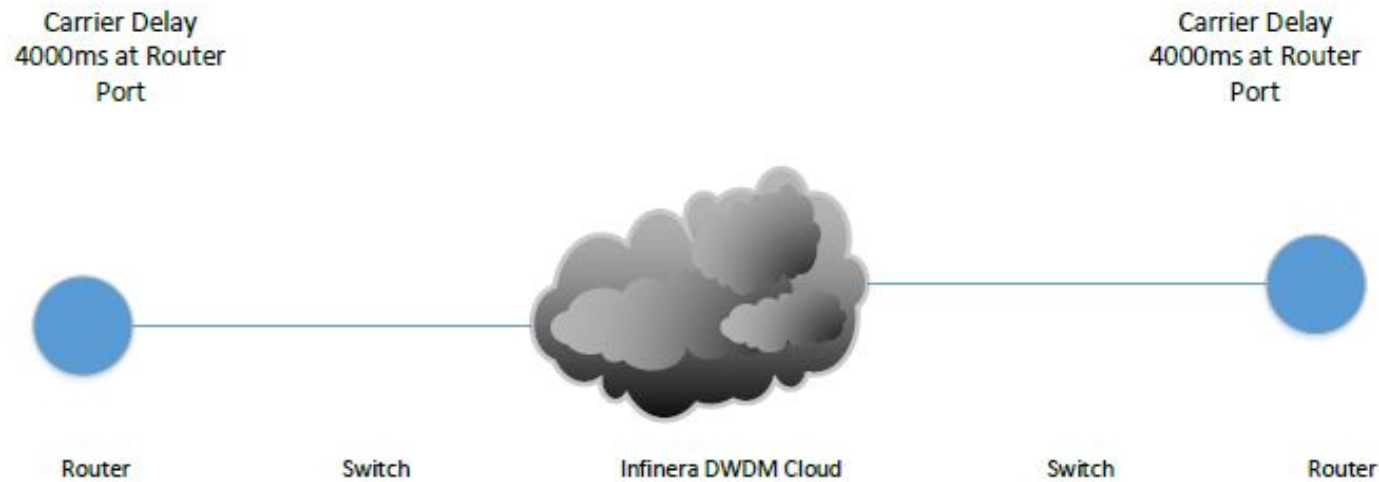
Infinera DWDM Cloud is connected from Switch to Switch for 10GE Circuit:



Output : No physical or Logical Flap Observed, **only 2/3 ping loss** during switching. Carrier delay value lower than 1000ms shows physical link flap.

Observation : Router Topology

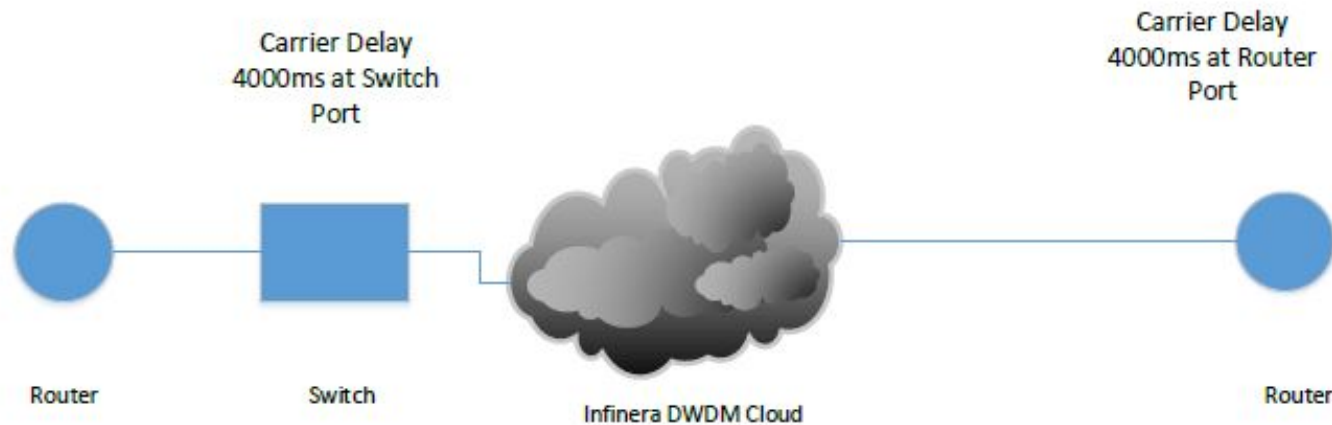
Infinera DWDM Cloud is connected from Router to Router for 10GE Circuit:



Output : No physical or Logical Flap Observed, **only 2/3 ping loss** during switching. Carrier delay value lower than 3000ms shows physical link flap.

Observation : Mixed Topology

Infinera DWDM Cloud is connected from Switch to Router for 10GE Circuit:



Output : No physical or Logical Flap Observed, **only 2/3 ping loss** during switching. Carrier delay value lower than 3000ms shows physical link flap.

Final Findings

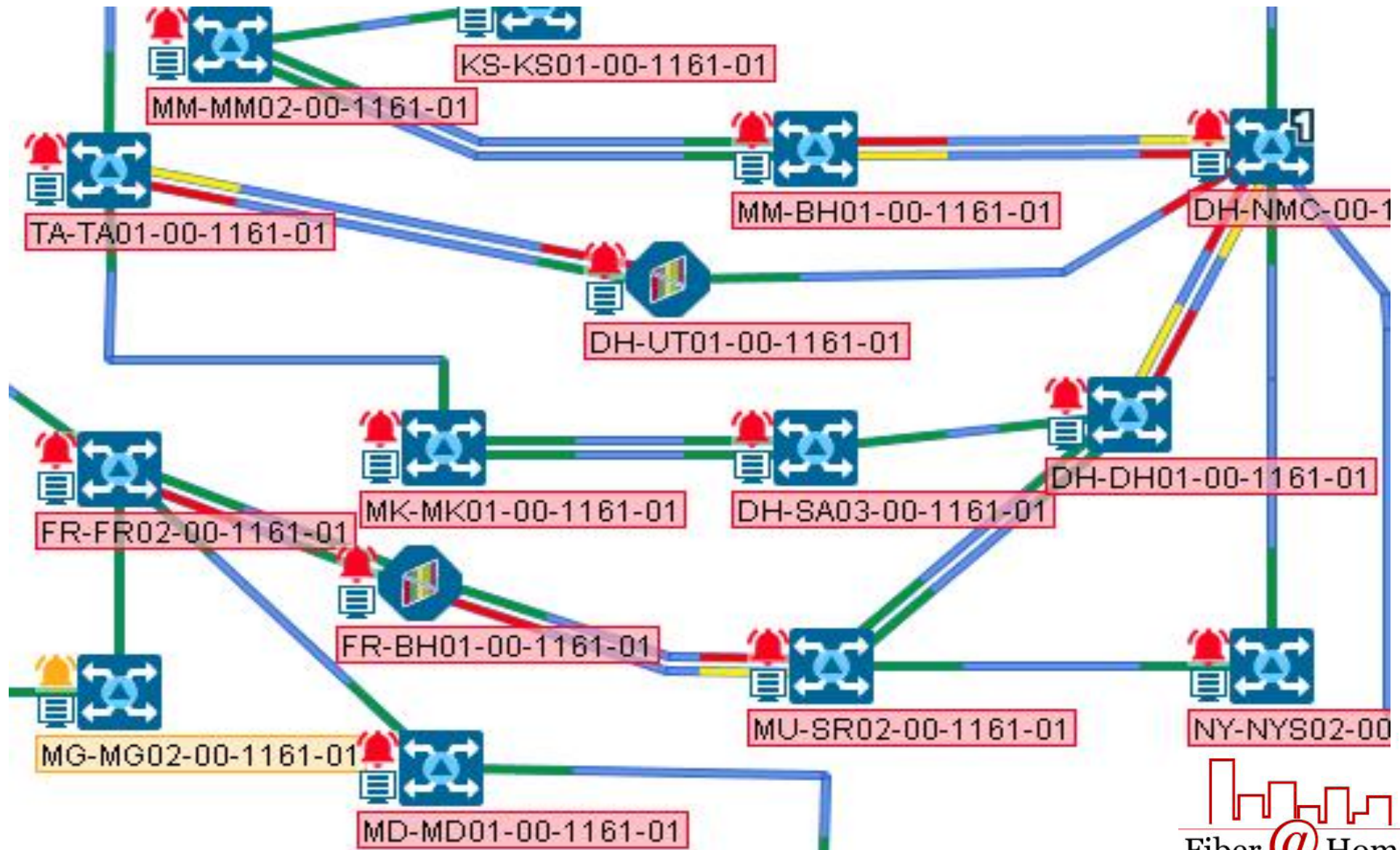
- Analyzer was showing that the switching was done below 50ms
- Vendor got cleared with that
- Routers were seeing that carrier was going down

- So we worked with carrier delay and squeeze the time duration required for DWDM system to find the new path by reducing CD searching parameter

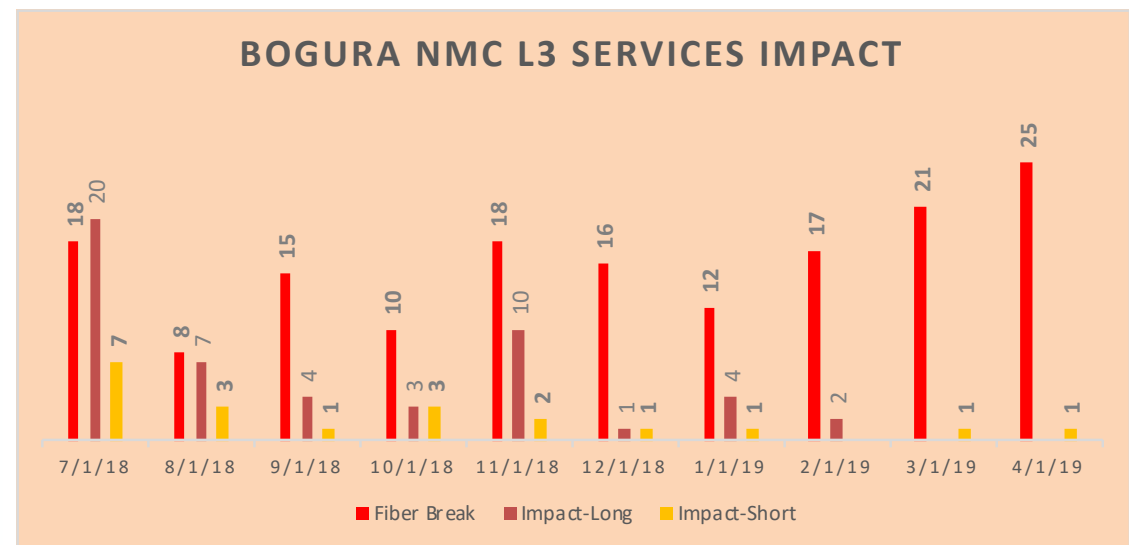
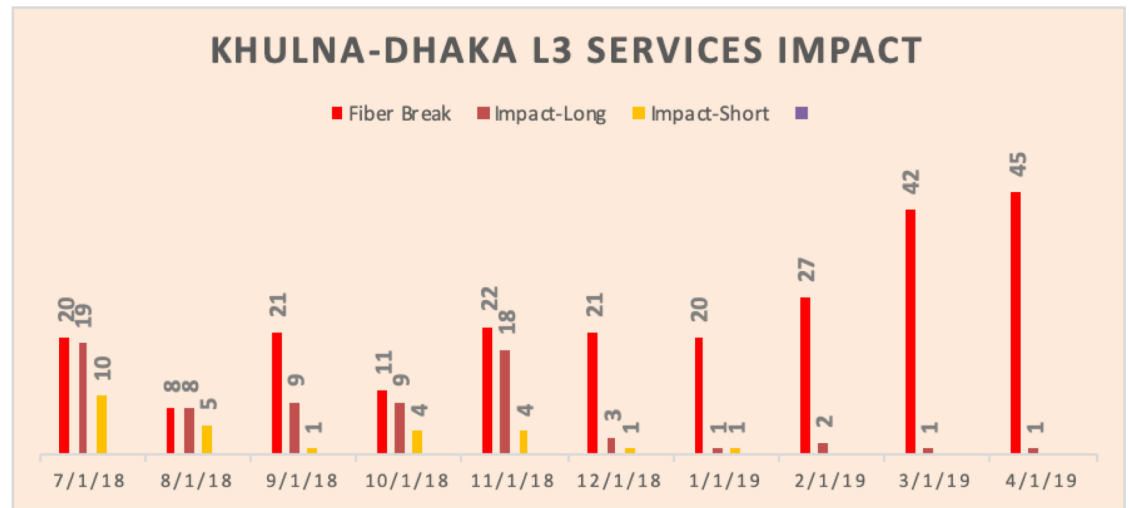
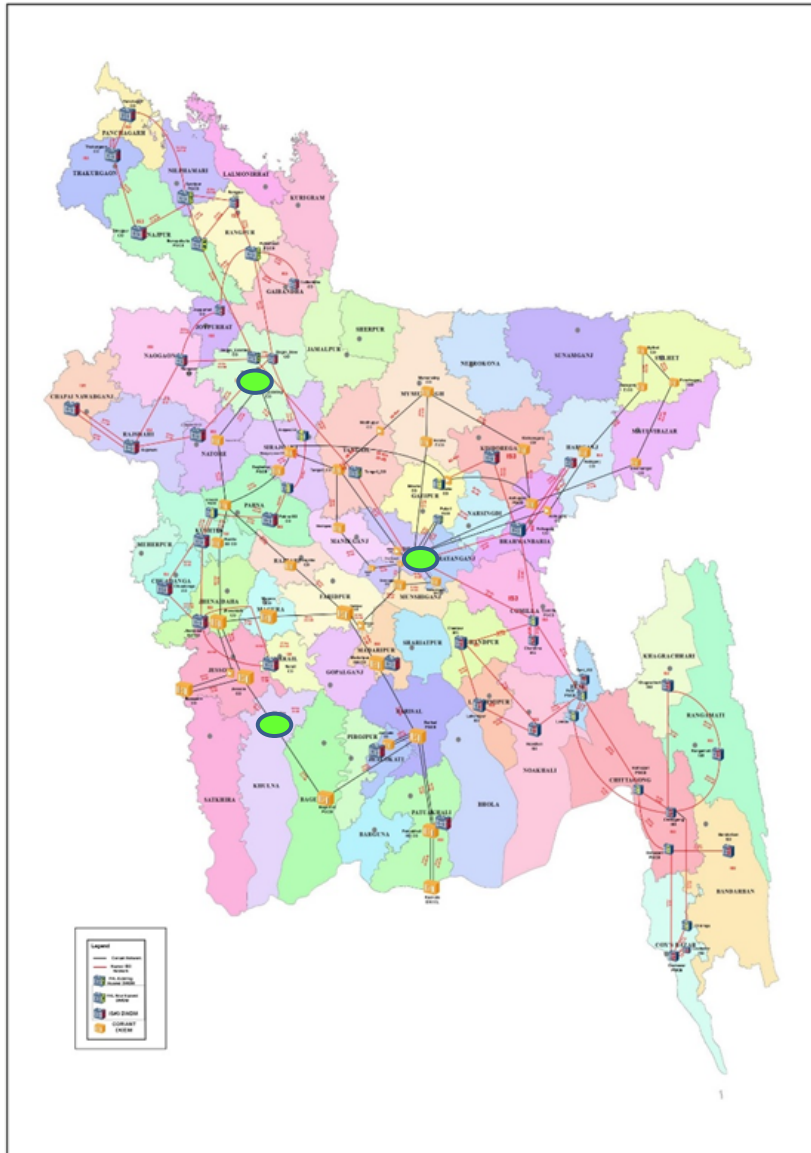
Operational Challenges

- Completely dependent on Optical Parameters
- Absence of real time latency check from DWDM layer
- Path selection is dynamic, so latency may vary
- If low latency is maintained, paths might have to be ignored
- Optical infrastructure has to be fine tuned all the time
- Different vendor DWDM handshaking is difficult
- Limitation on different feature due to licensing issue
- Theoretical standards are not followed all the time
- If one span is effected, numbers of 100G gets effected
- Difficult to integrate open source software
- Vendor dependency exists

Resiliency – 18th May 2019



Performance



Acronyms

- WDM - Wavelength division multiplexing
- CWDM - Coarse Wavelength division multiplexing
- DWDM - Dense Wavelength division multiplexing
- Mux/Demux - Multiplexer & demultiplexer
- OADM - Optical add-drop multiplexer
- ROADM - Reconfigurable optical add/drop multiplexer
- OTN - Optical transport network
- OTU - Optical transport unit

Query ?

Thanks