Template for submitting comments/inputs in respect of Draft Standard

(Draft Test Guide No. TEC 86091:2026)

Name of Manufacturer/Stakeholder:

Organization:

Contact details:

Clause No.	Clause	Comments	Other Remarks, if any

Note: The comments/inputs on the draft Test Guide (Draft Test Guide No. TEC 86091:2026) may be provided in the above format vide email to **dirt2-tec-dot@gov.in** , **adet-tx-tec-dot@gov.in** and **ratx.tec-dot@nic.in**

परीक्षण निर्देशिका

सं: टीईसी ८६०९१:२०२६

(पूर्व सं: टीईसी/टीजी/टीएक्स/ओटीएन-३०१/०२/दिसम्बर-१७)

TEST GUIDE

No.: TEC 86091:2026

(Supersede No. : TEC/TG/TX/OTN-301/02/DEC-17)

मेट्रो और कोर नेटवर्क अनुप्रयोग के लिए डीडब्लूडीएम बेयरर ट्रांसपोर्ट सिस्टम के साथ बहु-सेवा ऑप्टिकल ट्रांसपोर्ट नेटवर्क (ओटीएन) प्लेटफार्म

Multi-Service Optical Transport Network (OTN) Platform with DWDM Bearer Transport System for Metro and Core Network Application

(मानको सं.: टीईसी ८६०९०:२०२६)

(Standard No.: TEC 86090:2026)

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली–११०००१, भारत

TELECOMMUNICATION ENGINEERING CENTRE

KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI–110001, INDIA

www.tec.gov.in

Release 3:……. , 2026

FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This Test Guide of testing pertains to test schedule and procedure for evaluating conformance/functionality/requirements/performance of the Standard for Generic Requirements for a Multi-Service Optical Transport Network (OTN) platform for applications in the metro as well as core domains of the Indian telecom networks. The equipment shall be able to converge all legacy as well as new client interfaces and map them to OTN based signals using ODU-k switching, grooming, consolidation and multiplexing. Finally, these OTN signals shall be transported through a pair of fibre using DWDM technique. The equipment shall, therefore, consist of two parts – OTN adaptation and switching and DWDM transport. The OTN part of the equipment shall interface various kinds of legacy & new client optical signals. These signals shall first be converted into electrical signals, map them to OTN frame format standardized as per G.709, Cross-connected with ODU-k switching, groomed, consolidated, multiplexed and

thereafter the colored OTN line signals shall be introduced to the DWDM Mux De-Mux for onward transmission. The OTN part of the equipment shall provide 40 / 80 or optionally 96 wavelengths carrying OTN signals. The Dense Wavelength Division Multiplexing (DWDM) Optical Line System (OLS) shall consist of DWDM Mux De-Mux, booster amplifier, pre-amplifier etc. which shall operate at discrete wavelengths in the C-band centered around 193.1 THz frequency as per ITU-T Rec. G.694.1 grid, at 100 /75/ 50 GHz/flexible grid channel spacing as the case may be. The DWDM system shall support transmission of 40/80 or optionally 96 wavelengths channels comprising of OTU-4/OTUCn per channel in the C-band.

CONTENTS

A. HISTORY SHEET

Sl. No.	TSTP No.	Equipment/Interface	Issue
1.	TEC/ GR/TX/OTN -001/01/MAR- 2013	Multi-Service Optical Transport Network (OTN) platform with DWDM bearer transport system for Metro and Core Network Applications.	1st Release, March 2013
2.	TEC/TG/TX/OTN-301/02/DEC-17	Multi-Service Optical Transport Network (OTN) platform with DWDM bearer transport system for Metro and Core Network Applications.	2nd Release, December 2017
3.	TEC 86091:2026	Multi-Service Optical Transport Network (OTN) Platform with DWDM Bearer Transport System for Metro and Core Network Application	3rd Release

B. INTRODUCTION

This document enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance of Multi-Service Optical Transport Network (OTN) platform with DWDM bearer transport system for Metro and Core Network Applications as per Standard No. TEC 86090:2026.

C. General information:

Sn.	General Information	Details *(to be filled by testing team)*	
1	Name and Address of the Applicant		
2	Date of Registration		
3	Name and No. of GR/IR/Applicant's Spec. against which the approval Sought		
4	Details of Equipment		
	Type of Equipment	Model No.	Serial No.
(i)			
(ii)			
5	Any other relevant Information:-		

D. Testing team: *(to be filled by testing team)*

Sno.	Name	Designation	Organization	Signature
1.				
2.				
3.				
4.				
5.				

E. List of the Test Instruments:

Sno.	**Name of the test instrument**	**Make /Model** *(to be filled by testing team)*	**Validity of calibration** *(to be filled by testing team)*
1.	STM-16/64 SDH/OTN Analyzer with jitter		dd/mm/yyy
2.	Digitizing Oscilloscope		
3.	Optical Return Loss Measuring Set		
4.	WDM Analyzer		
5.	Optical Splitters		
6.	Ethernet Traffic Analyzer (GbE ,10GE & 100GbE)		
7.	Optical attenuator		
8.	Optical Power Meter		
9.	Relevant connectors, Patch cords.		

F. **Equipment Configuration Offered:** *(to be filled by testing team)*

(a) <Equipment/product name> Configuration:

S.No.	Item	Details	Remarks
1.			
2.			
3.			
4.			
5.			
6.			

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

(b) <Other equipment name> Configuration:

S.No.	Item	Details	Remarks
1.			
2.			
3.			
4.			
5.			
6.			

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

G. **Equipment/System Manuals:** *(to be filled by testing team)*

Availability of Maintenance manuals, Installation manual, Repair manual & User Manual etc. **(Y/N)**

H. Clause-wise Test Type and Test No.:

Clause No.	*Clause*	*Type of Test / Test No. etc. **
1.0	**Introductio** This document describes the generic requirements for a Multi-Service Optical Transport Network (OTN) platform for applications in the metro as well as core domains of the Indian telecom networks. The equipment shall be able to converge all legacy as well as new client interfaces and map them to OTN based signals using ODU-k switching, grooming, consolidation and multiplexing. Finally, these OTN signals shall be transported through a pair of fibre using DWDM technique. The equipment shall, therefore, consist of two parts – OTN adaptation and switching and DWDM transport. The OTN part of the equipment shall interface various kinds of legacy & new client optical signals. These signals shall first be converted into electrical signals, map them to OTN frame format standardized as per G.709, Cross-connected with ODU-k switching, groomed, consolidated, multiplexed and thereafter the colored OTN line signals shall be introduced to the DWDM Mux De-Mux for onward transmission. The OTN part of the equipment shall provide 40 / 80/ 96 wavelengths carrying OTN signals. The	Verified that the 40/80 Chl. DWDM system shall support the grid at 100/50GHz channel spacing. Therefore, measure the wavelength at the output of each line card, with an Optical Spectrum analyzer (OSA) as TSTP test no 1.0 and ensure that the wavelengths match with the grid as per ITU-T G.694.1. Record the result in the table. Prepare end to end setup as shown in fig. 3 & fig. 4 using 2 nos. of OTM, ILA as per long haul/very long haul configuration, FOADM & ROADM to converge all legacy as well as new client interfaces and map them to OTN based signals using ODU-k switching , grooming , consolidation and multiplexing. Finally , these OTN signals shall be transported through a pair

	Dense Wavelength Division Multiplexing (DWDM) Optical Line System (OLS) shall consist of DWDM Mux De-Mux, booster amplifier, pre-amplifier etc. which shall operate at discrete wavelengths in the C-band centered around 193.1 THz frequency as per ITU-T Rec. G.694.1 grid, at fixed grid of 100 /75/ 50 GHz channel spacing or in flexible grid design at nx6.25/12.5GHz(where "n" is the number of slices to define per channel spectral width) . The DWDM system shall support transmission of 40 / 80/ 96 wavelengths channels comprising OTU-4/OTUCn channel in the C-band. **Note:** The requirement of 96 channels is optional and may be decided by the purchaser or user. The Multi-Service OTN Platform shall enable service provisioning and re-provisioning using remote reconfigurability of WSS (Wavelength Selective Switch) based ROADM (Reconfigurable Optical Add Drop Mux). This Platform shall also support for ASON/GMPLS based Control plane at different layers including OTN & Wavelengths to achieve intelligent functioning. The system shall support a combination of client interfaces at different rates i.e. STM-1,	of fibre using DWDM technique. Make end to end client connections as per test no 22.0 for different client to ensure OTN adaptation, switching and DWDM transport.

	STM-4, STM-16, STM-64, OTU1, OTU2, OTU2e, OTU3, , OTU4, ODUflex, Gigabit Ethernet (as per IEEE 802.3 and 802.3ah) and 10G Ethernet LAN and WAN PHY as per IEEE 803.3ae, 40GE, 100GE, SAN based Fibre Channel services, Video Services etc. The IO cards shall interface various combinations of the aforementioned interfaces which shall be mapped to ODU-k (k=0, 1, 2, 2e, 3, , 4, flex etc.) depending upon the bandwidth of the individual interfaces. These ODU-k shall be cross-connected and groomed for consolidation to the OTN line signals @ OTU-4/OTUCn. The line signals shall be colored OTN signals and shall be fed to the DWDM Mux De-Mux block without using the transponder or muxponder. NOTE: STM-1 , STM-4 and STM-16 interfaces on client side are optional and may be decided by the purchaser.	
2.0	**Equipment architectural model** The equipment shall consist of two parts - OTN multi-service platform and DWDM bearer transport functions. The OTN multi-service platform shall consist of:	Heading, test is not required.
a	Client signal interface modules,	Verify all the Client interfaces supported.

b	OTN unified bearer layer, including the ODUk interface adapter processing,	Verify ODUk interface adapter processing in OTN Cross Connect.
c	OTN cross-connect switch module consisting ODUk cross-connect switch matrix,	Verify ODUk cross-connect switch matrix.
d	OTUk line interface processing module which shall carry out functionalities like optical conversion, coloring the wave, FEC codification, coherent detection etc.	Refer test no 1.0, 2.0 & 25.0: 1. Gray to optical color conversion. 2. In performance window check FEC value.
	The DWDM optical transport shall consist of:	
a	Optical multiplex section (OMS) consisting of Mux and De-Mux blocks,	Verify OMS section as per as the implementation by passive or active components.
b	DWDM bandwidth transport layer consisting of Optical Transmission Section (OTS) processing module having booster and pre-amplifier. A schematic diagram of OTN multi-service platform is given in Figure-1 below. It shall support Multi–service unified control plane, according to different services.	Verify OTS section having booster and preamplifier.

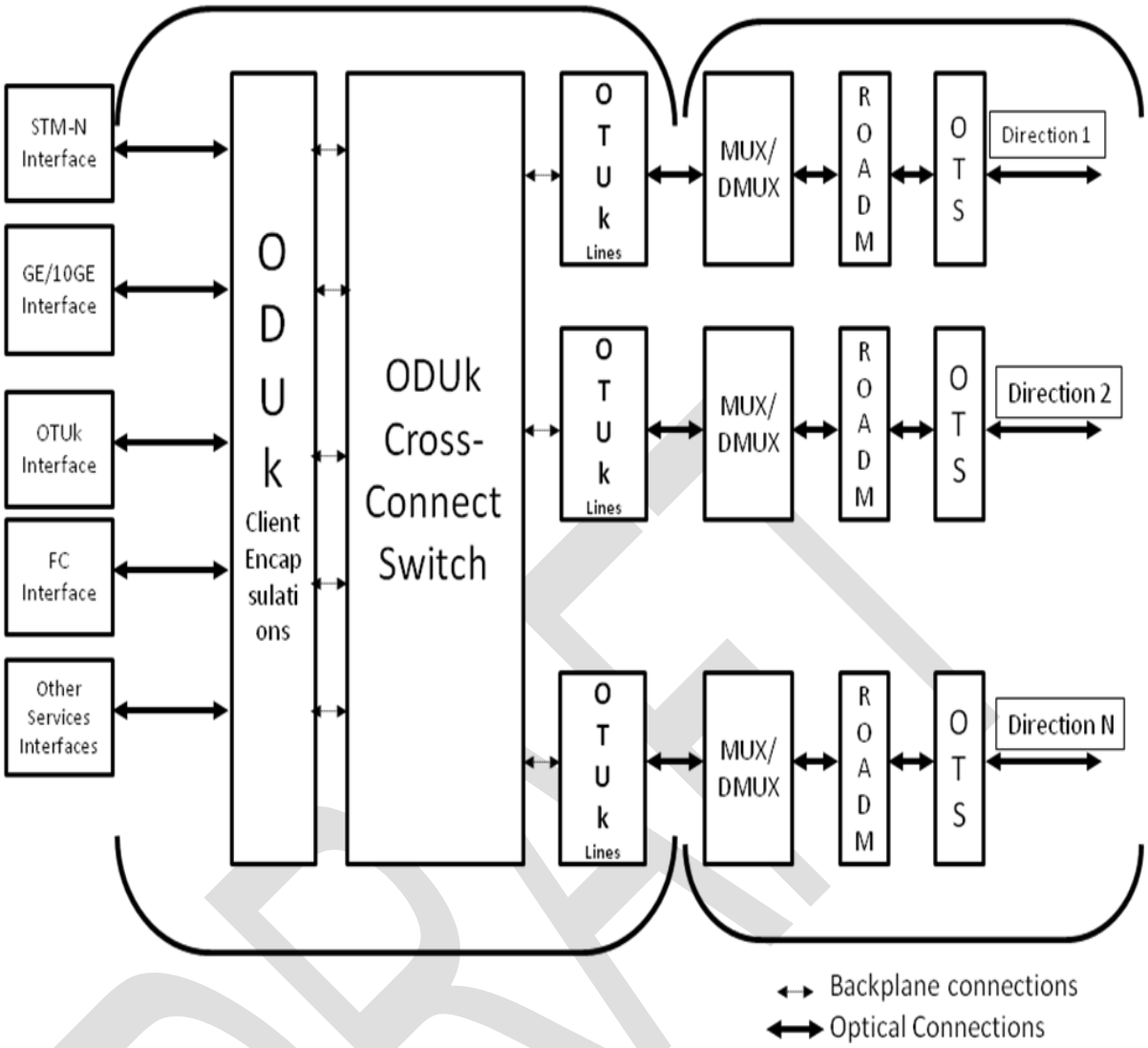
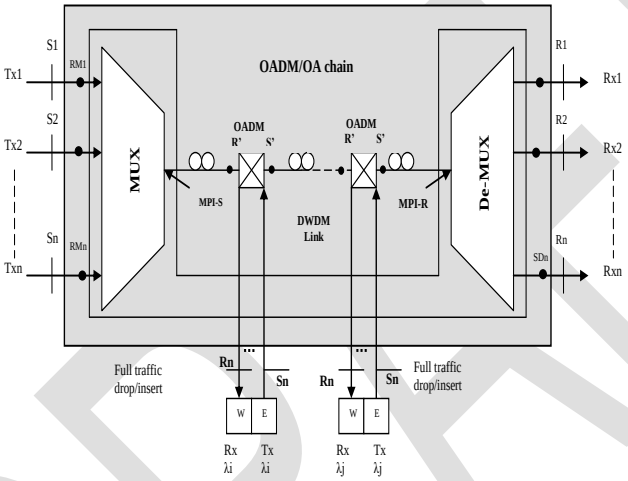
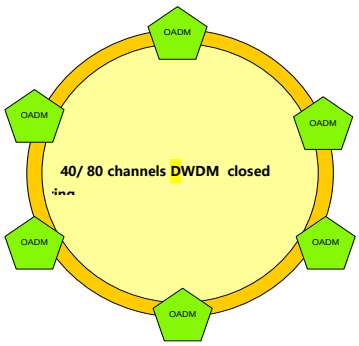
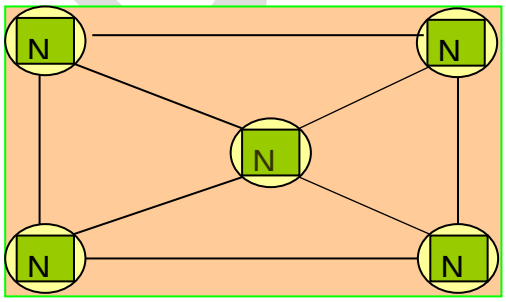


Fig 1: OTN Multi-Service bearer node based on a Single Platform Architecture Functional Model Diagram

2.1	Network topologies: It shall be possible to configure the equipment to implement various Network Topologies as detailed below: 1) 2) Linear-chain, 3) Ring and	Note that the equipment should be able to configure for Linear add drop, ring and mesh networks. However, test will be conducted as per offered equipment configuration for TAC.

	4) Mesh. Two-fibre application i.e., one dedicated fibre for transmit-direction and one for receive-direction is envisaged for all network applications as mentioned above.	
2.1.2	Linear add-drop topology The reference model for linear add-drop topology is outlined in Figure-2 below:  **Fig. 2: Reference Diagram for DWDM Linear-chain link** The DWDM equipment in linear-chain shall be able to carry a maximum traffic of 40 channels, on a fibre-pair with one fibre each for 'East-Bound' and 'West-Bound' direction. A pre-configured drop & insert facility, as defined later in the document, at any intermediate OADM node shall be possible. The DWDM system shall provide channel re-use in subsequent spans, after termination of a wavelength at an intermediate OADM node.	Ensure that the equipment supports client layer protection by using 1+1 Optical Sub-Network Connection protection. The parametric tests at different reference points are detailed later in TSTP Test no 1.0 to 21.0. Refer Figure 2.

	There shall be implementation of proper mechanism to combat OSNR penalties incurred due to continued channel add/drops of same wavelengths in subsequent spans at enroute ROADMs. The equipment shall provide a migration path from linear add/drop topology to two-fibre DWDM ring structure. Traffic shall be protected at client layer by using 1+1 Optical Sub-Network Connection protection (transponder protection envisaged). Separate fibre-pair shall be used for protection path. -	
2.1.3	Two-fibre DWDM ring: a) The two-fibre ring network is closed two-fiber ring topology.	Ensure that the equipment supports mesh topology at client layer by using 1+1 optical sub-network protection as well as Mesh protection using ASON. The parametric tests at different reference points are detailed later in TSTP Test no 1.0 to 21.0.
2.1.3.1	Closed two-fibre ring The schematic of closed two-fibre DWDM ring architecture with distributed traffic patterns between nodes is given in Figure-4. Traffic shall be protected at client layer by using 1+1 Optical Sub-Network Connection protection (transponder protection envisaged). The network shall support	

	termination of node to node traffic providing channel reuse feature.  **Figure-4: Reference diagram for an Internode DWDM ring**	
2.1.4	Mesh topology The schematic of a two-fibre DWDM mesh architecture is given in Figure-5. Traffic shall be protected at client layer by using 1+1 Optical Sub-Network Connection protection as well as by the implementation of Automatic Switched Optical Network (ASON). The network shall support termination of node to node traffic providing channel reuse feature. The architecture of ASON shall be as per Cl.12.0 and the ASON operation planning tool shall be as per Appendix-II of this document.  **Figure-5: Reference diagram for a OTN mesh architecture**	

3.0	Functional requirements	
3.1	Service interface module of the equipment shall provide SDH, Ethernet, FC, standard OTN interfaces, other various service interfaces, Packet services NNI interface to connect to other OTN equipment.	Connect equipment with NMS/EMS/LCT and Verify service configuration of client interface card. Refer test no 22.0.
3.2	The ODUk interface adaptation processing module shall map the multi-service signals to the ODUk (k = 0,1,2,2e,, 4, flex frame format).	Connect equipment with NMS/EMS/LCT & eerify service configuration of client interface card and adaptation to the ODUk (k = 0 , 1 , 2 , 2 e , 3 , 3e , 4 , flex) frame format. However, testing will be conducted as per offered equipment for TAC. Refer test no 22.0.
3.3	OTUk line interface processing module shall provide ODUk (k = 0,1,2,2e, , 4 and flex) signal to OTUk (k = 4)/OTUCn colored line interfaces.	Connect NMS/EMS/LCT with the equipment and verify ODUK line processing module for color line interface. However, testing will be conducted as per offerd equipment for TAC. Refer test no 22.0.
3.4	The ODUk cross-connect module shall be able to perform x-connections at ODUk (k = 0, 1, 2, 2e, 3, 4 and flex).	Prepare E2E setup and check cross connect to support ODUk (k =0 , 1 , 2 , 2e , 3 , 4 and flex). However, testing will

		be conducted as per offerd equipment for TAC. Refer test no 22.0.
3.5	The Optical Channel Layer shall perform Optical Channel connection routing, processing of the Optical Channel overhead, Optical Channel supervisory functions & wavelength conversion.	Verify OTN structure as per ITU-T G.709 structure with help of EMS/LCT. Refer TSTP Test no 27.0.
3.6	In case of ROADM, OCh cross-connect functional modules shall support for multi-directional wavelength switching with remote configurability.	Verify multi directional wavelength switching with remote configurability from EMS/LCT. Refer test no 22.0.
3.7	The Optical Multiplex section processing module or the DWDM multiplexer shall multiplex optical channels in the wavelength multiplexing / demultiplexing subsystem.	Connect OSA at the monitor point of Multiplexer and Demupliplexur In test setup and verify the multiplexing & demultiplexing functionality. Refer test no 28.0.
3.8	The equipment shall support multi-layer protection mechanism. It shall support SNCP protection at both ODUk and Och layers. -	Refer TSTP Test no 23.2.3 & 24.0 for multi-layer protection mechanism & SNCP protection.
3.9	ASON/GMPLS control plane shall support automatic creation, discovery and recovery of the ODUk and Och channels.	Prepare ASON setup and verify to check support of automatic creation , discovery and recovery of the ODUk and OCh

		channels. Refer TSTP Test no 23.0.
3.10	The cross-connections within the switch matrix shall be done at ODUk level, irrespective of nature of payloads at the client interfaces. The control processor unit, cross connect switch matrix, timing circuitry and power supply shall be redundant. Expansion shelf, when required, shall house the IO cards and controller/power supply. The switching fabric shall support the redundancy of N:1.	Verifiy cross-connections within the switch matrix. It shall be done at ODUk level. Check redundancy of cross connect switch matrix , timing circuitry and power supply. For cross connection refer test no 22.0.
3.11	The equipment shall support the state of art technologies such as ASON/G.8080 and GMPLS. The ASON, which is client independent, shall provide optical transport network with dynamic connection capability. It shall also provide added facilities such as Traffic engineering of optical channels, Mesh network topologies and restoration, Managed bandwidth to core IP connectivity and introduction of new optical services.	Prepare ASON setup and insure to support optical transport network with dynamic connection capability. It shall also provide added facilities such as Traffic engineering of optical channels , Mesh network topologies and restoration , Managed bandwidth to core IP connectivity and introduction of new optical services. Refer ASON test in TSTP test no 23.0.

3.12	The hot-swapping of a card/unit shall not affect working of any other tributaries / modules. Hot-swapping capability shall be provided for all cards/units except the power supply unit. No EMS notification or system setting shall be required for extraction or insertion of any unit/card.	Verify that hot-swapping of a card/unit shall not affect working of any other tributaries /Modules and No EMS notification or system setting shall be required for removal or insertion of any unit/card.
3.13	It shall be possible to configure the network as fully protected, partially protected or un-protected as per details mentioned in clause 12.14.	Equipment should support protection as fully protected, partially protected and unprotected. Purchaser can give option for Network protection.
3.14	The power-supply failure/EMS server break-down/ bugs in the software shall not affect the current cross-connection map. The removal/replacement of any unit shall also not affect the existing connection-map. No reconfiguration shall be called for against this action. The equipment shall restore back the existing connection-map, as configured in the pre-failure condition, upon clearance of the afore-mentioned faults.	Configure cross connection with help of EMS and configure the service at any client level. Put analyzer and make service through. Now shutdown the equipment and after some time power on the equipment. Check cross connection that should not be changed and service should be OK. Do same verification with removal /replacement of any unit shall also not affect the existing connection- map. Refer TSTP test no 22.0.

3.15	The equipment shall include fully redundant non-volatile memory which shall facilitate cross-connection map configuration, as existent immediately prior to any system-failure, to be acquired back once the fault is cleared. Automatic switch-over to the redundant memory shall take place when detection of failure in the active memory occurs. It shall also be possible for the user to take-over the switching action manually.	Prepare setup as per TSTP test figure under test no. 22.0 and show the redundancy test of Control cards and Cross Connect cards.
3.16	The equipment shall support Automatic Switched Optical Network (ASON) and Generalized Multi-Protocol Label Switching (GMPLS) and shall be Optical Internetworking Forum (OIF) complaint. ASON/G.8080 is client independent transport network enriched with Control Plane. The purpose of control plane is to facilitate fast restoration and efficient configuration of connection in OTN (ITU-T G.872) environment. The ASON shall provide circuit switching capabilities, whereas the GMPLS with unified signaling and integrated routing approach shall provide for resource provisioning recovery and control-plane optimization.	Prepare ASON Setup and insure to compliant as per GMPLS and Optical Internetworking Forum (OIF). Refer TSTP Test no. 23.0

3.17	The ASON/G.8080 control plane shall perform many functions such as neighbor (adjacency) discovery, resource discovery, service discovery, protocol control, link resource management, routing control, signaling, connection control and call control. The GMPLS with ASON network architecture referred to as vertical networking, the nodes shall host multiple switching layers and shall be controlled by a single control plane.	Test the function of ASON control plane to support the mentioned functions. Refer TSTP Test no. 23.0
3.18	The ASON shall support different connection type viz. permanent connection, soft permanent connections. Since interoperability between the equipment of different vendors is still a concern, switched connection may be optional to the purchaser.	Check PC & SPC function in ASON test setup. Refer TSTP Test no. 23.0
3.19	Grooming & Consolidation: The ODUk cross-connect in the equipment shall provide traffic grooming & consolidation. Grooming is the re-organization of incoming traffic from different links destined for a common destination, over links assigned for this traffic destination. Consolidation means re-organizing traffic from lightly-loaded links on to fewer, high-speed links for a better system-fill and efficient system capacity utilization.	Configure E2E connection at ODUK layer for different services and verify traffic grooming & consolidation. Refer TSTP Test no. 22.0

3.20	The system shall support a set of optical cards that when equipped in a specific configuration shall allow the system to function as an Optical Terminal Multiplexer (OTM), Reconfigurable Optical Add/Drop Multiplexer (ROADM) or In-Line Amplifier (ILA).	Note that equipment for various configurations are offered such as OTM, OADM, ROADM, ILA etc, if not otherwise specified by the purchaser. Note that the system supports Reconfigurable Optical Add Drop Multiplexer (ROADM) in case the purchaser requires it.
3.21	The system shall support various topologies such as, linear add/drop, mesh and shall also support closed ring. The network protection shall be available as per the details given later in the document.	For type approval of the equipment, vendor may apply for any of the topologies from Linear Add Drop, Closed ring and Mesh. The topology applied and tested shall be mentioned in the TAC certificate.
3.22	The DWDM system shall work in unidirectional mode of operation for all network topologies using dedicated separate fibres for 'TX' and 'RX' directions in terrestrial Longhaul and Very Longhaul networks with or without In-Line Amplifiers (ILA) as per network requirements. The DWDM link shall support spans for long haul and very long haul applications deploying In Line Amplifiers and FOADMs/ ROADMs or a combination thereof for various span-budget specifications as mentioned later in the GR.	Note that the equipment should support all the configuration in unidirectional mode but test will be conducted as per offered configuration. Prepare setup as per figure 3 & figure 4 for long haul / very long haul application using FOADM/ROADM and

	Since the no. of spans varies depending upon the type of equipment used, the purchaser, if so desires, may also ask the vendors to carry out the complete network planning on the basis of the network information provided by the purchaser.	check the traffic for unidirectional mode for OTM, FOADM and ROADM
3.23	The Booster Amplifier and Pre-Amplifier (optical amplifiers) shall be an integral part of DWDM Terminals, as well as ILAs, FOADMs and ROADMs. The DWDM system design shall be such that it implements wavelength reuse after dropping a particular channel at a node. There shall be no restriction on the reuse of particular added/dropped channel, e.g. the same channel can be dropped and reinserted at all the ROADM nodes of a link. Any insertion-loss incurred in channel add/drop process and dispersion compensation shall be compensated by the system only.	Verify that the Booster Amplifier and Pre-Amplifier (optical amplifiers) shall be an integral part of DWDM Terminals, ILAs and OADMs/ROADMs.

3.24	The system shall comply with ITU-T Recs. G.709 and G.959.1 in relation to optical transport network (OTN) specifications including support for OTU-4/OTUCn frame format on the line side. In order to maintain transparency and supervision capability of client services in accordance with ITU-T Rec. G.709, all client services shall be supervised by processing out DU/OTU overhead bytes. At least path monitoring and section monitoring shall be supported. The equipment shall support Forward Error Correction (FEC) in accordance with ITU-T Rec. G.709 in the optical budget of the equipment and the same shall be a part of the network planning. It shall also support and implement HD-FEC (Hard Decision FEC) (Optional) as well as SD-FEC (Soft Decision FEC). The system shall be provided with the FEC enable/disable facility through LCT/EMS. The equipment shall support super-FEC to provide higher performance. The equipment is expected to give 8 dB or better net coding gain at 10^{-12} output BER. NOTE: HD-FEC compliance is optional and to be decided by the purchaser.	Note that the system supports OTU-4/OTUCn OTN interfaces. The checking of the OTU-4 frame format shall be carried out as outlined for the checking of the Line cards. Ensure that equipment should comply with ITU-T Recs. G.709 and G.959.1. Verify that the equipment should support HD-FEC as well as SD- FEC. Refer TSTP Test no. 25.0 Verify that equipment gives 8 dB or better net coding gain at 10^{-12} output BER.

3.25	The fibre-media as stipulated in this document shall be compliant to ITU-T Rec. G.652D/ITU-T Rec. G.657A single-mode optical fibre and ITU-T Rec. G.655 NZ-DSF fibre.	The fibre media shall be as per ITU-T Rec. G.652 fibre for single-mode optical fibre and ITU-T Rec. G.655 fibre for NZ-DSF – is for Information.
3.26	The equipment shall support coherent detection to aid polarization separation and phase resolution and to clean up the effects of chromatic and polarization-mode dispersion. The electro-optics with coherent technology shall use DSP algorithms to facilitate polarization separation and phase resolution and clean up the effects of chromatic and polarization mode dispersion. This improves signal propagation and provides fast wavelength reconfiguration when restoration is required. Dispersion Compensation Modules (DCM), however, shall not be used in any of the Amplifiers. In case the purchaser requires the link engineering support/link engineering exercise, the manufacturer shall provide such support using link planning/design tools or any other method. -	In linear setup use long fiber as specified for linear long haul/very long haul configuration and verify performance of 100G Cards without Using DCM/DCU unit using coherent technology. Refer TSTP test no 22.0.
3.27	The manufacturer shall supply entire common hardware including ROADM Mux / Demux, Coherent Channel System and embedded control & management software etc. for 40 / 80/ 96 channels OTU-4/OTUCn DWDM system on day one. The system shall hitlessly upgrade in field to 40 / 80/ 96 channels @	Verify that the Mux/Demux, and embedded control & management software etc., for 40/80 channels @ OTU4/OTUCn DWDM system are provisioned

	OTU-4/OTUCn through insertion of IO cards followed by necessary cross connection and mapping functions. **Note:** The requirement of 96 channels is optional and may be decided by the purchaser or user.	on day one. Configure the system for the check of BER on any channel and then insert and also remove any other IO card and observe that the BER is not disturbed at all. In case the BER is disturbed at the time of insertion as well as removal of any other IO card, the equipment shall be rejected forthwith.

3.28	The Booster Amplifier and Pre-Amplifier (Optical Amplifier) shall be the integral part of OTMs, ILAs, FOADMs and ROADMs.	Verify that the Booster Amplifier and Pre-Amplifier (Optical Amplifier) shall be the integral part of OTMs, ILAs and OADMs/ROADMs. Booster Amplifier and Pre-Amplifier provisioned separately shall not be allowed.
3.29	The equipment shall support the optical monitoring as specified in ITU-T Rec. G.697 through EMS of the equipment at all nodes (ILA, OTM, FOADM and ROADM).	Verify that the monitoring points are provided in the ILA, OTM and OADM/ROADM through which parameters such as channel power, OSNR etc. can be monitored. Refer TSTP no 28.0.
3.30	The removal/insertion of any card including the redundant one shall not disturb the working of the system or deteriorate the BER of the other working channels in the system.	This feature has already been checked in Cl. 3.12.
3.31	To accurately simulate the performance of the offered equipment under end of life conditions (i.e. equipment with aged components operating at full capacity over aged fibre) and ensure successful transmission at OTU-4/OTUCn per channel over high loss optical fibre, a comprehensive network planning tool shall be supported. The tool may be	Ensure that the supplier of the equipment provides a network planning tool which may be either be standalone or may be integrated in to EMS. The purpose of this n/w planning tool is to recommend the optimum settings of the optical power, gain etc. due to the factors like attenuation, CD, PMD, OSNR and also non-linear effects.

	standalone or may be integrated in to EMS. The tool shall, among others, perform the following analysis and recommend the most suitable hardware components as well as settings (i.e. optical power, gain) to mitigate the limiting effects: a. Attenuation (including optical fibre loss, system component loss and margins), b. Chromatic dispersion (including required residual dispersion), c. Polarization mode dispersion (including contribution from both optical fiber and system components), d. Optical signal to noise ratio (OSNR) e. Non-linear effects(inc. XPM, SPM, FWM and SRS) (optional)	including XPM, SPM, FWM and SRS. The aging condition of the link can be simulated by increasing the fibre loss in each span in an unsystematic manner and using the n/w planning tool, the effects may be analyzed. Refer TSTP Test no 22.0 and check PMD and CD value in performance of the line card
3.32	The terminations for the unused channels shall be provided by the manufacturer as a part of the system. It shall be possible to equip the unused channel at a later date without affecting the existing traffic.	Verify that the provision of the termination for the unused channels is proper. The unused channels are terminated with auto shutter type caps.

3.33	The system shall support one Optical Supervisory Channel (OSC) as specified by ITU-T Rec. G.692 for the monitoring and configuration of OTM, ILA, F/ROADM on the route and shall be manageable from one location for the entire route via the EMS or LCT of the equipment. All OSC related functions including transmission, termination and processing shall be integrated within a single card; separate cards for OSC extraction, OSC insertion and OSC processing are not allowed to avoid slot wastage. The OSC channel shall be provided at 1510nm wavelength and shall have a capacity of at least 2 Mbps. The OSC transmitter and receiver behavior at the Inline Amplifier/Booster/Pre-Amp shall be monitored through EMS via suitable alarms. The OSC shall be accessible at all the ILAs and OADM sites, in addition to the terminal sites. It shall be required that OSC channel shall provide access to underlying DCC at Ethernet interface making possible to transport management information to other nodes through extended DCN. OSC is also used to transmit alarm information and consequently locating	Ensure that the transmission, termination and processing of OSC channel is integrated within a single card. Separate cards for OSC extraction. Also measure the wavelength of the OSC channel with a WDM Analyzer. It should be 1510 nm. Refer TSTP Test no 27.0. **Central Frequency** Refer TSTP Test no 27.0. 1) According to the test setup shown in Fig 39, connect the test instrument, 2) Read and record actual central wavelength value of the OSC/OSCF under test (in nm). The specification is 1510±10nm. **Mean launched power** Refer TSTP Test no 27.0. Optical launched power is defined as the average optical power coupled into the fiber by the OSC/OSCF transmitter. Test instrument includes optical power meter. The test setup is shown in Fig.39. 1) According to the test setup as shown in Fig. 49, connect the

	failures. If a card in a node fails, the alarm is written on the DCC of the OSC with the corresponding address of the "Smallest Replaceable Unit" failed. The information is propagated through the network carried by the DCC until it reaches the gateway to the EMS. NOTE 1: The attenuation of the OSC hybrid possibly used to access the OSC is not part of the optical path power-budget. NOTE 2: The OSC channel shall not consume any of the 40/80 traffic wavelengths.	test instrument, 2) Read and record optical launched power of the OSC/OSCF under test (expressed in dBm). The specification is 0~-7dBm:
3.33.1	Supervisory parameters: The supervisory system of the equipment shall be capable of local & remote monitoring the following of the Local and Remote equipment: 1. Input power of the Booster Amplifier 2. Output power of the Booster Amplifier 3. Laser temperature of the Booster Amplifier(Optional) 4. Input power of the pre-amplifier 5. Output power of the pre-amplifier 6. Laser temperature of pre-amplifier(Optional) 7. Input power of the Optical Line Amplifier 8. Output power of the Optical Line	The supervisory system of the equipment shall be capable of local & remote monitoring of the parameters mentioned in GR clauses 3.33.1. Check that the parameters are possible to be monitored through the EMS. Record the results in the schedule given later in this document.

	Amplifier 9. Laser temperature of the Optical Line Amplifier(Optional) 10. Output power of the Dropped Channel 11. Input power of the individual optical channel 12. Input power of the Optical Supervisory Channel (optional) 13. Output power of the Optical Supervisory Channel (optional) 14. Laser temperature or Laser-Bias current of the Optical Supervisory Channel(Optional) 15. 16. Bit error ratio (BER) before FEC at line interface 17. Fan failure at ROADM/ILA/OTM. 18. ODU/OPU alarms as per the list given below as per G.709. TCM Facility alarms • ODU AIS • ODU LCK • ODU OCI • ODU BDI • ODU Trace Identifier Mismatch • ODU Signal Degrade • TCM Loss of Tandem Connection ODUCTP alarms • ODU Signal Fail (monitor or terminate modes)	

	• ODU AIS • ODU LCK • ODU OCI • ODU BDI • ODU Loss of Frame and Multiframe • ODU Signal Degrade ODUTTP alarms • ODU AIS • ODU LCK • ODU OCI • ODU BDI • ODU Trace Identifier Mismatch • OPU Payload Type Mismatch • ODU Loss of Frame and Multiframe • ODU Signal Degrade The supervisory parameters shall be monitored and on crossing the specified limits an alarm shall be activated against each parameter listed as above. On the basis of nature of alarm, it shall be possible to mark it as Critical, Non-urgent and Deferred. The measurement accuracy of input/output power of the Booster/In-Line Amplifier/ Pre-Amplifier from the EMS of the system shall be within ±1.0 dB from the actual measured value on a wide-band Optical Power Meter.	

	The supervisory system shall provide necessary audio/visual alarm on equipment for indicating the alarms. Also from the EMS of the system it shall be possible to locate the faulty-section in the case the fibre is cut.- To maintain transparency and supervision capability of client services in accordance with ITU-T Rec. G.709, all client services shall be supervised by processing the ODU/OTU overhead bytes. At least path monitoring (PM) and section monitoring (SM) shall be supported.	
3.34	The system shall provide software controlled Optical Pre-emphasis via Variable Optical Attenuators (VOA) which provides for a capability to adjust the optical power per channel via the LCT/EMS. The optical power per channel must be adjusted automatically in case the DWDM equipment is equipped with a power monitoring unit.	Ensure that Variable Optical Attenuators (VOA) are provided for Optical Pre-emphasis. It is desirable that the Pre-emphasis via Variable Optical Attenuators is software controlled. Optimize power level of all the channels with the help of inbuilt VOA in TSTP Test no 22.0.

3.35	The output jitter and input jitter tolerance at the optical channels shall be as per ITU-T Rec. G.825 & G.783 for SDH and as per IEEE 802.3 standards for Ethernet client signals. The jitter and wander within digital networks which are based on OTN hierarchy shall be as per ITU-T Rec.G.8251.	Input Jitter Tolerance: Refer TSTP Test no 21.1 Input Jitter Tolerance mask shall comply with G.825. Attach the printouts of the test results Jitter Transfer: Refer TSTP Test no 21.2 Jitter Generation: Refer TSTP Test no 21.3.
3.36	The optical amplifiers must implement the following mechanisms to maintain error free system operation under dynamic conditions: Fast gain control loop: to protect against short term transient conditions such as sudden loss of channels. Slow output power control loop: to protect against long term conditions such as fibre aging.	Ensure that all the OAs support gain control and power control. Refer to TSTP test no 29.0

3.37	The equipment shall provide monitoring points for in-service monitoring the wavelength, power & OSNR of individual channel at the output points of the Booster Amplifier, ILA and Pre-amplifier by using an external test instrument. These points shall be suitably connectorised and on connection of a measurement device, the main transmission path shall not be affected at all. The equipment shall also facilitate monitoring the combined power at the output of Booster Amplifier, ILA and Pre-amplifier through the EMS / LCT.	Ensure that OBA, OLA, OPA have the monitoring points and power, wavelength, OSNR etc. are monitorable at those points This feature has already been checked in Cl. 3.33.1.
3.38	NMS/EMS related requirements:	
a	The equipment shall provide support for a comprehensive Element Management System (EMS). The managed-object database access protocol shall be either TL-1 or XML or Qx or SNMPver.2c (or later) or JSON or Web service interface with standard MIB Browser implemented therein based on UDP/IP stack shall be provided.	Test the protocol shall be either TL- I or XML or Qx or SNMP v2c or any later version or JSON or Web service offered for testing with MIB browser.

b	The EMS shall be provided with an open northbound interface towards Network Management Layer (NML) as per ITU-T standard Q3 or TMF-814 compliant CORBA or XML or JSON or Web service for future NMS/OSS integration objectives.	Check that the northbound interface of the EMS is either Q-3 or CORBA or XML or JSON or Web service. CORBA shall be tested as per TMF-814.
c	The manufacturer shall arrange testing for TL-1 or XML or Qx or SNMPv2c (or later) interface during the testing as per the PICS & MIBs (as applicable) and shall support the factory test results during testing of their products.	SNMPv2c or any later version offered for testing shall be tested as per the applicable PICS and MIBs.
d	The functional as well as protocol compliance for the management system shall be tested. Complete information on the NMS/EMS Northbound, Southbound interfaces and the NMS/EMS implementation protocol stacks shall be disclosed in details, in writing during the testing process.	Ensure that the details of southbound and northbound interfaces are disclosed in writing. A hard copy as well as a copy in a CD shall be obtained.
e	The manufacturer shall submit the soft as well as hard copy of his PICS & MIBs (as applicable) along with equipment for testing.	Obtain a soft copy as well as hard copy of the PICS and MIBs.
f	The model of the EMS shall be as per ITU-T Recs. M.3100 & M.3010 and software of the system shall reside in the Work Station/Server.	Ask the manufacturer to give in writing that the EMS model is as per ITU-T rec. M.3100 & M.3010.

g	The power-supply failure (not applicable for 'on-board' power-supply), Work Station breakdown & bugs in the software etc., shall not affect the healthy working of the system.	Ensure that the power supply failure, Work station breakdown, bugs in the soft ware do not affect the working of the system. Ask undertaking from manufacturer.
h	The Manufacturer shall provide a soft copy of his NMS/EMS on a CD/DVD as asked by the purchaser during the supply of the equipment. The setup/procedure to download the software shall be very clearly mentioned in the system manual of the equipment.	Obtain the softcopy of the EMS on a CD.
i	The NMS/EMS of the equipment shall have complete protection from the virus.	Ask manufacturer to give in writing that the NMS/EMS have protection from the virus.
j	The EMS of the equipment shall support the management of minimum 500 NEs where NE shall mean a fully equipped DWDM terminal, ROADM and ILA nodes.	Ensure that the EMS is able to support 500 NEs.
k	It shall be possible to manage complete DWDM link involving distant-end terminal, Optical Line Amplifiers and Reconfigurable Optical Add/Drop Multiplexers enroute. The Management System shall be provided for the ultimate capacity of the network.	Check that it is possible to manage the distant TM, OADMs and ILAs with the EMS.

3.39	The equipment shall have the provision of Automatic Laser Shut-Down (ALSD) in the case of fibre-plant breakdown and automatic re-start on restoration of fault in accordance with ITU-T Recs. G.664. The system shall restore within 0 – 10 sec (programmable) after restoration of fibre, plant breakdown or a faulty amplifier.	Check the ALSD/ APR takes place in case of fibre break down and also on restoration of the fibre fault, the equipment restarts automatically. Verify that the RST pulse can be programmed within 0-10 sec and that the system gets restored with the programmed time period.
3.40	The equipment shall provide built-in 'plug and play' type of Optical Equalization/ Pre-emphasis, if any, to meet individual channel power difference (channel-power balancing) and individual channel OSNR requirements etc. No field adjustments such as use of external attenuators etc., at the output of Mux/Transponders shall be permitted for the purpose of equalization/gain adjustments etc.	Check that to meet individual channel power balancing, the Optical Equalization/Pre-emphasis are plug and play type for channel power balancing and individual channel OSNR requirements etc.
3.41	The equipment shall provide guaranteed end to end performance at the BER of $1x10^{-12}$ (with FEC enable) at beginning of the life. To ensure end-of-life margins, the span lengths shall be tested for 3dB higher values than that values specified during testing	The BER should be the BER of $1x10^{-12}$ (with FEC enable) at the beginning of life. To ensure end-of-life margins, each span length shall be tested with a 3 dB higher value. Similarly, the receiver sensitivity of Optical channels shall be 3 dB lower than the value specified.

3.42	The removal/insertion of the Line Card shall not disturb the working of other channels in the system.	Configure the equipment for BER test and check that any insertion or extraction of Transponder or Muxponder card does not affect the BER.
3.43	There shall be sufficient sideways space for the running of the fibres/cables for inter- rack cabling etc. It shall be possible to handle the cabling from the front-side only.	Ensure that sideways space is only utilized for running cables for inter rack connectivity.
3.44	There shall be provision of in-service monitoring points for the optical power, and channel wavelength measurement at output points of Optical Amplifiers (including ILAs), ROADMs, Mux & input point of Demux.	Check that monitoring points are provided to measure channel power and wavelength in-service at the output points of all the Optical Amplifiers and Mux and also at the input point of De-mux.
3.45	The termination of the unused channels shall be provided by the manufacturer as a part of the equipment. It shall be possible to equip an unused channel at a later date without affecting the existing traffic.	Ensure that proper termination for the unused channels are provided so that they can be used as when required without affecting the existing traffic. The unused channels shall be provided with preferably auto-shutter type caps.

4.0	Mapping functions of the client signals	
4.1	ODUk Interface Adaptation: Multi-service interface modules shall support STM-1/4/16/64, OTU1/2/2e/flex/3//4, GE/10GE/40GE/100GE Ethernet services well as FC-100/200/40( )0/1200 and other customer se ce access. The Interface adaptation r ules shall be able to map the client signal into appropriate ODUk (k =0, 1, 2, 2e, flex, 3, , 4) size bandwidth. The ODUk interface adapter modules shall support packet services directly through the Ethernet interface modules to achieve ODUk through GFP-F functionality. Note: STM-1, STM-4 and STM-16 interfaces are optional for client side and may be decided by the purchaser	Configure E2E trail for multi service functiioality of STM-1/4/16/64 , OTU1/2/2e/flex/3/3e , GE/10GE/40GE/100GE. GE/10GE/40GE/100GE Ethemet services as well as FC-100/200/400/800/1200 and other customer service access. However, testing will be conducted as per offerd equipment for TAC. Refer TSTP Test no 22.0
4.2	**Client signal mapping flow** The client signal mapping and multiplexing path shall be as shown in Figure 6 below.	Connect EMS to the equipment & verify mapping flow of client signal. Refer TSTP Test no 22.0 and verify signal flow.

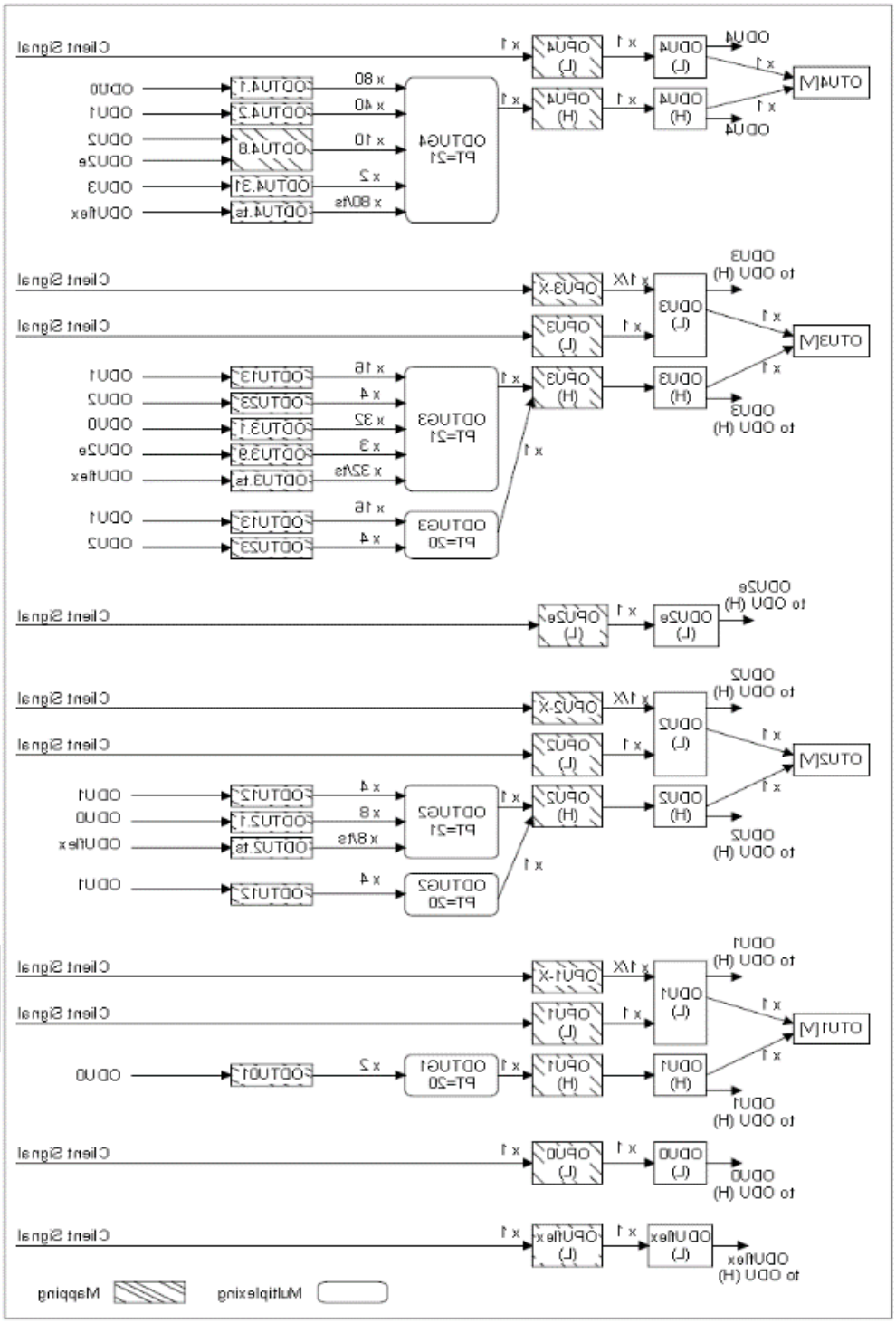


Figure-6 – OTM multiplexing and mapping structures

4.3	**Mapping of Client signals to LO OPUk** Constant Bit (CBR), traditional SDH client signals as STM-16/64 are mapped to OPU1/2/3 using asynchronous mapping or bit synchronous mapping procedures (AMP / BMP). Ethernet client signals GE/10GE/40GE are traditionally mapped on to OPU0/2e/3 by using GFP-F. In case of GE/40GE, the client signal is first compressed using the timing transparent encoded transformation (TTT) compression technique before mapping to OPU0 / 3 using Generic mapping procedure (GMP). 10GE is mapped using bit synchronous mapping (BMP) to OPU2e. - The client signals 1.238Gbit / s and below the CBR client signal, such as STM-1/4, FC-100 is mapped to OPU0 by using generic mapping procedure (GMP); the 2.488 Gbit / s and below CBR client signals such as FC-200 are mapped to OPU1; the rate near 9.995Gbit /s CBR client signals are mapped to OPU2; the rate closed to 40.149 Gbit/s CBR client signals are mapped to OPU3. Other CBR client signals such as FC-400/800 are mapped to OPUflex using bit synchronous mapping (BMP), and	Ensure mapping of client signal to LO OPUK as per Table XII.I of ITU-T Rec.G.709 as per procedure mentioned below. Refer TSTP Test no 22.0.

	FC-1200 signal with 50B/51B compression is mapped to OPU2e. Table XII.1 of ITU-T Rec. G.709 below provides an overview of the mapping procedure of the CBR client signals into LO OPUk.	

	OPU0	OPU1	OPU2	OPU2e	OPU3	OPU4	OPUflex
STM-1	GMP	-	-	-	-	-	-
STM-4	GMP	-	-	-	-	-	-
STM-16	-	AMP, BMP	-	-	-	-	-
STM-64	-	-	AMP, BMP	-	-	-	-
1000BASE-X	TTT+GMP	-	-	-	-	-	-
10GBASE-R	-	-	-	16FS + BMP	-	-	-
40GBASE-R	-	-	-	-	TTT+ GMP	-	-
100GBASE-R	-	-	-	-	-	GMP	-
FC-100	GMP	-	-	-	-	-	-
FC-200	-	GMP (C_{8D})	-	-	-	-	-
FC-400	-	-	-	-	-	-	BMP

FC-800	-	-	-	-	-	-	BMP
FC-1200	-	-	-	TTT+ 16FS+BMP	-	-	-
FC-1600							
FC-3200							

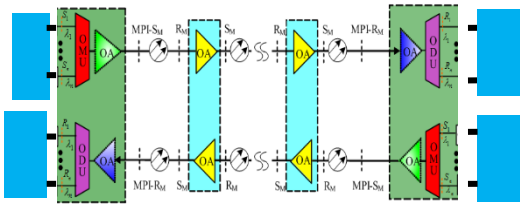
Table-1: Overview of CBR client into LO OPU mapping types

4.4	**ODUk to ODTU signal mapping** ODUk to ODTU signal mapping can be supported using two mapping procedures - the asynchronous mapping procedures (AMP) and the generic mapping procedures (GMP): a) ODUj to ODTUjk {(j, k) = {(0,1), (1,2) (1,3) (2,3); ODTU01 ODTU12, ODTU13 ODTU23} using the asynchronous mapping procedures (AMP). b) ODUj to ODTUk.ts {(k, ts) = {(2,1... 8) (3,1... 32), (4, 1...80); j = 0,1,2,2e, 3, flex} using generic mapping procedure (GMP)	Verify that the ODUK to OTUk signal mapping can be supported using AMP and GMP. For AMP refer TSTP Test no 22.0

4.5	**ODTU to HO OPUk mapping** ODTU signal multiplexing mapped to the HO OPUk in three ways, a) ODTUjk {(j, k) = {(1,2) (1,3) (2,3); ODTU12, ODTU13, ODTU23} mapped to a 2.5G HO OPUk tributary slot (TS = 1, 4,16) any one of the combinations; b) ODTUjk {(j, k) = (0, 1), (1, 2) (1, 3) (2, 3); the ODTU01, ODTU12 ODTU13, ODTU23}), wherein ODTU12, ODTU13, ODTU23 mapped to HO OPUk 1.25G tributary slot (TS = 2, 8, 32) any two combination; ODTU01 mapped to HO OPUk 1.25G tributary slot (TS = 2, 8, 32) any one of the combinations; c) ODTUk.ts {(k, ts) = (2,1 ... 8), (3,1 ... 32), (4,1 ... 80)} is mapped to the HO OPUk 1.25G tributary slot (ts = 8,32,80) any of the ts combinations.	Verify that the ODTU signal multiplexing mapped to the HO OPUk as per ITU-T G. 709 multiplexing process. Refer TSTP Test no 22.0 and verify mapping in EMS.
5.0	**Cross Connect Capacity, Equipment Configurations and Network Topologies:**	
5.1	**Cross Connect capacity:** The cross connect module of the equipment shall be universal packet / OTN switch matrix type. The	Verify that the cross connet module of the equipment shall be universal for packet & OTN swith matrix type. The equipment is divided into eight distinct

	equipment is divided in to thirteen distinct categories based on cross-connect matrix size and functionality, as equivalent OTU4/OTUCn. Category-1: 600 Gbit/s non-blocking matrix with each port configurable for any direction of transmission. Category-2: 1Tbit/s non-blocking matrix with each port configurable for any direction of transmission. **New Category**: 1.6 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. Category-3: 2 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. **New Category**: 2.4 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. Category-4: 3 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. **New Category**: 3.6 Tbit/s non-blocking matrix with each port configurable for	categories based on cross- connect matrix size and functionality. Note that User may order for an equipment of any of the categories with reduced no. of line ports (eg. < 40 chl. in case of 40 chl. DWDM) as per the networking requirements. Refer TSTP Test no 22.0 and configure cross connection of all the interfaces through single cross connect cards.

	any direction of transmission. Category-5: 4 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. **New Category**: 4.8 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. Category6: 6 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. Category 7: 8 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. Category8: 9.6 Tbit/s non-blocking matrix with each port configurable for any direction of transmission. **New Category**: 12Tbit/s non-blocking matrix with each port configurable for any direction of transmission. **New Category**:24Tbit/s non-blocking matrix with each port configurable for any direction of transmission NOTE: User may order for an equipment of any of the above categories with	

	reduced no. of line ports (eg. < 40 chl. in case of 40 chl. DWDM) as per the networking requirements.	
5.2	Equipment configuration: Reference point definitions See the reference configuration for 40/80 × OTU4/OTUCn WDM system in the Figure-7, where - OTUk Line unit is the optical transport unit which performs optical wavelength conversion, coloring the wave, FEC codification, coherent detection etc. OMU is the Optical wavelength multiplexer unit, implements many wave length multiplexing functions; OA is the Optical Amplifier unit and also includes chromatic dispersion compensatory function; ODU is the Optical Wavelength De-multiplexer unit which implements many wave length de-multiplexing functions; Tx/Rx is the client side trans and receive Optical interface.  **Figure-7: OUT-3/4 WDM system reference configuration** Figure above defines the network reference points as under –	Note that 40/80 channel OTN equipment configuration for OTU-4/OTUCn WDM system should be as per mentioned below: 1. OTUK Line Unit: Line unit for optical wavelength conversion , coloring the wave, FEC codification, coherent detection etc 2. OMU: Optical wavelength Multiplexer. 3. OA: Optical amplifier unit. 4. ODU: Optical De-Multiplexer Unit. 5. TX/Rx – Client side trans and receive interface. Refer TSTP Test no 3.0 for testing of all these parameters.

	S is the output client reference point, - S_1…S_n are reference points between OTUk Line unit and OMU for channels 1…n respectively, - MPI-S_M is a multi-channel reference point on the optical fiber just after the multi-channel OA output connector, - S_M is a reference point just after the line multi-channel OA output optical connector, - R is the input client reference point, - R_1 ... R_n are reference points between the ODU and OTUk Line unit for channels 1…n respectively, - MPI-R_M is a multi-channel reference point on the optical fiber just before the multi-channel OA input connector, - R_M is a reference point just before the line multi-channel OA input optical connector.	

6.0	**Physical Interface Requirements:** The MS OTN platform equipment shall provide a combination of the following physical user interfaces and services. Purchaser / user shall explicitly indicate the interfaces as per requirements. The interfaces against the related international and TEC standards are as given below:	Verify that MS OTN platform equipment should provide a combination of physical user interfaces complying with international and TEC standards. Purchaser /user can select Interfaces as per Network requirement. Refer TSTP Test no 22.0

Service type and service rate				
Service Category	**Service Type**	**Service Rate**	**Reference Standard**	**TEC GR/IR**
SDH interfaces	STM-1(Optional)	155.52 Mbit/s	ITU-T G.707 ITU-T G.691 ITU-T G.957 ITU-T G.693 ITU-T G.783 ITU-T G.825 ITU-T G.693 ITU-T G.783 ITU-T G.825	TEC/IR/TX/DMX/ 006/03.DEC 11
	STM-4 (Optional)	622.08 Mbit/s		
	STM-16	2.5 Gbit/s		
	STM-64	9.95 Gbit/s		
Ethernet interfaces	GE	1.25 Gbit/s	IEEE 802.3u IEEE 802.3z IEEE 802.3ae	TEC/IR/TX/ETH/008/01.JUN.12
	10GE WAN	9.95 Gbit/s		
	10GE LAN	10.31 Gbit/s		
	40GE	41.25Gbit/s		

	100GE	120.579 Gbit/s	IEEE 802.3ba	
SAN service interfaces	FC100	1.06 Gbit/s	ANSI X3.296 ANSI X3.230 ANSI X3.303	
	FC200	2.12 Gbit/s		
	FC400	4.25 Gbit/s		
	FC800	8.5 Gbit/s		
	FC1200	10.51 Gbit/s		
	FC-1600			
	FC-3200			
OTN interfaces	OTU1	2.67 Gbit/s	ITU-T G.709 ITU-T G.959.1 GR-2918-CORE	TEC/GR/TX/OTA/001/01.MAR.11
	OTU2	10.71 Gbit/s		
	OTU2e	11.10 Gbit/s		
	OTU3	43.02 Gbit/s		
	OTU4	111.80 Gbit/s		
	OTUCn			

Table-2: Interfaces and relevant international and TEC standards

7.0	**DWDM equipment functional blocks**	
7.1	The DWDM equipment shall provide the following functionalities - a) Terminal Blocks: - Line interface from/to OTN block - Multiplexing/de-multiplexing element - Booster/pre-amplification - OSC termination - Power Monitoring Unit, if used - Optics for Coherent detection	The detail testing of the OTM, ILA and FOADM/ROADM are covered later in TSTP test no 1.0 to 21.0.

	b) In Line Amplifier Block: - Optical line amplification - OSC termination c) FOADM/ ROADM Block: The GR envisages a common platform for Reconfigurable Optical Add/Drop Mux and Fixed Optical Add/Drop Mux. The ROADM shall have East West separation resulting in traversing the east direction traffic not sharing the common cards with add/drop channels in the west direction and vice versa. The FOADM/ ROADM shall provide the following functionalities: a) Multiplex/de-multiplex of wavelengths for channel add/drop functionality, b) Booster/pre-amplification, c) OSC termination, d) Power Monitoring Unit, if used,	

7.2	Mux/Demux: The Multiplexer of the DWDM equipment shall combine a maximum of 40/80/96 colored DWDM channels into a multi-channel signal. Similarly, the Demux shall provide the reverse function. **Note:** The requirement of 96 channels is optional and may be decided by the purchaser or user. The Mux/Demux shall contain passive optical DWDM filter components to combine and split the light of different ports associated with different DWDM wavelengths. Various DWDM Mux/Demux characteristics for 'Add-out insertion loss (max.) per channel for Mux', 'Drop-in insertion loss (max.) per channel for De-Mux', are left open for implementation to manufacturer subject to conformance to parametric limits as stipulated in Table 1 & 2/ Annexure-I at all relevant reference points 'RMn/SDn' and 'MPI-S/MPI-R'. a. It shall be possible to upgrade the Optical Terminal Multiplexer equipment to Fixed/Reconfigurable Optical	Verify that Multiplexer of the DWDM equipment shall combine a maximum of 40/80 colored DWDM channels into a multi-channel signal. Similarly , the Demux shall provide the reverse function. Refer TSTP no18.0 & 22.0 a. Ensure to upgrade OTM equipment into FOADM & ROADM.

	Add/Drop Multiplex equipment. b. The details of technology and characteristics (other than defined in this document) of Multiplexer/Demultiplexer shall be specified by the manufacturer. c. Upgrades to additional add/drop channels shall be hitless and shall be supported in field. NOTE: Cross-talk values - 'Maximum adjacent channel cross-talk for De-Mux', 'Minimum Isolation (for adjacent as well as non-adjacent channels) for Mux & De-Mux' shall be complied at relevant 'SDn' reference point (for the disturbed channel) at De-Mux, S' reference point on ILA/ROADM and MPI-S reference point at MUX output under the following conditions: 1. The channel power for the disturbed channel at 'RMn' reference point at MUX is at a minimum. 2. The powers at other channels at respective 'RMn' reference points are at a maximum. 3. The optical filter characteristics in Mux/De-Mux shall be such as to compensate for channel-power disparities to adhere to cross-talk specifications.	b. Specify details of technology and characteristics (other than defined in this document) for Mux & Demux. c. Ensure upgrade to additional add/drop channels shall be hitless with adding /revoving additional channel. **1. Optical interface at the output of Muxer/Amplifier** a) **Cross talk at Mux:** Refer TSTP Test no 10.0 The cross talk basically is the ratio of peak signal power to the peak signal noise from the neighboring channel and is some time referred as channel isolation as well. It is more effective in case of adjacent channels. The noise effect of the disturbing channel on two neighboring channels on either side of the disturbing channel shall be taken. Take the peak signal power of the disturbing channel (A dB) and record it. Now look for the cross talk effect of disturbing channel on disturbed

		channel by selecting the wavelength of the disturbed channel on DWDM Analyser, There shall be the low amplitude spectral noise in the frequency bandwidth of disturbing channel present in the designated slot in the neighboring channels. Measure the amplitude of this spectral noise (B dB) on next channel and record it. Similarly go the other adjacent channel i.e previous channel and measure the amplitude of the spectral noise in the previous channel. The specs limits for the cross talk is <-22 dB for adjacent channel. b) **Cross talk at the Optical Line Amplifiers:** The test set up for Optical Line Amplifier shall be same as Booster amplifier except connecting the DWDM analyser at the out of Optical Line amplifier as shown TSTP test no 10.0. Connect the DWDM analyzer at output of each optical line amplifier including Pre Amplifier one by one and take the reading at the output of every Amplifier and record the reading. 2. **Optical interface at the input of Demuxer/Amplifier**

		a) **Optical signal cross talk at Input of Demuxer/Amplifier:** Refer TSTP Test Procedure 13.0. Connect the DWDM Analyser at the far end of 22 dB optical fibre spool inserted between the Muxer and Demuxer by opening the connection in other words at the input of the Optical Line Amplifiers or the Pre Amplifier. The measurement method is same as earlier measurement mentioned above. The spec. limit is <- 22 dB for adjacent channel & <-25 for non adjacent channels. Record the reading for each channel including maintenance channels. Record the reading for all the 40 working channel and on maintenance channels also.

7.3	Optical Amplifier: The DWDM system shall provide EDFA Booster Amplifiers (at Mux end), Pre-Amplifiers (at Demux end) and ILA's at enroute stations to compensate fibre-attenuation etc. The Optical In-Line Amplifier shall amplify the optical signals received at the input and shall have the characteristics as given in the Table-1 & 2/Annexure-I. - The Optical Amplifiers shall amplify the aggregate DWDM optical signal received at the input using EDFA technology. At least two types of Line Amplifiers shall be supported viz. Longhaul Amplifier and Very Longhaul Amplifiers based on the amplification capabilities. The equalization and other parameters shall be the same for both types unless these are specified. There shall be active control and instantaneous adaptation of express traffic due to any degradation arising out from rapid reconfigurations. Sudden addition/removal of channels at intermediate site must not affect whole transmission of DWDM signals. The optical amplifiers shall respond	1. Multi Chl Gain Variation at Booster/Pre amplifiers: Refer TSTP Test no 17.1 2. Multi Chl Gain Tilt: This is also referred as Inter-Chl gain- change ratio. This is defined as the ratio of the change in gain in each Chl to the change in gain at a reference Chl as the input conditions are varied from one set of input Chl power to second set input Chl powers. First, adjust the input power to Optical amplifiers to its minimum specified level i.e., –8 dB with optical power meter at point R' (Input of Optical amplifier). Now connect the DWDM Analyser at the point R' of the Optical Amplifier (Input of the Optical Amplifier) as shown in figure 10 and check the power spectral of each Chl and record it. Similarly, move the DWDM Analyser to the output of the Amplifier i.e. at point S' with -8 db level in the input. Take the difference of output channel power and input channel power for each channel and calculate the Gain. Similarly take the reading for maximum specified level i.e –3 dB at the point R' of Optical Amplifier and

	automatically to changes in the number of channels without the need for manual intervention or realignment. Integrated VOA shall allow the amplifier units to automatically compensate for variations in span-attenuation due to ageing and splicing etc. The adaptation response for restoration after ILA fault, fibre-plant restoration or change in power levels etc., shall be immediate. The system shall restore autonomously on the restoration of link after fibre plant breakdown or a faulty amplifier. The optical amplifiers shall be capable to accommodate the optical gain and power requirements up to a full channel capacity per node. NOTE: The above bindings shall hold good for the optical amplifiers that are part of Terminals, FOADM and ROADM.	thereafter take the readings at point S' with the help of DWDM Analyser and record the readings. From the set of reading at the input of the Amplifier and Output of Amplifier calculate the Gain of each channel The Channel 40 shall be kept as reference channel. Refer TSTP Test no 17.2 3. Multi Chl Gain –Change Difference at Optical Amplifier: Refer TSTP Test no 17.3 4. Signal Spontaneous Noise Figure: NF is a test of the Amplifiers and is nor measured in the link. The instrument is connected to the input and output ports of the Amplifier where the instrument computes both the readings and gives the result of NF directly. The test set shall include the 22 dB optical Fibre section in each span. Refer TSTP Test no 17.4 5. Center Frequency: The test is covered under the spectral of colour lasers at the Muxer's Input and Demuxer Out put, and at the Amplifier sites , this test will not be taken.

		6. Center Frequency drift: The test set up for the Center frequency drift shall be same as Center frequency From the test results of centre frequency note down the drifrt w.r.t to the specified frequencies in table-2 for each Chl. The permissible drift shall be +/- 25 pm. where as the N is frequency spacing which in this case shall be 100 Ghz. Record the the drit in the table shown for centre frequency above. 7. Maximum Power channel Difference (at point S'): Connect OSA at the output of Mux, input and output of amplifiers of each span and record the channel power. Difference between maximum and minimum channel power in each span should not be more than 6 dB. Refer TSTP test no 16.0
7.4	Optical Add/Drop Multiplex Block Two types of OADM units are envisaged to be used in the network viz FOADM (Fixed OADM) and ROADM (Reconfigurable OADM). The usage of the 2 types of OADMs is dependent on the application and shall be as per the	Ensure that common cards for East and West direction should not share with add drop channels.

	purchaser's requirements. The equipment vendor shall support both types of OADMs. Design Requirements The add-drop channels traversing the east direction do not share common cards with add/drop channels in the west direction. This allows for protection of local traffic at a particular OADM. For example, let's assume that there is one protected channel originating from an OADM, whereby the working channel traverses east and the protected channel traverse west. If there are common cards that are shared by both the east and west channels and these cards fail, both the working and protection channel will fail and the local traffic in the OADM is lost. The OADM architecture shall guarantee east-west separation such that optical card failures(s) involving either the east or west direction of transmission shall not impact optical channels traversing in the respective west or east direction.	

7.4.1	FOADM (Optional) Two variants of Fixed Optical Add/Drop multiplexers shall be supported: i. Low Capacity FOADM: Such a FOADM shall support a maximum of 4 optical wavelengths for add/drop traffic (fixed & pre-defined) with the remaining optical wavelengths passed through to outgoing path without 3R regeneration. ii. High Capacity FOADM: Such a FOADM shall support any subset of add/drop traffic in steps of 4 optical wavelengths up to the full system capacity, with the remaining optical wavelengths passed through to any other location without 3R regeneration. The architecture used shall be flexible enough to allow for in-service scaling of add/drop capacity from 4 optical wavelengths up to the maximum of 40 optical wavelengths. There shall be no restrictions on wavelength assignment to the add/drop channels, allowing any or all unique optical wavelengths to be added/dropped at any location. Both symmetric add/drop (whereby no. of dropped channels is equal to no. of inserted channels) and asymmetric add/drop (whereby no. of dropped channels is not equal to no. of inserted channels) shall be supported.	i. This is fixed and predefined wavelength for add/drop of 4 optical wavelength. Pl. ensure flexible wavelength for add/ drop and there should be provisioning for in-service scaling of add/drop capacity from 4 optical wavelengths up to the maximum of 40 optical wavelengths. ii. Refer figure 3 & 4.

	The system design shall be such that it implements wavelength reuse at Optical Add/Drop Multiplexers, allowing any particular wavelength that has been dropped from a previous optical multiplex section to be reinserted into any subsequent optical multiplex section to carry new traffic. Any insertion losses incurred in the add/drop process shall be compensated within the system. The wavelengths drop/insert shall be random and not necessarily in order of sequence. The OADM design shall be such as to allow unrestricted continued re-use of same channel/channels in the subsequent cascaded spans for the dropped channels. Upgrades to additional add/drop channels shall be hitless and shall be supported in field. NOTE: The user shall clearly specify the variant of FOADM at the time of procurement.	
7.4.2	Reconfigurable Optical Add-Drop Multiplexer (ROADM) A reconfigurable optical add-drop multiplexer (ROADM) is a form of optical add-drop multiplexer that adds the ability to remotely configure wavelengths in	Test the ROADM and in ROADM

	OADM system. This allows individual wavelengths carrying traffic channels to be added, dropped or pass through from a transport fibre without the need to convert the signals on all of the WDM channels to electronic signals and back to optical signals. Such an Optical Add Drop Multiplexer shall support the add/drop of any channel in resolution of single channel of bi-directional optical wavelengths up to the maximum capacity of the bidirectional optical wavelengths, with the remaining optical wavelengths passed through to any other location without 3R regeneration. There is no, in fact, any restrictions on wavelength assignment to the add/drop channels, allowing any or all unique optical wavelengths to be added/dropped at any location. The system also provides both symmetric add/drop facility whereby no. of dropped channels is equal to no. of inserted channels and asymmetric add/drop facility whereby no. of dropped channels is not equal to no. of inserted channels.	

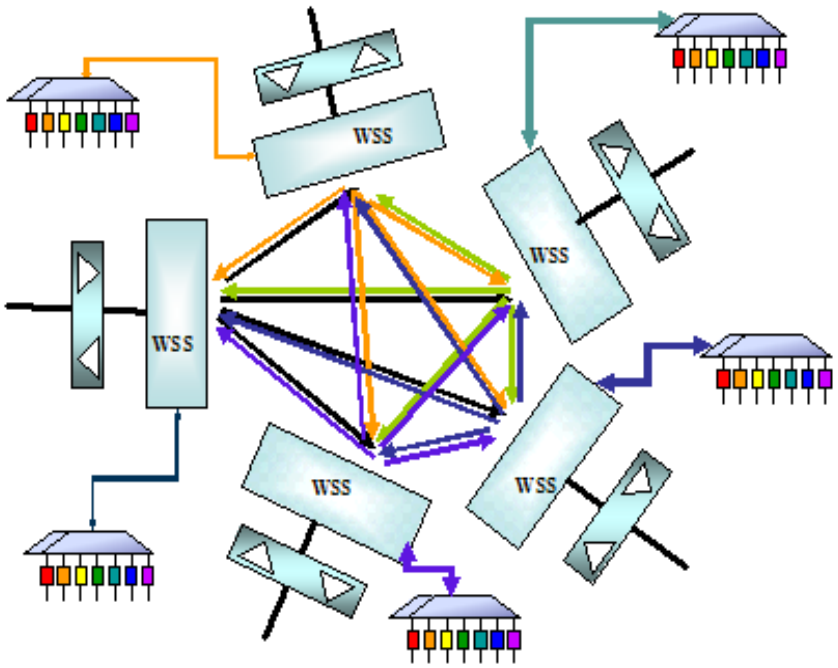


Figure-8: A model diagram for ROADM supporting 5 directions

NOTE: The user shall specify the degree of ROADM during the procurement of the equipment.

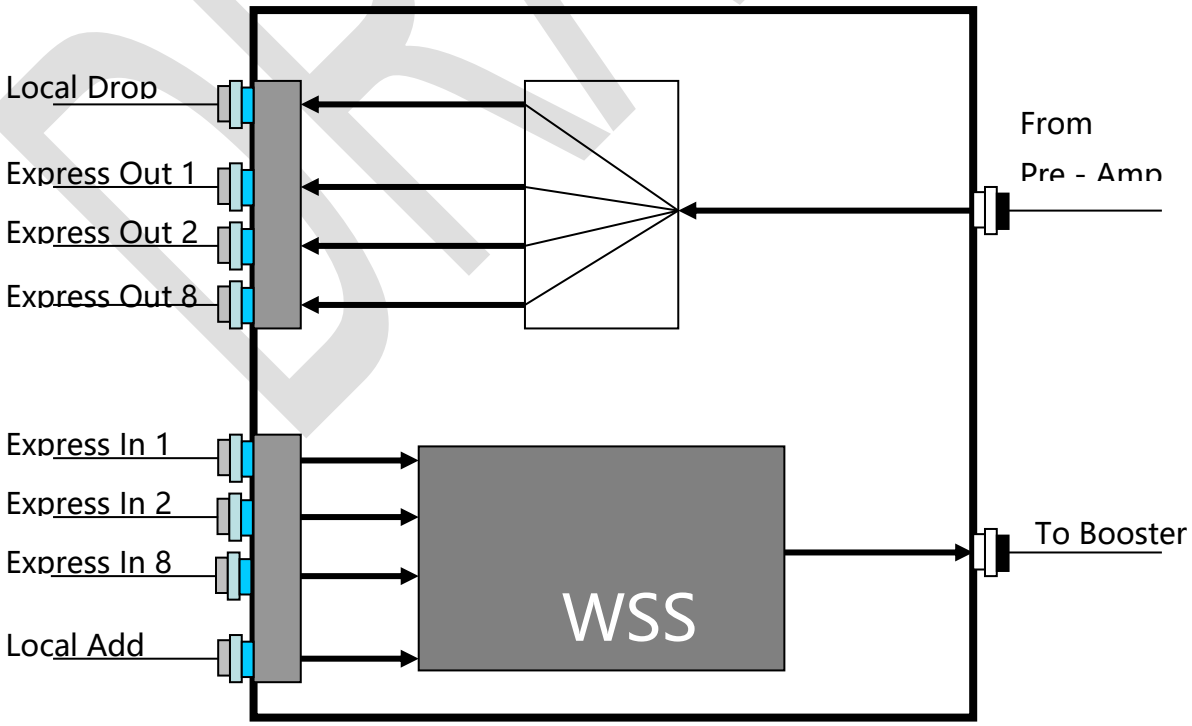


Figure-9: Block diagram of the WSS ROADM

	A reconfigurable optical add-drop multiplexer (ROADM) shall be colorless, directionless, contentionless and flexible and shall support up to eight degrees. ROADM shall be a wavelength selective switch (WSS) based on Micro-Electro-Mechanical Systems (MEMS) or LCOS technology or a combination of both and shall support the following functionalities: 1. The planning of entire bandwidth assignment need not be carried during initial deployment of a system. The configuration can be done as and when required. 2. ROADM shall allow for remote configuration and reconfiguration. 3. In ROADM, as it is not clear beforehand where a signal can be potentially routed, there is a necessity of power balancing of these signals. ROADMs shall allow automatic power balancing. 4. The ROADM shall be compact in size and shall be of low power consumption and low insertion loss type.	

	5. It shall provide Express channel equalization. 6. ROADM shall provide add/drop scalability from 0 to 40/80 channels. 7. It shall be highly reliable. 8. Each ROADM node shall be a multi-degree node supporting 8 directions. However, during the evaluation testing, support of at least 4 directions shall be demonstrated.	
7.4.3	General Design requirements of OADM (FOADM/ROADM) It shall be ensured that add/drop channels traversing the east direction do not share common cards with add/drop channels in the west direction. This allows for protection of local traffic at a particular OADM. For example, let's assume that there is one protected channel originating from an OADM, whereby the working channel traverses in the eastern direction and the protection channel traverses in the western direction. If it is a common card which is shared by both the east bound and west bound channels and the card fails, both the working and protection	Verify that the ROADM/FOADM add/drop channels traversing the Channel upgradation/removal should be hitless. Put the analyzer between OTM and FOADM/ROADM and make service OK. Now add /remove the channel Between OTM and FOADM/ ROADM and check the service which should be hitless.

	channel will fail and the local traffic in the OADM is lost. The OADM architecture shall, therefore, guarantee east-west separation (EWS) such that optical card failure(s) involving either the east or west direction of transmission shall not impact optical channels traversing in the respective west or east direction. A separate booster and preamplifier cards for the two directions are a precondition for EWS. An OADM with random channel add/drop is envisaged in the GR. OADM node shall provide an EDFA amplifier to offset various losses i.e., insertion loss for channel add/drop and fiber-attenuation etc. Upgrades to additional add/drop channels up to limits proposed, shall be hitless and shall be supported in field.	
8.0	**Technical requirements and characteristics of DWDM system:**	
8.1	DWDM window of operation: The optical window of operation of the DWDM system shall be in the range from 1529 nm to 1565 nm (C-band) as per ITU-T Rec. G.694.1.	Refer TSTP Test no 1.0

8.2	**Channel spacing:** The nominal central wavelength spacing shall be 100/75/50 GHz/ flexible grid. The source wavelength variation shall be as per Table-1 & 2/Annexure-I. Any consecutive 40/80/96 wavelengths may be chosen by the user from DWDM-grid as specified in ITU-T Rec. G.694.1 or flexible grid. **Note:** The requirement of 96 channels is optional and may be decided by the purchaser or user.	Check that the system supports channel spacing between the adjacent channels as 100GHz/50 GHz as per 40/80 channels. Refer TSTP Test no 1.0
8.3	Central frequency: The allowed channel frequencies are based on ITU-T grid with reference frequency at 193.1 THz.	Ensure that the channel frequencies as per ITU-T grid with reference frequency at 193.1 THz. Refer TSTP Test no 1.0
8.4	Equipped channel capacity of the equipment: The DWDM system shall provide an end to end capacity for 40 channels @ OTU-4/OTUCn, on day one. The exact number of actual equipped interface cards shall be as per the requirements of the purchaser. Proper termination of the unused channels shall be provided by the manufacturer as part of system design. It shall be possible to utilize the unequipped channels at a later date without affecting the existing traffic.	Ensure that the common boards are configured for 40 channels on day one.

8.5	Type of connectors: The connectors used at the OTM, Optical Amplifiers and OADMs shall be SC/LC type with automatic shutters having spring-action. When out-of-use, they shall remain closed or otherwise the optical connectors shall be so positioned as to be leaning down towards ground to avoid direct laser-beam incidence on the user. The Return Loss of the optical connectors shall be ≥40dB. At the ODF/FDF-end, the connectors used shall be Angle Polished FC/SC/LC/APC type. In case, the connectors provisioned are other than FC/SC/LC/APC, the manufacturer shall supply two sets of suitable patch cords for each port for DWDM Add/Drop Mux & Terminals and eight patch-cords for optical amplifier sites for compatibility with the existing ODF/FDF. NOTE: The user shall take care not to exceed the above mentioned span limits.	Ensure that SC, LC or better types of connectors are provided at the equipment side and FC/SC/LC/APC types of connectors are provided at the ODF side.

9.0	**Optical Monitoring (OM)** The objective of optical monitoring is to detect anomalies, defects, degradations and fault affecting the quality of DWDM systems at optical layer. The optical monitoring of the DWDM system shall provide the facility of locally and remotely monitoring of some important parameters as specified in the ITU-T Rec. G.697. The parameters shall facilitate in-service fault analysis and performance degradation of DWDM system and enhance the reliability of the system. The methodology of "Optical Monitoring" shall be as specified in ITU-T Rec.G.697. The local and remote monitoring of following Optical parameters of the DWDM system shall be supported by the system through its EMS.	Verify that the system supports in-service optical monitoring at various points as stated under: Refer TSTP Test no 28.0.
1.	Channel power: The equipment shall support the channel power measurements at the following points: a. Channel power before the DWDM multiplexer, b. Channel power after the DWDM demultiplexer.	a. Check that the output power of the individual channel can be measured through EMS. b. Measure channel power at the monitor point of Demultiplexure.

2.	Total power: The equipment shall support the total channel power measurements at the following points: a. Total power at input of various stages of optical amplification, b. Total power at output of various stages of optical amplification,	Connect EMS to the equipment and measure total channel power at the input and output of the amplifier at various amplification stages.
10.0	**Performance requirements** The equipment shall be tested for error performance as follows: The equipment shall support the following performance parameters relating to the ODU-k as specified in ITU-T Recs.G.8201 and G.7710. 1. Optical Channel Transport Unit Background Block Error (OTU_ BBE). 2. Optical Channel Transport Unit Errored Second (OTU_ ES). 3. Optical Channel Transport Unit Severely Errored Second (OTU_ SES). 4. Optical Channel Transport Unit Unavailable Second (OTU_ UAS). 5. Optical Channel Transport Unit Far End Error Background Block Error (OTU_FEBBE). 6. Optical Channel Transport Unit Far End Errored Second (OTU_FEES).	Transmit any OUT-k signal from an instrument and connect the output of the instrument to the input OUT- k port of the equipment. Receive the same signal at the other end of the system and connect the same to the receive port of the same instrument of another instrument. Verify the performance parameters one by one and note the observation in the table. Check the BER performance over simulated-section (end-to-end) for 48 hours on a channel in the link. BER performance shall be better than $1x10^{-12}$ with FEC enable. Also, run an RFC-2554 tests on an end-to-end basis for any GbE port and ensure that the parameters such as throughput, latency and frame loss are ok.

	7. Optical Channel Transport Unit Far End Severely Errored Second (ODU_FESES) 8. Optical Channel Transport Unit Far End Unavailable Second (OTU_ FEUAS). 9. 10. Optical Channel Data Unit Path Monitoring Background Block Error (ODU_PM_BBE). 11. Optical Channel Data Unit Path Monitoring Errored Second (ODU_PM_ES) 12. Optical Channel Data Unit Path Monitoring Severely Errored Second (ODU_PM_SES). 13. Optical Channel Data Unit Path Monitoring Unavailable Second (ODU_PM_UAS). 14. Optical Channel Data Unit Path Monitoring Far End Errored Second (ODU_PM_FEES). 15. Optical Channel Data Unit Path Monitoring Far End Severely Errored Second (ODU_PM_FESES) 16. Optical Channel Data Unit Path Monitoring Far End Unavailable Second (ODU_PM_FEUAS) New Clause : Optical Channel Data Unit Path Monitoring Far End	Refer TSTP tests 31.0 & 34.0.

	Background Block Error (ODU_PM_FEBBE). In laboratory: BER performance over a simulated-section shall be tested for 48 hours and BER performance shall be better than 10^{-12} (with FEC enabled). For Ethernet clients, end to end IETF RFC 2544 compliance shall be tested. In field: BER performance for 48 hours shall conform to ITU-T Rec. G.828 for SDH payloads. For Ethernet clients, end to end IETF RFC 2544 compliance shall be tested.	

11.0	**Alarms:**	
11.1	The following DWDM related alarm conditions shall be reported by the EMS: 1. Input power failure of the Transponder/Mux-ponder interface (including Ethernet interfaces). 2. Input power failure of the Amplifiers 3. Output power failure of the Amplifiers 4. Fan/s failure 5. Output power out of range for OA, OADMs 6. Input power out of range for OA, OADMs 7. Derived power supply failure alarm 8. Loss of input at Optical Add/Drop Multiplex equipment 9. Input channel failure at Optical Add/Drop Multiplex equipment 10. Hardware mismatch alarm 11. Low input power of the client interface signal 12. Low input power at OA, Optical Add/Drop multiplex equipment 13. Degraded input at OA, Optical Add/Drop multiplex equipment 14. Degraded output of OA, Optical Add/Drop multiplex equipment	Simulate the error conditions and ensure that the alarms are reported in the EMS. Note down the observation in the table. Check that these alarms can be categorized as Urgent, Non-urgent and Deferred, with threshold programming by software, wherever applicable. Note whether the EMS is providing the open North-bound interface as either Q3 or MTNM TMF-508, 613, 814 specified CORBA. Most of the vendors shall offer CORBA as the North-bound interface. Obtain a copy of the GDMO/PICS from the vendor. Test compliance the support of CORBA and attach the results. Refer TSTP test no. 32.0.

	15. Degraded output of the dropped channel. 16. GFP related alarm for Ethernet clients. (optional, may be decided by the purchaser) These alarms shall be categorized as Urgent, Non-urgent and Deferred alarms, with threshold programming by software, wherever applicable.	
11.2	The following ODU-k related alarms listed in ITU-T G.798 shall be reported by the equipment through the EMS: 1. OTU-k Loss of Frame alarm (OTU - LOF). 2. OTU-k Loss of Multiframe alarm (OTU -LOM). 3. Loss of Payload alarm (LOS-P). 4. Open Connection Indication alarm (OCI). 5. OTU-k Degrade Defect alarm. 6. OTU-k Trace Identifier Mismatch alarm (OTU-k TIM). 7. ODU-k-AIS alarm 8. OTU-k Backward Defect Indication alarm (OTU-BDI). 9. ODU-k Payload Mismatch alarm. 10. ODU-k AIS alarm at path layers	Simulate the error conditions and ensure that the alarms related to ODUK are reported in the EMS. Note down the observation in the table. Refer TSTP test no. 33.0.

	11. ODU-k Backward Defect Indication alarm (ODU-kp BDI) at path. 12. ODU-k Locked Defect alarm at path layers. 13. ODU-k signal degrade alarm (ODU-kp DEG) 14. ODU-k loss of frame and multi frame. ODU-LOFLOM) 15. ODU-k Trace Identifier Mismatch alarm (ODU-k TIM) at path level. 16. ODU-k Payload mismatch alarm at path level (ODU-kp PLM)	
12.0	**Architecture of Automatically Switched Optical Network (ASON)** The architecture of Automatically Switched Optical Network (ASON) shall be based on ITU-T Rec. G.8080/Y.1304, which specifies a control plane that enables the equipment to facilitate fast and efficient configuration of connections within a transport network layer, supporting switched as well as soft permanent connections, reconfigure or modify the connections that have already been set up and perform a restoration function. The equipment shall support all the components which shall be required to meet the above functionalities as	Ensure the Architecture of Automatically Switched Optical Network (ASON) shall be based on ITU-T Rec. G.8080/Y.1304

	defined in ITU-T Rec. G.8080/Y.1304. The model showing the overview of the relationship architectural between the components shall be as per Figure-1/G.8080/Y.1304. The important components of the control plane which shall be implemented by the equipment shall be as per ITU-T Rec. G.8080/Y.1303 and shall be as given below: 1. Connection Controller Function (CC): The connection controller shall be responsible for coordination among the Link Resource Manager, Routing Controller for the purpose of the management and supervision of connection setup, release and modification. 2. Routing Controller (RC): The role of the RC shall be to respond to requests from CC for route information needed to setup a connection, and to respond to requests for topology information for network management purposes. 3. Link Resource Management (LRM): The LRM component shall be responsible for the management of network links including the allocation and de-allocation of	1. Prepare ASON setup as per TSTP test no. 23 and verify the feature of Connection Controller Function. 2. Prepare ASON setup as per TSTP test no. 23 and verify the feature of Routing Controller. 3. Prepare ASON setup as per TSTP test no. 23 and verify the feature of Link Resource Management.

	resources, providing topology and status information. 4. Traffic Policing (TP): The role of the TP shall be to check that the incoming user connection is sending traffic according to the parameters agreed upon. 5. Call Controller: There shall be two types of call controller, a calling/called party call controller and a network call controller. The role of the call control shall be the generation and processing of call requests. 6. Protocol Controller (PC): The PC shall provide the function mapping of the parameters of the abstract interfaces of the control components into messages that are carried by a protocol to support interconnection via an interface.	4. Prepare ASON setup as per TSTP test no. 23 and verify the feature of Traffic Policing. 5. Prepare ASON setup as per TSTP test no. 23 and verify the feature of Call Controller. 6.Prepare ASON setup as per TSTP test no. 23 and verify the feature of Protocol Controller.
12.1	ASON/GMPLS/G.8080 Planning Tools: The implementation of ASON/GMPLS/G.8080 shall require a Planning Tool to facilitate network operators to plan and simulate networks with an automated control plane such as GMPLS/ASON/G.8080. The Planning Tool emulates the behavior of GMPLS/ASON/G.8080 networks in all the possible operative scenarios such as	Planning tool support the following functions as mentioned below: 1. Plan and simulate networks with an automated control plane such as GMPLS/ASON. 2. The Planning Tool emulates the behavior of GMPLS/ASON networks in all the possible operative scenarios such as link , node and Shared Risk Link Group (SRLG) failures.

	link, node and Shared Risk Link Group (SRLG) failures. The goal of the ASON/GMPLS/G.8080 - Planner is to maximize the quality of service provided to customer and to optimize the network resources. The Planning Tool shall be a multi-layer, multi-technology network planning tool that helps network operators to plan, develop, manage and upgrade their transport network. The requirement of the Planning Tool has been detailed in Appendix-II. NOTE: The purchaser shall ask for the ASON/GMPLS/G.8080 Planner during the procurement of the equipment. The implementation may be carried out by the purchaser or the vendor may be asked to implement the same. In the latter case, the purchaser shall make available all the necessary network related information to the vendor.	3. The Planning Tool shall be a multi-layer , multi-technology network planning tool that helps network operators to plan , develop , manage and upgrade their transport network

12.2	The equipment shall support ASON, GMPLS/G.8080 and OIF framework to facilitate faster and efficient configuration and restoration of connections, easier network operation, higher network reliability, scalability and easier planning. The ASON and GMPLS shall characterize three autonomous planes, which shall be interacting with each other for the exchange of information: 1. Control plane: The control plane, using signaling, shall provide setting up of connections and may restore a connection in case of failure. It represents transport infrastructure for control traffic and could either be in band or out of band. The control plane topology can be different from the transport network topology. 2. Management plane: The management plane shall perform FCAPS functions and shall also provide co-ordination between all planes. 3. Transport plane: The Transport plane shall provide the flow transfer for user information from one location to another. It shall also provide flow transfer for some control and network management information.	Prepare ASON Setup and demonstrate the features of ASON and GMPLS shall characterize three autonomous planes , which shall be interacting with each other for the exchange of information: control plane 、 management plane , transport plane. Refer TSTP Test no. 23. Prepare ASON setup and show the feature of controle plane. Refer TSTP Test no. 23. Prepare ASON setup and show the feature of management plane for FCAPS and coordination between all planes. Refer TSTP Test no 23.0. Prepare ASON setup and show the feature of Transport plane. Refer TSTP Test no 23.0.

12.3	The ASON shall provide two types of connections: 1. Permanent connections The permanent connection shall be set up from the management of the system with network management protocols. 2. Soft permanent connections The Soft permanent connections shall be set up from the management system which shall use network generated signaling and routing protocols to establish connections.	Prepare ASON setup and show the feature of PC and SPC in TSTP Test no. 23.
12.4	Network resilience and disaster recovery time shall be significantly improved by network resource auto-discovery. This mechanism shall ensure that optimal use is made of any connectivity available without complex operator involvement. The degree of control given to the network elements shall be managed by the central EMS/NMS to ensure the traffic engineering requirements of the user are met. The ASON control software shall be distributed fully to all the network elements in the network.	Prepare ASON setup and show the feature of network resource auto-discovery. Ensure that the ASON control software shall be distributed fully to all the network elements in the network. Refer TSTP Test no. 23.

12.5	Both the routing and signaling shall be fully distributed to network elements. The path-selection function shall be distributed to the network elements.	Prepare ASON setup and ensure that routing and signaling shall be fully distributed to network elements. The path selection function shall be distributed to the network elements. Refer TSTP Test no. 23.
12.6	Every node shall maintain its own database of the entire network. This shall avoid single point of failure in the network.	Ensure for each nodes to maintain its own data base. Refer TSTP Test no. 23.
12.7	The ASON shall take in to account the underlying protection schemes, to allow efficient integration with established standards. A circuit that is established via ASON control plane may cross a protection in the client layer. For these reasons, an ASON backbone shall have to inter-operate with such kind of protection schemes. The ASON component shall implement this kind of interworking to provide end-to-end circuits with the degree of protection allowed by various parts of the network they traverse.	Prepare ASON setup and show protection in client layer. Refer TSTP Test no. 23.
12.8	There are a number of added values related to such a capability and equipment shall support these capabilities: 1.Traffic engineering of optical channels: Where bandwidth	1. Show all the TE links in ASON network.

	assignment shall be based on actual demand patterns. 2. Mesh network topologies and restoration: Mesh network topologies shall, in general, be engineered for better utilization for a given demand matrix. Ring topologies might not be as efficient due to the asymmetry of traffic patterns. 3. Managed bandwidth to core IP network connectivity: A switched optical network shall provide bandwidth and connectivity to an IP network in a dynamic manner compared to the relatively static service available today.	Refer TSTP Test no. 23. 2. Prepare Mesh N/W ASON setup and show traffic restoration. Refer TSTP Test no. 23. 3. Verify that the ASON N/W shall provide bandwidth and connectivity to an IP network in a dynamic manner compared to the relatively static service available today. Refer TSTP Test no. 23.
12.9	Automatic Discovery for Transport entities: The requirement of automatic discovery for transport entities and the methodology shall be implemented as specified in ITU-T Rec. 7714 and its further extensions in ITU-T Rec. G.7714.1/Y1705 and G.7714.1/Y1705 Amd.1.	Show automatic discovery of transport entities and the methodology shall be implemented as specified in ITU-T Rec.7714. Refer TSTP Test no. 23.
12.10	Architectural requirements and routing in ASON:	Ensure that the architectural and routing requirements of switched connections (SC) and soft

	The architectural and routing requirements of switched connections (SC) and soft permanent connections (SPC) for ASON based network shall be as per ITU-T Rec. G.7715/Y.1706. The ASON routing architecture, concepts for its implementation including Link State Protocol, routing area hierarchies' realization model, routing attributes shall be implemented as per ITU-T Rec. G.7715/Y.1706	permanent connectíons (SPC) for ASON based network shall be as per ITU-T Rec.G.7715/Y .1706. Refer TSTP Test no. 23.
12.11	Frame work of ASON management: The TMN of equipment shall support the requirements specified in ITU-T Rec. G.7718/Y1709 on "Frame work of ASON management". to keep ASON management within TMN context and addresses the management aspects of ASON control plane and the interactions between the management plane and the ASON control plane. The architecture, methodology, model and the requirements of ASON management shall be compliant to the ITU-T Rec. G.7718/Y.1709.	Ensure that the architecture , methodology , model and the requirements of ASON management shall be compliant to the ITU-T Rec. G.7718/Y.1709. Refer TSTP Test no. 23.
12.12	Distribution call and connection management: The equipment shall support the distribution call and connection	The equipment shall support the call distribution, connection management and the signaling based on the GMPLS RSVP-TE

<table>
<tr><td></td><td>management and the signaling based on the GMPLS/G.8080 RSVP-TE shall also be implemented as specified in ITU-T Rec.G.7713/Y.1704. The support of attribute specifications, message specifications, signal flow, DCM state diagrams and management of DCM by the equipment shall be as per ITU-T Rec.G.7713/Y.1704.</td><td>shall also be implemented as specified in ITU-T Rec.G.7713/Y.1704.
Refer TSTP Test no. 23.</td></tr>
<tr><td>12.13</td><td>GMPLS Implementation Requirements(Optional):

The GMPLS architecture shall be as per IETF RFC 3945. The GMPLS traffic engineering, routing, Link Management Protocol, signalling function, signalling RSVP-TE, signalling procedure etc shall be as per various IETF RFCs as indicated in Table-3 below:

Table-3: List of IETF RFCs documents

<table>
<tr><td>IETF RFC 4802</td><td>GMPLS Traffic engineering management information base</td></tr>
<tr><td>IETF RFC 4202</td><td>Routing extension in support of GMPLS</td></tr>
<tr><td>IETF</td><td>Link Management</td></tr>
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</td><td></td></tr>
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	RFC 4361	Protocol mgmt. information base		
	IETF RFC 3471	GMPLS signaling function		
	IETF RFC 3473	GMPLS signaling Resource Reservation Protocol – Traffic Engineering (RSVP-TE)		

12.14	ASON CoS and Customer SLA Requirements: The OTN based equipment shall support all the traditional protection schemes such as SNCP and MSP protection. Additionally, the equipment shall support ASON/ GMPLS based restoration. Combining the traditional based protection schemes and ASON/ GMPLS based restoration, it is envisaged that the following variants of Service Level Agreements are achieved within the ASON/GMPLS architecture: a) Platinum Service: Permanent 1+1 pa protection + ASON/ GMPLS base restoration b) Gold Service: Permanent 1+1 pa protection c) Silver Service: ASON/ GMPLS base restoration d) Bronze Service: No protectio mechanism shall be implemented f network restoration.	OTN ASON should support SNCP and MSP protection. Additionally , the equipment shall support ASON/GMPLS based restoratíon. Refer TSTP Test no. 23. Demonstrate the test for Permanent 1+1 path protection as per ASON/ GMPLS based restoration. Refer TSTP Test no. 23. Demonstarte Permanent 1+1 palh protection. Refer TSTP Test no. 23. Demonstrate sliver service as per ASON/GMPLS based restoration Refer TSTP Test no. 23. Demonstrate bronze service as per TSTP Test no. 23.

12.15	ASON Implementation Guidelines ASON is basically a software tool which implemented either in OTN switch or optical switch i.e., ROADM. In OTN ASO switching takes place within 50 msec. ar restoration within 10 sec. On the oth hand, in Optical ASON switching take place within 50 msec but restoration take a few seconds. Therefore, from th networking point of view, it is effective implement OTN ASON for long ha applications and Optical ASON for Met applications. An overview of both the models – OT ASON and Optical ASON are depicted the figures below –	Please ensure switching time in ASON N/W should be less than 50ms and restoration time within 10 sec. In optical ASON switching takes place within 50 msec.but restoration takes a few seconds. Refer TSTP Test no. 23.

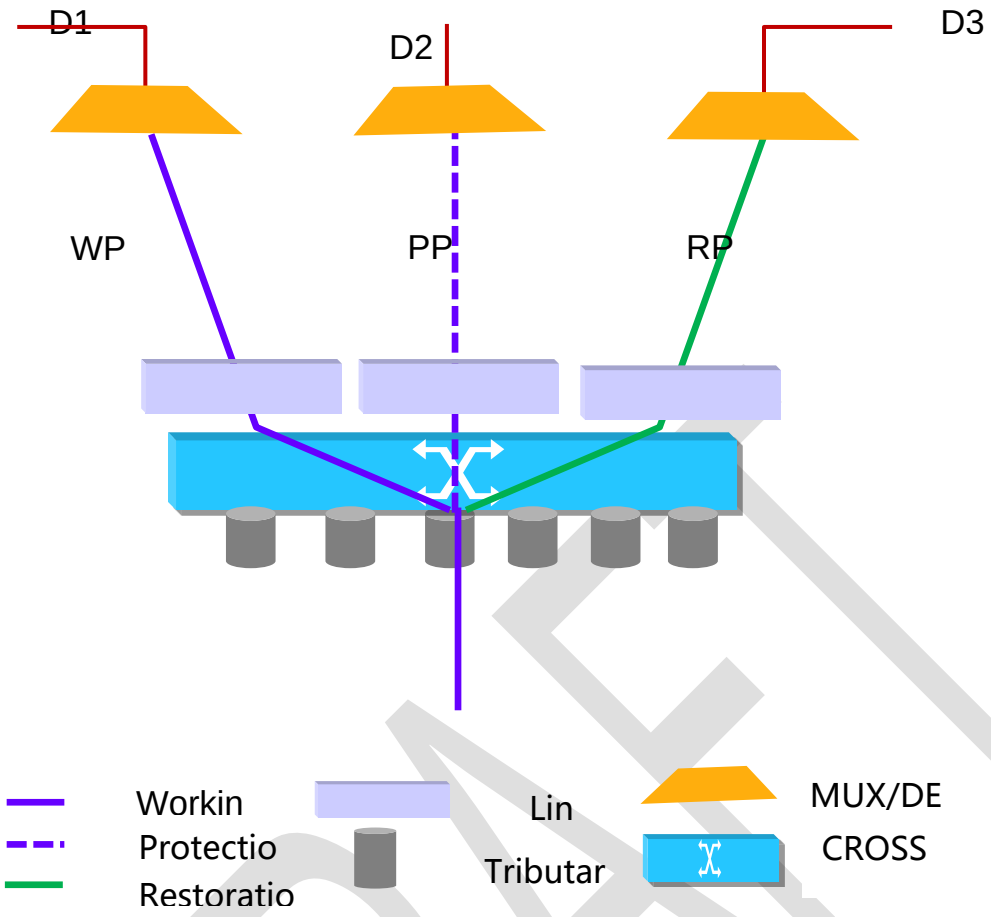
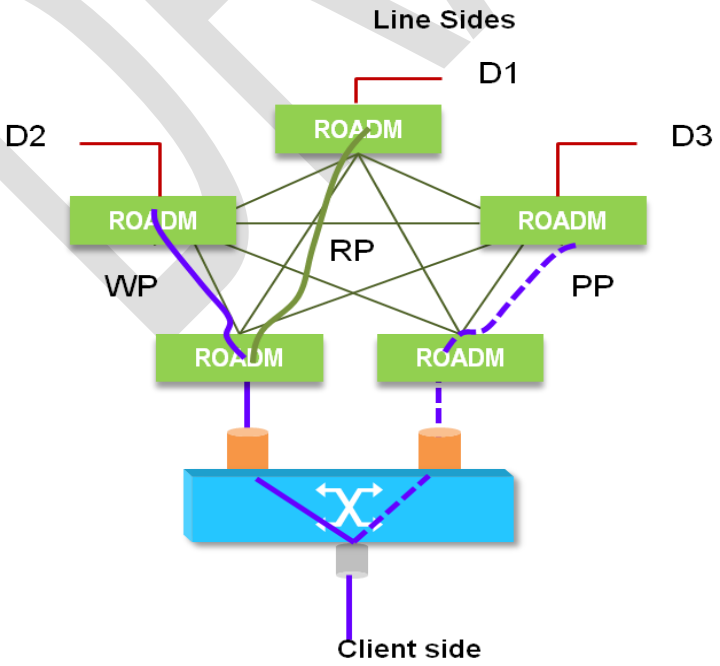


Figure-10: OTN ASON Model



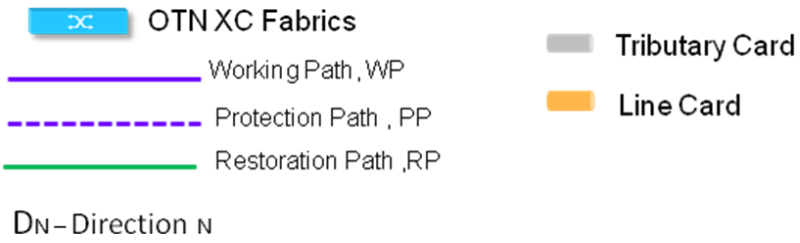


Figure-11: Optical ASON Model

13.0	**Mechanical standards:**	
1.	The equipment shall be housed in the standard 19" width sub-racks or ETSI standard racks or custom 23" rack. The sub-racks shall be fitted with mother-board duly masked to avoid short-circuiting.	Verify and note down.
2.	The height of the main rack shall be 2750 mm maximum or as per ETSI standards. No mini rack shall be accepted. The PCB's back and forth movement shall be very smooth without any significant sideway play.	Verify and note down.
3.	The connectors used on the PCB and their mating-connectors on the mother-board shall have tight grip to avoid jacking problems.	Verify and note down.

4.	No damage shall take place to PCBs when loaded in the wrong slot except in power supply units. The PCBs shall have the provision of locking/ screwing to the sub-rack.	Verify and note down.
5.	There shall be proper covers on the sub-racks/ main-racks or similar arrangements to avoid the ingress of dust.	Verify and note down.
6.	The permanent wiring such as distribution of power supply and ground etc. shall be pre-wired. During Type Approval and supply of the equipment, the racks and sub-racks quality supplied by the manufacturer shall be ensured.	Verify and note down.
7.	The front opening of the sub-rack/main rack is envisaged. The access to data terminations shall be from the front- side only. There may be provision for rear access in case chassis width is 600nm.	Verify and note down.
14.0	**Engineering requirements:**	
1.	The equipment shall be fully solid-state and adopt state-of-the-art technology. For all standard configurations, the system shall be manageable as a single network element.	For information only, no test is required.

2.	The equipment shall be compact and composite in construction and shall be light-weight. The actual dimensions and weight of the equipment shall be furnished by the manufacturer.	For information only, no test is required.
3.	All connectors shall be reliable and of standard type to ensure failure-free operation over long periods under specified environmental conditions. All cables & components shall be CACT approved.	QA to ensure the requirements.
4.	All connectors and cables used shall be of low-loss type and suitably shielded.	Verify and note down.
5.	The equipment shall be housed in standard 19" or ETSI standard rack or custom 23" rack and shall provide front access.	Verify and note down.
6.	the manufacturer may use fans for cooling purposes provided: i. The fan failure is reported through LCT/EMS. ii. Multiple fans are there in one tray with N+1 redundancy in each fan tray module. iii. Fans are located at convenient place in the equipment not disturbing the internal equipment layout. iv. Fans are DC operated. v. MTBF is better than 1,00,000 hours.	Verify and note down: i. fan failure is reported through LCT/EMS ii. Multiple fans are there in one tray with (N+1) redundancy or not. iii. Fans are located at convenient place in the equipment without disturbing the internal equipment layout. iv. Fans are DC operated or not. v. MTBF is better than 1,00,000 hours or not. vi. Inclusion of fans for cooling

	vi. Inclusion of fans for cooling purposes does not deteriorate the MTBF values of the equipment. vii. There shall be fan failure alarm for each of the installed fan.	purposes deteriorates the MTBF values of the equipment or not. vii. Alarm is actuated in the case of fan failure for each of the installed fan.
7.	The supervisory indications, built-in test equipment (BITE), if any, and other control/ switches shall be provided at convenient locations for ease of maintenance.	Verify and note down whether the supervisory indications, built-in test equipment (BITE), and other control/ switches are provided at convenient locations for ease of maintenance.
8.	The plug-in units shall be hot-swappable to allow easy removal/ insertion while the equipment is in energized condition.	Verify and note down as to whether the plug-in units are hot-swappable as to allow their removal/ insertion while the equipment is in energized condition. .
9.	The mechanical design and construction of each card/ unit shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage & transport and shall conform to the latest quality manuals of the purchaser.	QA to verify and note down.
10.	Each sub-assembly shall be clearly marked with schematic references to	QA to verify and note down.

	show its function, so as to be easily identifiable from the layout diagram in the handbook.	
11.	Each terminal block and individual tag shall be numbered suitably with clear identifying code and shall correspond to the associated wiring drawings.	QA to verify and note down.
12.	All controls, switches & indicators etc., shall be clearly marked to show their circuit designation and functions.	Verify and note down.
13.	Important Do's and Don'ts about the operation of the equipment shall be clearly indicated at a convenient place on the equipment.	Note that Do's and Don'ts are indicated properly.
15.0	**Operational requirements:**	Heading, no test is required.
15.1	The manufacturer shall guarantee satisfactory performance of the equipment without any degradation up to an altitude of 3,000 meters. A certificate to this effect shall be admissible.	Get a test certificate from the manufacturer.
15.2	The equipment shall be able to work without any degradation in saline atmosphere near coastal areas and should be protected against corrosion. A certificate to this effect shall be admissible.	Get a test certificate from the manufacturer.

15.3	Visual indication to show power ON/OFF status shall be provided.	Verify whether any visual indication is provided to show the power ON/OFF condition.
15.4	Suitable visual indications shall be provided. (It is suggested that 'green' colour for healthy and 'red' colour for unhealthy conditions may be provided. Some other colour, preferably 'Amber', may be used for non- urgent alarms).	Ensure that a healthy condition is indicated by green colored LED and 'red' colour is used for unhealthy conditions.
15.5	The software/hardware in equipment shall not pose any problem due to changes in date and time caused by events such as changeover of millennium/ century, leap year etc., in the normal functioning of the equipment.	Verify that in case of any changeover such as millennium/ century, leap year etc., the software/hardware in equipment does not pose any problem in the normal functioning of the equipment.
16.0	**Quality requirements**	
16.1	The manufacturer shall furnish the MTBF/MTTR values MTBF values wherever specified in the standard, shall be met. The calculations shall be based on the latest operator's quality manual on "Reliability Methods and Predictions" or any other international standard.	Record the values for MTBF/MTTR as supplied by the manufacturer.
16.2	a)The equipment shall be manufactured in accordance with international quality management system ISO-9001:2015 for which the manufacturer shall be duly accredited.	Get a copy of the ISO-9001:2000 certificate awarded to the company. Obtain a copy of the certificate from the manufacturer that the equipment has been manufactured as per his quality

	A quality plan describing the quality assurance system followed by the manufacturer, shall be required to be submitted. The equipment shall also meet the latest quality manual of the operator on a. Quality and reliability in product design, b. Guidelines for standard of workmanship for printed boards and assemblies, c. Guidelines for standard of workmanship for surface mounted devices, The supplier shall furnish a certificate from the manufacturer to this effect which shall be verified at the time of technical evaluation of the syste **New Clause** : The equipment shall conform to the requirement for the latest operator's quality manual for specification for environmental testing of electronic equipment for transmission and switching use for operation, transportation and storage, including vibration test.	manuals. Tester shall verify the compliance of the quality manuals .

16.3	The equipment shall conform to the requirements for environment as specified in the TEC document SD: QM-333 (or TEC 14016:2010) {latest issue} "Standard for environmental testing of Telecommunication Equipment . The applicable tests shall be for environmental category " A" including vibration test.	Climatic tests as per QM-333 Cat. 'A' shall be carried out separately. Vibration test shall also be conducted as per the operator's quality manual. Note down the functional as well as spec. tests readings to form a test report.
17.0	**General Electromagnetic Compatibility (EMC) Requirements:** -The DWDM equipment shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from a test agency. a) Conducted and radiated emission: Name of EMC Standard: "CISPR 32 {2015}-Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment". Limits:- i) To comply with Class A of CISPR 32 {2015} ii) The values of limits shall be as per TEC Standard No. TEC/SD/RD/EMC-002/02 Oct.2016 with Amendment No. 1 dated 01.01.2008.	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.

	iii) For radiated Emission tests, limits below 1Ghz shall be as per Table 4(a) or 5(a) for measuring distance of 10m or Table 4(a1) or 5(a1) for measuring distance of 3m b) Immunity to Electrostatic discharge: Name of EMC Standard: IEC 61000-4-2 {2008) "Testing and measurement techniques of Electrostatic discharge immunity test". Limits: - i) Contact discharge level 2 {± 4 kV} or higher voltage; ii) Air discharge level 3 {± 8 kV} or higher voltage; c) Immunity to radiated RF: Name of EMC Standard: IEC 61000-4-3 (2010) "Testing and measurement Techniques-Radiated RF Electromagnetic Field Immunity test" Limits: - i) Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and ii) Under test level 3 (10 V/m) for	

	protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz. d) Immunity to fast transients (burst): Name of EMC Standard: IEC 61000-4- 4 {2012) "Testing and measurement techniques of electrical fast transient's/burst immunity test" Limits: - Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0. 5 kV for signal / control / data / telecom lines; e) Immunity to surges: Name of EMC Standard: IEC 61000-4-5 (2014) "Testing & Measurement techniques for Surge immunity test" Limits: - i) For mains power input ports: (a)2.0 kV peak open circuit voltage for line to ground coupling (b) 1.0 kV peak open circuit voltage for line to line coupling ii) For telecom ports: (a) 2 kV peak open circuit voltage for line to ground (b) 2 KV peak open circuit voltage for line to line coupling.	

	f) Immunity to conducted disturbance induced by Radio frequency fields: Name of EMC Standard: IEC 61000-4-6 (2013) with amendment 1 (2004) & amendment 2 (2006) "Testing & measurement techniques-Immunity to conducted disturbances induced by radio- frequency fields" Limits:- Under the test level 2 {3V r.m.s.} in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines. New Clause: Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any): Name of EMC Standard: Name of EMC Standard: IEC 6100-4-11 (2020) "Testing & measurement techniques-voltage dips, short interruptions and voltage variation immunity tests" Limits: i. A voltage dip corresponding to reduction of the supply voltage of 30% for 500 ms (i.e 70 % supply voltage for 500 ms) ii. A voltage dip corresponding to reduction of the supply voltage of 60% for 200 ms (i.e 40 % supply voltage for	

	200 ms) iii. A voltage dip corresponding to reduction of the supply voltage of > 95% for 5 s iv. A voltage dip corresponding to reduction of the supply voltage of > 95% for 10 ms **New Clause**: Immunity to voltage dips & short interruptions (applicable to only DC power input ports, if any): Name of EMC Standard: IEC 61000-4-29:2000: Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests Limits: i. Voltage Interruption with 0% of supply for 10ms. Applicable Performance Criteria shall be B. ii. Voltage Interruption with 0% of supply for 30ms, 100ms, 300ms and 1000ms. Applicable Performance Criteria shall be C. iii. Voltage dip corresponding to 40% & 70% of supply for 10ms, 30 ms. Applicable Performance Criteria shall be B. iv. Voltage dip corresponding to 40% & 70% of supply for 100ms, 300	

	ms and 1000 ms. Applicable Performance Criteria shall be C. v. Voltage variations corresponding to 80% and 120%of supply for 100 ms to 10s as per Table 1c of IEC 61000-4-29. Applicable Performance Criteria shall be B. NOTE-1: The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted. NOTE-2: For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC/SD/RD/EMC-002/02.OCT.2016 and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (f) and TEC Standard No. TEC/SD/RD/EMC-002/02.OCT.2016. The details of IEC/CISPR and their corresponding Euro Norms are as follows:	

<table>
<tr><td></td><td>

Table 4: Euro Norms

<table>
<tr><th>IEC/CISPR</th><th>Euro Norm</th></tr>
<tr><td>CISPR 32</td><td>EN 55032</td></tr>
<tr><td>IEC 61000-4-2</td><td>EN 61000-4-2</td></tr>
<tr><td>IEC 61000-4-3</td><td>EN 61000-4-3</td></tr>
<tr><td>IEC 61000-4-4</td><td>EN 61000-4-4</td></tr>
<tr><td>IEC 61000-4-5</td><td>EN 61000-4-5</td></tr>
<tr><td>IEC 61000-4-6</td><td>EN 61000-4-6</td></tr>
<tr><td>IEC 61000-4-11</td><td>EN 61000-4-11</td></tr>
<tr><td>IEC 61000-4-29</td><td>EN 61000-4-29</td></tr>
</table>

</td><td></td></tr>
<tr><td>18.0</td><td>**Safety requirements**</td><td></td></tr>
<tr><td>18.1</td><td>The equipment shall conform to IEC 62368-1:2023 “Audio/video, information and communication technology Equipment- Part 1: Safety Requirements.</td><td>The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab.</td></tr>
</table>

18.2	If the fibre is broken or an optical connector is opened, the laser shall be automatically shut down or the optical power to be decreased to a value less than -10 dBm. Optical connectors, if used in the system, shall be self-protective against entry of dust when not occupied by external patch cord.	Check that in case the fiber is broken or an optical connector is opened, the laser gets automatically shut down or the optical power to be decreased to a value less than -10 dBm. Also. Ensure that the caps for the optical ports or auto-shutter type optical ports are provided.
19.0	**Optical safety:** The optical safety shall be as defined in ITU-T Rec. G.664 & IEC 60825-1 (latest edition). The optical access ports shall be designed to protect themselves against the entry of dust when they are not occupied by an external fibre-optic connection. The optical access port shall be easy to clean by the user.	As defined in ITU-T Rec. G.664, G.681 & IEC 60825-1 (latest edition), ensure that the optical access ports are designed to protect themselves against the entry of dust when they are not occupied by an external fibre-optic connection. The optical access port is easy to clean by the user.
20.0	**Protection requirements:**	
a.	The equipment shall have a terminal for grounding the rack.	Check that terminal for grounding the rack is provided.
b.	Protection against short circuit/ open circuit in the accessible points shall be provided.	Check that the protection against short circuit/open-circuit in the accessible points is provided. Also that all switches/controls panels have suitable safeguards against accidental operations

c.	All switches/controls on front panel shall have suitable safeguards against accidental operation.	Check that accidental operation of switches/controls on front panel does not create any problem in the system.
d.	The equipment shall be adequately covered to safe-guard against entry of even dust, insects etc.	Note that the equipment is provided with front panel cover.
21.0	**Power supply** The power supply to the equipment shall be fed from the station power- plant. The equipment shall meet the following requirements in respect of the power supply:	
a)	Nominal power supply is -48V DC with a variation over the range -40V to -60V. The equipment shall operate over this range without any degradation in performance.	The equipment shall work on the nominal voltage of - 48 V DC supply. Now reduce this voltage to - 60 V DC and then increase it to -40 V DC. Check that in both the cases, theequipment is functioning perfectly. Note down the minimum and maximum voltages at which the equipment functions correctly: Minimum voltage: Maximum voltage:
b)	The equipment shall be protected in case of voltage variation beyond the range specified in sub-clause (a) above and also against reverse input polarity. The manufacturer shall furnish the value of guaranteed input voltage up to which no irreversible damage to the equipment shall occur.	Check that the equipment is not damaged while the input voltage vary beyond the range specified above. Also check that the equipment is not damaged when the polarity is reversed: (OK / Not OK)

c)	The derived DC voltages in the equipment shall have protection against over- voltage, short-circuit and overload.	Check that the following protections are provided by the derived voltages i) over voltage : Ok / Not Ok ii) short circuit : Ok / Not Ok (iii) overload : Ok / Not Ok
d)	The equipment shall have the option of operating from two independent sources of input power supply.	Verify and note down.
e)	The equipment requiring AC mains shall operate from single phase AC power supply without any degradation in the performance. The nominal AC voltage shall be 230V with variation of –15 % to +10 % at 50 Hz ± 2 Hz. The actual power consumption shall be furnished by the manufacturer.	Check that the equipment is provisioned for working with dual feed and that when the working feed fails, the other one takes over without any disturbance. This may be confirmed by checking that the BER is not disturbed when the input power feed changes over. In cases where the equipment requires to operate on AC mains, check that the equipment is able to function without any degradation in the performance within the voltage range of 195 – 255 volts. Note down the power consumption of the equipment.
22.0	**Element Management System**	
22.1	unctional Requirements: (1) The EMS shall be multi-user system and based on Graphical User Interface.	1. Check that the EMS provided is a multi-user system and GUI based.

	(2) It shall provide the graphical layout of the network elements with modules drawn using different colours to indicate their status.	2. Check that the EMS provides the graphical layout of the network elements with modules drawn using different colors to indicate their status.
	(3) It shall be possible to execute schedulable administrative command i.e. NE backup, software download, performance, operator log-in/log-out etc., at any time by attaching a time tag to the command and it shall be executed when the Network real time matches the time tag. It shall be possible to define both time and date. If no date is mentioned, the command shall be executed daily at the time indicated.	3. Check that any administrative command like NE backup, software download, performance, operator log-in/ log-out etc. attach a time tag to the command and is executed when the network real time matches the time tag. Check that it is possible to define both time and date.
	(4) The EMS shall have a messaging system which will generate and send alert messages on telephone (fixed & mobile), e-mail or SMS to the designated personnel depending upon the location of NE, on generation of alarms.	4. Check that the EMS has a messaging system which will generate and send alert messages on telephone (fixed & mobile), e- mail or SMS to the designated personnel depending upon the location of NE, on generation of alarms.
	(5) Response time for query/command on any operator terminal, local or remote shall be 10 seconds or better. For updation on topological information on the terminals, the	5. Check that the response time for query/command on any operator terminal, local or remote is 10 seconds or better. For updation on topological information on the terminals, the response time is

	response time shall be better than 20 seconds under all conditions. The response time of any terminal shall however, be reviewed depending upon total NE load and topology by purchaser during testing of EMS.	better than 20 seconds under all conditions. (Note that the response time is reviewable depending upon total NE load and topology by purchaser during testing of EMS).
	(6) It shall be possible to manage complete DWDM link involving distant-end terminal, Optical Line Amplifiers and Optical Add/Drop Multiplexers enroute.	6. Check that it is possible to manage the distant TM, OADMs and ILAs with the EMS.
	(7) It shall be possible to have a view of selected sub-networks/rings controlled by the Element Management System as per requirement. By zooming-in, it shall be possible to drill down up to module-level in each NE for configuration and fault management. It shall also provide the ability to drill down to the individual element, then to subsystem, then to card and then to port level configuration template from the domain-map by clicking on the icon of the network element. The same shall be provided through user-friendly GUI commands.	7. Check that the EMS is able to provide a view of the sub networks/ rings and by zooming-in, it is possible to drill down up to module-level in each NE for configuration and fault management.
	(8) The Element Manager shall provide the complete view of the	8. Check that the EMS provides the complete view of the network

	network elements and the interconnecting links. The EMS shall have the ability to include the network elements and the links in the visual/graphical map of the domain. The visual maps shall display the elements and the links in different colour depending upon the status of the links. It is preferable that green colour for healthy and amber/yellow colour for degraded condition and red for unhealthy condition is used.	elements and the interconnecting links in the visual/graphical format. Also check that the visual maps display the elements and the links in different colour depending upon the status of the links - preferably green colour for healthy and amber/yellow colour for degraded condition and red for unhealthy condition.
	(9) It shall be possible to produce customised reports based on the data available in the database.	9. Check that it is possible to produce customized reports and that customization of reports based on the data available in the database from time to time is possible.
	(10) It shall be possible through a single Man-Machine Command or through GUI to obtain a list and the total number of equipment of a particular domain in various states (e.g. managed, Loss of Association, in-service, blocked etc.).	10. Check that it is possible through a single Man-Machine Command or through GUI to obtain a list and the total number of equipment of a particular domain in various states.
22.2	Configuration Management: **(1)** It shall be possible to configure the DWDM equipment for various capabilities and features like enabling/disabling of optical	Under the configuration management, check that the following functionalities can be configured: 1. Partitioning the network on the

	wavelengths, transponders configuration, optical channels addition/deletion, restricting client-speed at GigE interfaces, protection enabling/disabling at all wavelengths & inventory details of the local station as well as remote station at card level etc. The GUI shall provide efficient mechanisms to edit, re-groom, or decommission the service when necessary. (2) Users shall be able to identify explicit routing through the network, or just define the end-points and service characteristics and select from a list of automatically generated viable recommended paths through the network. (3) The system shall support 'Point & Click' provisioning in the DWDM sub-network, in respect of following: a) Network Element creation in the NE Management domain. b) Programming of a multiple interface unit. c) Create, update, delete and retrieve the managed network topology data. d) Assigning the equipment protection to a unit/interface/wavelength /channel.	basis of the full or limited network resources. This shall be as per G.803. 2. Creation and also deletion of the NEs. 3. Creation, update, deletion and retrieval of the managed network topology data. 4. Assigning the equipment protection to a unit. 5. Selection of protection switching within the managed network and protection switching granularity. 6. Creation, deletion of cross connections. 7. Setting thresholds for the detection of errors. 8. Configuring the NEs. Local & remote software download. 10. Enabling/disabling of protection switching for individual traffic interface at virtual containers, i.e., VC4.

	e) Selection of protection switching within the managed network and protection switching granularity enable/disable at individual channel level. f) Error detection thresholds. g) Network Element configuration. h) Software download (local & remote). i) It should be possible to provide an end-to-end wavelength service from an EMS Client system. j) Power values overlaid on the topology map/drop down menus for selected Lambda by User i. Per lambda Power ii. Total AMP Power iii. OSC (Optical Supervisory Channel) Power k) It should be possible to define the threshold (High/Low) for Power levels and EMS should be able to display if Power level is crossing the threshold. l) The configuration of the various network elements like creating, viewing, and editing shall be possible from the EMS. The configurations of the network elements shall also be stored in EMS which can be retrieved in case of failure.	11. Configuration of Ethernet/SAN interface bandwidth through VCAT and MAC. 12. Enabling/disabling of LCAS. 13. Enabling/disabling of FEC. 14. Configuration of DCC multiple management options. Selection of GFP-F and GFP-T.

22.3	Fault Management: (1) The EMS shall support 'Fault Management Functions'. The ' Equipment Management Function' within the NE shall perform a persistency check on the fault-cause, before it declares an alarm which is causing failure in the DWDM network. Each alarm/failure and clearance, thereof, shall be time-stamped. (2) The equipment shall carry out surveillance of alarms & their detection, reporting of relevant events and conditions that lead to the generation of alarm after filtering. The system shall produce, store and display the alarm history on demand. Further, the element management system shall have the following capabilities: a) Path alarm notification to be generated and recorded, the alarm notification shall include: type, occurrence, severity, probable cause and clearing. b) Path alarm shall be graphically shown by the EMS/LCT. c) Alarm and status display. d) Fault correlation control.	Check that the persistency check on the detection and the reporting of faults is as per G.784. Each failure and clearance, thereof, shall be time-stamped. An alarm report shall include type of fault, occurrence time, clearance time, severity, probable cause etc. Also check that the following functionalities are provided: a) Generation and reporting of the path alarm notification include type, occurrence, severity, probable cause and clearing. b) Path alarm is shown graphically by the EMS/LCT. c) Display of alarm and the status. d) Correction control of fault. e) Storing and processing of current alarm information.

	e) Storing and processing of current alarm information, up to module/unit level. f) Storing and processing of historical alarm information for 30 days minimum. The EMS/LCT shall provide on-line logging capability for historical alarms and events with sufficient information such as managed resources, alarm/event type, alarm severity, day and time of occurrence etc. The retrieving functions with filtering capabilities for historical alarms and events shall be provided as well. g) FCS errors for Ethernet clients. h) Assigning alarm severity i.e., Urgent, Non-urgent and Deferred. i) The EMS shall be able to diagnose its own faults by running diagnostic software. j) The information model shall be as per specified standards. The EMS shall support correlation (filtering and suppression) to avoid multiple alarms from a single source of failure within the sub-network. Single Alarm shall be provided for the events that are correlated and are due to a common cause. However, it may be possible for the user to see other related alarms.	f) The EMS/LCT shall provide on-line logging capability for historical alarms and events with sufficient information such as managed resources, alarm/ event type, alarm severity, day and time of occurrence etc. g) FCS errors for Ethernet clients. h) It should be possible to assigning alarm severity i.e., Critical, Major, Minor & Deferred. i) Diagnose its own faults by running diagnostic software. j) Check that the EMS provides correlated single alarm from single source instead of multiple alarms from a single source. k) Check that the EMS provides the visual presentation of the Network Element's status and the alarms. l) Check that it is possible to take any Network Element out-of- service & in-service from the EMS. m) Also check that restarting the Network Element from EMS is

	k) The EMS shall provide the visual presentation of the Network Element's status and the alarms. It shall also present the complete map of the network domain with suitable icons and in suitable colour like green for healthy, red for non-operational, yellow for degraded mode of operation etc. l) From the EMS, it shall be possible to view the status of any Card of Network Element whether it is out-of-service or in-service. m) The EMS shall carry out the systematic Health Monitoring of the elements of the Network. Check on the health of the card of any element of the Network shall be possible through command with settable periodicity - @ 24 Hrs, 1 week, 1 month. n) It shall be possible to log recent operations which be re-displayed on request through GUI. o) From a service assurance perspective, service to fault alarm correlation shall be supported. For each service there shall be an alarms tab visible on the service Display tab which displays the alarms impacting that specific service.	possible. n) Check that the EMS is able to carry out the health monitoring of the Network Elements, cards of any NE and that the periodicity can be set as 24 Hrs, 1 week, 1 month. o) Check that recent operations can be logged and re-displayed on request through GUI. p) For each service an alarms tab should be visible on the service Display tab which displays the alarms impacting that specific service.

	p) The DWDM related alarm conditions, as mentioned under Clause 11.1 and 11.2 in this GR shall be displayed by the EMS.	
22.4	Performance Management: (1) The EMS shall support the 'Performance Management' functions which shall consist of a set of functions that define, evaluate and report on the behavior of the Network Elements and their effectiveness relating to the overall functions carried out by the network. (2) EMS shall provide the information regarding degradation of the optical paths. It shall have the capability to monitor and display certain important parameters like optical power, λ & OSNR measurements of channels and of DWDM Central Office equipment, Line System and Remote Terminal. The EMS shall provide non-intrusive B-1 byte monitoring of individual channel of DWDM system and shall provide error-ratio/error-count along with other ITU-T Rec. G.826 parameters provisioning. EMS shall also be	The performance management of the system shall conform to ITU-T Recs. M.2100, M.2101, M.2120, G.828 and G.826. The near-end performance monitoring, far-end performance monitoring, performance data collection and performance history shall be as per ITU-T Rec. G.784. The following performance monitoring functionalities are required to be provided by the equipment: 1. Thresholds of the error counters shall be settable. 2. Reporting and monitoring of the performance data. 3. Check of FCS errors for Ethernet clients. 4. Check of Frame/Packets dropped in case of Ethernet frames.

	capable of setting the equipment performance thresholds in the range of 10^{-5} to 10^{-12}. (3) There shall be a provision for near-end performance monitoring, far-end performance monitoring, performance-data collection and performance history. The main performance functionality to be provided shall be as under: a. Configuration of threshold concerning the error counters. b. Performance monitoring by BIP check. c. Performance monitoring and reporting. d. Performance History (data logging). (4) EMS shall store the performance data of the system including NE name, date and the time. The collection of the performance counters will have to be performed at pre-assigned rate. In addition, it shall also be possible to take print out of the statistics and histograms. (5) It shall be possible to configure scheduling of performance measurement, collection, storage and transfer of traffic/ performance statistics for at least one month in the EMS system, after which it	5. Check of In coming Error Count in case of TCM. 6. Check of GFP headers error count. 7. Check of CRC Errors in case of GFP. 8. Check of Errors in CRC fields in case of LCAS. 9. Check of nos. of packets dropped due to CRC errors in case of LCAS. 10. Check of configuration of threshold concerning the error counters. 11. Logging the performance history shall be possible wherein the following different parameters are stored - a. Prints outs of the statistics and histograms. The collection of the performance counters shall be performed at pre-assigned rate as per ITU-T G.784.

	shall be possible to transfer the data to external media like USB, CD or any other server. It shall also be possible to generate daily, weekly, monthly reports for the individual element as well as complete domain. The report generation shall be supported in Text, CSV, Excel format and graphic reports as and when requested as well as at configurable interval automatically. (6) The EMS shall store the performance data of the sub-network in terms of configured circuits. (7) It shall be possible to generate reports that can be customized for various types of faults, performance history, security management etc. It shall also be possible to generate reports at various client's levels to facilitate monitoring of performance statistics in predefined/customised format.	

22.5	Security Management: (1) The management system shall provide adequate security in respect of the data and the access to the management system as per the following details: a) The EMS shall have the capability of supporting the management of network through local and remote operator terminals. The authorizations and the privileges of the operator terminals (Remote and Local) shall depend upon the Login and Password. b) Low level protection for read only access to faults and performance information. c) Medium level protection for reads only access to configuration status and features. d) High level protection for access to change in the configuration and control parameters. (2) The EMS shall support multi-level passwords as below- a. EMS shall allow the System Administrator to define the level of access to the network capabilities or feature for each assigned password. It shall be desirable that the EMS shall block the access to the	1. The management system of the equipment shall provide adequate security to the data. Note and verify that there are three levels of access to the management system and each level requires a separate programmable password for the following leveled access: a) Level-1: Low level access for read only and shall have the access to faults and performance information only; b) Level-2: Medium level protection for access to configuration status and features; c) Level-3: High level protection access for control of access to aforesaid clauses and to change the configuration and control parameters. 2. a. Check that the System Administrator is capable to define the level of access for

	operator in case of wrong login password and ID and also for unauthorized commands being tried for five consecutive times in both the occasions. b. The system administrator shall be able to monitor and log all operator activities in the EMS including operator terminal and Local Craft Terminal. c. The dynamic password facility shall be provided in which the operator may change its password at any time. (3) It should be mandatory for the system to have a record of all log-ins in read only password protected file for a period of at least six months after which a backup should be possible under system administrator command. All log-in and log-out attempts shall be logged in the security log file of the EMS system. (4) The man-machine communication programs shall have the facility of restricting the use of certain commands or procedures to certain passwords and terminals. (5) LCT should normally manage one node at a time. Remote management of any node in the sub-network should be possible via LCT.	each assigned password. EMS blocks the access to the operator in case of unauthorized commands or wrong password being tried for five consecutive times. b. Check that the system administrator shall be able to monitor and log all operator activities in the EMS and LCT. Dynamic password facility has been provided. 3. Each log in and log out attempt is logged in the security log file of the EMS system. 4. The EMS/NMS has adequate protection against intentional or accidental abuse, unauthorized access and loss of communication. 5. In the case of failure of the link between LCT location and the

	(6) It shall be possible to provide the connectivity of EMS and the network elements through IP-MPLS-VPN network for providing the inherent security required for the management information in addition to the login and Password based authorization for the operators of the Network Manager. (7) The EMS shall be able to back up and restore the data base to and from external storage media.	EMS, check that the LCT is able to supervise/monitor the faults and performance. 6. Check that it is possible to connect EMS and the network elements to the IP-MPLS network and also that the EMS and the Network Management layer (NML)/ Service Management Layer (SML) of a purchaser is a part of the common MPLS-VPN. Check that the security, login and Password based authorization are provided to the Network Manager. 7. Check that the backup for programs and data are provided.

22.6	Inventory management: (1) It shall indicate the presence or absence of any physical module in hardware elements. It shall also indicate the usage of module i.e. how many ports are in use, which interfaces are in use and which are free to be used. (2) The EMS shall be able to	1. Check that it is possible to indicate the absence or presence of any physical module and also how many ports are in use, which interface is in use and which are free to be used. 2. Check that the EMS provides discovery and the device information. 3. The EMS provides any change in

	discover, keep and display the device information (3) The EMS shall be able to keep track and report chronologically on any change in the network inventory. (4) The EMS shall be capable of providing the inventory information to the Network Management layer (NML)/Service Management Layer (SML) so that SML is able to create and activate a service to the customer. (5) The EMS shall provide the complete view of location wise network elements and the interconnecting links, in map format, list or rack picture format etc. for each independent links/networks as well as for all the links/networks under management of the EMS.	the network inventory reports the change of events chronologically. 4. Check that on the basis of the inventory information provided by the EMS to the Network Management layer (NML)/ Service Management Layer (SML), the SML can create and activate a service to the customer automatically. 5. Check that the complete view of the network elements and the interconnecting links are provided by the EMS.
22.7	Software Management: It shall be possible for the EMS to carry out the following tasks under the software management function: (1) Loading of new system software in EMS/local terminals/remote terminals and the LCTs. (2) Managing different versions of software. (3) Managing multiple versions of	Under the software management, check that the following activities are possible: 1. loading of new software. 2. manage different versions of software. 3. manage multiple versions of software such that one software

	software for individual elements. In this case, one software version shall remain active and other versions shall be passive. (4) Installation of software patches. (5) Examine contents and utilisation of all system memory and disk memory. (6) Local & remote software download via management system to NEs and LCT shall be possible, including the means of identification of software module versions. No loss of data/traffic & connection-map shall take place during the software downloading process. At the time of downloading the software, the message shall be displayed that the software has been downloaded successfully or failed and at what stage. (7) Downloading of Software, configuration, patches etc., to the Network Element through FTP/TFTP. No loss of data/loss of connection map shall take place during the software downloading process. (8) The operator terminals (local & remote) shall not allow loading of any software without the EMS	version remains active and other versions passive. 4. installs of software patches. 5. examines contents of all system memory and disk memory. 6. Check that no loss of data/traffic & connection-map shall take place during the software downloading process. display of downloading message of software such as downloaded successfully or failed and at what stage. 7. EMS support of FTP/TFTP for download of software, configuration, patches etc., to the Network Element. 8. loading of any software is not possible without the terminal administrator's authorization. 9. EMS enables system configuration and reconfiguration of input and output devices. 10. Check that all the executed commands over the EMS program or

	administrator's authorization. (9) Changing the system configuration, reconfiguration of input and output devices. (10) All commands which are executed over the EMS program or data shall be logged in a file (read only) and it shall be possible to retrieve the same on demand whenever required, using Man-Machine Commands. The EMS shall have suitable system level backup mechanism for taking backup of EMS data of at least one month on DVD, CD or transfer to another storage through LAN. The file usage of up to 50%, 75% and 90% shall generate alerts in the server platform, of suitable category prompting the operator to initiate the backup operation. (11) During the log-in by the system administrator, the system will provide the visibility of at least last 20 commands on the screen as system log. (12) The EMS of the DWDM equipment shall have e-protection from the virus.	data are logged in a file and retrieval of the same on demand is possible. File usage of up to 50%, 75% and 90% generates alerts in the server platform, prompting the operator to initiate the backup operation. 11. Check that at the system level, it is possible to store at least the last 20 commands on the screen and any command is re-executable by scrolling and editing. 12. Check that EMS of the DWDM equipment have e-protection from the virus.
22.8	EMS Server 1) EMS system shall consist of	1. EMS system consists of both Application and database server.

	Application and Database servers and it shall possible to mount these servers on different or on single server. 2) The memory of the Database Server shall be sufficient to store the data of minimum 500 fully loaded NEs with a capability of storing performance/ fault history of 30 days. 3) Application and Database servers as well as firewall system (if provided) shall have redundancy for control module, disk, power supply and LAN interface. 4) Industry standard Relational Database Management system (RDBMS)/SQL/Oracle for storing all the data related to the network and the system shall be used. 5) The database interface shall be open so that an EMS if upgraded at a future date is able to retrieve information from the EMS database using TCP/IP stack and do post processing. The data base structure for all the databases used in the system shall be provided. (6) TEC GR No. TEC/GR/IT/SRV-01. FEB2014 may be referred for servers.	2. Sufficient memory is provided in Database server to store the data of minimum 500 fully loaded NEs with a capability of storing performance/ fault history of 30 days. 3. Application and Database servers as well as firewall system (if provided) have redundancy for control module, disk, power supply and LAN interface. 4. Industry standard relational database (RDBMS) for storing all the data related to the network and the system is provided. 5 The database interface shall be open so as to retrieve information from the EMS database using TCP/IP stack in future. 6. Refer TEC GR No.TEC/GR/IT/SRV-01.FEB2014 or latest edition for servers.

22.9	Firewall [optional requirement]: If EMS is required to be connected to public network, it is desirable to provide security to EMS from public network. In such case a dual redundant hardware based Firewall system may be provided at each of the EMS locations for providing security to the various servers at the EMS. For Firewall System specifications TEC GR No. TEC/GR/IT/FWS-001/04.MAR.2014 may be referred. NOTE: For offering DWDM system for Type Approval, Firewall shall not be mandatory.	Provisioning of the Firewall system is optional. If provided or if the purchaser has demanded for its provisioning, then check the following features: 1. Check that the Firewall system for providing security to the EMS, is redundant. Other requirements of the Firewall system shall be as per TEC GR No.: TEC/GR/IT/FWS 001/04.MAR .2014 2. Ensure that the firewall system provides the security cover to the Web Based Customer Care System from the internet. Also ensure that this provides the security to the EMS Database from the Internet and the Web Based Customer Care Users & the Systems

22.10	Local Crafts Terminal/Client Terminal/Work Station: 1) Local Craft Terminal performs two types of functions in a network at NE level namely Configuration Management and Fault Management. 2) LCT can be installed on a client PC or Laptop. The LCT shall be able to access a local NE through a LAN or a serial port on DWDM equipment and any remote NE through data communications channel (DCC)/optical supervisory channel (OSC) of the DWDM system. For fault management it shall handle only basic alarm functions like Alarm Monitoring Policy Settings, Alarm Viewing and Alarm Deletion etc.	Check if LCT is able to access a local NE through a LAN or a serial port on DWDM equipment and any remote NE through data communications channel (DCC) of the DWDM system. For fault management it shall handle only basic alarm functions like Alarm Monitoring Policy Settings, Alarm Viewing and Alarm Deletion etc.
22.11	Typical minimum Desktop/Laptop configuration for LCT/EMS terminal shall be as follows a) Core I5, 2 GHz and above b) 17" Colour Monitor (for PC) / 15" LCD/TFT display (for Laptop) c) 8GB RAM d) 48X CD-ROM drive e) LAN port (10/100Mbps Ethernet interface) f) Inbuilt Modem g) 2 Nos. USB Ports	Check and note that the Desktop/Laptop supplied has the LCT software installed in it. Note that the following features are supported: a. Core I5, 2 GHz and above b. 7" Colour Monitor (for PC) / 15 " LCD/TFT display (for Laptop) c. 8GB RAM d. 8X CD-ROM drive e. LAN port (10/100Mbps

	h) Printer port i) Mouse port j) PS-2 Keyboard port (not for laptop) k) Licensed Operating software preloaded/Recovery CDs. l) Key board (Not for laptop) m) HDD 1TB or 512GB SSD	Ethernet interface) f. Inbuilt Modem g. 2 Nos. USB Ports h. Printer port i. Mouse port j. PS-2 Keyboard port (not for laptop) k. Licensed Operating software preloaded/Recovery CDs. l. Key board (Not for laptop) m. HDD 1 TB or 512 GB SSD
22.12	EMS Architecture	
22.12.1	Though the EMS can be PC based system for a small network, for a network having large numbers of NEs, Centralised EMS with server based architecture should be provided. (1) To ensure EMS connectivity to the sub-network under control-card failure, it shall be possible to dual home the EMS to two Gateway NEs (GNEs) in a sub-network so that performance and fault data for the sub-network shall be available even if the master control-card at one GNE fails. (2) In case of loss of EMS connectivity, the LCT privilege shall not be affected for monitoring and for local configurations, as per the privileges assigned by EMS administrator.	1. For no loss of EMS data, check that dual-homed connectivity of EMS to two Gateway NEs (GNEs) in a sub-network under control-card failure, has been provided. The performance and fault data for the sub-network is be available even if the master control-card at one GNE fails. In case of total loss of EMS connectivity, the sub-network continues to provide the services without any deterioration. 2. Check that in case of loss of EMS connectivity, monitoring of faults and local configurations is possible through LCT. 3. Check that it is possible to operate the Main and DR locations in 1+1 mode, either with manual

	(3) It shall be possible to operate the Main and DR locations in 1+1 mode, either with manual switchover or with automatic switchover. The system shall have data replication and synchronization mechanism so that servers at both locations have same data. Synchronization shall be in real time or in steps of 15 minutes or less. (4) Any failure in EMS including software bugs shall not affect the healthy working of the DWDM system. (5) It shall be possible to assign rights to each local and remote terminal for EMS function for monitoring and issue of commands for all links or any number of independent links or sub-networks by the EMS administrator. (6) In case of total loss of EMS connectivity, the performance data of the NE shall be stored in the controller card of the equipment, and shall be sent to central EMS server upon restoration of EMS connectivity. Minimum 6400 performance and fault data messages containing a minimum of 100 alarms shall be stored by the system.	switchover or with automatic switchover. Check that the system has data replication and synchronization mechanism in real time or in steps of 15 minutes or less. 4. Check that healthy working of DWDM system is not affected by any failure in EMS including software bugs. 5. Check that it is possible to assign rights to each local and remote terminal for EMS function for monitoring and issue of commands for all links or any number of independent links or sub-networks by the EMS administrator.
22.12.2	Scalability Aspects: (1) The EMS/NMS should be able to	1. Ensure that the EMS is able to support at least 500 NEs.

	support at least 500 NEs. NE is an OADM or TM or ILA with fully equipped line and client side interfaces. These elements may be spread over any number of independent links or sub-networks of the capacity up to 10G. (2) Operating system and applications for EMS including database server shall be multi-user with minimum 25 concurrent users including local terminals at EMS site and remote terminals which access the EMS through a WAN. (3) The EMS shall be equipped to connect to at least 10 local terminals at EMS site. It shall also be upgradeable to 25 local terminals. (4) EMS of the system shall have the capability of supporting dual stack 32/128 bit IP addressing, for internal communication with the equipment. The GNE shall automatically assign internal IP addresses for each equipment with in its domain via DHCP protocol or any other suitable/standard mechanism.	2. Ensure that the OS of the EMS including database server provide a multi-user system where a minimum of 25 users can operate simultaneously including local terminals at EMS site and remote terminals i.e. LCTs which access the EMS through a WAN. 3. Ensure that the EMS shall be equipped to connect to at least 10 local terminals at EMS site. It shall also be upgradeable to 25 local terminals. 4. The EMS shall support 32/128 bit IP addressing.
22.13	**Management Interface:**	

22.13.1	Southbound Interface of EMS: EMS shall provide south bound interface towards NE as implemented in the Gateway NEs (GNEs).	Check the provision of two management interfaces: remote management interface and Local Management Interface. Ensure that SNMP version2c [or later interface] has been provided on all the Gateway NEs (GNEs) to interact with a centralized Element Management System (EMS). Run the standard MIBs Browser with SNMP version2c [or later interface]. In case SNMP is not provided, ensure that either ITU-T specified Qx or Bellcore specified TL1 interface implemented on TCP/IP remote management interface has been provided.
22.13.2	Northbound Interface: The North bound interface meant for connectivity with NMS shall be open interface such as SNMP v2 or better/ XML/TL-1/ MTNM TMF-508, 613, 814 specified CORBA or JSON or Web service, using standard MIBs/ GDMO/ PICS etc., as per ITU-T Rec. G.873.1. **New Clause :** Security: OTN Payload	Ensure that the northbound interface of the EMS towards NMS layer is SNMP v2 or better/ XML/TL-1/ MTNM TMF-508, 613, 814 specified CORBA, using standard MIBs/ GDMO/ PICS etc., as per ITU-T Rec. G.873.1.

	Encryption Support for AES 128/ 256 **New Clause :**Energy Efficiency and Dynamic Power Management Support energy-efficient operation with dynamic power management features such as adaptive power control, shutdown of unused client ports, and power scaling based on traffic load. **New Clause:** Compliance with ITU-T G.698 for Multi-Vendor Interoperability Support for multi-vendor optical interoperability particularly ITU-T G.698.2 for amplified DWDM applications with single-channel interfaces, to enable transport of alien wavelengths over the optical line system.	
23.0	**DWDM Equipment required for Type Approval**	
23.1	Minimum Equipment for Testing Minimum five DXC nodes with equipped interfaces as per the following loading information shall be offered for testing along with all control and management entities in a wired chassis.	Verify and note down.

<table>
<tr><td>23.2</td><td>Interfaces to be offered against different categories of cross connect:

For offering the interfaces for testing, the following two conditions shall apply</td><td>Test is not required</td></tr>
<tr><td>a)</td><td>In the case of testing against a Purchase Order, the interfaces and the quantum of interfaces mentioned in the PO shall be offered by the vendor for testing.</td><td>Verify and note down.</td></tr>
<tr><td>23.3</td><td>The minimum nos. of OTN Cross Connect with DWDM equipment required to be offered for testing:

Table 5: Minimum OTN with DWDM Equipment for Linear Add/Drop system
<table>
<tr><th>Sl. No.</th><th>Item</th><th>Quantity</th></tr>
<tr><td>1.</td><td>OTN client interface and processing modules</td><td>Minimum equipped OTN cross connect with 10 channels @OTU-4/OTUCn.</td></tr>
<tr><td>2.</td><td>Cross Connect</td><td>5 nos. As per the Cl. 5.1 & Cl. 23.1.</td></tr>
</table></td><td>Pl. ensure minimum requirement of the equipment and cards for Testining as per GR - clause No. 23.3 for DWDM Linear Add/Drop System.

a) Pl. ensure minimum requirement of the equipment and cards for Testining as per GR - clause No. 23.3 for long haul configuration.

b) Pl. ensure minimum requirement of the equipment and cards for Testing as per GR - clause No. 23.3 for Very long haul configuration.

c) Pl. note TAC will be provided only for the offered configuration for any of</td></tr>
</table>

		3.	Terminals (inclusive of MUX/De-MUX for both directions of traffic along with protection related redundant equipment, if any)	2 nos. TEs equipped for 10 channels (DXC Channels). These channels can be configured over 80 channels grid.	the application codes - Longhaul and Very Longhaul.
		4.	In-Line Amplifiers	4 nos. for Long haul equipment 2 nos. for Very Long haul equipment.	
		5.	ROADM (inclusive of both directions of added/dropped traffic) for linear-chain DWDM system	3 nos. equipped for a total of 5 bi-directional channels (DXC Channels) in both fibre-directions for Long-haul equipment	

		2 nos. equipped for a total of 5 bi-directional channels in both fibre-directions for Very Longhaul equipment. (Applies only to the applied application code).
6.	Common equipment with an NMS/EMS & LCT along with software.	1 no. each

Note: Number of channel count at respective ROADM will be DXC channels.

Table 6: Minimum OTN Cross Connect with DWDM Equipment for Ring System

Sl. No.	Item	Quantity

		1.	OTN client interface and processing modules	Minimum equipped OTN cross connect with 10 channels @OTU-4/OTUCn.	
		2.	Cross Connect	5 nos. As per Cl. 5.1 & Cl. 23.1.	
		4.	In-Line Amplifiers	4 nos. for Longhaul equipment 2 nos. for Very Longhaul equipment. (If OADM not offered for testing, there shall be 7 & 4 ILAs for longhaul and very longhaul application codes respectively).	
		5.	ROADM (inclusive	5 nos. equipped for	

	of both directions of added/dropped traffic)	a total of 5 bi-directional channels (DXC Channels) in both fibre-directions for Long-haul equipment
6.	Common equipment with an EMS & LCT along with software.	1 no. each

Note: Number of channel count at respective ROADM will be DXC channels.

New Table : Minimum OTN Cross Connect with DWDM Equipment for Mesh System

Sl. No.	Item	Quantity
1.	OTN client interface	Minimum equipped

	and processing modules	OTN cross connect with 10 channels @OTU-4/OTUCn.	
2.	Cross Connect	5 nos. As per Cl. 5.1 & Cl. 23.1.	
3.	In-Line Amplifiers	4 nos. for Longhaul equipment	
4.	ROADM (inclusive of both directions of added/dropped traffic)	5 nos. equipped for a total of 10 bi-directional channels (DXC Channels).	
5.	Common equipment with an EMS & LCT along with software.	1 no. each	

Note: Number of channel count at respective ROADM will be DXC channels.

The details for minimum equipment required for type approval are elaborated as follows:

a) Longhaul application:

Table 7: Minimum OTN with DWDM Equipment detail for Longhaul applications.

S. No.	Item	Quantity
1.	OTN client interface and processing modules	Minimum equipped OTN cross connect with 10 channels @OTU-4/OTUCn.
2.	Cross Connect	5 nos. As per Cl. 5.1 & Cl. 23.1.
3.	DWDM terminal Equipment	2 no. each
4.	Inline Amplifiers	4 nos
5.	Reconfigurable Optical	3 nos.

	Add /Drop Mux along with provision for channel add/drop capability	
6.	Optical fibre 25dB loss irrespective of length	G.652 SMF: 10/7 Spools for 40/80 Channels G.655 SMF: 7/6 Spools for 40 Channels
7.	NMS supporting LCT and Work Station	1 no.

a) Very Long haul application:

Table8: Minimum OTN with DWDM Equipment detail for Very Longhaul applications.

S. No.	Item	Quantity
1.	OTN client interface and processing modules	Minimum equipped OTN cross connect with 10 channels

		@OTU-4/OTUCn.
2.	Cross Connect	5 nos As per Cl. 5.1 & Cl. 23.1.
3.	DWDM terminal Equipment	2 nos.
4.	Inline Amplifiers	2 nos.
5.	Reconfigurable Optical Add /Drop Mux along with channel add/drop	2 nos
6.	Optical fibre 33dB loss irrespective of length	G.652 SMF: 3/2 Spools for 40/80 Channels G.655 SMF: 3/2 Spools for 40/80 Channels
7.	NMS supporting LCT and Work Station	1 no.

	NOTE 1: The TAC can be applied against any of the DWDM network topologies -, linear add/drop, ring, & mesh (ASON). The same shall be outlined on the TAC. NOTE 2: The TAC can be applied for any of the application codes – Metro, Longhaul and Very Longhaul.	
24.0	**Field Trial:** The equipment shall be subjected to field trial for a minimum of 4 weeks with working traffic. The equipment shall be loaded with maximum possible live-traffic & in case of unavailability of live traffic, simulated traffic shall be loaded for the entire capacity of the system to assess the actual performance of the equipment in the field.	Simulate field condition in the lab with using long fiber for creating actual span loss. and conduct pre A/T test as per A/T test schedule. The trial shall be of 4 weeks with simulated traffic in case of unavailability of live traffic for all the offered interfaces. After four weeks remove the traffic and conduct Final A/T test as per A/T schedule. Submit thereport of pre A/T and Final A/T

25.0	Application codes The GR envisages two different application codes for a, linear-chain & ring in accordance with Table-1 & 2/Annexure-I of the GR. Under all network topologies, viz., , linear add/drop & DWDM ring architecture, all fibre-spans between 'MPI-S & MPI-R', S' & R' and 'Sn & Rn' reference points of figure nos. 7, shall be limited by Table-1 & 2/Annexure-I specifications for both application codes for the worst-case channel. All the optical amplifiers shall be designed for nominal 22db span-loss for Long Haul applications and 30db span-loss for Very Long Haul applications.	Ensure that the equipment supports point-to-point, Ring and linear chain. topology offered for the test with or without protection. How ever test will be conducted only for offered topology. The parametric tests at different reference points are detailed later in the TSTP Test no 1.0 to 21.0.

25.1	Longhaul application code The LH 40 channels DWDM equipment shall acquire approximately 800/550 km (G.652 /G.655 SMF) route length before acquiring 3R regeneration. This is based on 0.28 db/km loss over single mode optical fibre. Based on these projections, total dispersions requirements shall be 14400/ 1100 ps/nm for LH 40 channels configuration @ 18/ 2 ps/nm.km over C-band for G.652/G.655 SMF. The LH 80 channels DWDM equipment shall acquire approximately 550/475 km (G.652 /G.655 SMF) route length before acquiring 3R regeneration. This is based on 0.28 db/km loss over single mode optical fibre. Based on these projections, total dispersions requirements shall be 9900/ 950 ps/nm for LH 80 channels configuration @ 18/ 2 ps/nm.km over C-band for G.652/G.655 SMF. Span-loss between MPI-S & R', S'& MPI-R and S' & R' reference points for all spans shall be 22 dB. The number of spans for long haul application is detailed later in the document. The dispersion – CD as well as PMD in the link shall be addressed through coherent detection technique as indicated in cl. 3.28.	Long Haul application: Before commencement of the link test, confirm and verify the followings: 1. Span length : 80 kms/span. 2. Attenuation of cable: 22 dB/ span 3. No. of spans: 10 4. Total length: 800/550 kms. (G.652/G.655 SMF) 5. Loss over single mode fibre: 0.28 dB/km 6. Chromatic dispersion: 18 /2 ps/nm.km over C-band for G.652/G.655 7. Total CD: 14,400 /1100 ps/nm.km

25.2	Very Longhaul application code The VLH 40 channels DWDM equipment shall acquire approximately 300 km (for both G.652 & G.655 SMF) route length before acquiring 3R regeneration. This is based on 0.28 db/km loss over single mode optical fibre. Based on these projections, total dispersions requirements shall be 5400/ 600 ps/nm for VLH 40 channels configuration @ 18/ 2 ps/nm.km over C-band for G.652/G.655 SMF. Span-loss between MPI-S & R', S'& MPI-R and S' & R' reference points for all spans shall be 30 dB. The number of spans for Very long haul application is detailed later in the document. The dispersion – CD as well as PMD in the link shall be addressed through coherent detection technique as indicated in cl. 3.28. - NOTE 1: The above power-budgets shall be valid even for the worst-case channel for which proper channel equalization scheme shall be implemented in the system to adhere to end-to-end OSNR requirements in uniformity with other channels.	Very Long Haul application: Before commencement of the link test, confirm and verify the followings: 1. Span length : 100 kms/span. 2. Attenuation of cable: 30 dB/span 3. No. of spans: 3 4. Total length: 300 kms. 5. Loss over single mode fibre: 0.28 dB/km 6. Chromatic dispersion: 18 ps/nm.km Total CD: 5400/600 ps/nm.km for VLH 40 channels configuration @ 18/ 2ps/nm/km over C-band for G.652/G.655 SMF.

	NOTE 2: The exact distances covered shall be subject to actual fibre-attenuation coefficient and dispersion parameters for the worst-case channel. NOTE 3: All enroute nodes for both Longhaul & Very Longhaul application codes shall include ILAs, FOADMs/ ROADMs or a combination of them. The insertion-loss of FOADMs/ ROADMs shall be compensated by the OA element contained within OADM node. The OA element shall be designed accordingly.	
25.3	Span attenuation: The span-loss of the optical cable including splice-losses and cable-margin etc. shall be as detailed above, for respective application codes. The span-losses specified in the clause are beginning-of-life values and a margin for the ageing of fibre and optical amplifiers etc., to adhere to end-of-life values shall be tested. Testing of the link shall be performed for a span-loss 3db higher than beginning-of-life values during testing.	The system must support 3dB margin during the testing. The parameters specified are the beginning-of-life values, and so to adhere to the end-of-life values, a 3dB margin during the testing becomes necessary.

<table>
<tr>
<td>25.4</td>
<td>Number of spans without 3R-Regenerator:

For a comprehensive network planning, the purchaser may ask the vendor to provide the relevant network planning tool for the network design. Since the DWDM equipment is required to function in both Longhaul as well as Very Longhaul applications and the no. of spans in respect of both these applications vary depending upon the type of NEs used i.e., TMs, ILAs, ROADMs, the purchaser may ask the vendor to carry out the complete network planning as per the network information provided by the purchaser.

The DWDM link over the Single-mode Optical fibre shall support the number of spans as under:

Table-9: No. of spans as per application and type of fiber
<table>
<tr><th colspan="2">Long Haul Application @ 40Channels</th></tr>
<tr><th>Fibre Type</th><th>No. of Spans</th></tr>
<tr><td>G.652</td><td>10</td></tr>
<tr><td>G.655</td><td>7</td></tr>
<tr><th colspan="2">Long Haul Application @ 80 Channels</th></tr>
</table>
</td>
<td>The equipment shall be able to work for Long Haul & Very Long Haul as per span budget as mentioned in below table over SMF of G.652/655. This link shall include no regeneration of any kind.</td>
</tr>
</table>

	<table><tr><th>Fibre Type</th><th>No. of Spans</th></tr><tr><td>G.652</td><td>7</td></tr><tr><td>G.655</td><td>6</td></tr><tr><th colspan="2">Very Long Haul Application @ 40Channels</th></tr><tr><th>Fibre Type</th><th>No. of Spans</th></tr><tr><td>G.652</td><td>3</td></tr><tr><td>G.655</td><td>3</td></tr><tr><th colspan="2">Very Long Haul Application @ 80Channels</th></tr><tr><th>Fibre Type</th><th>No. of Spans</th></tr><tr><td>G.652</td><td>2</td></tr><tr><td>G.655</td><td>2</td></tr></table>	
25.5	Network Protection: For the various topologies, namely, Linear Add-Drop topology Two fibre DWDM ring and mesh topology, traffic shall be protected at client layer by using 1+1 Optical Sub-Network Connection protection.. The protection switching excluding fault detection time, fault propagation time, etc., shall be completed within 50 ms. The user shall specify the exact	The protection shall be executed at the client level. Also check that the protection switching time for any type of client is less than 50 msec. Refer TSTP test no 24.0.

	requirement of protection mechanism during the procurement of the equipment.	
25.6	Equipment redundancy requirements 1. Control/Processor: The Control/Processor unit/module and Power supply shall not affect the working traffic as the same shall have the redundancy. Further, there shall not be any disruption to system-working when the faulty card is taken out and the healthy one is inserted back. Immediately upon insertion of a healthy card, the system shall revert back to its pre-failure EMS configuration. There shall be support for dual-homing for EMS connectivity for no loss of EMS connectivity, through two Gateway NEs (GNE's) on a DWDM link. In case of total loss of EMS connectivity to the system/network, the system design shall provide local storage of all performance & fault data, as specified in Appendix-I of the GR, for all connections pertaining to all NEs, in the sub-network. Such connectivity loss might happen due to control-card failure at both GNE's and/or failure of DCN link to EMS. In-built intelligence shall be there in EMS for	Check that if the control/processor unit fails, the working existing traffic does not fail or is not affected any way. This can be ensured by simulating a BER measurement and at the same time removing the control/processor unit. Under this condition, no error should be detected. Upon re-insertion of the unit back in its place, the BER should not be disturbed. It shall also be possible to designate any NE as GNE. The system shall support connectivity to two GNEs for dual homing such that the fault, performance data are stored in both the GNEs. Failure of connectivity to one shall not amount to total loss of EMS data.

	selection of appropriate GNE at distant end of a DCN link upon failure of control card at one of the GNE's, for EMS connectivity.	
	2. Switch matrix The universal cross-connect matrix cards having dimension and capacity as per specific category of equipment (clause 5.1 of the GR) shall provide N:1 protection. Upon failure of any of the working card, the protection card shall take-over within 50ms (along with a replica of existing connection-map).	Ensure cross connect card should be redundant and Upon failure of any of the working card , the protection card shall take-over within 50ms . Refer TSTP Test no 24.0 and check redundancy of switch matrix.
	3. Power Supply: If the power-supply is provided through a centralized power-supply unit at chassis level, a hot-standby power-supply shall be provided at chassis level, to ensure smooth working of the equipment during failures. Further, there shall be provision for dual-feed arrangement to the chassis power-supply, such that in case of failure of one feed, the system shall be able to function in a healthy manner without traffic interruption.	Ensure that the Power supply unit is redundant. Also check that the equipment has the provisioning of dual-feed arrangement. Note that redundancy is executed within 50 msec. Check redundancy of power supply.

	4. There shall be complete redundancy for Timing Circuitry against failures. The changeover of all redundancy actions shall be completed within 50ms.	Very the redundancy of Timing Circuitry unit. Note that redundancy is executed within 50 msec. Check redundancy of timing cards.
26.0	**Maintenance requirements**	
	Maintenance philosophy is to replace faulty units/subsystems after quick on-line analysis through monitoring sockets, alarm indications and Built-in Test Equipment/ hand-held terminal/laptop PC. The actual repair will be undertaken at centralized repair-centers. The corrective measures at site shall involve replacement of faulty units/sub-systems.	In order to provide quick maintenance by replacing the faulty units all the traffic affecting units shall have the front access and shall not involve any screw to mount them. Also ensure that online analysis is provided in case Built-In-Test Equipment facility is supported by the equipment.
a.	The equipment shall have easy access for servicing and maintenance.	Verify that easy access, front access in particular is provided for ease of maintenance.
b.	Suitable alarms shall be provided for identification of faults in the system and faulty units.	Check that LEDs are provided to indicate the faults in the system and also for the faulty units.
c.	Suitable provision shall be made for extension of summary alarms.	Check that potential free contacts are provided to extend the alarms.
d.	Ratings and types of fuses used are to be indicated by the supplier.	Ensure from the documents supplied by the manufacturer that the types of fuses used and their ratings are provided.

27.0	**Accessories:**	
27.1	The supplier shall provide one complete set of:	Ensure that the supplier has supplied one complete set of the following:
a)	All the necessary interfaces, connectors, connecting cables and accessories required for satisfactory and convenient operation of the equipment. Types of connectors, adapters to be used and the accessories of the approved quality shall be clearly indicated in the operating manuals, which should be in conformity with the detailed list in the GR;	a) Set of connectors, connecting cables, adapters and any other accessories required for satisfactory working of the equipment.
b)	Software and the arrangement to load the software at site. NOTE 1: Additional sets may be ordered optionally. NOTE 2: Special tools, extender boards, extender cables and accessories essential for installation, repair, operation and maintenance of the equipment shall be clearly indicated and supplied along with the equipment.	b) A copy of the software on a CD and detailed procedure in the eqpt. Manual as to how to download the same at site.
28.0	**Documentation:** Technical literature in English language for assembly of modules and wiring shall be supplied. All aspects of installation, operation, maintenance shall be	Ensure that the technical literature is in English language. It contains the complete layout detailed block schematic and circuit diagrams of various assemblies. Ensure that the

	covered in the manuals. The soft copy of the manuals shall also be provided in pen drive/by email. The soft copy or hard copy of the manuals may also be provided in Hindi language, if feasible. The manuals shall include the following: i) Installation, Operation and Maintenance Manual- a) Safety measures to be observed in handling the equipment; b) Precautions for installation, operation and maintenance; c) Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance, trouble-shooting and sub-assembly replacement; d) Illustration of internal and external mechanical parts. e) The detailed description about the operation of the software used in the equipment including its installation, loading and debugging etc. ii) Repair Manual (to be supplied when ordered)- a) List of replaceable parts used including their sources and the approving authority; b) Detailed ordering information for all	repair philosophy is defined in the documents in respect of installation, operation and maintenance. Further the manual shall include the following. a) Ensure that the safety measures have been listed in handling the equipment. b) Ensure that the precautions for installation, operation and Maintenance are given in the manual. c) Ensure that the details of test jigs and fixture if any required procedures for routine maintenance, preventive maintenance trouble shooting and sub assembly replacement have given in the manuals. d) Internal and external mechanical parts are illustrated. e) Ensure that the detailed description about the operation and procedure for software download, installation and debugging etc. are Given Repair manual**:** Verify the documents for the following: a) Ensure that the repair manuals contain the list of replaceable parts and their source and approving authority. b) Ensure that the repair manuals contain the detailed ordering

	the replaceable parts shall be listed in the manual to facilitate reordering of spares as and when required; c) Procedure with flow chart for troubleshooting and sub-assembly replacement shall be provided.	information for all replaceable parts. c) Ensure that the repair manuals contain the procedure for the trouble shooting and sub-assembly replacement if any. Also note that details of fixture and accessories if any required for repair is given in the repair manuals. Check that the systematic trouble shooting chart is given in the repair manuals.

	Annexure-II ASON Planning Tool	Optional
	ASON Planning tool shall facilitate network operators to plan and simulate networks with an automated control plane such as GMPLS/ASON. GMPLS/ASON networks behave differently from legacy transport networks. The flexibility and benefit of having a transport layer control plane often results in a complex network planning process based on the operator's Traffic Engineering policies. The ASON-Planning Tool emulates the behavior of GMPLS/ASON networks in all the possible operative scenarios such as link , node and Shared Risk Link Group (SRLG) failures. The goal of the ASON-Planner is to maximize the quality of service provided to customer and to optimize the network resources. The ASON-Planning Tool shall be a multi-layer , multi-technology network planning tool that helps network operators to plan , develop , manage and upgrade their transport network.	Ensure ASON planning tool should provide facilities as mentioned below: 1. Planning tool should plan and simulate networks with an automated control plane such as GMPLS/ASON. 2. There should be flexibility of having a transport layer control plane often results in a complex network planning process based on the operator's Traffic Engineering policies. 3. The ASON-Planning Tool emulates the behavior of GMPLS/ASON networks in all the possible operative scenarios such as link , node and Shared Risk Link Group (SRLG) failures. 4. Planning tool should maximize the quality of service provided to customer and to optimize the network resources. 5. ASON planning tool should be multilayer & Mullti technology Network planning tool.
1.0	**Applications:**	
1.1	a) Planning the needed capacity of a network The ASON Planning Tool shall be	Ensure that planning tool shall provide option as mentioned below:

	able to perform capacity planning of new network builds. For an optimal design of the network , the tool shall provide an option to specify the following parameters: The traffic matrix, and more specifically: i. The number of circuits to be created with the same characteristic; ii. The source and a (the) destination(s); iii. The required protection/restoration scheme; iv. The required diversity between worker and protection/restoration circuit (link, node or SRLG) v. Resources (link, node or SRLG) to be included or excluded in the network vi. Traffic parameters for the circuit(s) e.g. the bandwidth. b) The physical topology of the network, including the connectivity among the network elements, c) The required network survivability specifying the number and type of the failure(s) policy, e.g. double links failure, single SRLG failure etc. d) The type of network interfaces to be used during the capacity planning process,	i. The number of circuits to be created with the same characteristic; ii. The source and the destination(s); iii. The required protection/ restoration scheme; iv. The required diversity between worker and protection/restoration circuit (link , node or SRLG) Resources (link , node or SRLG) to be included or excluded in the network v. Traffic parameters for the circuit(s) e.g. the bandwidth.

1.2	Periodical check of the network status:	
	With the ASON Planning Tool , it shall be possible to update the snapshot of the network status , either from management system or directly from the network via standard Simple Network Management Protocol (SNMP) interface. These snapshots shall be used to: a) Perform the sensitivity analysis or 'what if' scenarios of failures or planned works, b) verify if there are enough resources to accommodate new traffic requests when a new or modified traffic matrix is applied to the snapshot, c) check if the network status is in line with the forecast.	Ensure that planning tool should be capable to update the snapshot of the N/W status. either from management system or directly from the network via standard Simple Network Management Protocol (SNMP) interface.
2.0	**Functionality:**	
2.1	Capacity Planning: Having the current network topology and the current network occupation as input , the capacity planning analysis function should generate a batch of circuits according to the traffic matrix , If some link or node exceeds a configurable percentage of occupation , an extension of the link/node capacity would be required.	Ensure that the capacity planning analysis function should generate a batch of circuits according to the traffic matrix based of the input of the current network topology and the current network occupation. If some link or node exceeds a configurable percentage of occupation, the planning tool should perform an extension of the link /node automatically.

	This operation could require the addition of ports and pairs of fiber to the links (or in case of DWDM links , of the number of transponders required by the line terminals. The ASON Planning Tool shall be able to perform such automated operations. The required modifications shall be stored and available on screen or file.	
2.2	Fault Analysis: Fault analysis allows the simulation of network faults and evaluation of the possibility to recover traffic. According to the current network configuration , the risk and the lost circuits can be evaluated. It shall be possible to simulate faults on every link , node or SRLG of the network. The report will highlight the quantity of circuits protected and the circuits not saved by the network resource. This can be useful for discovering possible weak points of the network.	Planning tool should simulate the Network faults & Evaluate the possibility of traffic recovery.

2.3	Availability Analysis: The ASON Planning Tool shall facilitate an availability analysis providing the estimation of the total availability of a network configuration on a per-circuit or per-SLA basis. It shall be possible to use this feature to compare different protection/restoration schemes for the same network. It shall produce failure times for all the protection/restoration schemes (with or without control plane) and in case of single or multiple failures , it shall provide traffic impact data in case there are not enough resources to protect/restore the failure(s).	Ensure that planning tool shall facilitate an availability analysis providing the estimation of the total availability of a network configuration on a per-circuit or per- SLA basis. It shall be possible to use this feature to compare different protection/restoration schemes for the same network. It shall produce failure times for all the protection/restoration schemes (with or without control plane) and in case of single or multiple failures , it shall provide traffic impact data in case there are not enough resources to protect/restore the failure(s).
2.4	Bottleneck Analysis: The bottleneck analysis shall allow the ability to find out network bottlenecks , that nodes or links that need to be or that will be upgraded in order to properly satisfy the traffic requirements of the network. Having the current network topology (and the current network occupation) as input , the bottleneck analysis function shall generate a batch of circuit creation according to the traffic matrix.	Ensure that planning tool should allow the ability to findout network bottlenecks. Bottleneck analysis function shall generate a batch of circuit creation according to the traffic matrix based upon current network topology as input.

2.5	Network Inventory: The network inventory allows generation of a list of all the resources available in the net work , and the map of the circuits. It should be possible to customize the network inventory depending on the need of the Network Operator , the level of details produced ranging from; all possible details to only circuits or node traffic interface inventory	Ensure that planning tool should generate a list of resources available in network and possible to customize the network inventory depending on the need of the Network Operator
2.6	Available Reports For each of the ASON — Planning tool functionalities , it should be possible to generate a report. The reports should be available in text file , Word and Excel compatible formats. Moreover it should be possible to customize each report , including all the available details or only a summarized view of the feature performed.	Ensure that planning tool should generate a report that may be in twxt file, word file and excel file. It should possible to customize the report , including all the available details or only a summarized view of the feature performed.
2.7	ASON Planner to NE The ASON-Planning tool shall be able to plan the networks, the output of the planning activity shall be configuration files that can be directly downloaded to the Network Elements.	Ensure that planning tool should be able to plan the Network.

2.8	ASON-Planner GUI ASON-Planning tool shall provide the network operator with a user friendly graphical interface: this GUI can be used to have a view of network or a frontal view of the network element	Ensure that planning tool should be user friendly and GUI based.
3.0	**Features** a) Map view of the network topology, allowing to create or modify a network directly from the map. Background map should be available. b) Support of traffic at ODU1, ODU2/e, ODUflex, ODU3 etc. c) Additional Constraints: Administrative colors, Explicit routes or inclusion/exclusion of certain categories of network resources. d) Restoration with diversity W/P on nodes, links or SRLG Ids (Shared Risk Link Group Ids). Diversity from a list of selected existing circuits. e) Support of Traffic engineering. Configurable TE policy. f) Import from and export to ASON Planning tool of network topology files. g) Import from and export to NMS of network topology files. h) Network reports including:	Ensure that planning tool should allow to create or modify network directly from the map. Background map should be available It should support traffic at QDU 1. ODU2/e. ODUflex. ODU3 etc. Ensure additional constraints as mentioned below: 1. Administrative colors , Explicit routes or inclusion/exclusion of certain categories of network resources 2. Restoration with diversity W/P on nodes , links or SRLG Ids 3. Diversity from a list of selected existing circuits. 4. Support of TE link policy. 5. Import & Export feature of network topology file. 6. Network report including bottleneck analysis, fault analysis, capacity planning, network inventory & Availability analysis. 7. Support of ASON control plane. 8. Fully configurable list view of network resources.

	Bottleneck analysis, Fault Analysis, Capacity Planning, Network Inventory and Availability Analysis. i) Support of ASON control plane j) Automatic generation of ASON parameters k) Import/Export of Traffic Matrix data from/to Excel (CSV); Full import/export of network data from/to Excel (CSV) l) Fully configurable list views of network resources m) Link details (including ASON parameters) on the map.	

TEST SCHEDULE AND TEST PROCEDURE

In the minimum equipment requirements clause of the GR, i.e., Cl. 23.0, it has been envisaged that for Type Approval, the equipments to be offered are as given under. However, supplier can offer different quantity of boards to maintain 10 channels.

OTN Cross connect configuration for Mesh Network:

1. OTN cross connect: 05 No.
2. No. of channels: 50 No. (10 channels per node)
3. In line Amplifier: 04 No.
4. ROADMs: 05 No.
5. Optical fiber 22 dB loss irrespective of length: 10 spools.

Sample tables for recording the measured results / observation have been given below. The tester may use additional tables as per requirements.

Application topologies:

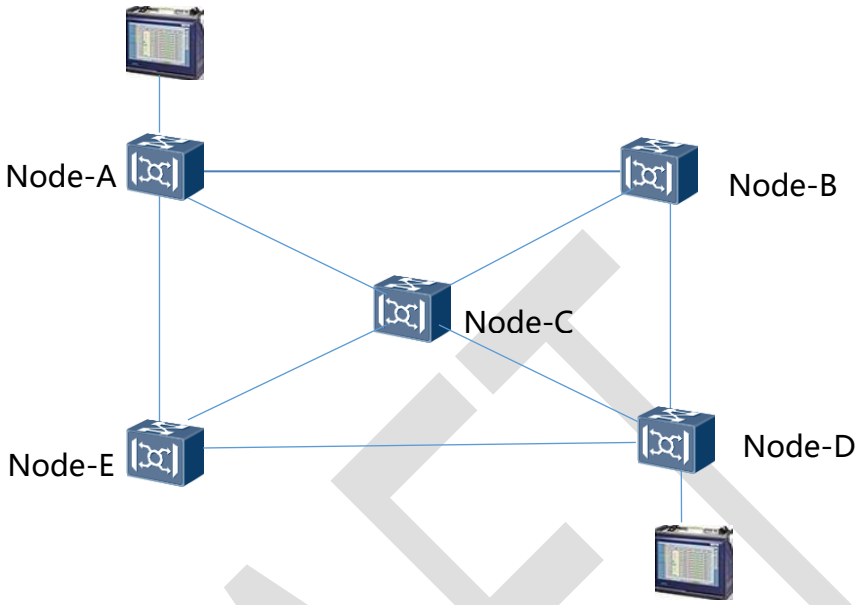


Figure -1: Mesh Topology

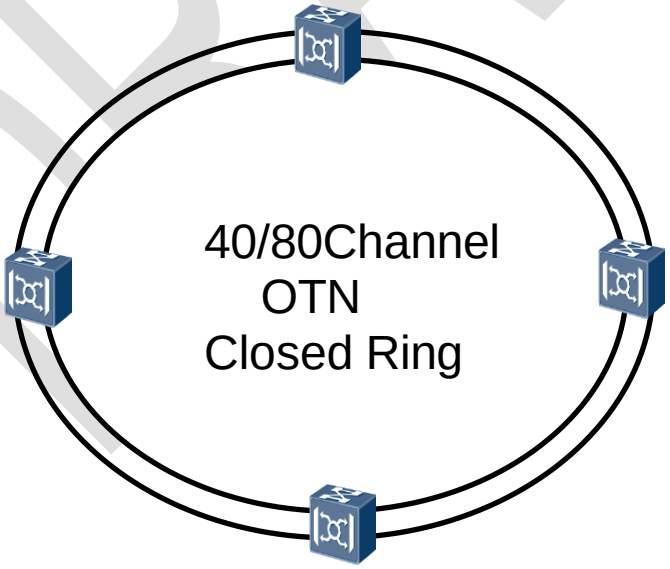


Figure -2 - Closed Ring Topology

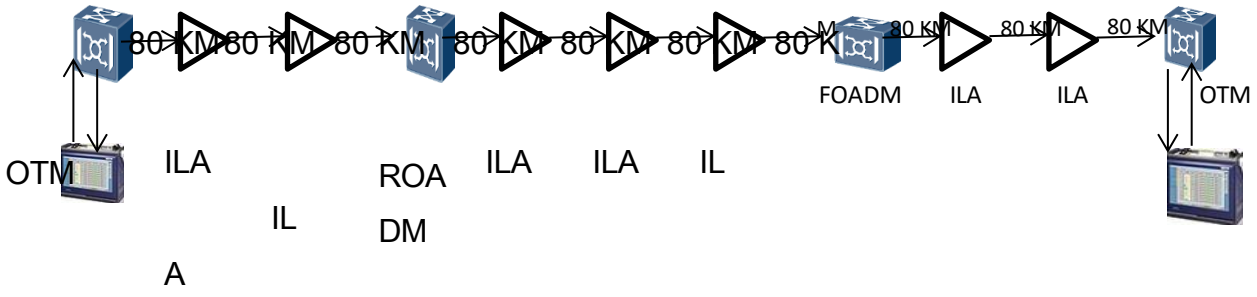


Figure-3: Test set up for linear add drop using FOADM & ROADM for Long Haul application using fiber G-652 D

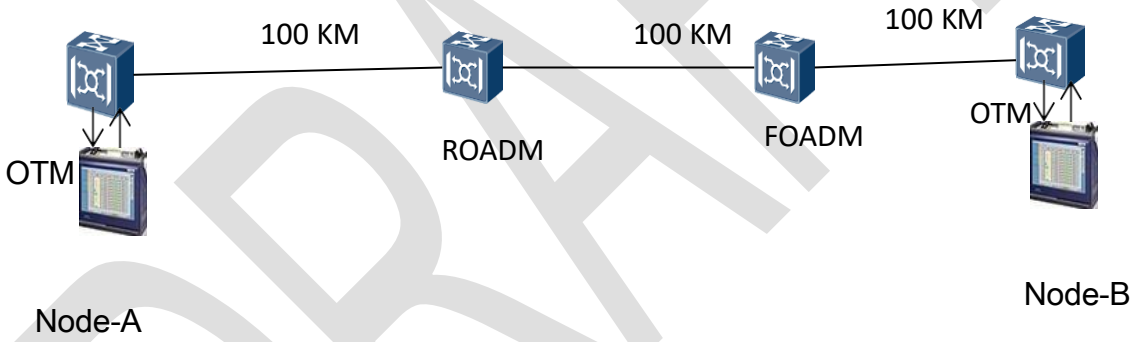


Figure -4 : Test set up for linear add drop using FOADM & ROADM for Very Long Haul application using fiber G.652 D.

Remarks:

1) Test setup shown in figure -3 and figure-4 are for longhaul application and very longhaul application using figer G.652D. Nos. of span will be changed depending upon the type of fiber if we are using G.655.
2) Test setup shown in figure -3 & figure-4 are for one direction Node -A to Node-B. Same test will be conducted for other direction also i.e. from node B to Node- A.

1.0. Check of individual channel wavelength:

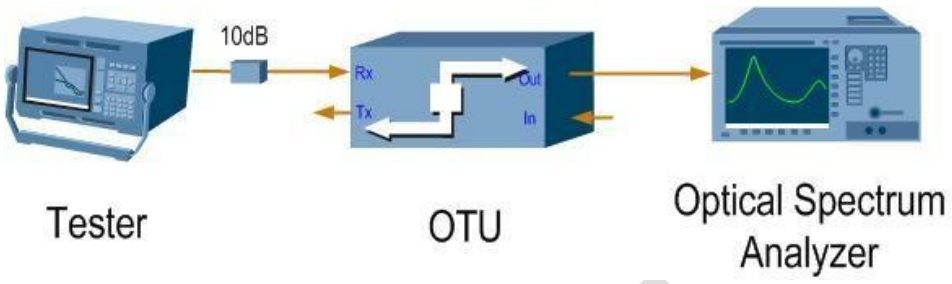


Figure- 5: Test set up for checking individual wavelength

Connect OSA (Optical Signal Analyzer) to the output of each Line cards. Configure OSA for measurement of Wavelength and central frequency and recard the value in the table mentioned below.

Specification: Wavelength deviation = ± 25pm.

Channel No.	Approximate nominal central wavelength in nm	Frequency in THz	Measured wavelength in nm	Wavelength drift (Δλ)	Measured Freq. in THz
1.	1529.55	195.90			
2.	1530.72	195.85			
3.	1531.12	195.80			
4.	1531.51	195.75			
5.	1531.90	195.70			
6.		195.65			
7.		195.60			
8.		195.55			
9.		195.50			
10.		195.45			
11.		195.40			
12.		195.35			
13.		195.30			

14.		195.25			
15.		195.20			
16.		195.15			
17.		195.10			
18.		195.05			
19.		195.00			
20.		194.95			
21.		194.90			
22.		194.85			
23.		194.80			
24.		194.75			
25.		194.70			
26.		194.65			
27.		194.60			
28.		194.55			
29.		194.50			
30.		194.45			
31.		194.40			
32.		194.35			
33.		194.30			
34.		194.25			
35.		194.20			
36.		194.15			
37.		194.10			
38.		194.05			
39.		194.00			
40.		193.95			
41.		193.90			
42.		193.85			
43.		193.80			
44.		193.75			

45.		193.70			
46.		193.65			
47.		193.60			
48.		193.55			
49.		193.50			
50.		193.45			
51.		193.40			
52.		193.35			
53.		193.30			
54.		193.25			
55.	1551.72	193.20			
56.	1552.12	193.15			
57.	1552.52	193.10			
58.	1552.93	193.05			
59.	1553.33	193.00			
60.	1553.72	192.95			
61.	1554.12	192.90			
62.	1554.52	192.85			
63.	1554.92	192.80			
64.	1555.32	192.75			
65.	1555.72	192.70			
66.	1556.12	192.65			
67.	1556.52	192.60			
68.	1556.92	192.55			
69.	1557.32	192.50			
70.	1557.72	192.45			
71.	1558.12	192.40			
72	1558.52	192.35			
73.	1558.92	192.30			
74.	1559.32	192.25			
75.	1559.72	192.20			

76.	1560.12	192.15			
77.	1560.52	192.10			
78.	1560.92	192.05			
79.	1561.32	192.00			
80.	1561.72	191.95			
-	-	-			
-	-	-			
-	1565.00	-			

2.0. Central frequency, SMSR & Optical Spectral width:

Connect the Output of the Line card to the Optical spectrum analyzer (OSA) and program the instrument for the measurement of optical spectrum. From the spectrum record the following. Central frequency Spectral width at 20 dB down point and Side Mode Suppression ratio.

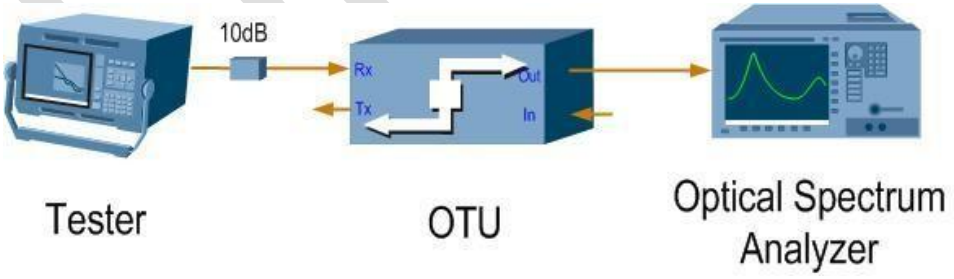


Figure 6: Test set up for spectral characteristics

Procedure:

Connect the Output of the Line card to the Optical spectrum analyzer (OSA) and program the instrument for the measurement of optical spectrum. From the spectrum, record the

following:

Central frequency, Spectral width at 20 dB down point and Side Mode Suppression Ratio (SMSR).

Specifications: Side Mode supression Ratio: ≥30dB

Spectral width at –20 dB: ≤0.5nm

Central freq: 193.1 THz

Terminal-A

OTUCn Line cards

Chl.No.	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
Central Frequency								
SMSR								

Spectral width @-20dB								
Chl.No.	Chl #9	Chl #10	Chl #11	Chl 12	Chl 13	Chl #14	Chl #15	Chl #16
Central Frequency								
SMSR								
Spectral width @-20dB								
Chl. No.	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl #22	Chl #23	Chl #24
Central Frequency								
Spectral Width @20dB								

NOTE: Similar tables shall be filled for Terminal B.

NOTE: Similar tables shall be filled for ROADM-1 (A to B Direction) & ROADM-1 (B to A Direction) and other ROADMs.

3.0. Launched power:

Connect the output of the Line card / Client card to the Optical power meter and record the transmitted power of the Line / Client-side interface.

Terminal A

OTUCn Line cards Specification: -5 to +5 dBm

Chl.No.	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
Optical Launch power								
Chl.No.	Chl #9	Chl #10	Chl #11	Chl 12	Chl 12	Chl #14	Chl #15	Chl #16
Optical Launch power								
Chl.No.	Chl #17	Chl #18	Chl #19	Chl # 20	Chl # 21	Chl # 22	Chl # 23	Chl # 24
Optical Launch power								

10G Client card: Transmit Side : Limit: < 0.5 dBm

Client card No.	TX#1	TX#2	TX#3	TX#4	TX#5	TX#6	TX#7	TX#8	TX#9	TX#10
Optical Launch power										

100G Client card: Transmit Side : Limit: < 10.5 dBm

Client card No.	TX#1	TX#2	TX#3	TX#4	TX#5	TX#6	TX#7	TX#8	TX#9	TX#10
Optical										

Launch power										

NOTE: Similar tables are to be filled for other Terminals.

4.0. Receiver Sensitivity:

Receiver sensitivity of Line card / Client side Rx interfaces.

Test configuration:

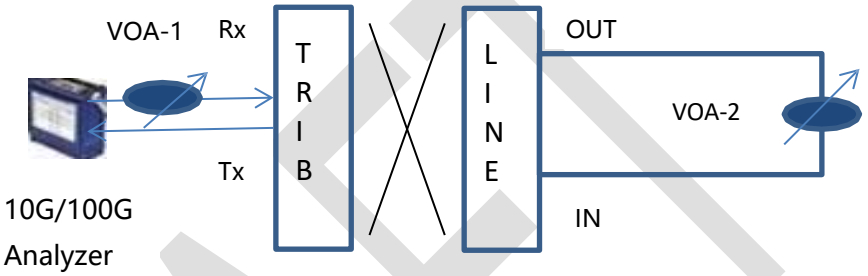


Figure 7: Reciever Senstivity

Procedure:

1) Establish the testing configuration according to the above diagram.
2) Make cross connection between tributary card and line card.
3) Connect SDH Analizer in client side & configure the traffic according to the card to be tested.
4) onfigure the service as per required service rate (STM64, OTU-2, 10GbE etc).
5) Now Adjust the attenuation of VOA1 gradually until observing bit-error for getting Receiver sensitivity in Client side of the tributary card /Line card.
6) When the equipment under test starts giving the errors reduce the attenuation slightly to receive error free signals.
7) Monitor the signals at SDH Analyzer for 15 minutes (BER minimum 1 X 10^{-12}).

8) Read the attenuator the value or check the result with optical power meter, and get the client side sensitivity that should be within limit of specified specification as per TEC GR/ITU-T or provided in below table.
9) Adjust the attenuation of VOA2 gradually until get the bit-error for getting receiver sensitivity in WDM side.
10) When the equipment under test starts giving the errors reduce the attenuation slightly to receive error free signals.
11) Monitor the signals at SDH Analyzer for 15 minutes (BER minimum 1 X 10^{-12}).
12) Read the attenuator the value or check the result with optical power meter, and get the client side Receiver sensitivity that should be within limit of specified specification as per TEC GR/ITU-T or provided in below table.

Terminal A:

10G Client card: Receive Side: Limit: < -14.1 dBm

Chl.No.	RX#1	RX#2	RX#3	RX#4	RX#5	RX#6	RX#7	RX#8	RX#9	RX#10
Receiver Sensitivity										

100G Client card:

Manufacturer's Specification: ≤-8.6 dBm per lane (100GE)

≤-10.3 dBm per lane (OTU-4)

Chl.No.	RX#1	RX#2	RX#3	RX#4	RX#5	RX#6	RX#7	RX#8	RX#9	RX#10
Receiver Sensitivity										

Line card (OTUCn) : Receive side: Limit: < -18 dBm

Chl.No.	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
Receiver Sensitivity								
Chl.No.	Chl #9	Chl #10	Chl #11	Chl 12	Chl 12	Chl #14	Chl #15	Chl #16
Receiver Sensitivity								

Chl.No.	Ch #17	Ch #18	Ch #19	Ch # 20	Ch # 21	Ch # 22	Ch # 23	Ch # 24
Receiver Sensitivity								

NOTE: Similar tables shall be filled for all Terminal

5.0 Receiver Overload:

Receiver Overload of Line card /client card Rx interfaces.

Test configuration:

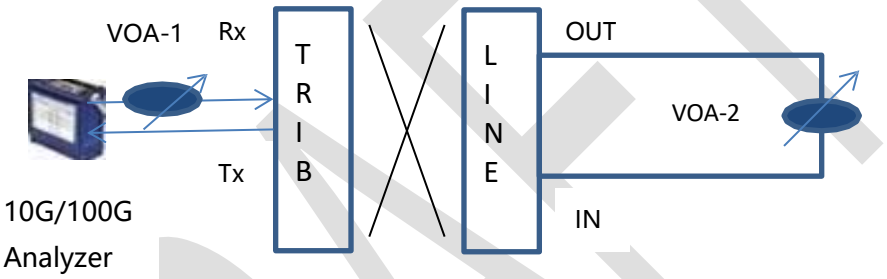


Figure 8: Receiver Overload

Procedure:

1. Establish the testing configuration according to the above diagram.
2. Make cross connection between tributary card and line card.
3. Connect SDH Analizer on client side & configure the traffic according to the card to be tested.
4. Configure the service as per required service rate (STM64, OTU-2, 10GbE etc).
5. Now Adjust the attenuation of VOA1 to increase input power of client side gradually until observing bit-error for getting Receiver overload in Client side of the tributary card /Line card /Muxponder.
6. When the equipment under test starts giving the errors reduce the attenuation slightly to receive error free signals.
7. Monitor the signals at SDH Analyzer for 15 minutes (BER minimum 1 X 10^{-12}).

8. Read the attenuator value or check the result with optical power meter, and get the client side Receiver overload that should be within limit of specified specification as per TEC GR/ITU-T or provided in below table.
9. Adjust the attenuation of VOA2 gradually to increase input power in WDM side until get the bit-error for getting Receiver overload in WDM side.
10. When the equipment under test starts giving the errors reduce the attenuation slightly to receive error free signals.
11. Monitor the signals at SDH Analyzer for 15 minutes (BER minimum 1 X 10^{-12}).
12. Read the attenuator the value or check the result with optical power meter, and get the WDM side Receiver overload that should be within limit of specified specification as per TEC GR/ITU-T or provided in below table.

Terminal A:

10G Client card:

Manufacturer's Specification: ≤0.5 dBm

Chl.No.	RX#1	RX#2	RX#3	RX#4	RX#5	RX#6	RX#7	RX#8	RX#9	RX#10
Receiver Overload										

100G Client card:

Manufacturer's Specification: 100GbE ≤ 4.5 dBm per lane OTU4 ≤2.9 dBm per lane

Chl.No.	RX#1	RX#2	RX#3	RX#4	RX#5	RX#6	RX#7	RX#8	RX#9	RX#10
Receiver Overload										

Line card (OTUCn): Transmit side: Limit: < 0 dBm

Chl.No.	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
Receiver Overload								
Chl.No.	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Chl #15	Chl #16
Receiver Overload								
Chl.No.	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl # 22	Chl #23	Chl # 24
Receiver Overload								

NOTE: Similar tables shall be filled for all Terminals.

6.0 Eye Pattern:

Loop the line card interface via 20 dB attenuator. Connect the output of client side to the Communication Analyser. From the selection menu of the Communication Analyser select the Eye pattern function and bit rate STM-64. The instrument shall display the built-in standard mask of eye pattern as per ITU-T G.957 and the eye pattern of the equipment under test shall also be displayed. Note that the eye pattern equipment under test shall fall within the built-in standard mask of the STM-64. Take the printout of the mask and attach the prints.

Terminal A: (Transmit Interfaces)

Client Card	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.
Eye pattern	Enclosed / Not enclosed	Enclosed / Not enclosed	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d

Line card	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
Eye pattern	Enclosed / Not enclosed	Enclosed / Not enclosed	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclos ed/Not enclo s e

NOTE: Similar tables are to be mandatorily filled for all Terminals.

7.0 Extinction ratio

Under the test same set up as stated above, programme the instrument for the Extinction ratio test. Extinction ration can be directly read from communication signal analyzer. Record the extinction ratio value in the table mentioned below.

Terminal A: (Transmit Interfaces) Specification: ≥12 dB

Client Card	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.	Cl. No.
Extinction ratio	Enclose d/Not enclose d	Enclosed /Not enclosed	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclose d/Not enclose d	Enclosed/ Not enclose

Line card	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5
Extinction Ratio	Enclosed/ Not enclosed	Enclosed /Not enclosed	Enclose d/Not enclose	Enclose d/Not enclose	Enclose d/Not enclose

NOTE: Similar tables are to be filled for all terminals.

8.0 Optical Return Loss:

Figure 9: Optical Return Loss test setup

Procedure:

1) Calibrate optical return loss according to the instrument user manual;

2) According to the test setup, connect the setup, and get the optical receiver reflectance test result (expressed in dB).

Terminal A:

10G Client card:

Manufacturer's Specification: > 12 dB

Chl.No.	RX#1	RX#2	RX#3	RX#4	RX#5	RX#6	RX#7	RX#8	RX#9	RX#10
Optical Return										

100G Client card:

Manufacturer's Specification: >20 dBm

Chl.No.	RX#1	RX#2	RX#3	RX#4	RX#5	RX#6	RX#7	RX#8	RX#9	RX#10
Optical Return										

Line card (OTUCn):

Specification: > 24 dB

Chl.No.	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
Optical Return Loss								
Chl.No.	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Chl #15	Chl #16
Optical Return Loss								
Chl.No	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl #22	Chl #23	Chl #24
Optical Return								

NOTE: Similar tables shall be filled for all Terminals.

9.0 Optical Signal to Noise Ratio at Demuxer output (individual Channel):

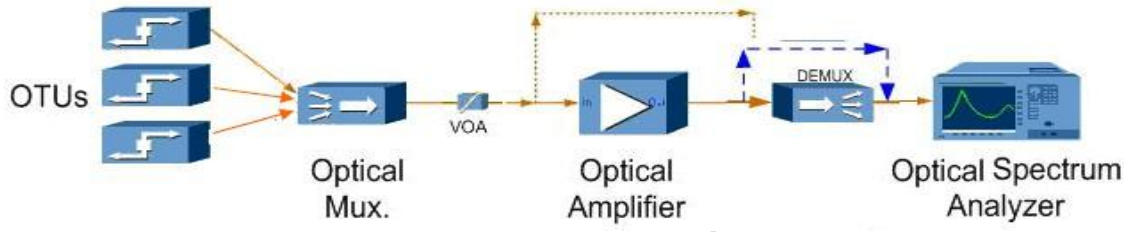


Figure 10: OSNR Set up

Connect OSA (Optical spectrum Analyzer) to each individual channel of Demux and measure the OSNR value. Record the OSNR value in the below table.

A-B direction

Individual Channel Optical Signal to Noise Ratio (Long Haul Application)								
Optical Signal to Noise Ratio	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Ch#15	Ch#16
	Ch#17	Ch#18	Ch #19	Ch #20	Ch#21	Chl #22	Chl #23	Chl #24
	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32
	Chl #33	Chl #34	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40

B-A direction

Individual Channel Optical Signal to Noise Ratio (Long Haul Application)								
Optical Signal to Noise Ratio	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Ch#15	Ch#16
	Ch#17	Ch#18	Ch #19	Ch #20	Ch#21	Chl #22	Chl #23	Chl #24

	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32
	Chl #33	Chl #34	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40

10.0 Cross talk at Mux –Demux & Amplifier:

The purpose of this test is to take the Optical Cross talk between adjacent channel of the DWDM link with the specified section loss and dispersion, which is 22 dB. Make the test set up as shown in the figure as mentioned below. Connect the Optical Spectrum Analyzer at Mux out and run OSA to get all the channels. Configure two pointers in OSA. Put one pointer on previous channel No. 1 (disturbing channel) and other pointer on next channel No. 2 (disturbed channel). Swith off power of previous channel No. 1 (disturbing channel). Pointer of channel No. 1 will down at noise level. Take difference between both Channel power with reading pointer value. Now power on the previous channel -1 and consider 2nd channel as a disturbing channel and channel 1 and channel 3 will be disturbed channel. switched off channel 2 and meaure power difference between channel -1 and channel 2 cross talk of as previous channel. Now shift pointer on channel -3 and measure power difference between channel 3 nan channel 2 as cross talk of next channel. Now power on Channel 2 and switched off channel 3 as a disturbing channel. Measure power of channel 2 as previous channel and power of channel 4 as next channel. continue same process for all channels and record the value in below table Take cross talk measurement at all amplifier and Mux-Demux of complete path and record the value in the table.

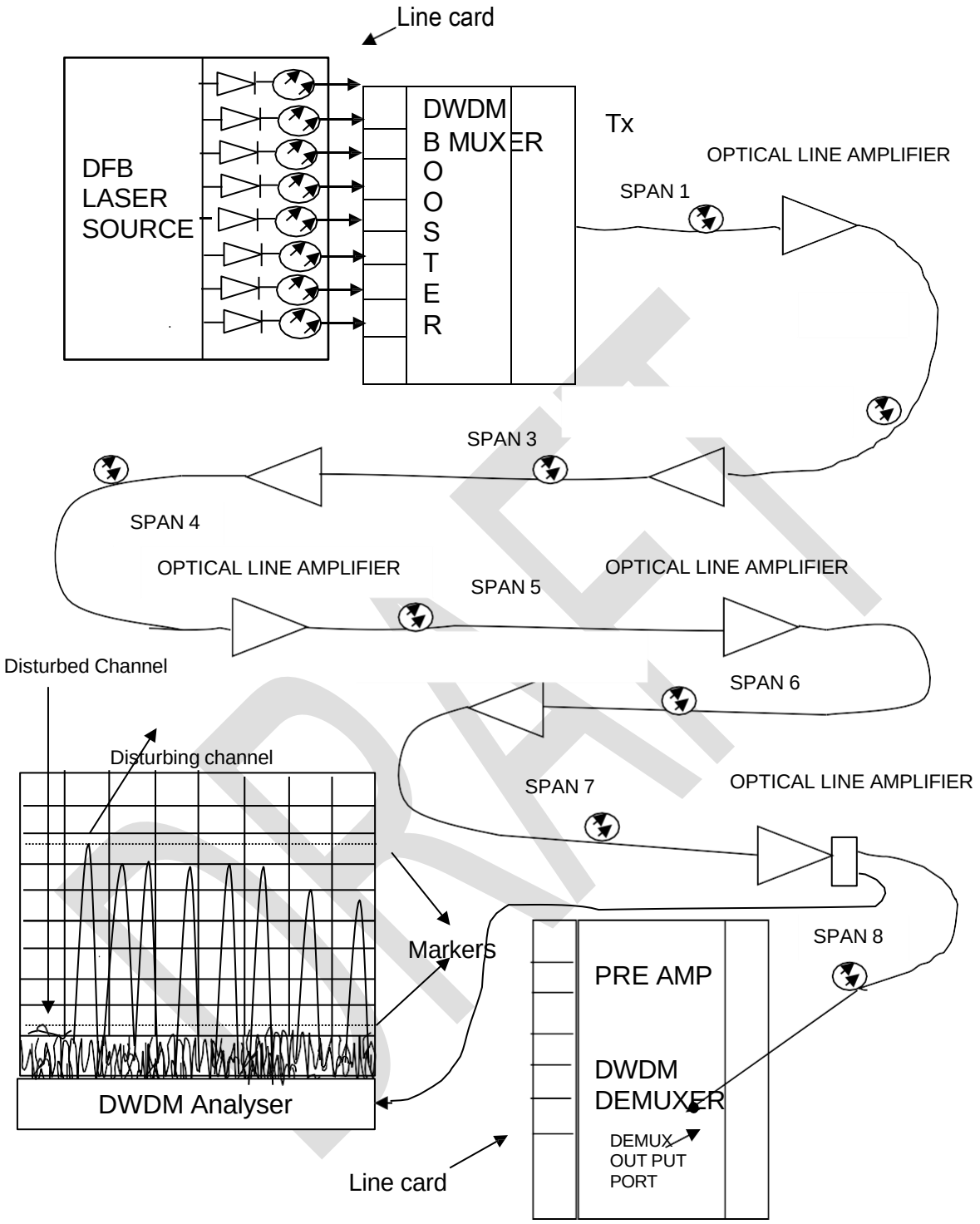


Figure 11: Test Setup for Cross Talk at Pre-Amplifier Output Port

Cross talk at individual channel output (De-muxer output)

A-B Direction:

Cross talk Demuxer output (Long Haul Application)																
Disturbing Channel	Ch l #1	Ch l #2	Ch l #3	Ch l #4	Ch l #5	Ch l #6	Ch l #7	Ch l #8	Ch l #9	Ch l #10	Ch l #11	Ch l #12	Ch l #13	Ch l #14	Ch l #15	Ch l #16
Previous Channel																
Next Channel																
	Chl #17	Ch l #18	Ch l #19	Ch l #20	Ch l #21	Ch l #22	Ch l #23	Chl #24	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32
Previous Channel																
Previous Channel																

	Chl #33	Ch l #34	Ch l #35	Ch l #36	Ch l #37	Ch l #38	Ch l #39	Chl #40
Previous Channel								
Previous Channel								

NOTE: Similar table shall be filled for B-A direction.

Optical Transmit cross talk at the output of Mux/Optical Amplifiers: Terminal A:

Cross talk Long Haul Application at Mux/Booster output																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Chl #15	Chl #16
Previous Channel																
Next Channel																
	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl #22	Chl #23	Chl #24	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32
Previous Channel																
Previous Channel																

	Chl #33	Chl #34	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous Channel								
Previous Channel								

Cross talk Long Haul Application at Pre Amp out																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Chl #15	Chl #16
Previous Channel																
Next Channel																

	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl #22	Chl #23	Chl #24	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32
Previous Channel																
Previous Channel																

	Chl #33	Chl #34	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous Channel								
Previous Channel								

NOTE: Similar table shall be filled for Terminal B.

Cross talk at the Optical Line Amplifiers /Pre Amplifier:

A-B direction :

Cross talk Long Haul Application Output of Line Amplifier #1																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Chl #15	Chl #16
Previous Channel																
Next Channel																

	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl #22	Chl #23	Chl #24	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32

Previous Channel																
Previous Channel																
	Chl #33	Chl #34	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40								
Previous Channel																
Previous Channel																

NOTE: Similar tables shall be filled for all terminals.

NOTE: Similar tables shall be filled for B-A direction.

11.0 Mean Channel output power & Maximum Channel power difference:

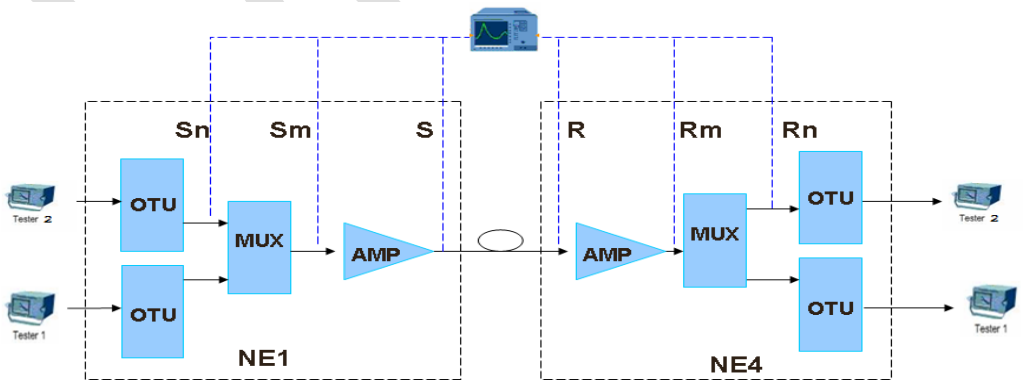


Figure 12: Test set up for Mean channel output Power

Put the OSA at the output of the Mux, and amplifier and programme the instrument for wavelengths and power measurement. Record the channel power at the output of the Muxer. Take the test on Longhaul. Similarly connect the instrument at the output of Booster, Optical line Amplifiers & Optical pre amplifier one by one and record the output power of each channel in the spectrum of the Optical Line Amplifier.

Terminal A

Channel output power at Long haul application Muxer output									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power difference									

Channel output power at Long haul application Booster amplifier									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power difference									

NOTE: Similar tables shall be filled for Terminal B

Similarly connect the instrument at the output of ROADMs, Optical line Amplifiers, pre-Amplifier one by one and record the output power of each channel in the spectrum of the Optical Line Amplifier.

A-B direction

Channel output power at Long haul application OPA OTU ROADM-1									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power difference									

Channel output power at Long haul application OBA OTU ROADM-2									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power difference									

Channel output power at Long haul application OPA OTU ROADM-3									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power difference									

Channel output power at Long haul application Optical Line Amplifier #1									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl#	Chl#	Chl# 34	Chl# 35	Chl#	Chl#	Chl# 38	Chl#	Chl# 40

	32	33			36	37		39	
Maximum Channel Power difference									

Channel output power at Long haul application Optical Line Amplifier #2									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30

Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power difference									

NOTE: Similar tables shall be filled for B – A Direction.

12.0 Total Launched power

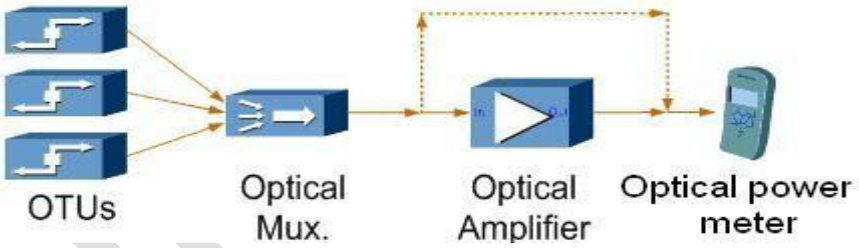


Figure 13: Total Launched power set up

Prepare test setup as above figure and Programme the optical power meter for wide band selection i.e 1530 nm-1565 nm and take the power reading of the total band of the Optical Line. The maximum output power and minimum output power level of Booster & amplifiers shall be as under. Record the reading the limit for the Total Launch Power is as under:

Manufacturer's Specifications:

Booster amplifier: +5 to +20 dBm

Pre amplifier: +5 to +20 dBm

A-B Direction:

Measurement port	Booster output	OADM 1	OADM 2	ROADM	Optical Line Amplifier#1
Total Launch Power reading					
Measurement port	Optical Line Amplifier#2	Optical Line Amplifier#3	Optical Line Amplifier#4	Optical Line Amplifier#5	Optical Line Amplifier#6
Total Launch Power reading					

B-A Direction:

Measurement port	Booster output	OADM 1	OADM 2	OADM 3	Optical Line Amplifier#1
Total Launch Power reading					
Measurement port	Optical Line Amplifier#2	Optical Line Amplifier#3	Optical Line Amplifier#4	Optical Line Amplifier#5	Optical Line Amplifier#6
Total Launch Power reading					

13.0 Channel Signal to Noise Ratio:

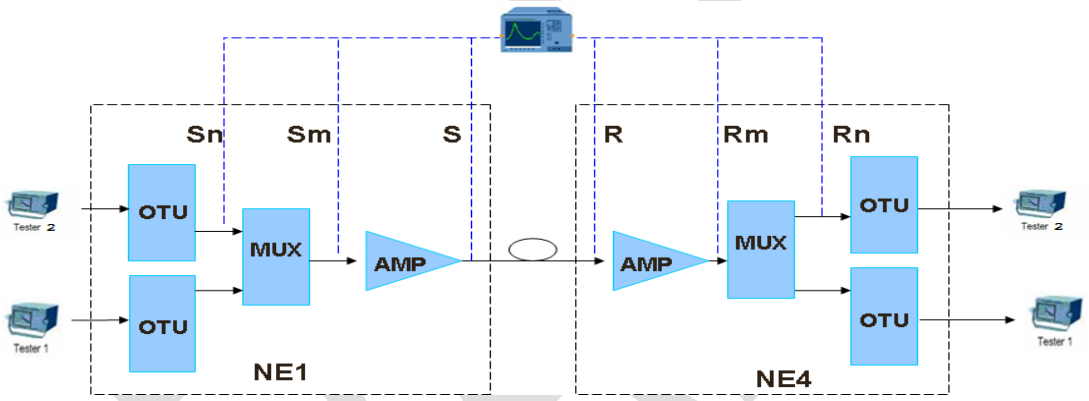


Figure 14: Channel Signal to Noise Ratio

Procedure:

Connect the (Booster Amplifier output to the DWDM Analyser. Select the Multiwavelength signal for noise measurement. Select the wavelength of the channels one by one and measure the channel signal to noise ratio and record the readings. The DWDM Analyser shall have the builtin measurement for Channel signal to noise ratio measurement. Record the reading. At the MPI-S point, the specs limits for channel signal to noise ratio is> 15 dB. Since the Booster and Optical Line amplifier have the same characterestics, take the test on the Line amplifiers as well.

A-B direction:

Channel Signal to Noise Ratio (Long haul application output of Booster amplifier)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40

Channel Signal to Noise Ratio (Long haul application output of OPA-ROADM 1)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40

Channel Signal to Noise Ratio (Long haul application output of OBA-ROADM 2)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl#	Chl#	Chl#	Chl# 34	Chl# 35	Chl#	Chl#	Chl# 38	Chl#	Chl# 40

31	32	33			36	37		39	

Channel Signal to Noise Ratio (Long haul application output of OPA-ROADM 3)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40

Channel Signal to Noise Ratio (Long haul application Output of Line amplifier # 1)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40

Channel Signal to Noise Ratio (Long haul application Output of Line amplifier #2)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl#	Chl#	Chl# 34	Chl# 35	Chl#	Chl#	Chl# 38	Chl#	Chl# 40

	32	33			36	37		39	

Channel Signal to Noise Ratio (Long haul application Output of Pre amplifier)									
Chl# 1	Chl# 2	Chl# 3	Chl# 4	Chl# 5	Chl# 6	Chl# 7	Chl# 8	Chl# 9	Chl# 10
Chl# 11	Chl# 12	Chl# 13	Chl# 14	Chl# 15	Chl# 16	Chl# 17	Chl# 18	Chl# 19	Chl# 20
Chl# 21	Chl# 22	Chl# 23	Chl# 24	Chl# 25	Chl# 26	Chl# 27	Chl# 28	Chl# 29	Chl# 30
Chl# 31	Chl# 32	Chl# 33	Chl# 34	Chl# 35	Chl# 36	Chl# 37	Chl# 38	Chl# 39	Chl# 40

NOTE: Similar tables shall be filled for b-a direction.

14.0 Mean channel input power:

A-B Direction:

Mean Launched power (ROADM# 1)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl# 21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl# 31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power (ROADM# 2)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl# 21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl# 31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
MAX		MIN		Mean chl input power (Max)					
Mean Launched power (ROADM# 3)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl# 21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl# 31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Line amplifier# 1)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl# 21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl# 31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Line amplifier# 2)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl# 21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl# 31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
MAX		MIN		Mean chl input power (Max)					
Mean Launched power Maximum (Long haul application Pre amplifier)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl# 21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl# 31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
MAX		MIN		Mean chl input power (Max)					

NOTE: Similar tables shall be filled for B-A direction.

15.0 Mean total input power: (Power at the input of Optical Line amplifier/Pre Amplifier)

This is the power received at the input of the Pre amplifier on the whole band width. Connect the Multi wavelength power meter at the output of the Optical fibre spool with attenuation of 22 dB and dispersion of 12800 ps/nm i.e far the end of cable going to the input of Optical Pre Amplifier for Long application. The spec is -22dBm— +3.5dBm.

A-B direction

Long Haul Application				
Measurement port	ROADM #1	ROADM #2	ROADM #3	Optical Line Amplifier #1
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #2	Optical Line Amplifier #3	Optical Line Amplifier #3	Optical Line Amplifier #3
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #3	Pre Amplifier		
Mean Total Power Reading				

B-A direction

Long Haul Application				
Measurement port	ROADM #1	ROADM #2	ROADM #3	Optical Line Amplifier #1
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #2	Optical Line Amplifier #3	Optical Line Amplifier #3	Optical Line Amplifier #3
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #3	Pre Amplifier		
Mean Total Power Reading				

1.0 Maximum channel power difference at Booster input/Pre-amplifier output point:

A-B direction:

Maximum channel power difference at point R' (Input ofBooster Amplifier)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl#21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl#31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
Channel power difference									

Maximum channel power difference at point MPI- R (output of Pre-Amplifier)									
Chl#1	Chl#2	Chl#3	Chl#4	Chl#5	Chl#6	Chl#7	Chl#8	Chl#9	Chl#10
Chl#11	Chl#12	Chl#13	Chl#14	Chl#15	Chl#16	Chl#17	Chl#18	Chl#19	Chl#20
Chl#21	Chl#22	Chl#23	Chl#24	Chl#25	Chl#26	Chl#27	Chl#28	Chl#29	Chl#30
Chl#31	Chl#32	Chl#33	Chl#34	Chl#35	Chl#36	Chl#37	Chl#38	Chl#39	Chl#40
Channel power difference									

NOTE: Similar table shall be filled for B-A direction.

17.0 Optical Amplifiers characteristics

17.1: MultiChl Gain Variation at Booster/Pre amplifiers:

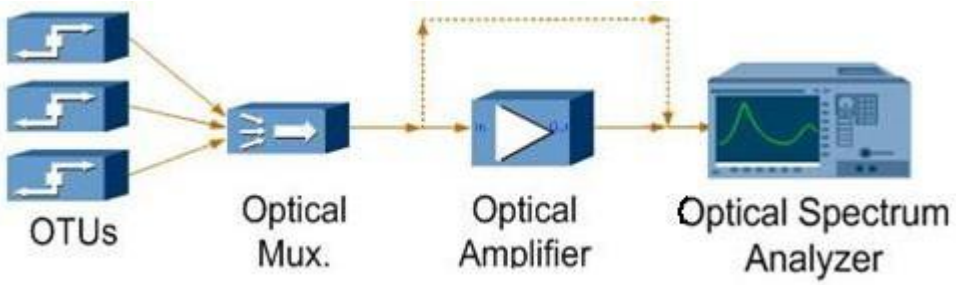


Figure 15: Test set up for Multi channel Gain Variaton

Built the DWDM link with Optical Booster/Pre Amplifiers comprising of 3 /10 spans based upon very long haul /long haul application. To simulate a nearly actual gain in the desired band for the Optical amplifier, Set the input level of the Optical amplifier to maximum specified value of –3dB and take the spectral reading on the DWDM analyzer. Shift the DWDM Analyzer to the output of the Optical Line Amplifier & take the spectral reading. Now take the gain of each channel and record it. From the Gain calculated readings, note difference, which shall be the Multi Chl gain varation.

The Multi Chl gain in this case is less than 2dB.

Similarly adjust the input power to the Optical amplifier to minimum specified value of –8dB and record the spectral reading on the DWDM analyzer Now repat the test by putting DWDM Analyser at output of the amplifier and record the amplitude of the all the Chl present in the EDFA band Now take the gain of each channel and record it. From the Gain calculated readings, note difference, which shall be the Multi Chl gain varation.

Repeat the same test for all the amplifier in the link and record the value of multi channel gain variation.

The value of -3dB and -8dB can be changed depends upon Maximum Gain of the amplifier.

A-B Direction:

Multi Chl Gain variation at Booster Amplifier (Long Haul Application)						
At the maximum input power at R'= -3 dB				At the minimum input power at S' = -8 dB		
Chl No.	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=Po-Pi	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=Po-Pi
1						
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27						
28						
29						
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31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
Multichannel gain variation= dB				Multichannel gain variation = dB		

Multi Chl Gain variation at ROADM# 1 (Long Haul Application)						
At the maximum input power at R'= -3 dB				At the minimum input power at S' = -8 dB		
Chl No.	**Chl power at I/p of Amp (dBm)**	**Chl power at o/p of Amp (dBm)**	Gain of Ampifier in (dB) G=Po-Pi	**Chl power at I/p of Amp (dBm)**	**Chl power at o/p of Amp (dBm)**	Gain of Ampifier in (dB) **G=Po-Pi**
1						
2						
3						
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16						
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32						
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35						
36						
37						

38						
39						
40						
Multichannel gain variation= dB				Multichannel gain variation = dB		

Multi Chl Gain variation at ROADM# 2 (Long Haul Application)						
At the maximum input power = -3 dB				At the minimum input power S = -8 dB		
Chl No.	**Chl power at I/p of Amp (dBm)**	**Chl power at o/p of Amp (dBm)**	Gain of Amplifier in (dB) G=PO-Pi	**Chl power at I/p of Amp (dBm)**	**Chl power at o/p of Amp (dBm)**	Gain of Amplifier in (dB) **G=PO-Pi**
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36						
37						
38						
39						
40						
Multichannel gain variation= dB				Multichannel gain variation = dB		

Multi Chl Gain variation at ROADM# 3 (Long Haul Application)						
At the maximum input power = -3 dB				At the minimum input power S = -8 Db		
Chl No.	**Chl power at I/p of Amp (dBm)**	**Chl power at o/p of Amp (dBm)**	Gain of Ampifier in (dB) G=PO-Pi	**Chl power at I/p of Amp (dBm)**	**Chl power at o/p of Amp (dBm)**	Gain of Ampifier in (dB) **G=PO-Pi**

1						
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32						
33						
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35						
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37						
38						
39						
40						
variation=			Multichannel gain dB		Multichannel gain variation = dB	

Multi Chl Gain variation at Pre Amplifier (Long Haul Application)						
At the maximum input power = -3 dB				At the minimum input power S = -8 dB		
Ch l No.	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=PO-Pi	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=PO-Pi
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38						
39						
40						
Multichannel gain variation= dB				Multichannel gain variation = dB		

NOTE: Similar tables shall be filled for B-A direction.

17.2: Multi Chl Gain Tilt:

The gain tilt shall be Difference of Gain of an individual Channel at -3 dB input power to

the Amplifier and -8 dB input power to the Amplifier divided by diffrerence of Gain of Reference Channel under the same input power conditions to the Amplifier.In reading under two conditions for reference Chl is the gain tilt and its limit is 1.6 dB/dB. The maximum and minimum power setting should be done with optical fibre cable only. The value of -3dB and -8 dB can be change based upon Maximum Gain of the amplifier.

A-B direction:

Multi channel Gain Tilt at Booster Amplifier							
Chl. No.	Measurements @ -3 dB input			Measurements @ -8 dB inputs			Gain Tilt $\frac{G1-G2}{Gr1-Gr2}$ dB/dB Gr=Ref. Chl
	Chl power at i/p of Amp	Chl power at o/p of Amp	Gain (G1)of individual Chl	Chl power at i/p of mp	Chl power at o/p of Amp	Gain (G2)of individual Chl	
1							
2							
3							
4							
5							
6							
7							
8							
9							
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11							
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38							
39							
40							

Multi channel Gain Tilt at ROADM # 1							
Chl No	Measurements @ -3 dB input			Measurements @ -8 dB inputs			Gain Tilt G1-G2 Gr1-Gr2 dB/dB Gr=Ref . Chl
	Chl power at i/p of Amp	Chl power at o/p of Amp	Gain (G1)of individual Chl	Chl power at i/p of mp	Chl power at o/p of Amp	Gain (G2)of individual Chl	

1							
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11							
12							
13							
14							
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32							
33							
34							
35							
36							
37							
38							
39							
40							

NOTE: Similar tables shall be filled for ROADM#2 & ROADM#3 and Pre Amplifier NOTE: Similar tables shall also be filled for B-A direction.

17.3 Multi Chl Gain –Change Difference at Optical Amplifier:

Multi Chl Gain –Change Difference at Booster/Optical Line Amplifier:

This is also referred as Inter-Chl gain –change difference. This is definition of Multi Chl Gain-change Difference is " For a specified Chl allocation, the difference in gain in one Chl with respect to the change in gain of another Chl for two specified sets of Chl input powers. The Gain at the -3 dB and -8 dB Input power to the amplifier is already recorded under the "Multi Channel Gain Tilt "test From the avilable readings, Calculate the Gain change difference as under; Let G1 be the gain Channel 1 under-3 dB and G1' under -8 dB input power condition and Gx and "Gx'" be the Gain of "X' channel under the same input power condition of the Amplifier then the Gain change difference shall be as under; GD1 ={G1-G1'}- {Gx-Gx'} or = ∆G1-∆GXs where as x=1 to 40. Note that the difference of highest and lowest reading which shall be the MultiChl Gain change difference and the reading shall be ≥ 2dB . Similarly repeat the reading for each Optical Line amplifier

A-B Direction:

Multi Channel gain change difference R OADM-1																			
∆G	Values	GD1	GD2	GD3	GD4	-	-	-	-	-	-	-	-	GD15	GD16	GD17	GD18	GD19	GD20
∆G1																			

ΔG2																			
ΔG3																			
ΔG4																			
ΔG5																			
ΔG6																			
ΔG7																			
ΔG8																			
ΔG9																			
ΔG10																			
ΔG11																			
ΔG12																			
ΔG13																			
ΔG14																			
ΔG15																			
ΔG16																			
ΔG17																			
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ΔG30																			
ΔG31																			
ΔG32																			

ΔG33																			
ΔG34																			
ΔG35																			
ΔG36																			
ΔG37																			
ΔG38																			
ΔG39																			
ΔG40																			
ΔG	VALUES	GD21	GD22	GD23	GD24	-	-	-	-	-	-	-	-	GD35	GD36	GD37	GD38	GD39	GD40
ΔG1																			
ΔG2																			
ΔG3																			
ΔG4																			
ΔG5																			
ΔG6																			
ΔG7																			
ΔG8																			
ΔG9																			
ΔG10																			
ΔG11																			
ΔG12																			
ΔG13																			
ΔG14																			
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ΔG33																			
ΔG34																			
ΔG35																			
ΔG36																			
ΔG37																			
ΔG38																			
ΔG39																			
ΔG40																			

NOTE: Similar tables shall be filled for Booster Amplifier, Line Amplifier, and Pre Amplifier.

NOTE: Similar tables shall be filled for B-A direction.

17.4 Signal Spontaneous Noise figure (Optical interface at ouput of Amplifier)

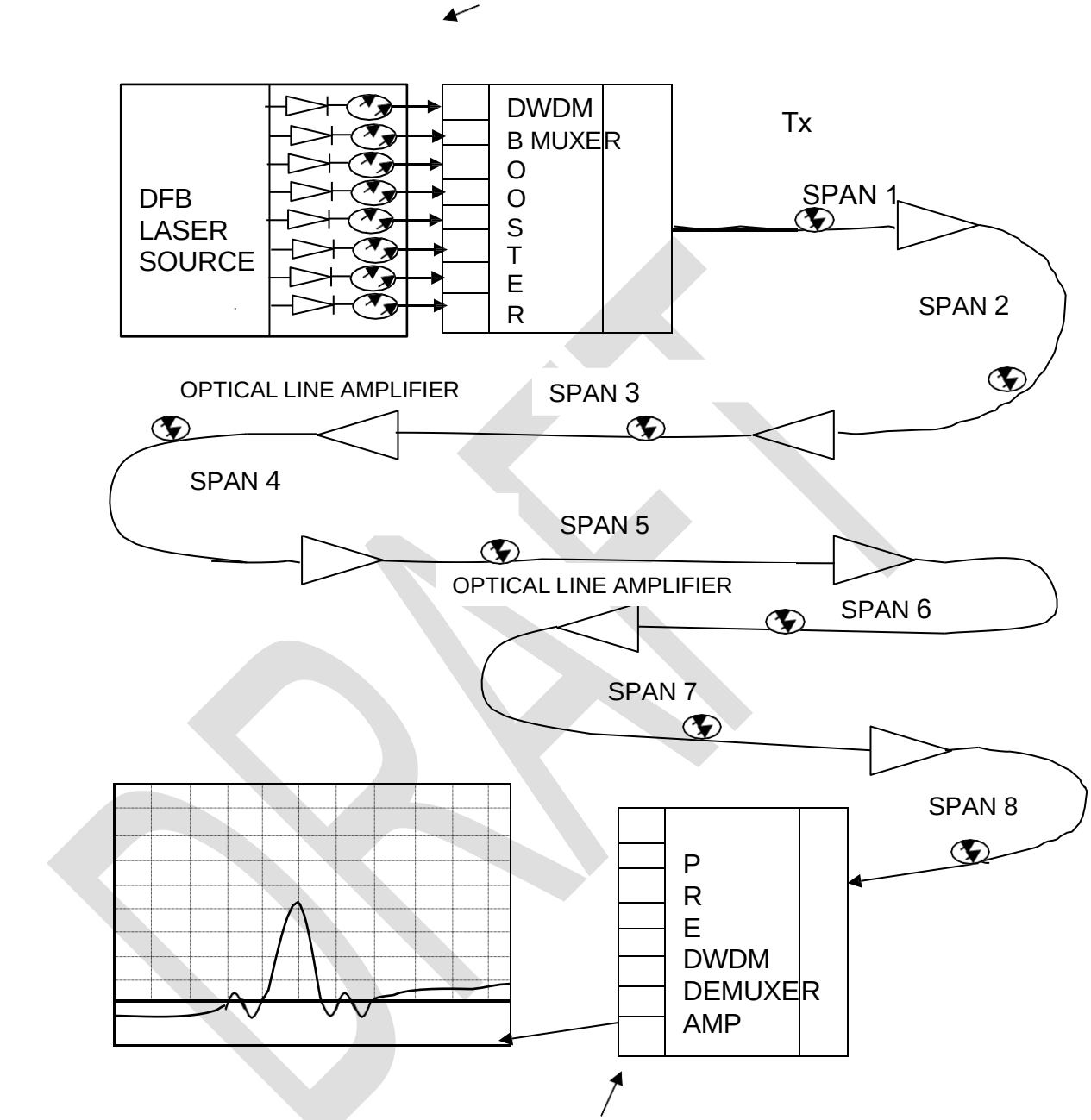

Figure 16: Test set up for Spontaneous Noise Figure

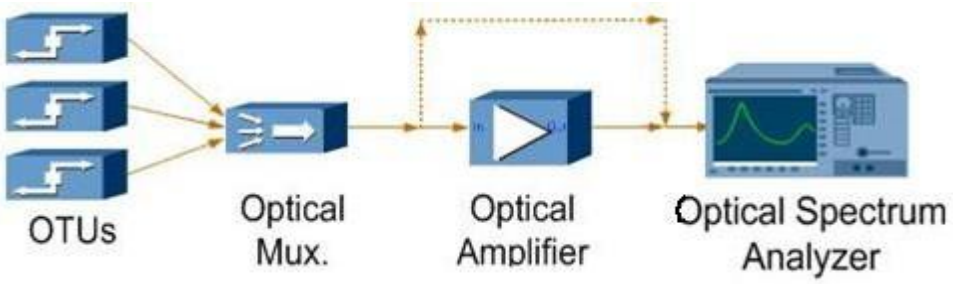

Figure 17: Test set up of Optical Spectrum Analyser

Set up Optical Spectrum Analyser for the measurement of Amplifier parameters. Connect the in put Booster /Optical Line amplifier for Long haul application to the input of Optical Spectrum Analyser and take the set of OSNR reading for all the channels. Now move the Optical Spectrum Analyser to the output of Amplifier, store both the rading in the memory of the Optical Spectrum Analyser. Now programme the Optical Spectrum Analyser for the Noise figure measurements. The instrument shall compute the input and output data and directly provides the Noise figure readings. The specs limit for this Noise figure shall be 7 dB. Repeat the test for all the optical Line amplifiers one by one. Output of multiplexer can be taken as a source for getting accurate Noise figure of the amplifier

A-B Direction:

Manufacturer's Specification: ≤7 dB

Signal Spontaneous Noise figure Long Haul OBA TM-1								
Chl No	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	Chl #6	Chl #7	Chl #8
Noise figure								
Chl No	Chl #9	Chl #10	Chl #11	Chl #12	Chl #13	Chl #14	Chl #15	Chl #16
Noise figutre								
Chl No	Chl #17	Chl #18	Chl #19	Chl #20	Chl #21	Chl #22	Chl #23	Chl #24
Noise Figure								
Chl No	Chl #25	Chl #26	Chl #27	Chl #28	Chl #29	Chl #30	Chl #31	Chl #32
Noise Figure								
Chl No	Chl #33	Chl #34	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40

Noise Figure								

NOTE: Similar tables shall be mandatorily filled for all amplifiers and attach the printouts for the same.

18.0 Optical Monitoring (OM)

Channel power at the DWDM receiver input after the demultiplexer **Terminal A**

Chl. No.	Chl. 1	Chl. 5	Chl. 11	Chl. 17	Chl. 21	Chl. 26	Chl. 33	Chl. 40
Optical Input power by power meter at monitoring point								
Optical Input power through EMS/LCT								

Terminal B

Chl. No.	Chl. 1	Chl. 5	Chl. 11	Chl. 17	Chl. 21	Chl. 26	Chl. 33	Chl. 40
Optical Input power by power meter at monitoring point								
Optical Input power through EMS/LCT								

19.0 Total power at input of various stages of optical amplification A-B Direction

Measurement port	Booster Amplifier input	OADM 1 input	OADM 2 input	OADM 3 input	ILA 1 input	ILA 2 Input
Total Input Power reading						
Total Input Power reading (EMS)						
Measurement port	ILA 3 input	ILA 4 input	ILA 5 input	ILA 6 input	ILA 7 input	Pre Amplifier input
Total Input Power reading						

NOTE: Similar table shall be filled for B-A direction.

20.0 Total power at output of various stages of optical amplification

A-B Direction

Measurement port	Booster Amplifier output	ROADM 1 output	ROADM 2 output	ROADM 3 output	ILA 1 output	ILA 2 output
Total Input Power reading						
Total Input Power reading (EMS)						
Measurement port	ILA 3 output	ILA 4 output				Pre Amplifier output
Total Input Power reading						

NOTE: Similar table shall be filled for B-A direction.

21.0 Jitter & Wander

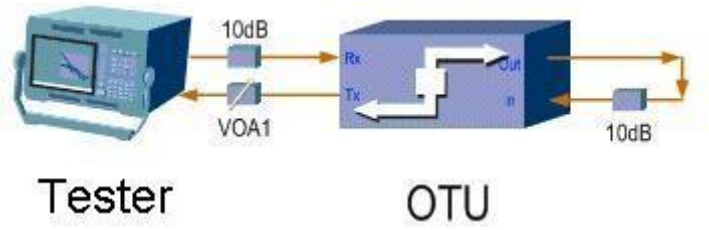

Figure 18: Test Set up for Jitter and Wander

21.1 : Input Jitter Tolerance:

Configure the SDH Analyzer for Jitter and wander measurement. Select the option Jitter Generation/ analysis mode Set bit rate, Type of interface, Jitter measuring filters and frequency vs amplitude mask. In the case the SDH Analyzer does not support an option as "Input Jitter tolerance function conduct the test by conventional method detailed as under; From the Transmitter of the SDH Analyzer select the Bit rate as STM-64, and select the Input Jitter tolerance mask at STM-64 bit rate from the Jitter/wander from the menus. Select the receiver part of the instrument for jitter measurement. Select the frequency vs amplitude mask mentioned below or programme the mask manually. Now connect the output of the SDH Analyzer to the input of the transponder and output of the corresponding transponder at Demuxer to the input of SDH Analyzer. In the case the SDH Analyzer has got the Input Jitter Tolerance function option built in the instrument then run the mask directly on the interface.

Input Jitter Tolerance mask: Comply with G.825

Terminal A (Grey Interface):

2.5G STM-16 Interface:

Input jitter frequency	Input jitter tole rance on	Input jitter tole rance on	Input jitter tole rance on Chl. No	Input jitter tole rance on	Input jitter tole rance on	Input jitter tole rance on Chl. No	Input jitter tole rance on	Input jitter tole rance on

	Chl. No.	Chl. No		Chl. No	Chl. No		Chl. No	Chl. No
5000 Hz								
750 kHz								
1.0 MHz								
1.5 MHz								
3.0 MHz								
10.0 MHZ								
15.0 MHz								
20.0 MHz								

10G STM-64 Interface:

Input jitter frequency	Input jitter tolerance on Chl. No.	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No
20kHz								
100kHz								
400kHz								
1MHz								
2MHz								
4 MHZ								
20 MHz								
80 MHz								

NOTE: Similar table shall be used for all Terminals.

21.2 : Jitter Transfer:

Configure the SDH Analyzer for Jitter and wander measurement. Select the option Jitter Generation/ analysis mode Set bit rate, Type of interface, Jitter measuring filters and frequency vs amplitude mask In the case the SDH Analyzer does not support an option as "Jitter Transfer function ", conduct the test by conventional method detailed as under; Loop the SDH Analyzer at aggregate level. Select the Bit rate as STM-64, from the Transmitter

and select the Jitter/wander from the menus. Select the Input Jitter tolerance mask at STM-64 bit rate. Select the receiver part of the instrument for jitter measurement. Select the following frequency vs amplitude mask and record the reading in dB. Now insert the DUT into the circuit i.e connect the output of the SDH Analyzer to the input of the transponder and out put of the corresponding transponder at Demuxer to the input of SDH Analyzer. Repeat the frequency vs amplitude mask in this condition also and record the reading. In the case the SDH Analyzer has got the Jitter transfer function option built in the instrument then run the mask directly on the interface.

Jitter input mask: Comply with G.783.

Terminal A (Transmit side):

2.5G Transponder interfaces									
Input jitter frequency	Jitter trans fer on self loop	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.	Jitter trans fer on 2.5G Chl.No.
5000 Hz									
750 kHz									
1.0 MHz									
1.5 MHz									
3.0 MHz									
10.0 MHZ									
15.0 MHz									
20.0 MHz									

10G Transponder interfaces									
Input jitter frequency	Jitter trans fer on self loop	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.
20kHz									
100kHz									
400kHz									
1MHz									
2MHz									
4 MHZ									
20 MHz									
80 MHz									

NOTE: Similar tables shall be filled for all terminals.

21.3 : Jitter Generation

Configure the ONT tester for Jitter and wander measurement. Select the option Jitter Generation/ analysis mode. Set bit rate, type of interface, jitter measuring filters. The frequency vs amplitude mask shall be kept off in the Generator. Connect output optical port to the Rx port of the instrument. Select the proper filters and run the instrument. Allow the measurement to continue for 1 minute.

Limits: For 10G: 20kHz to 80 MHz = 1.5 UI

4MHz to 80 MHz = 0.15 UI For 2.5G:

5000 Hz to 20 MHz = 1.5 UI

1 Mhz to 20 MHz = 0.15 UI

A – B Direction

10G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl.No.
	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

2.5G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl.No.
	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p	Jitter Ul p-p
5000 Hz to 20 MHz								
1 Mhz to 20 MHz								

NOTE: Similar tables shall be filled for OADM-2 to Terminal A.

NOTE: Similar tables shall be filled for ROADM-1 to Terminal A.

22.0 ODU-k Cross-connection Test

Purpose

To validate ODU0/ODU1/ODU2/ODU2e/ODU3/ODU4 aggregation Cross-Connection function.

Test Configuration

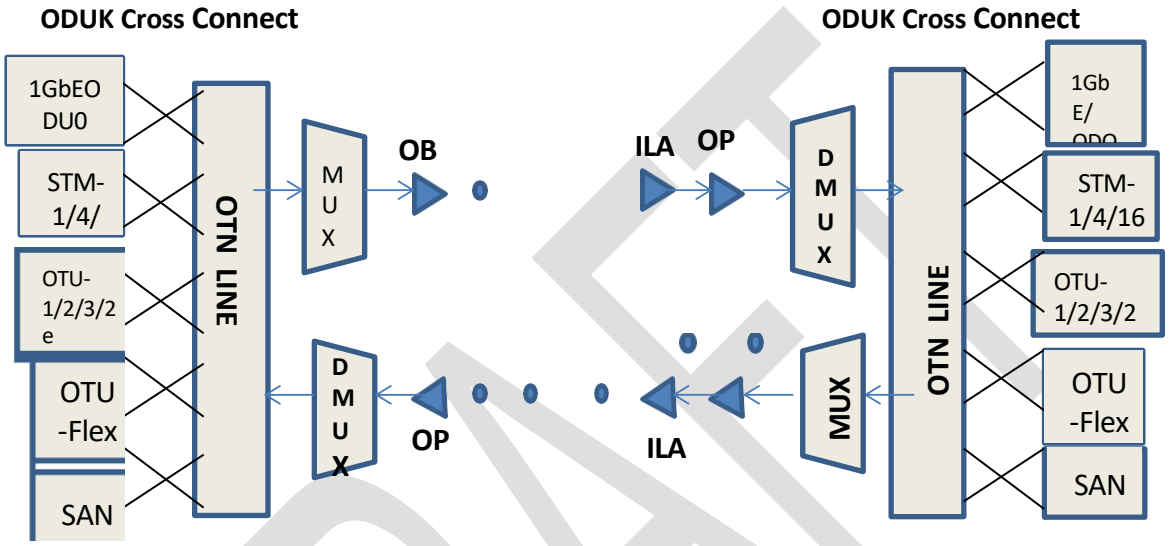

Figure 19: Test configuration for ODU-k Cross Connection test

Procedure

1) Establish the testing configuration according to the above diagram.
2) Configure the service in different type of tributary cards with help of EMS for STM-1, STM-4, STM16, OTU-1, OTU-2, OTU-2e, OTU-3, GbE etc. Vendor can use different type of cards for different rate of clients and 100G aggregate cards.
3) Create the ODU0/1/2/2e/3/4 cross connection between the client card and 100G (OTU-4) line card
4) Check the service for all the client rates from the analyzer that should be OK.

23.0 Tests for Automatic Switched Optical Network (ASON)

23.1.0 Optical ASON Test

23.1.1 Platinum class service: Permanent 1+1 path protection+ ASON based restoration

Purpose

Test the creation, deletion, protection and restoration capability of platinum class service, and test the switching time of Platinum class service.

Test Configuration:

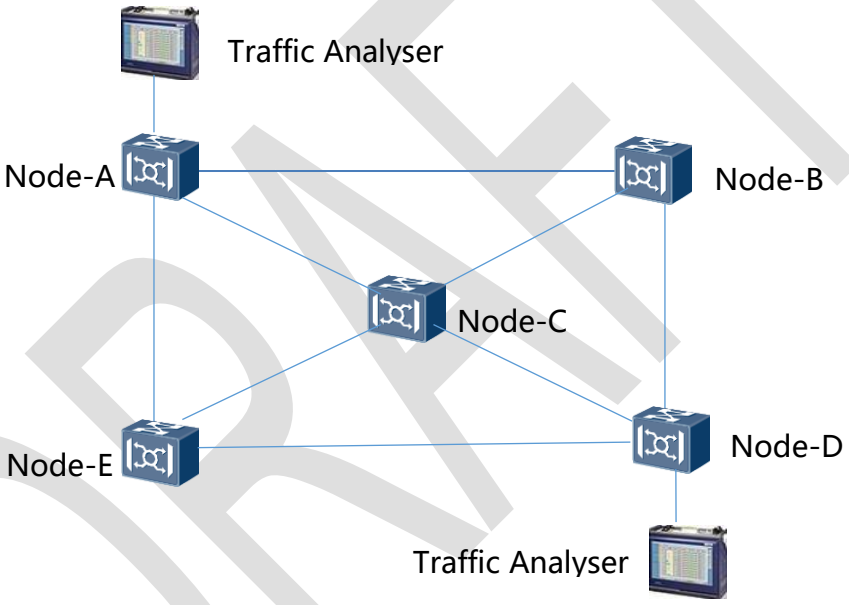

Figure 20: Test Configuration for Platinum class service

Procedure:

1) Platinum service between two nodes (A & D) can be created to full fill complete specification as defined for platinum services in GR.
2) Configure the client traffic, and select one channel as working channel, another channel as protection channel.
3) Break the current working fiber.
4) Check the switching time and the reroute after fiber break.
5) Now break the protection fiber.
6) Check the restoration time and the reroute of traffic on restoration path

Result:

Test item	Check the protection and restoration of Permanent 1+1 Platinum Class Service
Expected Results	(1) Resource should be available for protection switching after disjoint path. (2) The switching time should be less than 50 ms. (3) The restoration time should be few seconds.

23.1.2 Gold Class Service: Permanent 1+1 path protection

Purpose:

Tests the creation, deletion, protection and switching capability of Gold service

Test Configuration:

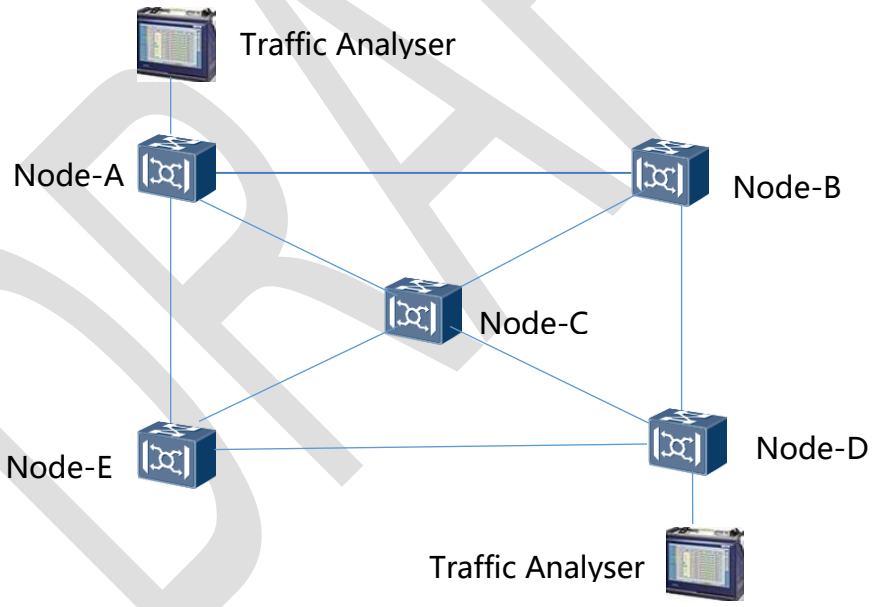

Figure 21: Test set up for Gold class service

Procedure:

1) Establish the test Configuration as shown in the above figure.
2) Create the gold service between node A and Node D.
3) Check the service is running.

4) Remove the fiber of working path and check the service.

5) Traffic should switch on other fiber path.

6) Check the switching time which should be less than 50ms.

7) For further fiber break traffic will be fail because this is only 1+1 Protection.

Results:

Test item	Network topology construction
Expected Results	Swtching time should be less than 50ms.

23.1.3 Silver Class Service: ASON based restoration

Purpose:

Test the creation, deletion, protection and restoration capability of silver class service, and test the switching time of silver class services.

Test Configuration:

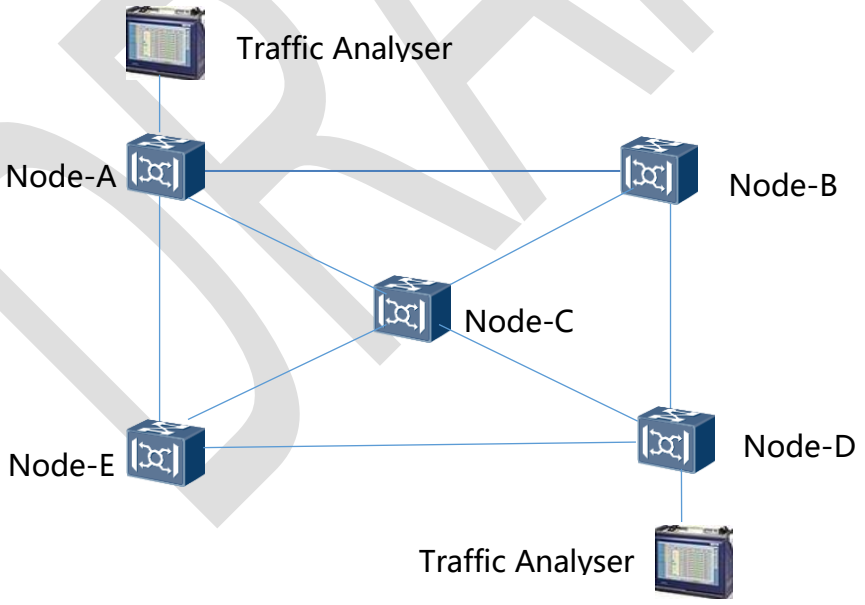

Figure 22: Test Configuration for Silver class service

Procedure:

1) Establish the test Configuration as shown in the above figure.
2) Configure a channel from A to D and make the traffic through.

3) Break the fiber in the working channel till there is no resource to reroute.
4) Check the rerouting time and the new reroute path at each time fiber break.

Results:

Test item	Silver Class Services Test
Expected Results	When the link is broken, the service is rerouted to new path. Silver services can find a correct path as long as the resource is available. The restoration time should be few seconds.
Results:	

23.1.4 Path pre-calculation function

Purpose: To Test OCH path pre-calculation function

Test Configuration:

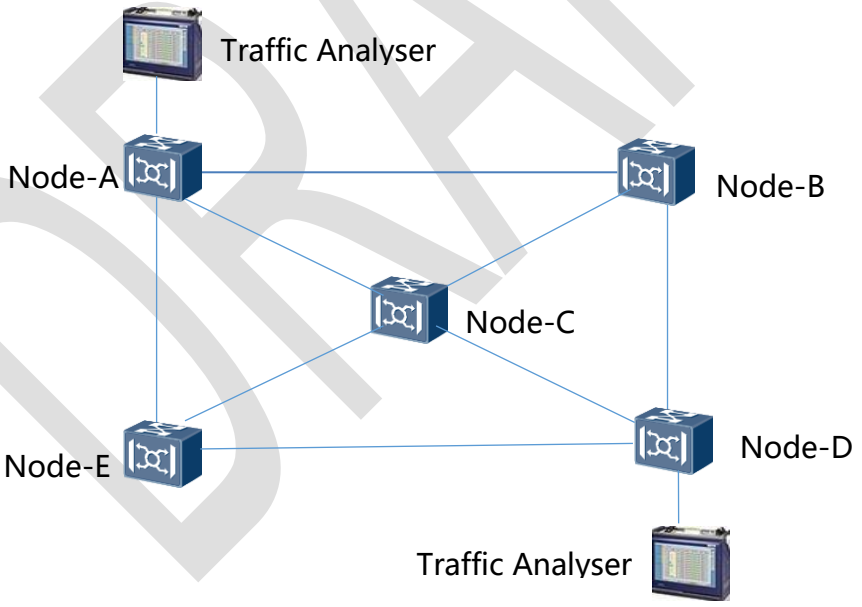

Figure 23: Test Configuration for Path Pre-calculation Function

Procedure:

1) Establish the test environment according to the above figure.
2) Try to create OCH service of Gold class level from A to D.
3) Make the OCH path includes Node B using a preferred link of Node B, pre-

calculation is successful.

4) Start the traffic on the created path and check with the traffic analyzer to confirm whether the service is set up and query the path on the EMS/NMS.

Results:

Test item	Path pre-calculation function.
Expected Results	If path pre-calculation is successful, the service will be created successfully.
Results:	

23.1.5 Rerouting Lock Function

Purpose: Test rerouting lock function of OCH SPC.

Test Configuration:

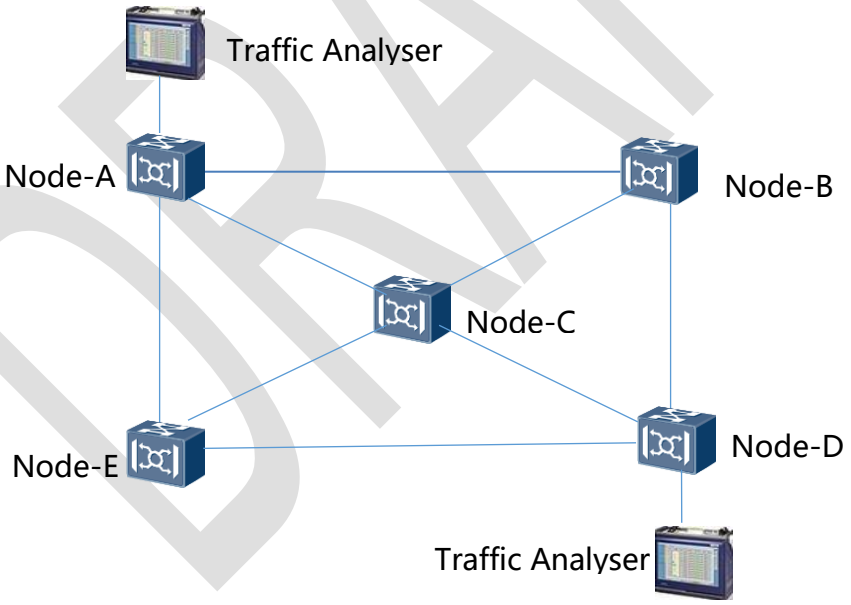

Figure 24: Test Configuration for Rerouting Lock Function

Procedure:

1) Establish the test environment according to the above figure.
2) Try to create OCH service of gold class level from A to D, select the

route A-B-D as current path, and also configure the mode as non-Revertive mode.

3) Make the OCH path includes Node B using a preferred link of Node B.
4) Start traffic on the gold class lambda service, check with the traffic analyzer to confirm whether the service is set up and query the path on the EMS/NMS.

Results:

Test item	Path pre-calculation function.
Expected Results	If path pre-calculation is successful, the service will be created successfully.
Results:	

23.1.6 Manually Revert to Original Path

Purpose: Test the function of manually coming back to original path for OCH SPC.

Test Configuration:

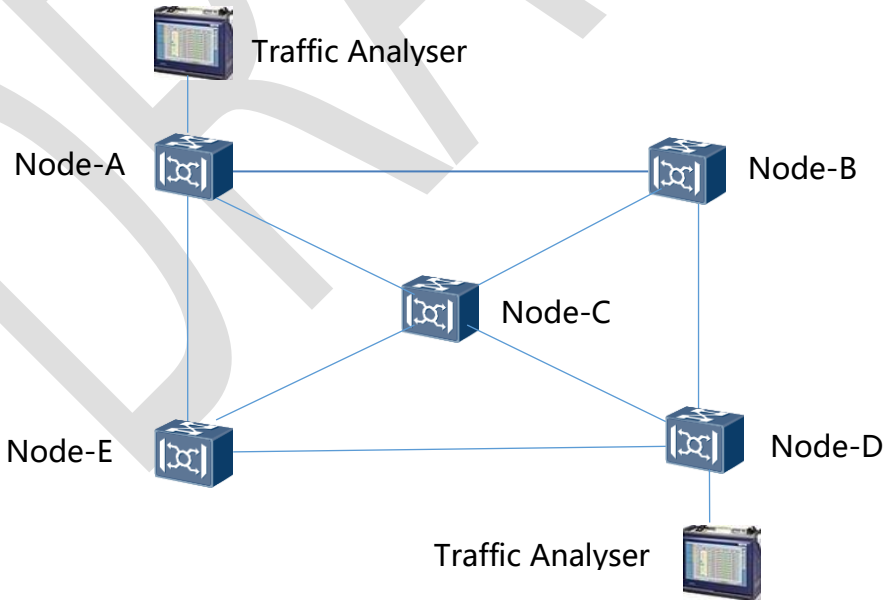

Figure 25: Test set up for Manually Revert to Original Path

Procedure:

1) Establish the test environment according to the above figure.
2) Create silver class OCH connection from Node A to Node D, select the route

A-B-D as current path, and also configure the mode as non-Revertive mode.

3) Disconnect the fiber between A and B, to make the OCH reroute.
4) Query the new paths of gold OCH on the EMS/NMS.
5) Restore the fiber. Then select those connections and perform the function of reverting back to original path manually.
6) Check whether those connections come back to their original routes.

Results:

Test item	Manually Revert to Original Path.
Expected Results	OCH path can be restored to the original path manually after the fault is removed.
Results:	

23.1.7 Automatic Revert to Original Path

Purpose: Test the function of timing reverting back to original path for ODUK SPC

Test Configuration:

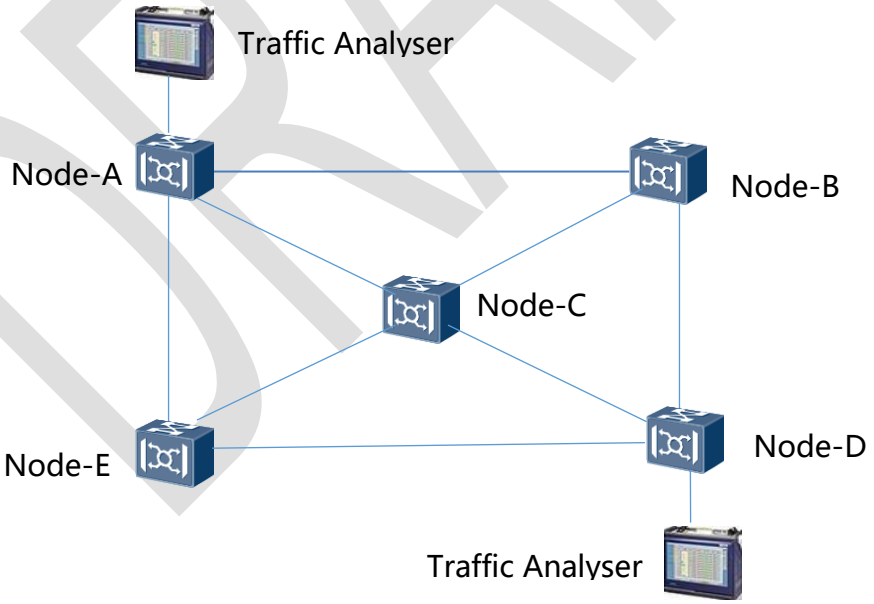

Figure 28: Test set up for Automatic Revert to Original Path

Procedure:

1) Establish the test environment according to the above figure.
2) Create Gold class OCH from Node A to Node D, select the route A-B-D as current path, and also configure the mode as Revertive mode.
3) Disconnect the fiber between A and B, to make the OCH reroute.
4) Query the new paths of OCH on the EMS/NMS.
5) Restore the fiber. Check whether those connections come back to their original routes after the revertive set time.

Results:

Test item	Automatic Revert to Original Path.
Expected Results	OCH path can be restored to the original path in set time.
Results:	
Remark:	

23.2 OTN ASON Test:

23.2.1 Discovery and update of resource and topology

Purpose: Tests the resource automatic discovery function when the network is add new Resource.

Test Configuration

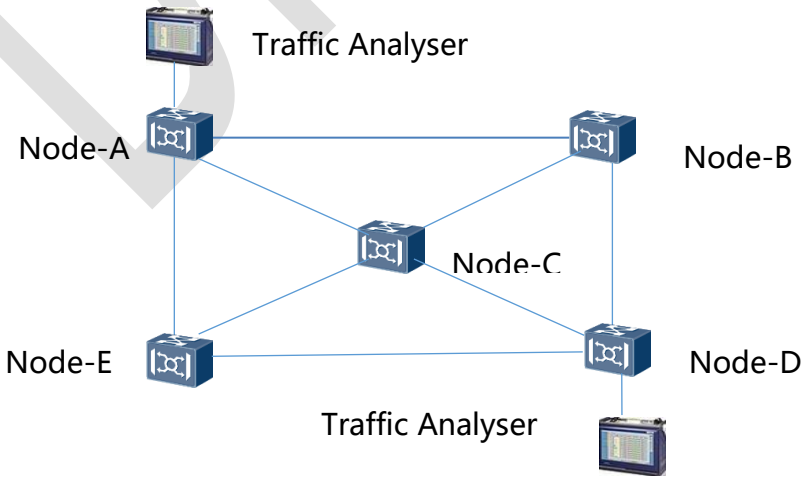

Figure 27: Test set up for topology and resource discovery

Procedure:

(1) Establish the test environment according to the above figure.

(2) Search the topology on EMS/NMS.

(3) EMS shall be able to get the entire NEs in the network and entire links between the NEs.

(4) Disconnect the fiber between node A and node E.

(5) Connect the fiber between node A and node E.

(6) Check the toplogy is automatically updated after fiber is connected (automatic discovery).

(7) Add a NE in the network and connect it with one of the NEs. It shall be automatically discovered along with the link.

Results:

Test item	Automatically topology and resource discovery
Expected Results	1. The line should be red when the fiber is disconnected. 2. The topology is updated automatically when the fiber is connected.
Results:	

23.2.2 Platinum Class Service: Permanent 1+1 path protection + ASON based restoration

Purpose: Test the creation, deletion, protection and restoration capability of permanent 1+1 platinum class service, and test the switching time of platinum class service.

Test Configuration:

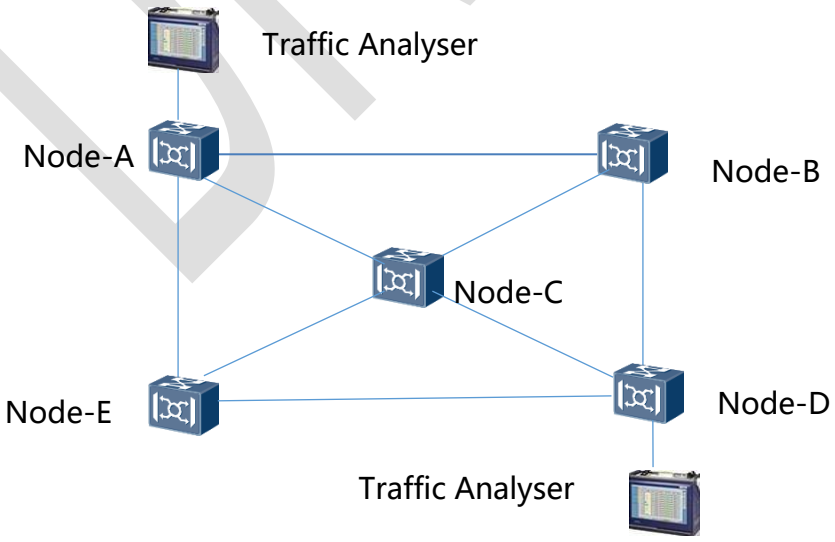

Figure 28: Test set up for Permanent 1+1 Platinum class service

Procedure:

1) Establish the test Configuration as shown in the above figure.
2) Create permanent 1+1 ODUK diamond service from site A to site D, and select one 100G route as working channel and another as protection channel.
3) Check the service is normal.
4) Disconnect the working path.
5) Check the switching time and the new route.
6) Connect the fiber again and delete the service on the NMS.

Results:

Test item	Check the protection and restoration of Permanent 1+1 platinum Class ODUK Service
Expected Results	(1) The working path and the protection path are provided permanently if the resource is sufficient. (2) The switching time of platinum lambda service is less than 50 ms.
Results:	

23.2.3 Gold Service: permanent 1+1 path protection

Purpose: Tests the creation, deletion, protection and switching capability of Gold service

Test Configuration:

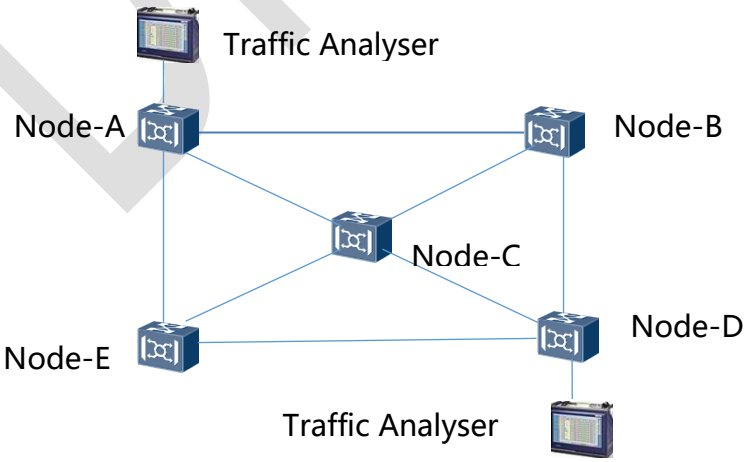

Figure 29: Test set up for Gold class service

Procedure:

1. Establish the test Configuration as shown in the above figure.
2. Create the gold service between node A and Node D.
3. Check the service is running.
4. Remove the fiber of working path and check the service.
5. Traffic should switch on other fiber path.
6. Check the switching time which should be less than 50ms.
7. For further fiber break traffic will be fail because this is only 1+1 Protection.

Results:

Test item	Network topology construction
Expected Results	Swtching time should be less than 50ms.
Result	

23.2.4 Silver Class Services Test

Purpose: Tests the creation, deletion, protection and switching capability of Silver service

Test Configuration:

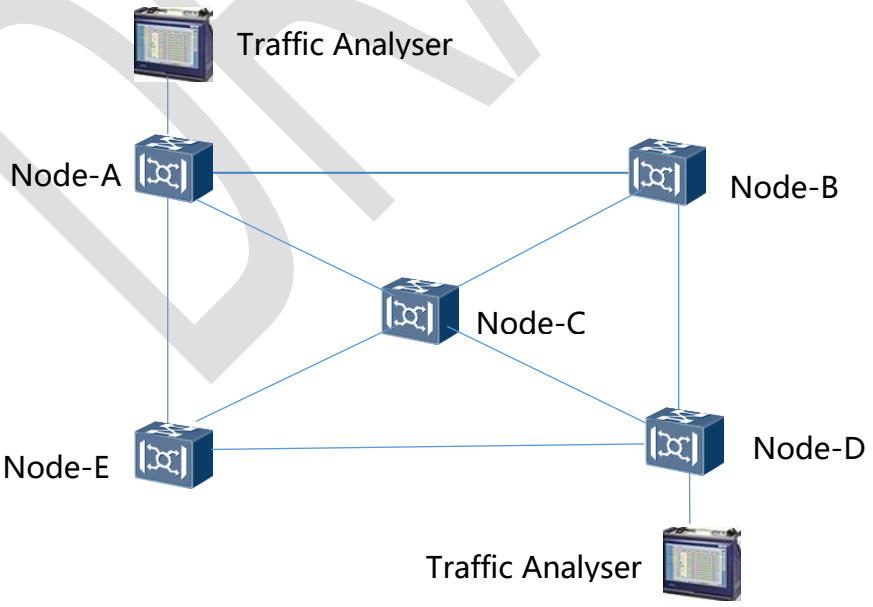

Figure 30: Test set up for Silver class service

Procedure:

1) Establish the test Configuration as shown in the above figure.
2) Create an ODUK service of silver class level from A to C by click on NM system.
3) Check the service is running.
4) Disconnect the working route.
5) Check the rerouting time and the new route.
6) Disconnect the new route.
7) Check the rerouting time and the new route

Results:

Test item	Silver Class Services Test
Expected Results	When the link is broken, the service is rerouted to new path. Silver services can find a correct path as long as the resource is available
Results	

23.2.5 Bronze Class Service: No protection mechanism

Purpose: Tests the creation, deletion, protection and restoration capability of bronze class service,

Test Configuration:

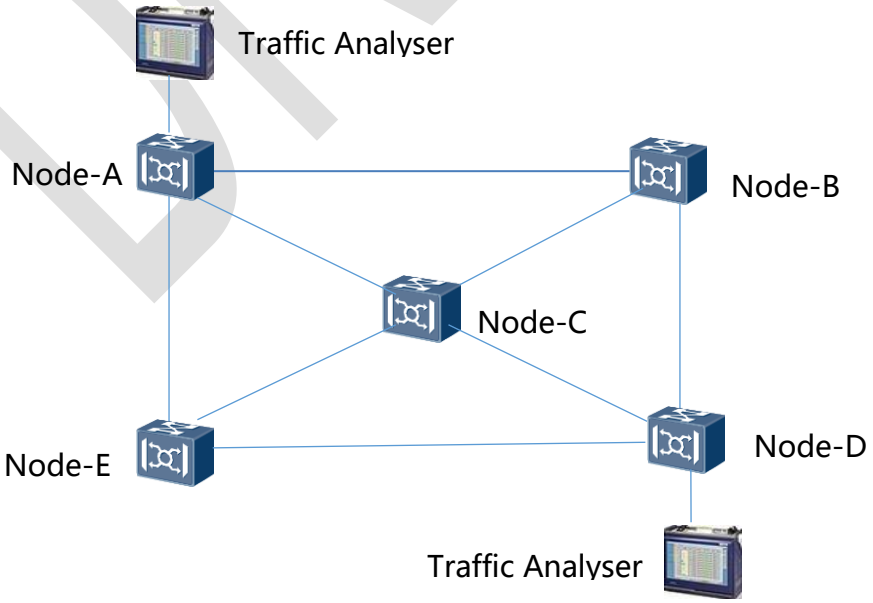

Figure 31: Test set up for Bronze class service

Test Procedure:

1) Establish the test Configuration as shown in the above figure.
2) Create an ODUK service of bronze class level from A to D by click on NM system.
3) Check the service is running.
4) Disconnect the working route.
5) Check the service that should be fail.

Results:

Test item	Bronze Class Services Test
Expected Results	After fiber break service should be fail.
Result	

23.2.6 : Path pre-calculation function

Purpose: Test electrical ODUK connection path pre-calculation function.

Test Configuration:

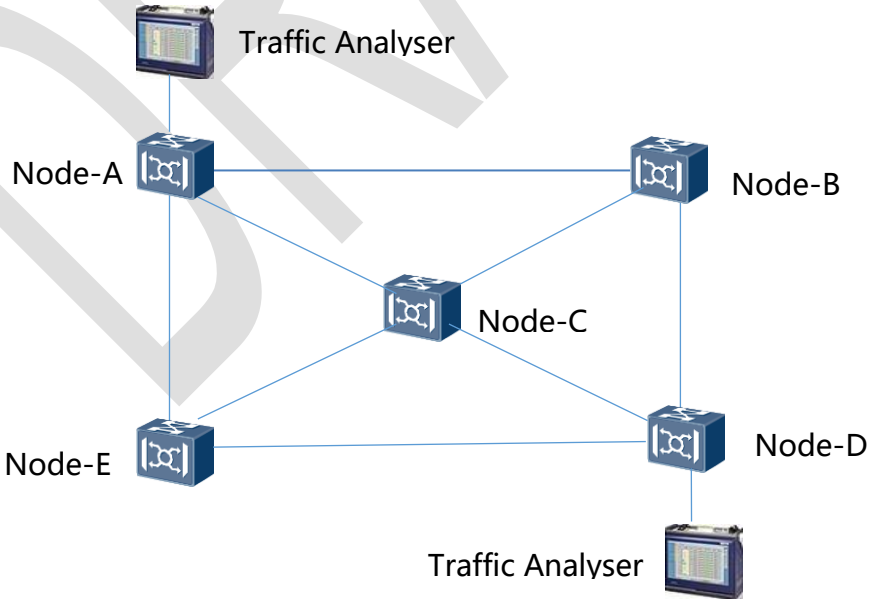

Figure 32: Test set up for Path Pre-calculation

Procedure:

1) Establish the test environment according to the above figure.
2) Try to create an ODUK service of gold class level connection from A to D, using path pre-calculation function.
3) Make the connection path includes Node B, pre-calculation is successful.
4) Activate the gold class lambda service, check with the signal analyzer to confirm whether the service is set up and query the path on the NMS.
5) Delete the connection on the EMS/NMS.

Results:

Test item	Path pre-calculation function.
Expected Results	If path pre-calculation is successful, the service will be created successfully.
Results:	

23.2.7 : Rerouting Lock Function

Purpose: Test rerouting lock function of ODUK connection.

Test Configuration:

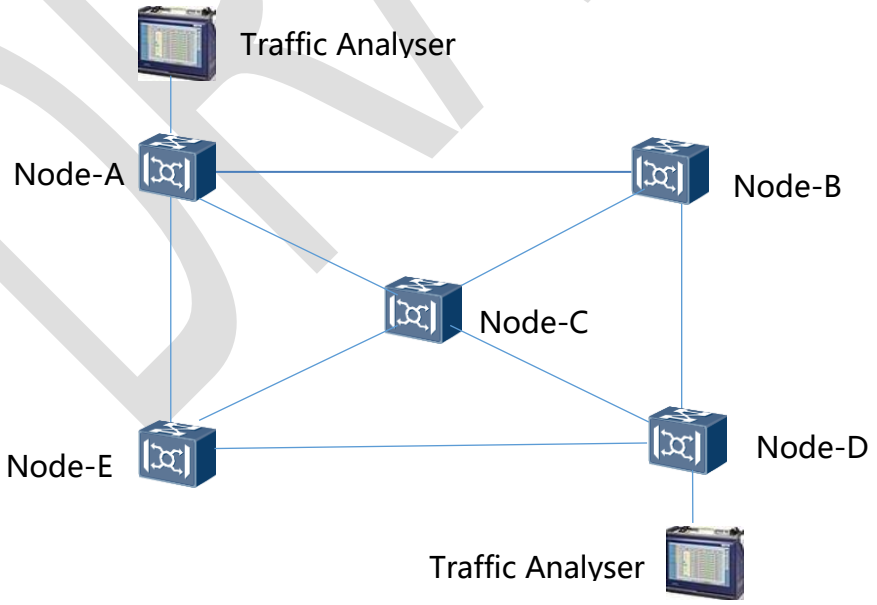

Figure 33: Test set up for Path Pre-calculation

Procedure:

1) Establish the test environment according to the above figure.
2) Create an ODUK service of gold class connection from A to D. The path is A->- B->D.
3) Set the connection attribute to non-Revertive.
4) Disconnect the path between A and B, the ODUK connection reroutes to protection path and the service is un-interrupted.
5) Disconnect the protection path the ODUK connection does not reroute and the service is interrupted.
6) Reconnect the protection path between A and D, the service is recovered.

Results:

Test item	Rerouting lock function.
Expected Results	When fault happens in the network, connection with rerouting lock attribute does not reroute.
Results:	

23.2.8 Manually Revert to Original Path

Purpose: Test the function of manually coming back to original path for ODUK SPC Test

Test Configuration:

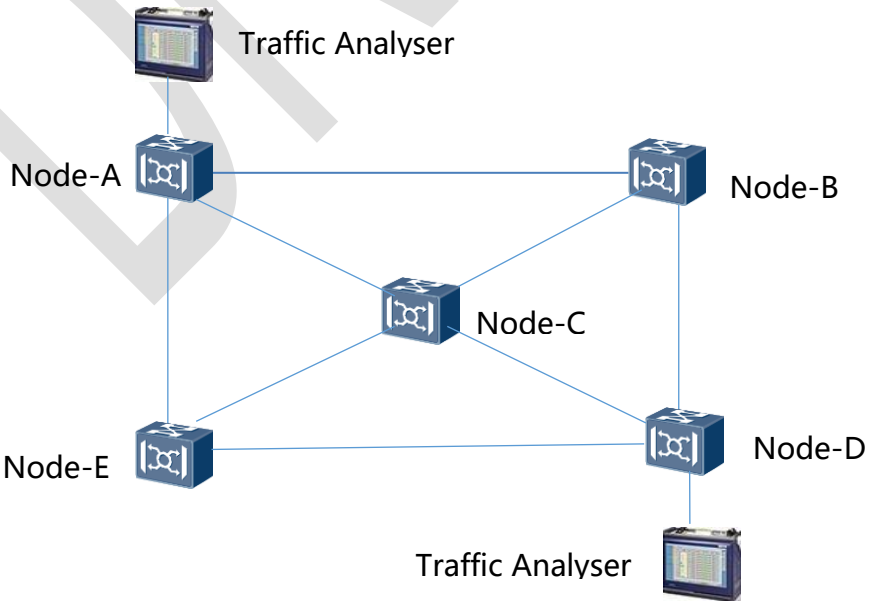

Figure 34: Test set up for manually revert to original

Results:

Test item	Manually Revert to Original Path.
Expected Results	ODUk path can be restored to the original path manually after the fault is removed.
Results:	

23.2.9 : Automatic Revert to Original Path

Purpose: Test the function of timing coming back to original path for ODUK connection.

Test Configuration:

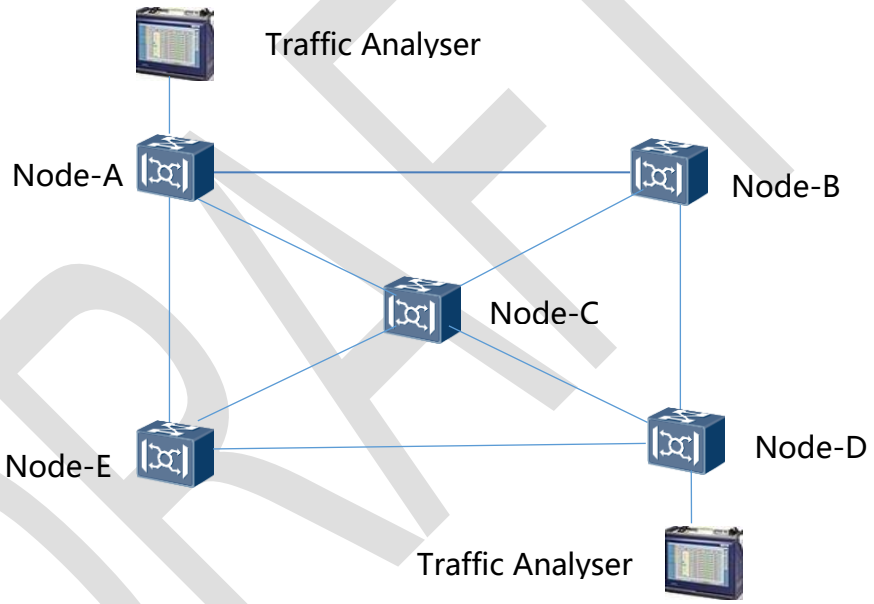

Figure 35: Test set up for automatic revert to original

Procedure:

1) Establish the test environment according to the above figure.
2) Create a gold class ODUK connection from Node A to Node D on the EMS/NMS with the path of A->B->D. Set Revertive Mode.
3) Disconnect the connection between site A and site D, to make the ODUK path reroute.
4) Check the protection path of ODUK connection on the EMS/NMS.
5) Restore the fiber and check whether the ODUk connection come back to original routes as per set time.

Results:

Test item	Timing Revert to Original Path.
Expected Results	ODUk path can be restored to the original path on time.
Results:	
Remark:	

24.0 Multi Layer Protection Test:

24.1 Client-side 1+1 SNCP protection: (Non Revertive Mode)

Purpose: To validate the 1+1 Client-side protection function in Non revertive Mode

Test Configuration:

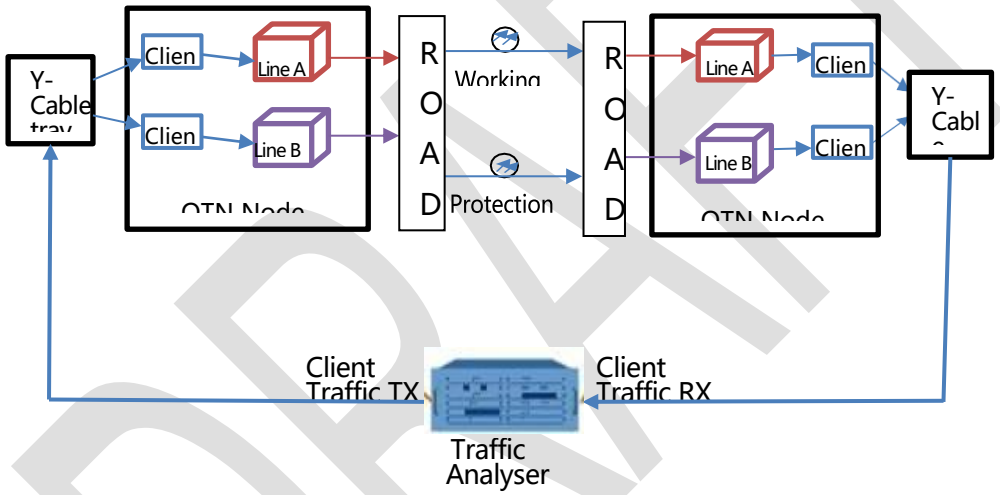

Figure 36: Test set up for Multi Layer Protection

Test Procedure:

1) Establish the testing configuration according to the above diagram.
2) Create the service and configure Client 1+1 protection with EMS/NMS.
3) Set protection group as Non revertive mode.
4) Check the service, and make sure the service is normal.
5) Pull out the fiber on the working path.
6) Check the switching time which should be less than 50ms.
7) Revert back all the fiber and wait for protection group become normal.
8) Pull out the fiber on the protection path.
9) Check the switching time which should be less than 50ms.

Results:

Test item	Client-side 1+1 Protection
Expected Results	The service should switch to the protection channal and switching time should be less than 50ms.
Results:	

24.2 Client-side 1+1 SNCP protection: (Revertive Mode)

Purpose: To validate the OTU Client-side protection function in revertive mode.

Test Configuration:

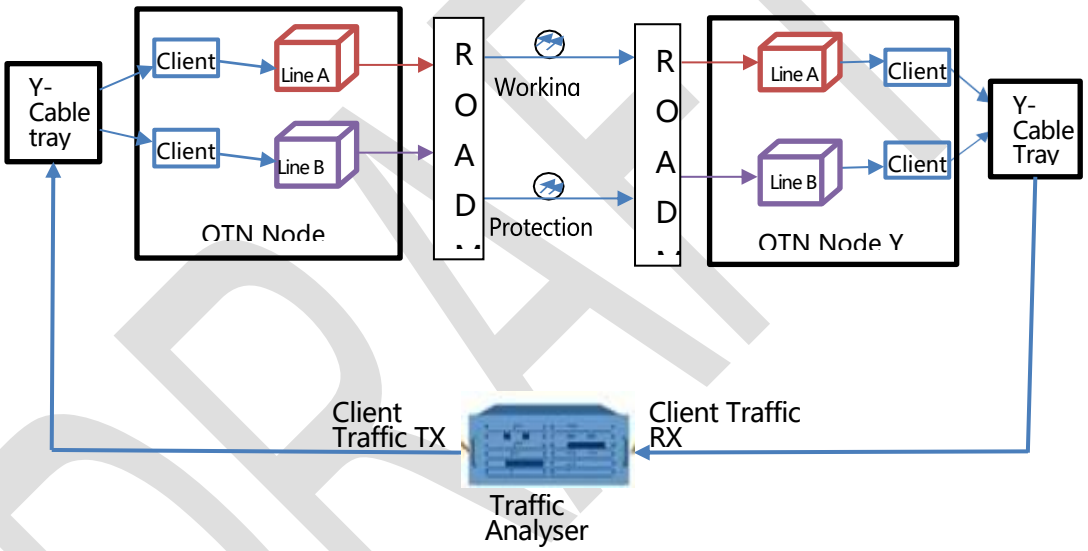

Figure 37: Test set up for Multi Layer Protection

Procedure:

1) Establish the testing configuration according to the above diagram.
2) Create the service and configure Client 1+1 protection.
3) Set protection group as revertive mode.
4) Check the service, and make sure the service is normal.
5) Pull out fiber on the working path.
6) Check the switching time which should be less than 50ms.
7) Revert back all the fiber and check switching status which should be in WTR mode.

8) Wait for WTR time for traffic restoration.

Results:

Test item	Client-side 1+1 Protection
Expected Results	The service should switch to the protection channal and switching time should be less than 50ms. After fiber restoration traffic shpuld revert back to working path within WTR time.
Results:	

25.0 Test to verify Forward error Correction.

Purpose: To validate the FEC function of the OTU board.

Test configuration:

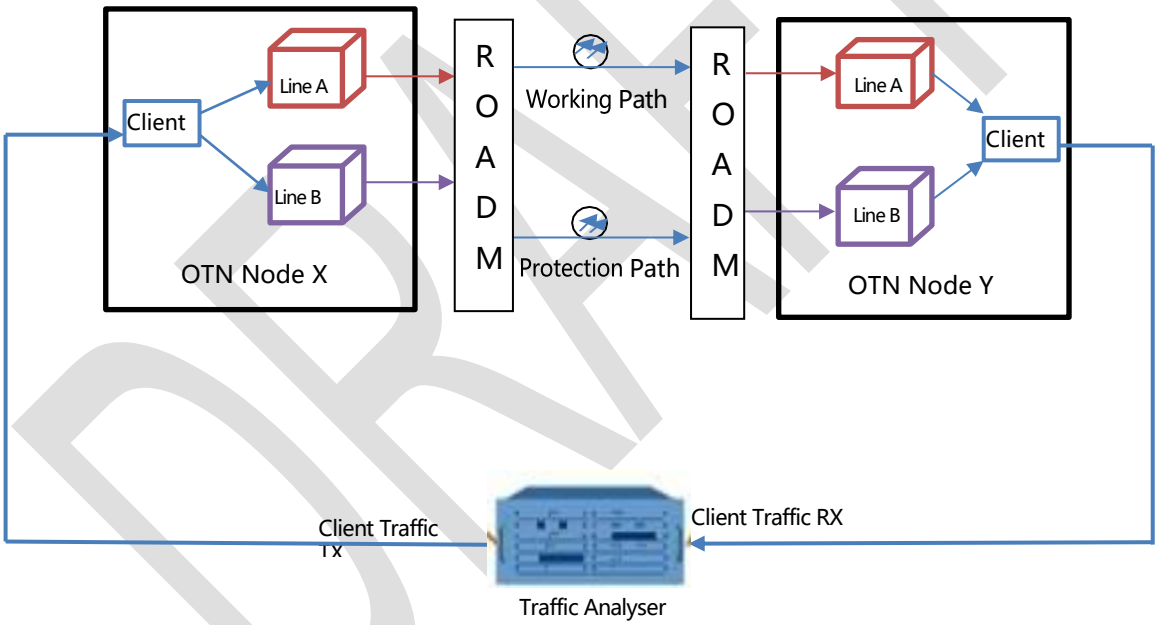

Figure 37: Test set up for Forward Error Correction

Procedure:

1) Establish the testing configuration according to the above diagram.
2) Configure the tester according to the service.
3) Disable FEC function of at OTU line.
4) Wait for 15 minutes and measure the Pre-FEC BER at Rx line. The error rate should be <10E-12.
5) Enable FEC function of OTU line.

6) Wait for 15 minutes and check BER of the link. BER should be >10E-12.

7) Compare the result.

Results:

Test item	Test to verify Forward error Correction.
Expected Results	With FEC enable condition BER level will be high.
Results:	

26.0 Overhead byte testing

Purpose: To verify the OTUk overhead as per ITU-T G.709.

Test Configurations:

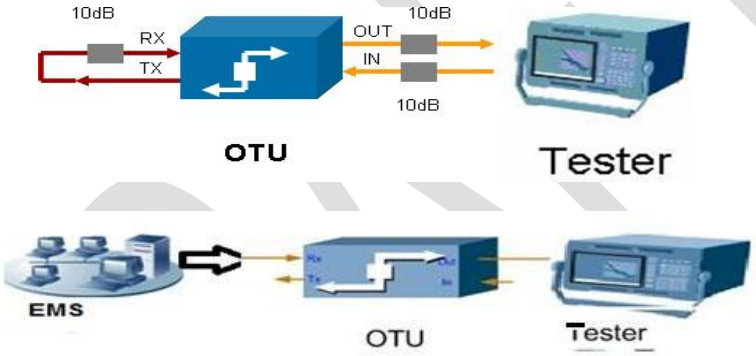

Figure 38: Test set up for Overhead Byte Testing

Procedure:

1) Establish the testing configuration according to the above diagram.
2) When the equipment if work normal, the OTN analyzer should receive the frame alignment byte: A1=11110110 or F6，A2=00101000 or 28.
3) Use the analyzer to check the TTI byte that the equipment transmitted. Change the send TTI byte of the equipment. The received TTI byte of the analyzer should as the same to the send TTI byte of the equipment.
4) The OTN analyzer send such as BDI to the equipment under test. The EMS/NMS should report BDI.
5) Verify other overhead bytes for supervisory Channel and wavelength conversion function.

Results:

Test item	OTUk overhead test
Expected Results	In accord with G.798

27.0 Test case to verify wavelength and power of OSC Channel (wavelength)

Purpose: To validate the transmitter central wavelength of OSC interface.

Test Configuration:

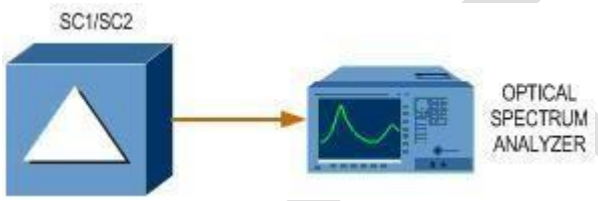

Figure 39: Test set up for OSC wavelength and power Testing

Procedure:

1) Establish the testing configuration according to the above diagram.
2) Connect Optical Spectral analyzer to the OSC Tx port and check wavelength and power.
3) Read and record the test result.

28.0 Test to verify monitoring ports facility.

Purpose: To verify the MON port **function.**

Test Configuration:

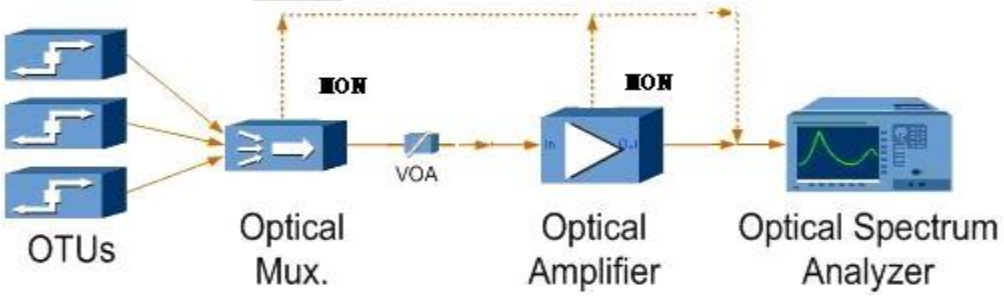

Figure 40: Test set up for Monitoring ports facility

Procedure:

1. Establish the testing configuration according to the above diagram.
2. Connect the optical spectrum analyzer to MON interface of the amplifier , multiplexer, de multiplexer & FIU.
3. Read the value of OSNR and multi channel power.

29.0 Test to verify Fast Gain Control.

Purpose: Test to verify automatic fast gain control loop.

Test Configuration:

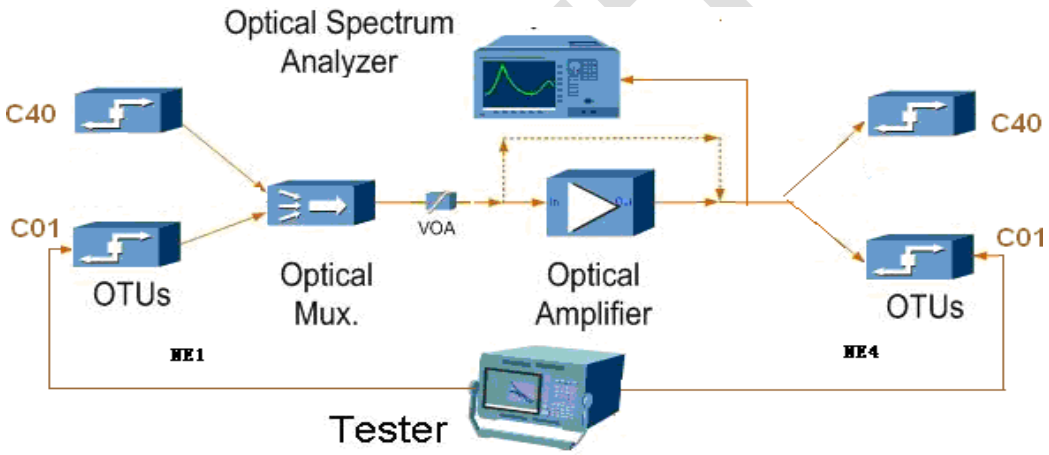

Figure 41: Test set up for Fast Gain Control

Procedure:

1) Establish the test configuration according to the above diagram.
2) Set the Tester, Check the traffic is ok.
3) Check the optical power gain of channel 1.
4) Increase no. of channels with adding lambda of any wavelengths within C band)
5) Check the Tester. Service should be normal.
6) Check the power gain of channel 1 which should be unchanged.
7) Drop traffic from of any channel and check the power gain of channel 1 which should be unchanged.
8) Check the service which should be normal during adding/dropping the channels.

Results:

Test item	Test to verify automatic gain control (Channel scalability)
Expected Results	1. The gain values of the channel 1 during all the three conditions should be same. 2. During channel addition / deletion, the performance of channel should not be affected.
Result	

30.0 Supervisory Parameters:

Sl. No.	Parameters	Possibility
1.	Input power of the Booster Amplifier	Possible/Not possible
2.	Output power of the Booster Amplifier	Possible/Not possible
3.	Laser temperature of the Booster Amplifier	Possible/Not possible
4.	Input power of the Pre-amplifier	Possible/Not possible
5.	Output power of the Pre-amplifier	Possible/Not possible
6.	Laser temperature of the Pre-amplifier	Possible/Not possible
7.	Input power of OLA	Possible/Not possible
8.	Output power of OLA	Possible/Not possible
9.	Laser Temperature of OLA	Possible/Not possible
10.	Output power of the Dropped Channel	Possible/Not possible
11.	Input power of the individual optical channel	Possible/Not possible
12.	Input power of OSC	Possible/Not possible
13.	Output power of OSC	Possible/Not possible
14.	Laser Temp. or Lase Bias-current of OSC	Possible/Not possible
15.	Bit error rate (BER) before FEC at OTU-1 and OTU- 2 line interface of the Transponders	Possible/Not possible
16.	Fan fault, rack alarm for temp. for ROADM/ILA/OTM	Possible/Not possible

17.	ODU/OPU alarms as per the list given below as per G.709 TCM Facility alarms • ODU AIS • ODU LCK • ODU OCI • ODU BDI • ODU Trace Identifier Mismatch • ODU Signal Degrade • TCM Loss of Tandem Connection ODUCTP alarms • ODU Signal Fail (monitor or terminate modes) • ODU AIS • ODU LCK	Possible/Not possible
	• ODU OCI • ODU BDI • ODU Loss of Frame and Multiframe • ODU Signal Degrade ODUTTP alarms • ODU AIS • ODU LCK • ODU OCI • ODU BDI • ODU Trace Identifier Mismatch • OPU Payload Type Mismatch • ODU Loss of Frame and Multiframe • ODU Signal Degrade	

31.0 Performance Requirements:

Sl. No.	Parameters	Status
1.	Optical Channel Transport Unit Background Block Error (OTU_BBE)	OK / Not OK
2.	Optical Channel Transport Unit Errored Second (OTU_ ES)	OK / Not OK

3.	Optical Channel Transport Unit Severely Errored Second (OTU_SES)	OK / Not OK
4.	Optical Channel Transport Unit Unavailable Second (OTU_ UAS).	OK / Not OK
5.	Optical Channel Transport Unit Far End Error Background Block Error (ODU_FEBBE)	OK / Not OK
6.	Optical Channel Transport UnitFar End Errored Second (ODU_FEES)	OK / Not OK
7	Optical Channel Transport Unit Far End Severely Errored Second (ODU_FESES)	OK / Not OK
8.	Optical Channel Transport Unit Far End Unavailable Second (OTU_ FEUAS)	OK / Not OK
9.	Optical Channel Transport Unit Incoming Alignment Errored Second (OTU_IAES)	OK / Not OK
10.	Optical Channel Data Unit Path Monitoring Background Block Error (ODU_PM_BBE)	OK / Not OK
11.	Optical Channel Data Unit Path Monitoring Errored Second (ODU_PM_ES)	OK / Not OK
12.	Optical Channel Data Unit Path Monitoring Severely Errored Second (ODU_PM_SES)	OK / Not OK
13.	Optical Channel Data Unit Path Monitoring Unavailable Second (ODU_PM_UAS)	OK / Not OK
14.	Optical Channel Data Unit Path Monitoring Far End Errored Second (ODU_PM_FEES)	OK / Not OK
15.	Optical Channel Data Unit Path Monitoring Far End Severely Errored Second (ODU_PM_FESES)	OK / Not OK
16.	Optical Channel Data Unit Path Monitoring Far End Unavailable Second (ODU_PM_FEUAS)	OK / Not OK

32.0 Alarms:

Sl. No.	Particulars of conditions	Detection report
1.	Input power failure of the Transponder/Mux-ponder interface (including Ethernet interface)	Ok / Not Ok
2.	Input power failure of the Amplifiers	Ok / Not Ok
3.	Output power failure of the Amplifiers	Ok / Not Ok
4.	Fan/s failure	Ok / Not Ok

5.	Output power out of range for OA, OADMs	Ok / Not Ok
6.	Input power out of range for OA, OADMs	Ok / Not Ok
7.	Derived power suppy failure alarm	Ok / Not Ok
8.	Loss of input at Optical Add/Drop Muliplex equipment	Ok / Not Ok
9.	Input channel failure at Optical Add/Drop Multiplex equipment	Ok / Not Ok
10.	Hardware mismatch alarm	Ok / Not Ok
11.	Low input power input to Transponder	Ok / Not Ok
12.	Low input power at OA, Optical Add/Drop multiplex equipment	Ok / Not Ok
13.	Degraded input at OA, Optical Add/Drop multiplex equipment	Ok / Not Ok
14.	Degraded output at OA, Optical Add/Drop multiplex equipment	Ok / Not Ok
15.	Degraded output of the dropped channel	Ok / Not Ok
16.	GFP related alarm for GE client (optional)	Ok / Not Ok

33.0 OTU-k Related Alarms

Sl. No.	Particulars of conditions	Detection report
1.	OTU-k Loss of Frame alarm (OTU -LOF).	OK / Not OK
2.	OTU-k Loss of Multiframe alarm (OTU -LOM).	OK / Not OK
3.	Loss of Payload alarm (LOS-P).	OK / Not OK
4.	Open Connection Indication alarm (OCI).	OK / Not OK
5.	OTU-k Degrade Defect alarm.	OK / Not OK
6.	OTU-k Trace Identifier Mismatch alarm (OTU-k TIM).	OK / Not OK
7.	OTU-k-AIS alarm	OK / Not OK
8.	OTU-k Backward Defect Indication alarm (OTU-BDI).	OK / Not OK
9.	OTU-k Payload Mismatch alarm.	OK / Not OK
10.	ODU-k AIS alarm at path layers .	OK / Not OK
11.	ODU-k Backward Defect Indication alarm (ODU-kp BDI) at path	OK / Not OK
12.	ODU-k Locked Defect alarm at path layers	OK / Not OK
13.	ODU-k signal degrade alarm (ODU-kp DEG)	OK / Not OK
14.	ODU-k loss of frame and multi frame. ODU-LOFLOM)	OK / Not OK
15.	ODU-k Trace Identifier Mismatch alarm (ODU-k TIM) at path level	OK / Not OK
16.	ODU-k Payload mismatch alarm at path level (ODU-kp PLM)	OK / Not OK

34.0 BER performance test

BER performance over simulated-section shall be tested for 48 hours on each channel and BER performance shall be better than 10^{-12}. The test setup is shown in below.

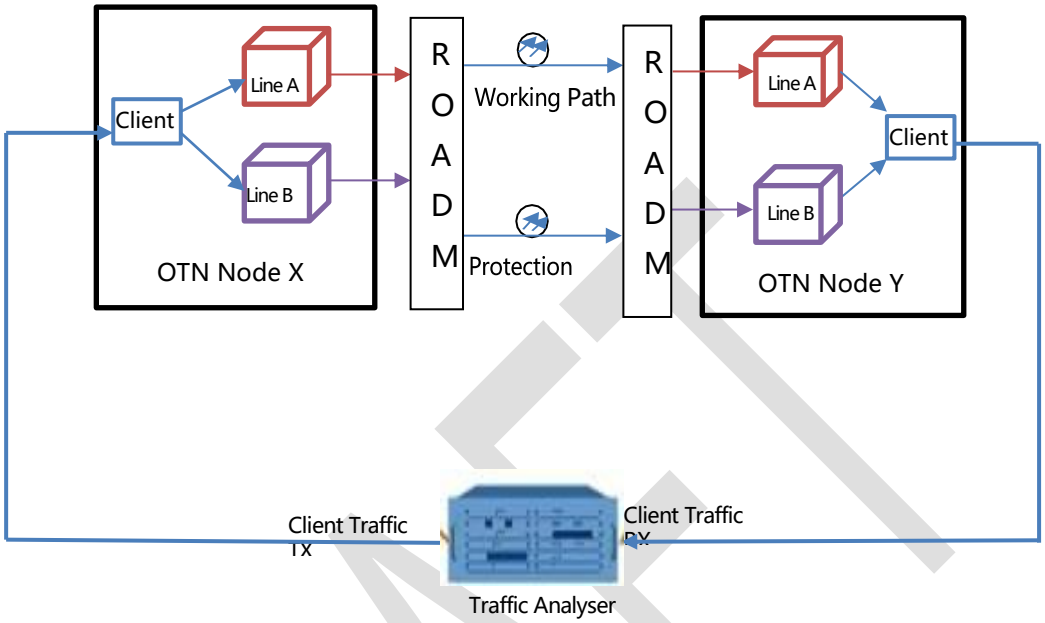

Figure 42: Test set up for BER Performance Test

35.0 Testing of Ethernet ports:

The service tests of Ethernet testing involve RFC 2544 standards of IETF. The following tests shall be conducted for all the GbE ports as well as 10GE LAN ports. 10GE WAN ports shall be tested with SDH frames.

35.1 Throughput tests

The object of this test is to verify the capability to support the fully Ethernet traffic and to assess the capacity of the buffers of the equipment under test. The test set up connections for this test is shown in Fig.45.

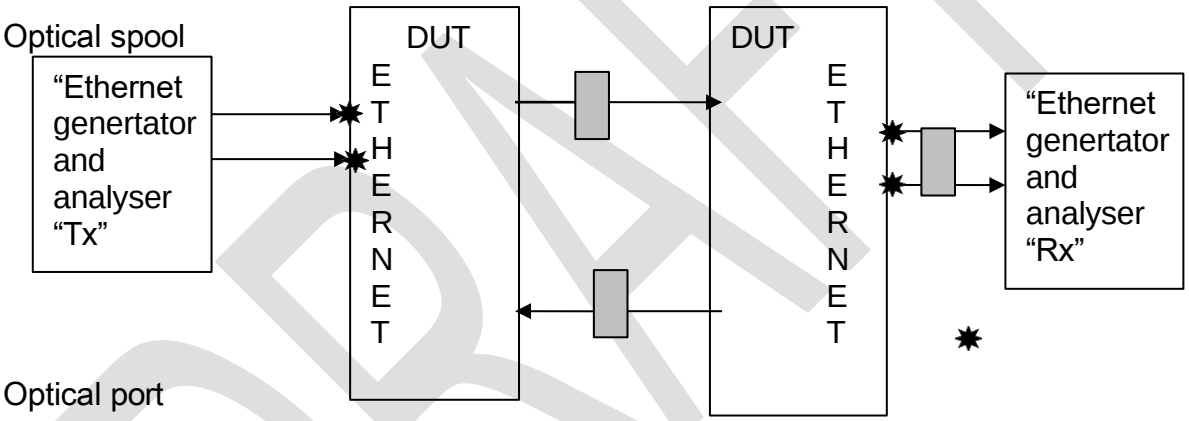

Figure 43: Test setup for Ethernet

Configure "Ethernet generator and analyser" for RFC-2544 Throughput tests for Ethernet MAC protocol. For checking GbE channel, use virtual concatenation of 7 nos. of VC-4s and for 10GE channel, use virtual concatenation of 64 nos. of VC-4s (in case of WAN).

Run the instrument for the throughput test. Store the results and take the print of the results.

The following results are expected from the instrument

i. Port address, :

ii. Half duplex/Full duplex operation:

iii. List of frame size transmitted on “pair 1 and pair 2” in this case there only two ports enabled

iv. % of TXTput

v. Average rate (fps)

vi. Tolerance %

Check the through put for various packet sizes such as: 64, 128, 256, 512, 1024, 1280, 1518 byte frames and also for Runt and Jumbo frames.

Throughput test with Virtual concatenation of VC4 configured for each port =7 Auto negotiation” and “Flow control” enabled									
Port address : Port 1 : Port 2 : Port 3 : Port 4 : This test is not applicable to 2R transponders”									
Ethernet rate	Frame sent	Frame received	Byte Sent	yte received	Packet dropped	% of TX Tput	Average rate (fps)	Latency	NMS of DUT Frame dropped /received with error
Packet size of 64 bytes per frame									
Packet size of 128 bytes per frame									
Packet size of 256 bytes per frame									
Packet size of 512 bytes per frame									
Packet size of 1024 bytes per frame									
Packet size of 1280 bytes per frame									
Packet size of 1518 bytes per frame									
Runt Frame									
Jumbo Frame									

Prints of Log dumps : Enclosed/Not Enclosed									

35.2: Frame loss rate tests

The test setup connections for this test remain the same.

Configure "Ethernet generator and analyser" for RFC-2544 for Ethernet MAC protocol.

Run the instrument for the Frame loss test. Store the results and take the print of the results.

Check the through put for various packet sizes such as: 64, 128, 256, 512, 1024, 1280, 1518 byte frames and also for Runt and Jumbo frames.

Frame Loss test with Virtual concatenation of VC4 configured for each port =7 Auto negotiation" and "Flow control" enabled										
Port address: Port 1				Port 2:				Port3:		Port4:
Port No	Ethernet rate	Frame sent	Frame received	Byte Sent	Bytes received	Packet dropped	% of TXTput	Average rate (fps	Frame loss if any	NMS of DUT Frame dropped /received with error
Packet size of 64 bytes per frame										
1										
2										
3										
4										
Packet size of 128 bytes per frame										
1										
2										
3										
4										
Packet size of 256 bytes per frame										
1										
2										

3										
4										

Packet size of 512 bytes per frame										
1										
2										
3										
4										
Packet size of 1024 bytes per frame										
1										
2										
3										
4										
Packet size of 1280 bytes per frame										
1										
2										
3										
4										
Packet size of 1518 bytes per frame										
1										
2										
3										
4										
Prints of Log dumps : Enclosed/Not Enclosed										

35.3 : Latency Tests:

The “Ethernet generator and analyser” automatically give the Latency under “Throughput test” bench marking. From the print out of the Throughput tests mentioned in this document take the Latency figure and record in the tables given below.

Throughput test with Virtual concatenation VC4 configured for each port =7									
Port address : Port 1 : Port 2 : Port 3 : Port 4 :									
This test is not applicable to 2R transponders"									
Ethernet rate	Frame sent	Frame received	Byte Sent	yte received	Packet dropped	% of TX Tput	Average rate (fps)	Latency	NMS of DUT Frame dropped /received with error
Packet size of 64 bytes per frame									
Packet size of 128 bytes per frame									
Packet size of 256 bytes per frame									
Packet size of 512 bytes per frame									
Packet size of 1024 bytes per frame									
Packet size of 1280 bytes per frame									
Packet size of 1518 bytes per frame									
Runt Frame									
Jumbo Frame									
Prints of Log dumps : Enclosed/Not Enclosed									

Annexure-I

1) Name of the Vendor:

2) Name of the technology:

3) TAC is against: GR/PO:

4) In case of PO, PO no:

5) Date of registration:

6) Date of Commencement of tests: Place of testing:

7) Details of Environmental cycle: Place of environmental testing From to

8) Date of field trials:

i) Field trial route details:

Field trial route allotted:

Terminal A :

Terminal B :

Optical Line Amplifier : Optical Add Drop mux :

From to

---------- ----------

ii) Details of First A/T:

Please list the following

details, date wise Terminal A :

Terminal B ;

Optical Line Amplifiers :

Optical Add Drop mux :

iii) Details of second A/T;

Please list the following detail, date wise

Terminal A :

Terminal B :

Optical Line Amplifier :

Optical Add Drop mux :

9) Details of equipment:

i) Long Haul application :

a) No. terminals :

b) No of Subracks per terminals :

c) Details of Subracks :

Size of the Subrack :

Comments……

……

Type of PCB guide used: Built in embossed type PCB guides / Metallic PCB guides riveted type/ Non metallic removable PCB guides

Comments……

……

In case of Non metallic removable PCB guides, manufacturer shall give the details of material used:

Comments……

Please inspect the Subrack and record the following information;

Max. nos. of PCBs that can be loaded in the sub rack:

Comments……
……

Check the space between any two PCB is sufficient for the purpose of Air Circulation/heat dissipation

Comments……

Smooth flow of PCBs within the Subrack without colliding/touching the adjacent PCBs

Comments……
……

Locking arrangements of PCBs is provisioned. If yes, whether the Screwing to the body of Subrack/ Clips at the top and bottom of the PCB/Any other arrangement

Comments……
……

Are the Top and bottom plates of Sub rack are sufficient strength and do not sag or bend when slightly pressed from the center of these plates, if so please indicate

Comments……
……

Whether the Subrack has got the front cover to avoid the ingress of dust.

Comments……
……

Whether care has been taken the for the EMI and EMC induction or not. If yes what sort of arrangement has been engineered by the manufacturer

Comments……
……

Please check and detail arrangements for fixing the Subrack to the full/main rack (It should preferably be the screwing arrangements, with minimum four undetectable screws)

Comments……

……

……

Please check the material of the Subrack, in case it is mild steel, check that the proper enameling has been done or not

Comments……

……

……

d) Details of Rack: Dimension of full size:

No of subracks, a Full Rack can accommodate:

How many sub racks a manufacturer proposes to accommodate in a full rack:

Please ensure that the full rack has sufficient strength, so that it does not get twisted while erecting

Comments……

……

Please ensure that the top and base plates of the Full tack is sufficiently thick and proper arrangements i.e holes etc are there to mount the the rack on floor;

Comments……

……

Please ensure that there is a sufficient space for running the Optical fibre cables/optical patch cord/ electrical cables etc.

Comments……

……

e) No of PCBs supported during the type approval:

General observations regarding the PCBs Do PCBs have the solder mask?

Comments……

……

Do PCBs have got the etched designation, version and serial number?

Comments……

……

Move the PCBs to and fro in the Subrack and notice the lateral movement of the PCBs in the Subrack. Please check that the PCBs should have a free to and fro movement and do not come out of the top and bottom PCB guides and there should not be much lateral movement

Comments……

……

I. Optical Terminal A

Name of the PCB Sr No.

1) ……

2) ……

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

78) ……

79) ……

80) ……

Terminal B

Name of the PCB	Sr No.
1) ……..	…….
2) ……	…….
3) ……..	……...
. . . . .	
. . . . .	
. . . . .	
. . . . .	
. . . . .	
78) ……..	……
79) ……..	……
80) ……..	……

II. Optical Line Amplifier Optical Line amplifier #1

Name of the PCB	Sr No.
1) ……..	……
2) ……	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

Optical Line amplifier # 2

Name of the PCB	Sr No.
1) ……..	……
2) ……	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

Optical Line amplifier # 3

Name of the PCB	Sr No
1) ……	……
2) ……	……
3) ……	……
4) ……	……
5) ……	……
6) ……	……

Optical Line amplifier # 4

Name of the PCB	Sr No.
1) ……	……
2) ……	……
3) ……	……
4) ……	……
5) ……	……
6) ……	……

Optical Line amplifier # 5

Name of the PCB	Sr No.
1) ……	……
2) ……	……
3) ……	……
4) ……	……
5) ……	……
6) ……	……

Optical Line amplifier # 6

Name of the PCB	Sr No.
1) ……	……
2) ……	……
3) ……	……

4) …….. ……

5) …….. ……

6) …….. ……

III. Optical Add/Drop Mux: OADM #1

Name of the PCB	Sr No.
1) ……..	……
2) ……..	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

OADM #2

Name of the PCB	Sr No.
1) ……..	……
2) ……..	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

ROADM #1

Name of the PCB	Sr No.
1) ……..	……
2) ……..	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

ROADM #2

Name of the PCB	Sr No.
1) ……..	……
2) ……	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

ASON Node-1

Name of the PCB	Sr No.
1) ……..	……
2) ……	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

ASON Node-2

Name of the PCB	Sr No.
1) ……..	……
2) ……	……
3) ……..	……
4) ……..	……
5) ……..	……
6) ……..	……

ASON Node-3

Name of the PCB	Sr No.
1) ……..	……
2) ……	……
3) ……..	……
4) ……..	……

5) …….. ……

6) …….. ……

ASON Node-4

	Name of the PCB	Sr No.
1)	……..	……
2)	……..	……
3)	……..	……
4)	……..	……
5)	……..	……
6)	……..	……

ASON Node-5

	Name of the PCB	Sr No.
1)	……..	……
2)	……..	……
3)	……..	……
4)	……..	……
5)	……..	……
6)	……..	……

Ensure that the PCB s and other hardware are the same as are quoted in the bid document by the vendor.

f) Connectors:

Type of optical connectors used in

the system: Make :

Model no.:

In the case connector used for FDF termination are other than FC/PC, ensure that the suitable adapters are provided by the manufacturer.

Comments

g) Chromatic Dispersion of Fibre spools:

The length of each spool measured with Chromatic Dispersion meter.

The loss of the fibre using light source and Power meter

Details of Dispersion Fibre spools in case of Single mode fibre							
Spool No	Spool #1	Spool #2	Spool #3	Spool #4	Spool #5	Spool #6	Spool #7
Fibre Loss/Km =dB							
Total loss in dB							
Dispersion/Km =ps/nmkm							
Total dispersion in ps/nm							
Spool No	Spool #.8	Spool #9	Spool #10	Spool #11	Spool #12	Spool #17	Spool #14
Total loss in dB							
Total dispersion in ps/nm							
Spool No	Spool #.15	Spool #16	Spool #17	Spool #18	Spool #19	Spool #20	Spool #21
Total loss in dB							
Total dispersion in ps/nm							

Section wise details of dispersion fibre: Long Haul Application:

Multiplex section No	Section #1	Section #2	Section #3	Section #4	Section #5	Section #6	Section #7	Section #8
Loss In dB								
Length in Km								
Multiplex section No	Section #9	Section #10						
Loss In dB								
Length in Km								

h) Polarization Mode Dispersion:

i. A-B direction:

ii. B-A Direction:

10. Equipment installation for evaluation

These sequences shall be taken in the way as specified below, at the time of TEC evaluation of DWDM technology

I. The manufacturer shall erect the main racks and subracks before the commencement of TEC type approval

II. Install the Terminal Mux and Demux equipment and record the followings

I. Number of transponders per subrack

……

II. Attenuator at the output of Transponder, if yes give the details

i. Variable/Fixed …….

ii. Resolution……

iii. Type/make

……

III. Any attenuator at the output of Mux, if yes give the detail

i. Variable/Fixed…….
ii. Resolution……
iii. Type/make……

III. Install the Optical Line amplifiers one by one after inserting the specified value of Optical Fibre in each span and record the following

i) Attenuator at the Input/output of Booster/Line amplifier/Pre amplifier, if yes give the details

a) Variable/Fixed…….
b) Resolution…….
c) Type/make
……

ii) Is the Pre emphasis is provisioned by
a) Booster, if yes, give the details, in the term of type of Pre Emphasis, Equalisation range
……
……
……
……

b) Pre amplifier if yes, give the details, in the term of type of Pre Emphasis, Equalisation range
……
……
……
……

IV. No of Optical Line amplifier supported by each subrack duri ng the equalization……
……

V. Now switch on the equipment i.e Mux/demux and Optical Line amplifiers. Feed the signal on all the channels and record the output power at the output point of each of the Booster/Pre amplifier.

Allow the system in this state for about one hour or little more and again record the output power at each stage as stated above. This is to ensure that the system is fit for the traffic instantly or requires some time for handshaking with amplifiers etc. Also to ensure this from the SDH analyzer map one 2488.32 Mb/s pay load onto STM-64 and feed the data to one of the transponder especially with lowest amplitude in the spectrum. On the Demux end demap the 2488.32 M/s data and feed back to the SDH analyzer and see there should be no error. This test shall especially be taken during the field trial with an actual traffic of 40/ 80 channel or by simulation method.

Comments……
……
……

VI. Now open the fiber and verify that the equipment restores back instantly i.e within 50 –100 ms

Comments……
……

VII. Now add about 1 to 2 dB attenuation in the section and ensure that the equipment does not change its performance,
Comments……
……

VIII. Please ensure that the arrangements for mounting the subracks in the Full rack are adequate:
Comments……
……

IX. Please attach an undertaking from the manufacturer stating that he will supply same Rack/sub rack during the supply of the equipment to BSNL/MTNL

Connectors: Type of optical used in the system: Make :

Model no :

In the case connector used are other than FC/PC, ensure that the suitable adapters are provided by the manufacturer

Comments……
……

11. System Manuals

1. Maintenance manuals:
2. Installation manual:
3. Repair manual:

12. NMS

Software model :

Version :

Check sum :

Please attach an undertaking from the manufacturer stating that he will supply the same version of software with the supply of equipment and any change in the future version to be supplied to the purchaser, shall be with the consent of TEC. In the case of type approval against tender, ensure that it is the same as quoted in the tender bid.

13. Details of works

station/Server: Make :

Processor type and speed :

Hard disk capacity :

Key board Make :

Mouse make :

Monitor Make and size :

NMS capacity in terms of Manageability of NEs :

14. Local Craft Terminal:

Make :

Processor type and speed :

Hard disk capacity :

Key board Make :

Mouse make :

Monitor Make and size :

NMS capacity in terms of Manageability of NEs :

Please attach an undertaking from the manufacturer stating that he will supply the same version of software with the supply of equipment and change in the future version to be supplied to the BSNL/MTNL shall be with the consent of TEC. In the case of type approval against tender, ensure that it is the same as quoted in the tender bid.

15. Jigs/Tools and installation materials:

Please furnish the list of jigs/Tools and installation materials required during the repair of the equipment. In case of the type approval against P.O check it and ensure that it is as per tender bid;

Comments……
……

Testing team

a) Ambient testing:

b) Environmental testing

c) Field trials:

J. SUMMARY OF TEST RESULTS

TEC Standard No._____

TEC Test Guide No._____

Equipment name & Model No._____

Clause No.	*Compliance (Complied /Not Complied / Submitted/Not Submitted / Not Applicable)*	*Remarks / Test Report Annexure No.*

[Add as per requirement]

Date:

Place: ***Signature & Name of TEC testing Officer /***

**** Signature of Applicant / Authorized Signatory***

**** Section J as given above is also to be submitted by the Applicant/ Authorised signatory as part of in-house test results along with Form-A. The Authorised signatory shall be the same as the one for Form 'A'.***