Reference Specification

for

Optical Interfaces

IDA RS OPTIC
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Infocomm Development Authority of Singapore
Resource Management & Standards
8 Temasek Boulevard
#14-00 Suntec Tower Three
Singapore 038988

Contents

NOTICE

This Reference Specification is subject to review and revision.

Reference Specifications and Guides are informative documents and are not used for approval of customer equipment. They are either one of the following types of documents:

i Informative and interim documents on customer equipment standards which are yet to be adopted by network operators, and where standardisation is still in progress.

ii Informative documents describing network standards adopted by the public telecommunication networks in Singapore.

PART A INTRODUCTION

1 Scope

This Reference Specification identifies the optical interface requirements for the following types of equipment:

(a) Access network equipment which deploys a Passive Optical Network (PON) technology according to the ITU-T Rec. G.983/G.984 series or the IEEE Std 802.3-2005 (Part B of this Specification: Optical Access Network);

(b) Intra-office or inter-office network equipment which supports the Synchronous Digital Hierarchy (SDH) technology using optical interfaces according to the ITU-T Rec. G.957 and G.691 (Part C of this Specification: Synchronous Digital Hierarchy Equipment).

(c) Ethernet transport network equipment and service nodes such as IP-Routers and Automatically Switched Optical Network (ASON), using any optical interface specified in the ITU-T Rec. G.691, providing access link to equipment terminated at the customer edge (Part D of this Specification: Ethernet Transport Network).

2 General Requirements

2.1 Power Supply

The equipment may be a.c. powered or d.c. powered. For an a.c. powered equipment, the Specification shall be complied with when operating from an a.c. mains supply of voltage, 230V ± 10% and frequency, 50 Hz ± 2%. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the equipment to meet the Specification.

2.2 Identification of Equipment

The equipment shall be marked with the supplier or manufacturer's name or identification mark, and the supplier or manufacturer's model or type reference. The markings required shall be legible, indelible and readily visible.

3 Safety Requirements

3.1 The equipment shall comply with the IEC 60950-1 safety standard[1].

3.2 Where applicable, the equipment shall comply with the limits for conducted disturbance at the mains terminals and the limits for radiated disturbance defined in the IEC CISPR 22.

3.3 The optical safety considerations shall be in accordance with the ITU-T Rec. G.664. The optical transceivers of the PON shall conform to Class 1 laser requirements as defined in the IEC 60825-1.

[1] The safety standard includes, among others, protection of telecommunications network service personnel and users of other equipment connected to the network from hazards in the equipment.

PART B OPTICAL ACCESS NETWORK

1 Scope

This part of the Specification defines the interface requirements for the Optical Access Network (OAN). It defines the OAN architecture and optical interfaces, and outlines the user network interface (UNI) and the service node interface (SNI) requirements of the OAN in relation to services supported through the OAN.

2 Architecture of the Optical Access Network

The OAN architecture is as shown in Figure 1, covering network options such as Fibre to the Home (FTTH), Fibre to the Building/Curb (FTTB/C) and Fibre to the Cabinet (FTTCab). Regardless of the network option to be employed, the OAN is characterised by an Optical Line Termination (OLT) system and an Optical Network Unit (ONU) or Optical Network Termination (ONT) with a passive Optical Distribution Network (ODN) interconnecting them (Figure 2). It is usually a one-to-many relationship between the OLT and the ONT/ONU (point-to-multipoint tree and branch option). In practice, the ONT is a single integrated electronics unit used in the FTTH scenario while the ONU is a shelf with plug-in circuits used in the FTTB/C or FTTCab scenario. Both terms are generically referring to the user-side interface of the OAN. The OLT provides the network-side interface of the OAN. OLT and ONT/ONU shall comply with the applicable physical and transmission medium layer requirements specified in the ITU-T Rec. G.983/G.984 series or the IEEE Std 802.3-2005.

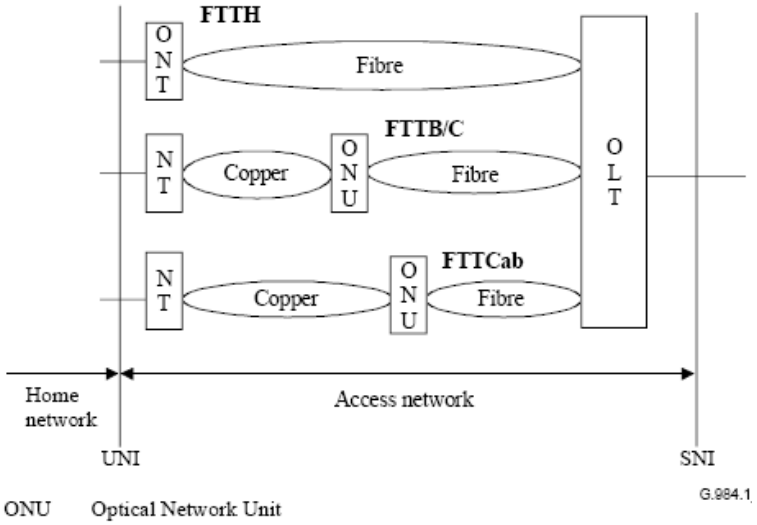
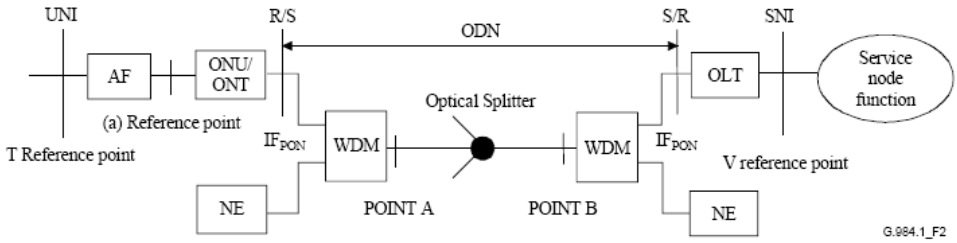


Figure 1: Network Architecture (Figure 1/G.984.1)

3 Optical Interfaces

3.1 The ODN has a PON configuration with optical components such as optical fibres and cables, connectors, splices and wavelength division multiplexing (WDM) devices as shown in Figure 2. All optical components used in the ODN shall comply with the transmission related parameters defined in the ITU-T Rec. G.671, and shall be compatible with single-mode optical fibre specified in the ITU-T Rec. G.652. The optical components shall have essential properties such as optical wavelength transparency, reciprocity and fibre compatibility. Bidirectional transmission is achieved

using either WDM technique on a single fibre or unidirectional transmission over two fibres.



ONU	Optical Network Unit
ONT	Optical Network Terminal
ODN	Optical Distribution Network
OLT	Optical Line Termination
WDM	Wavelength Division Multiplex Module (If WDM is not used, this function is not necessary.)
NE	Network Element which uses the different wavelength from the OLT and the ONU
AF	Adaptation Function (Sometimes, it may be included in the ONU.)
SNI	Service Node Interface
UNI	User Network Interface
S	Point on the optical fibre just after the OLT (Downstream)/ONU (Upstream) optical connection point (i.e., optical connector or optical splice)
R	Point on the optical fibre just before the ONU (Downstream)/OLT (Upstream) optical connection point (i.e., optical connector or optical splice)
(a) Reference point	If AF is included in the ONU, this point is not necessary.
POINT A/B	If WDM is not used, these points are not necessary.

Figure 2: PON Reference Configuration (Figure 2/G.984.1)

3.2 The optical interface parameters shall be in accordance with Table 4/G.983.1 or Table 2/G.984.2, depending on the downstream and upstream bit rate; or clause 60 of the IEEE Std 802.3-2005, depending on the interface type: 1000BASE-PX10 or 1000BASE-PX20.

4 User Network & Service Node Interfaces and Services

4.1 Located between the UNI and the SNI as shown in Figure 1, the OAN is used to transport various services between the end-users' networks and the operators' networks (backbone network). OAN is a high-speed access system that supports services with bandwidth requirements ranging from that of voice to Gigabit-per-second data services (e.g. video distribution with interactivity, electronic data transfer, LAN interconnection and transparent Virtual Path). The OAN shall be flexible and upgradeable, especially at the ODN, to cater to future services with higher bandwidth requirements.

4.2 Examples of UNI, physical interfaces and services that may be supported by the OAN at the UNI are shown in Table 1 (with reference to Table I.2/G.984.1, including cross-references to the relevant IDA standards).

Table 1: Examples of UNI and Services

UNI	Physical Interface	Service	IDA Technical Specification (TS)
10BASE-T (IEEE 802.3)	–	Ethernet	–
100 BASE-TX (IEEE 802.3)	–	Ethernet	–
1000BASE-T (IEEE 802.3)	–	Ethernet	–
ITU-T Rec. I.430	–	ISDN Basic Access	TS ISDN BA
ITU-T Rec. I.431		ISDN Primary Rate Access	TS ISDN PRA
ITU-T Rec. G.703	PDH	ATM, E1 (2 Mbit/s), E3 (34 Mbit/s)	TS DLCN
ITU-T Rec. I.432.5	25 Mbit/s metallic interface	ATM	TS BISDN
ITU-T Rec. G.957	STM-1, STM-4	ATM	Part C of this Specification

4.3 Examples of SNI, including aspects of the physical layer that may be supported by the OAN at the SNI, are shown in Table 2 (with reference to Table I.3/G.984.1, including cross-references to the relevant IDA standards).

Table 2: Examples of SNI and Services

SNI	Physical Interface	Service	IDA Technical Specification (TS)
1000BASE-X (IEEE 802.3)	–	Ethernet	–
ITU-T Rec. G.965	V5.2	POTS, ISDN BA, ISDN PRA	IDA RS PSTN 6
ITU-T Rec. G.703	PDH	ATM, E1 (2 Mbit/s), E3 (34 Mbit/s)	TS DLCN
ITU-T Rec. G.957	STM-1, STM-4, STM-16	E1 (2 Mbit/s), ATM	Part C of this Specification
ITU-T Rec. G.691	STM-64	E1 (2 Mbit/s), ATM	Part C of this Specification

PART C SYNCHRONOUS DIGITAL HIERARCHY EQUIPMENT

1 Scope

1.1 This part of the Specification defines the optical interface requirements for Synchronous Digital Hierarchy (SDH) equipment described in the ITU-T Rec. G.783 with the Network Node Interface (NNI) structured according to the ITU-T Rec. G.707. SDH equipment includes add-drop multiplexers and cross-connect systems that are used in backbone networks.

1.2 The purpose of this part of the Specification is to enable the mixing of different manufacturers' SDH equipment within a single optical section to achieve the multi-vendor compatibility. The optical section shall be represented by optical fibre line system interfaces as shown in Figure 1, where single-mode fibres conforming to the ITU-T Rec. G.652, G.653 and G.654, and optical components (e.g. connectors) conforming to the ITU-T Rec. G.671 are used.

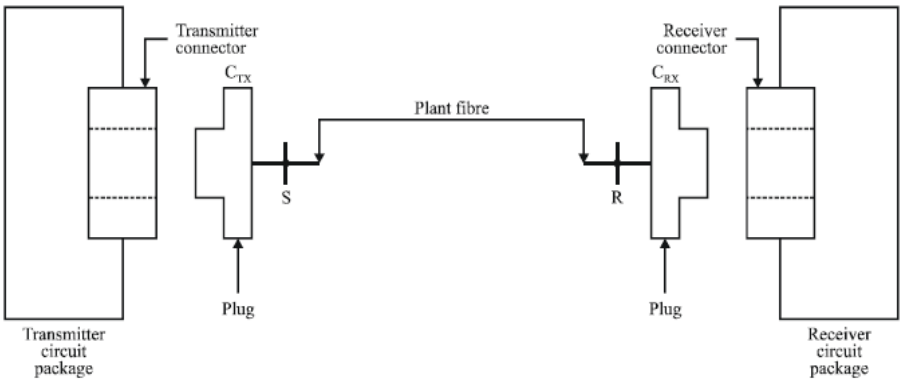


Figure 1: Representation of optical line system interface (Figure 1/G.957)

1.3 Referring to Figure 1, point S is a reference point on the optical fibre just after the transmitter optical connector (C_{TX}) and point R is a reference point on the optical fibre just before the receiver optical connector (C_{RX}). Any additional connectors at a distribution frame (if used) are considered to be part of the fibre link located between points S and R. Optical parameters are specified for the transmitter at point S and the receiver at point R, and the optical path between points S and R. Parameters are specified relative to an optical section design objective of a Bit Error Ratio (BER) not worse than 1×10^{-10} for the extreme case of optical path attenuation and dispersion conditions in each application given in Table 1. For systems with improved performance (e.g., BER of 10^{-12}), either improved receiver sensitivity or reduced attenuation range for the applications listed in Table 1 may be required.

2 Classification of Optical Interfaces

2.1 For achieving multi-vendor compatibility, optical interfaces for SDH equipment have been classified according to the ITU-T Rec. G.957 and G.691 into a number of application categories with corresponding application codes. Each application category has a combination of optical parameter values for the transmitter and the receiver to achieve a power budget for the optical fibre line system in terms of attenuation/dispersion.

2.2 SDH optical interfaces are classified under 3 broad application categories with prefixes corresponding to the interconnecting distances for Intra-office (I); Short-haul inter-office (S); or Long-haul inter-office (L) applications. Classification of optical interfaces based on application codes I, S and L, and nominal bit rates (STM-1, STM-4, STM-16 and STM-64 according to ITU-T Rec. G.707) are shown in Tables 1/G.957, 1a/G.691 and 1b/G.691, which are reproduced in Annex A.

3 Optical Parameter Values for SDH Applications

3.1 Optical parameter values for applications of Table 1/G.957 are given in Table 2/G.957 for the STM-1 optical interfaces, Table 3/G.957 for the STM-4 optical interfaces and Table 4/G.957 for the STM-16 optical interfaces.

3.2 Optical parameter values for intra-office, short-haul inter-office and long-haul inter-office applications of Tables 1a/G.691 and 1b/G.691 are given in Tables 5a/G.691, 5b/G.691 and 5c/G.691 for the STM-64 optical interfaces.

3.3 Table 2/G.957 (STM-1, 155 Mbit/s), Table 3/G.957 (STM-4, 622 Mbit/s), Table 4/G.957 (STM-16, 2.5 Gbit/s) and Tables 5a/G.691, 5b/G.691 and 5c/G.691 (STM-64, 10 Gbit/s) are reproduced in Annex B.

PART D ETHERNET TRANSPORT NETWORK

1 Scope

This part of the Specification defines the optical interface requirements for the Ethernet UNI and NNI. These interfaces for the Ethernet transport networks are described in ITU-T Rec. G.8012/Y.1308 according to the architecture of the Ethernet layer networks defined in ITU-T Rec. G.8010/Y.1306, supporting services defined in ITU-T Rec. G.8011/Y.1307.

2 Architecture of the Ethernet Transport Network

2.1 The Ethernet transport network is characterised by two types of interface:

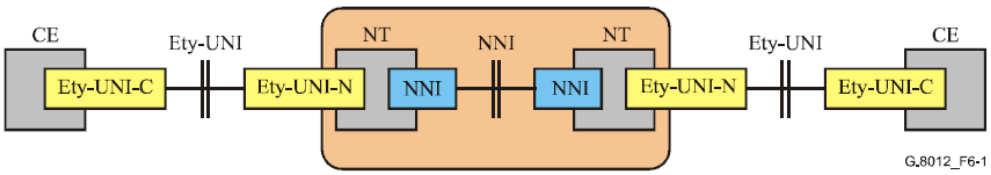
(a) Ethernet interface specified in IEEE Std 802.3-2005; and

(b) Ethernet-over-Transport (EoT) interface specified in ITU-T Rec. G.8012/Y.1308.

2.2 The Ethernet interface is defined as the Ethernet User-to-Network Interface (Ety-UNI) at the edge of the transport network, and as the Ethernet Network Node Interface (Ety-NNI) within the transport network (shown in Figures 1 and 3). The Ety-NNI is used as an Intra-Domain Interface (IaDI) within a single administrative domain and as an Inter-Domain Interface (IrDI) between two administrative domains (shown in Figure 7).

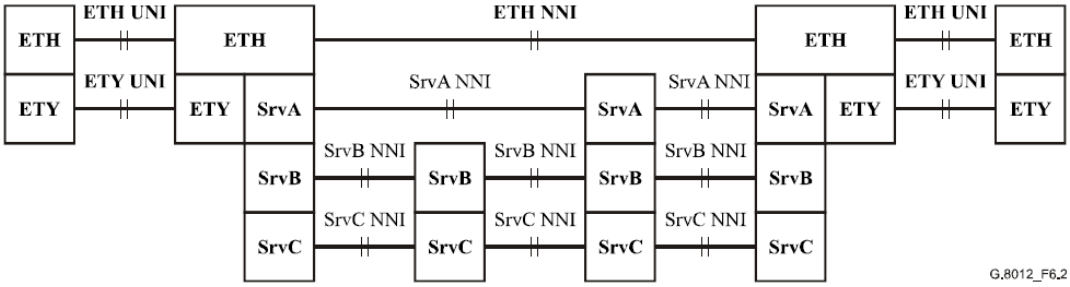
2.3 The Ethernet-over-Transport (EoT) interface is used as the EoT-NNI connecting two service nodes (shown in Figure 5); or the IaDI-NNI and IrDI-NNI within the transport network (shown in Figure 7). A set of EoT interfaces is defined in ITU-T Rec. G.8012/Y.1308 for the Ethernet NNI. They are Ethernet-over-ATM, Ethernet-over-OTH, Ethernet-over-PDH, Ethernet-over-SDH, Ethernet-over-MPLS and Ethernet-over-RPR. Correspondingly, the EoT-NNI may use server layer networks such as Asynchronous Transfer Mode (ATM), Optical Transport Hierarchy (OTH), Plesiochronous Digital Hierarchy (PDH), Synchronous Digital Hierarchy (SDH), Multi-Protocol Label Switching (MPLS) and Resilient Packet Ring (RPR) networks. Detailed requirements of these server layer networks are defined in other ITU-T Recommendations, IEEE standards and IETF RFC given in the references.

2.4 Multiple layer networks are described in the Ethernet transport network architecture. The layer networks may include an Ethernet PHY (ETY) layer network, an Ethernet MAC (ETH) layer network and a server layer network, each with dedicated UNI and NNI (examples are given in Figures 2, 4 and 6). The ETH and ETY layers are defined in the ITU-T Rec. G.8010/Y.1306.



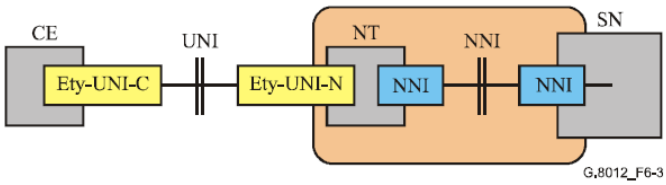
CE	Customer Edge
Ety-UNI	Ethernet UNI
Ety-UNI-C	Customer side of the Ety-UNI
Ety-UNI-N	Network side of the Ety-UNI
NNI	Network Node Interface
NT	Network Termination

Figure 1: Locations of Ethernet UNI and NNI (Figure 6-1/G.8012/Y.1308)



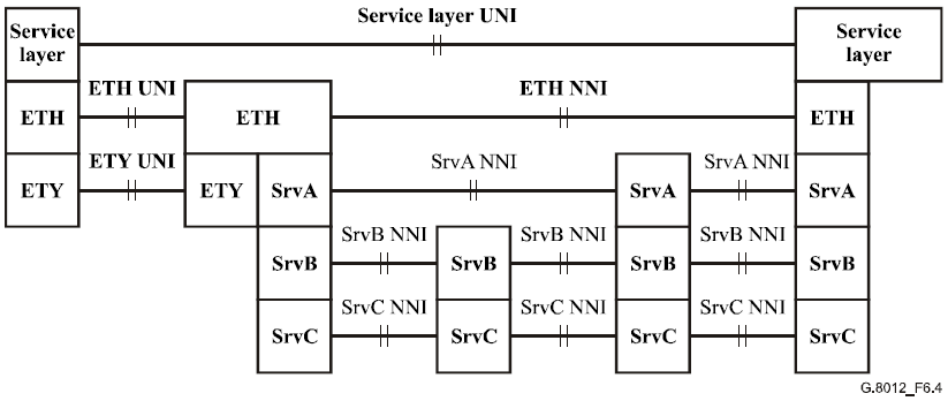
ETH	Ethernet MAC layer network
ETY	Ethernet PHY layer network
Srv	Server
NNI	Network Node Interface
UNI	User Network Interface

Figure 2: Example of layer networks in Ethernet UNI and NNI for case of point-to-point ETH layer connection (Figure 6-2/G.8012/Y.1308)



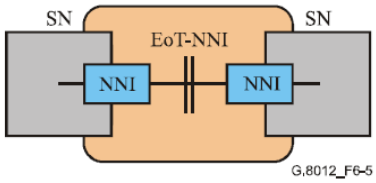
CE	Customer Edge
Ety-UNI	Ethernet UNI
Ety-UNI-C	Customer side of the Ety-UNI
Ety-UNI-N	Network side of the Ety-UNI
NNI	Network Node Interface
NT	Network Termination
SN	Service Node
UNI	User Network Interface

Figure 3: Locations of Ethernet UNI and NNI of an access link to an SN (Figure 6-3/G.8012/Y.1308)



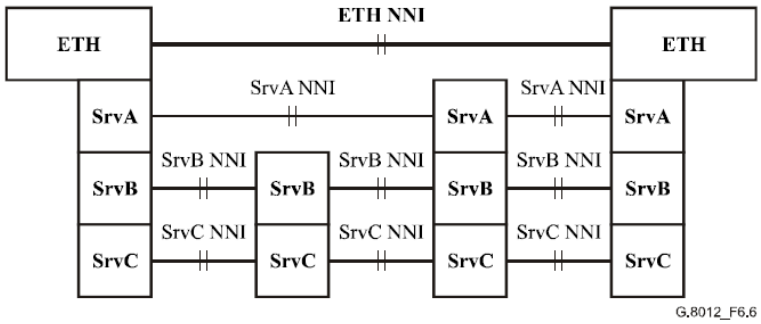
ETH	Ethernet MAC layer network
ETY	Ethernet PHY layer network
Srv	Server
NNI	Network Node Interface
UNI	User Network Interface

Figure 4: Example of layer networks in Ethernet UNI and NNI for case of access link to a client layer service node (Figure 6-4/G.8012/Y.1308)



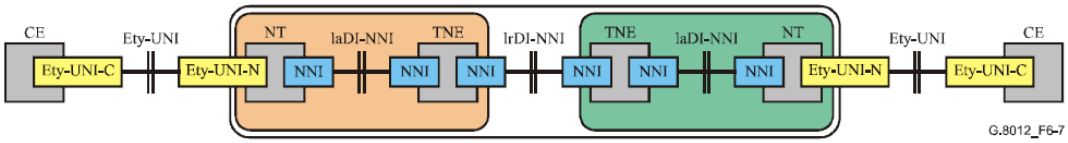
EoT-NNI	Ethernet-over-Transport NNI
NNI	Network Node Interface
SN	Service Node

Figure 5: Ethernet-over-Transport NNI between service nodes (Figure 6-5/G.8012/Y.1308)



ETH	Ethernet MAC layer network
ETY	Ethernet PHY layer network
Srv	Server
NNI	Network Node Interface

Figure 6: Example of layer networks in Ethernet NNI for case of interconnecting two ETH layer service nodes (Figure 6-6/G.8012/Y.1308)



CE	Customer Edge
Ety-UNI	Ethernet UNI
Ety-UNI-C	Customer side of the Ety-UNI
Ety-UNI-N	Network side of the Ety-UNI
laDI-NNI	Intra-Domain NNI
lrDI-NNI	Inter-Domain NNI
NNI	Network Node Interface
NT	Network Termination
TNE	Transport Network Equipment

Figure 7: Locations of Ethernet UNI and NNI in a multi-operator network (Figure 6-7/G.8012/Y.1308)

3 Optical Interfaces in the Ethernet Transport Network

References for the physical characteristics of the Ety-UNI and Ety-NNI are given in Table 1 and for EoT-UNI and EoT-NNI in Table 2.

Table 1: Ety interfaces for Ethernet over Transport (Table 8-1/G.8012/Y.1308)

Ethernet Interface	Reference
1000BASE-SX	IEEE 802.3-2005, clause 38
1000BASE-LX	IEEE 802.3-2005, clause 38
10GBASE-SR	IEEE 802.3-2005, clauses 49 and 52
10GBASE-LR	IEEE 802.3-2005, clauses 49 and 52
10GBASE-ER	IEEE 802.3-2005, clauses 49 and 52

Table 2: EoT interfaces for Ethernet over Transport (Table 8-1/G.8012/Y.1308)

Ethernet Interface	Reference
10GBASE-SW	IEEE 802.3-2005, clauses 50 and 52
10GBASE-LW	IEEE 802.3-2005, clauses 50 and 52
10GBASE-EW	IEEE 802.3-2005, clauses 50 and 52
Note: The Ethernet NNI may use any of the optical STM-N interfaces specified in ITU-T Rec. G.691. Specification for the 10GBASE-W Ethernet interface and 10G Ethernet-over-SDH differs in the coding of the Overhead, the timing of the SDH signal and the set of optical interfaces.	

4 Ethernet Services

4.1 A service-independent framework for Ethernet services is defined in ITU-T Rec. G.8011/Y.1307 with reference to the architecture of Ethernet-over-Transport defined in ITU-T Rec. 8010/Y.1306. An Ethernet service is defined by the topology of the Ethernet network based on a corresponding set of attributes associated with the Ethernet connection (EC), the UNI ports, and NNI ports from the perspective of the network.

4.2 Models of an Ethernet network (for a single service provider and a multi-provider's network) are shown in Figures 8 and 9. Three Ethernet service areas are identified: access (UNI-C to UNI-N), edge-to-edge (the Ethernet connection from UNI-N to UNI-N), and end-to-end (UNI-C to UNI-C). These illustrate an intra-domain and an inter-domain NNI defined in ITU-T Rec. G.8012/Y.1308.

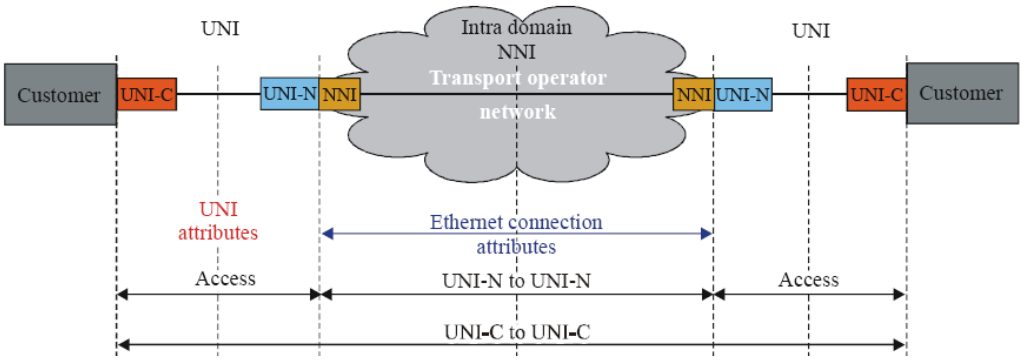


Figure 8: Single provider with NNI view of Ethernet service areas (Figure 6-2/G.8011/Y.1307)

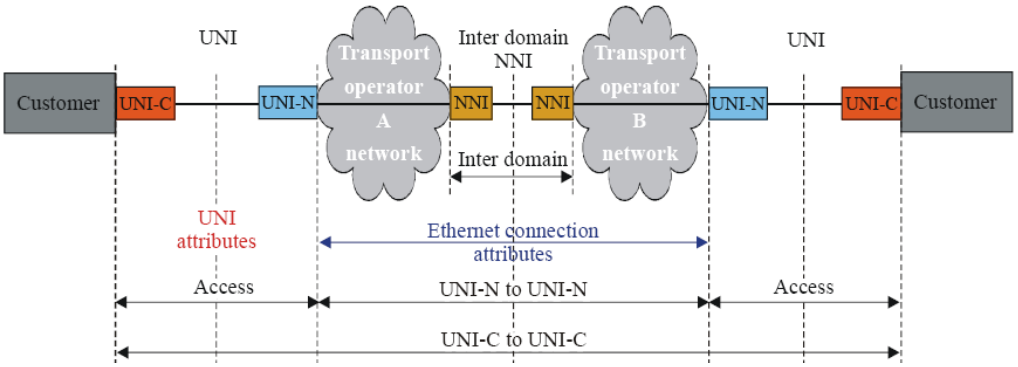


Figure 9: Multi-provider with NNI view of Ethernet service areas (Figure 6-3/G.8011/Y.1307)

4.3 Ethernet connection attributes for the support of Ethernet services for UNI-N to UNI-N, Ethernet UNI-N port attributes and Ethernet NNI port attributes for intra- and inter-carrier handoff have been defined in ITU-T Rec. G.8011/Y.1307. The attributes for the UNI-C port are understudy by the ITU-T. Details on the structures and mappings of the UNI and NNI to specific server layers are specified in ITU-T Rec. G.8012/Y.1308. The equipment functions of these interfaces are defined in ITU-T Rec. G.8021/Y.1341.

4.4 Ethernet services can also be described from the perspective of the customer based on the 'Ethernet Services Model, Phase 1' approved by the Metro Ethernet Forum (MEF) as the MEF 1. From the customer equipment point of view, the protocol operating at the UNI between the customer equipment and the Metro Ethernet Network is a Standard Ethernet protocol (Ethernet PHY and MAC layers). Services considered are limited to services between two or more UNI.

4.5 The MEF defines two generic service types called the Ethernet Line (E-Line) service for point-to-point connections and the Ethernet LAN (E-LAN) service for multipoint connections. Both service types include a set of service attributes with associated parameters. By setting different values for the service attribute parameters, many different Ethernet services can be created. These MEF Ethernet service types can be implemented using the Ethernet services defined in ITU-T Rec. G.8011/Y.1307 (refer to Table 3). The attributes of the MEF and ITU-T service definitions can be mapped to carry an MEF service on an ITU-T service. The mapping for MEF Ethernet virtual connection (EVC) to ITU-T Ethernet Connection (EC) is outlined in Table II.2/G.8011/Y.1307 and the mapping of UNI is outlined in Table II.3/G.8011/Y.1307.

Table 3: Comparison of MEF and ITU-T Ethernet services (Table II.1/G.8011/Y.1307)

MEF	ITU-T Rec. G.8011/Y.1307
E-Line	Point-to-point (line)
	Point-to-multipoint
E-LAN	Multipoint-to-multipoint (LAN)

ANNEX A: CLASSIFICATION OF OPTICAL INTERFACES

Table 1/G.957: Classification of optical interfaces based on application and showing application codes

Application		Intra-office	Inter-office				
			Short-haul		Long-haul		
Source nominal wavelength (nm)		1310	1310	1550	1310	1550	
Type of fibre		Rec. G.652	Rec. G.652	Rec. G.652	Rec. G.652	Rec. G.652 Rec. G.654	Rec. G.653
Distance (km)[a)]		≤ 2	~ 15		~ 40	~ 80	
STM level	STM-1	I-1	S-1.1	S-1.2	L-1.1	L-1.2	L-1.3
	STM-4	I-4	S-4.1	S-4.2	L-4.1	L-4.2	L-4.3
	STM-16	I-16	S-16.1	S-16.2	L-16.1	L-16.2	L-16.3
[a)] These are target distances to be used for classification and not for specification.							

Note: Only applications L-1.1, L-4.1 and L-16.1 are being supported by the SingTel SDH transmission system.

Table 1a/G.691: Classification of optical interfaces based on application and showing I application codes

Applications						
Source nominal wavelength [nm]	1310	1310	1550	1550	1550	1550
Fibre type	G.652	G.652	G.652	G.652	G.653	G.655
Target dist. [km]	0.6	2	2	25	25	25
STM-64	I-64.1r	I-64.1	I-64.2r	I-64.2	I-64.3	I-64.5
Parameters given in	G.693	G.693	G.693	G.959.1	G.959.1	G.959.1
as code	VSR600-2R1	VSR2000-2R1	VSR2000-2L2	P1I1-2D2	P1I1-2D3	P1I1-2D5

Table 1b/G.691: Classification of optical interfaces based on application and showing S and L application codes

Applications							
Source nominal wavelength [nm]	1310	1550	1550	1550	1310	1550	1550
Fibre type	G.652	G.652	G.653	G.655	G.652	G.652	G.653
Target dist. [km]	20	40	40	40	40	80	80
STM-64	S-64.1	S-64.2	S-64.3	S-64.5	L-64.1	L-64.2	L-64.3
Parameters given in	G.959.1	G.959.1	G.959.1	G.959.1	G.959.1	Table 5c	Table 5c
as code	P1S1-2D1	P1S1-2D2	P1S1-2D3	P1S1-2D5	P1L1-2D1		

ANNEX B: PARAMETERS SPECIFIED FOR STM-N OPTICAL INTERFACES

Table 2/G.957: Parameters specified for STM-1 optical interfaces

	Unit	Values											
Digital signal Nominal bit rate	kbit/s	STM-1 according to ITU-T Rec. G.707/Y.1322 155 520											
Application code (Table 1/G.957)		I-1		S-1.1	S-1.2		L-1.1		L-1.2	L-1.3	
Operating wavelength range	nm	1260-1360		1261-1360	1430-1576	1430-1580	1263-1360		1480-1580	1534-1566/1523-1577	1480-1580
Transmitter at reference point S Source type		MLM	LED	MLM	MLM	SLM	MLM	SLM	SLM	MLM	SLM
Spectral characteristics:											
– maximum RMS width (σ)	nm	40	80	7.7	2.5	–	3	–	–	3/2.5	–
– maximum –20 dB width	nm	–	–	–	–	1	–	1	1	–	1
– minimum side mode suppression ratio	dB	–	–	–	–	30	–	30	30	–	30
Mean launched power:											
– maximum	dBm	–8		–8	–8		0		0	0	
– minimum	dBm	–15		–15	–15		–5		–5	–5	
Minimum extinction ratio	dB	8.2		8.2	8.2		10		10	10	
Optical path between S and R Attenuation range	dB	0-7		0-12	0-12		10-28		10-28	10-28	
Maximum dispersion	ps/nm	18	25	96	296	NA	246	NA	NA	246/296	NA
Minimum optical return loss of cable plant at S, including any connectors	dB	NA		NA	NA		NA		20	NA	
Maximum discrete reflectance between S and R	dB	NA		NA	NA		NA		–25	NA	
Receiver at reference point R Minimum sensitivity	dBm	–23		–28	–28		–34		–34	–34	
Minimum overload	dBm	–8		–8	–8		–10		–10	–10	
Maximum optical path penalty	dB	1		1	1		1		1	1	
Maximum reflectance of receiver, measured at R	dB	NA		NA	NA		NA		–25	NA	
Note: Only application L-1.1 together with source type SLM is being supported by the SingTel SDH transmission system. For the parameters definitions, refer to section 6/G.957.											

ANNEX B: PARAMETERS SPECIFIED FOR STM-N OPTICAL INTERFACES (CONTINUED)

Table 3/G.957: Parameters specified for STM-4 optical interfaces

	Unit	Values						
Digital signal Nominal bit rate	kbit/s	STM-4 according to ITU-T Rec. G.707/Y.1322 622 080						
Application code (Table 1/G.957)		I-4	S-4.1	S-4.2	L-4.1		L-4.2	L-4.3
Operating wavelength range	nm	1261-1360	1293-1334/ 1274-1356	1430-1580	1300-1325/ 1296-1330	1280-1335	1480-1580	1480-1580
Transmitter at reference point S Source type		MLM | LED	MLM	SLM	MLM	SLM	SLM	SLM
Spectral characteristics:								
– maximum RMS width (σ)	nm	14.5 | 35	4/2.5	–	2.0/1.7	–	–	–
– maximum –20 dB width	nm	– | –	–	1	–	1	< 1	1
– minimum side mode suppression ratio	dB	– | –	–	30	–	30	30	30
Mean launched power:								
– maximum	dBm	–8	–8	–8	+2		+2	+2
– minimum	dBm	–15	–15	–15	–3		–3	–3
Minimum extinction ratio	dB	8.2	8.2	8.2	10		10	10
Optical path between S and R Attenuation range	dB	0-7	0-12	0-12	10-24		10-24	10-24
Maximum dispersion	ps/nm	13 | 14	46/74	NA	92/109	NA	1600	NA
Minimum optical return loss of cable plant at S, including any connectors	dB	NA	NA	24	20		24	20
Maximum discrete reflectance between S and R	dB	NA	NA	–27	–25		–27	–25
Receiver at reference point R Minimum sensitivity	dBm	–23	–28	–28	–28		–28	–28
Minimum overload	dBm	–8	–8	–8	–8		–8	–8
Maximum optical path penalty	dB	1	1	1	1		1	1
Maximum reflectance of receiver, measured at R	dB	NA	NA	–27	–14		–27	–14
Note: Only application L-4.1 together with source type SLM is being supported by the SingTel SDH transmission system. For the parameters definitions, refer to section 6/G.957.								

ANNEX B: PARAMETERS SPECIFIED FOR STM-N OPTICAL INTERFACES (CONTINUED)

Table 4/G.957: Parameters specified for STM-16 optical interfaces

	Unit	Values					
Digital signal Nominal bit rate	kbit/s	STM-16 according to ITU-T Rec. G.707/Y.1322 2 488 320					
Application code (Table 1/G.957)		I-16	S-16.1	S-16.2	L-16.1	L-16.2	L-16.3
Operating wavelength range	nm	1266-1360	1260-1360	1430-1580	1280-1335	1500-1580	1500-1580
Transmitter at reference point S Source type		MLM	SLM	SLM	SLM	SLM	SLM
Spectral characteristics:							
– maximum RMS width (σ)	nm	4	–	–	–	–	–
– maximum –20 dB width	nm	–	1	< 1	1	< 1	< 1
– minimum side mode – suppression ratio	dB	–	30	30	30	30	30
Mean launched power:							
– maximum	dBm	–3	0	0	+3	+3	+3
– minimum	dBm	–10	–5	–5	–2	–2	–2
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2	8.2	8.2
Optical path between S and R							
Attenuation range	dB	0-7	0-12	0-12	12-24	12-24	12-24
Maximum dispersion at upper wavelength limit	ps/nm	12	NA	800	NA	1600	450
Maximum dispersion at lower wavelength limit	ps/nm	12	NA	420	NA	1200	450
Minimum optical return loss of cable plant at S, including any connectors	dB	24	24	24	24	24	24
Maximum discrete reflectance between S and R	dB	–27	–27	–27	–27	–27	–27
Receiver at reference point R							
Minimum sensitivity	dBm	–18	–18	–18	–27	–28	–27
Minimum overload	dBm	–3	0	0	–9	–9	–9
Maximum optical path penalty	dB	1	1	1	1	2	1
Maximum reflectance of receiver, measured at R	dB	–27	–27	–27	–27	–27	–27
Note: Only application L-16.1 together with source type SLM is being supported by the SingTel SDH transmission system. For the parameters definitions, refer to section 6/G.957.							

ANNEX B: PARAMETERS SPECIFIED FOR STM-N OPTICAL INTERFACES (CONTINUED)

Table 5a/G.691 – Parameters specified for STM-64 optical interfaces

Application code (Table 1a/G.691)	Unit	I-64.1r	I-64.1	I-64.2r	I-64.2	I-64.3	I-64.5
Transmitter at reference point MPI-S		Parameters given in G.693 as code VSR600-2R1	Parameters given in G.693 as code VSR2000-2R1	Parameters given in G.693 as code VSR2000-2L2	Parameters given in G.959.1 as code P1I1-2D2	Parameters given in G.959.1 as code P1I1-2D3	Parameters given in G.959.1 as code P1I1-2D5
Source type							
Operating wavelength range	nm						
Mean launched power							
– maximum	dBm						
– minimum	dBm						
Spectral characteristics							
– maximum RMS width (σ)	nm						
– maximum –20 dB width	nm						
– chirp parameter, α	rad						
– maximum spectral power density	mW/ 10 MHz						
– minimum SMSR	dB						
Minimum EX	dB						
Main optical path, MPI-S to MPI-R							
Attenuation range							
– maximum	dB						
– minimum	dB						
Chromatic dispersion							
– maximum	ps/nm						
– minimum	ps/nm						
Passive dispersion compensation							
– maximum	ps/nm						
– minimum	ps/nm						
Maximum DGD	ps						
Min ORL of cable plant at MPI-S, including any connectors	dB						
Maximum discrete reflectance between MPI-S and MPI-R	dB						
Receiver at reference point MPI-R							
Minimum sensitivity (BER of 1×10^{-12})	dBm						
Minimum overload	dBm						
Maximum optical path penalty	dB						
Maximum reflectance of receiver, measured at MPI-R	dB						

Note: All applications in this Recommendation use single-longitudinal mode (SLM) lasers as sources except the I-64.1r application that uses multi-longitudinal mode (MLM) lasers.

ANNEX B: PARAMETERS SPECIFIED FOR STM-N OPTICAL INTERFACES (CONTINUED)

Table 5b/G.691: Parameters specified for STM-64 optical interfaces

Application code (Table 1b/G.691)	Unit	S-64.1	S-64.2a	S-64.2b	S-64.3a	S-64.3b	S-64.5a	S-64.5b
Transmitter at reference point MPI-S								
Operating wavelength range	nm							
Mean launched power								
– maximum	dBm							
– minimum	dBm							
Spectral characteristics								
– maximum –20 dB width	nm							
– chirp parameter, α	rad							
– maximum spectral power density	mW/ 10 MHz							
– minimum SMSR	dB							
Minimum EX	dB							
Main optical path, MPI-S to MPI-R								
Attenuation range								
– maximum	dB							
– minimum	dB							
Chromatic dispersion								
– maximum	ps/nm							
– minimum	ps/nm							
Passive dispersion compensation								
– maximum	ps/nm							
– minimum	ps/nm							
Maximum DGD	ps							
Min ORL of cable plant at MPI-S, including any connectors	dB							
Maximum discrete reflectance between MPI-S and MPI-R	dB							
Receiver at reference point MPI-R								
Minimum sensitivity (BER of 1×10^{-12})	dBm							
Minimum overload	dBm							
Maximum optical path penalty	dB							
Maximum reflectance of receiver, measured at MPI-R	dB							
		Parameters given in G.959.1 as code P1S1-2D1	Parameters given in G.959.1 as code P1S1-2D2a	Parameters given in G.959.1 as code P1S1-2D2b	Parameters given in G.959.1 as code P1S1-2D3a	Parameters given in G.959.1 as code P1S1-2D3b	Parameters given in G.959.1 as code P1S1-2D5a	Parameters given in G.959.1 as code P1S1-2D5b

Note: S-64.2a, 3a, and 5a have transmitter power levels appropriate for APD receivers; S-64.2b, 3b, and 5b have transmitter power levels appropriate for PIN receivers.

ANNEX B: PARAMETERS SPECIFIED FOR STM-N OPTICAL INTERFACES (CONTINUED)

Table 5c/G.691: Parameters specified for STM-64 optical interfaces

Application code (Table 1b/G.691)	Unit	L-64.1	L-64.2a	L-64.2b	L-64.2c	L-64.3
			(Notes 1, 2)	(Note 1)	(Note 1)	
Transmitter at reference point MPI-S						
Operating wavelength range	nm		1530-1565	1530-1565	1530-1565	1530-1565
Mean launched power						
– maximum	dBm		+2	13	+2	13
– minimum	dBm		–2	10	–2	10
Spectral characteristics						
– maximum –20 dB width	nm		ffs	ffs	ffs	ffs
– chirp parameter, α	rad		ffs	ffs	ffs	ffs
– maximum spectral power density	mW/10 MHz		ffs	ffs	ffs	ffs
– minimum SMSR	dB		ffs	ffs	ffs	ffs
Minimum EX	dB		10	8.2	10	8.2
Main optical path, MPI-S to MPI-R						
Attenuation range						
– maximum	dB		22	22	22	22
– minimum	dB		11	16	11	16
Chromatic dispersion						
– maximum	ps/nm		1600	1600	1600	260
– minimum	ps/nm		ffs	ffs	ffs	NA
Passive dispersion compensation						
– maximum	ps/nm		ffs	NA	NA	NA
– minimum	ps/nm		ffs	NA	NA	NA
Maximum DGD	ps		30	30	30	30
Min ORL of cable plant at MPI-S, including any connectors	dB		24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB		–27	–27	–27	–27
Receiver at reference point MPI-R						
Minimum sensitivity (BER of 1×10^{-12})	dBm		–26	–14	–26	–13
Minimum overload	dBm		–9	–3	–9	–3
Maximum optical path penalty	dB		2	2	2	1
Maximum reflectance of receiver, measured at MPI-R	dB		–27	–27	–27	–27

Parameters given in G.959.1 as code P1L1-2D1

Note 1: L-64.2a uses PDC as DA, L-64.2b uses SPM as DA, and L-64.2c uses prechirp as DA.
Note 2: See section 8.3.2/G.691 on the values and placement of the PDC.

ANNEX C: REFERENCES

For the technical requirements captured in this Specification, reference has been made to the following documents:

ITU-T Rec. G.652 (06/2005)	Characteristics of a single-mode optical fibre and cable
ITU-T Rec. G.653 (2003)	Characteristics of a dispersion-shifted single-mode optical fibre and cable
ITU-T Rec. G.654 (2004)	Characteristics of a cut-off shifted single-mode optical fibre and cable
ITU-T Rec. G.664 (03/2006)	Optical safety procedures and requirements for optical transport systems
ITU-T Rec. G.671 (01/2005)	Transmission characteristics of optical components and subsystems
ITU-T Rec. G.691 (03/2006)	Optical interfaces for single-channel STM-64 and other SDH systems with optical amplifiers
ITU-T Rec. G.704 (1998)	Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels
ITU-T Rec. G.707/Y.1322 (2003)	Network node interface for the synchronous digital hierarchy (SDH)
ITU-T Rec. G.709/Y.1331 (2003)	Interfaces for the optical transport network (OTN)
ITU-T Rec. G.783 (2004)	Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks
ITU-T Rec. G.957 (03/2006)	Optical interfaces for equipment and systems relating to the synchronous digital hierarchy
ITU-T Rec. G.959.1 (03/2006)	Optical transport network physical layer interfaces
ITU-T Rec. G.983.1 (01/2005)	Broadband optical access systems based on Passive Optical Networks (PON)
ITU-T Rec. G.984.1 (03/2003)	Gigabit-capable Passive Optical Networks (GPON): General characteristics
ITU-T Rec. G.984.2 (03/2003)	Gigabit-capable Passive Optical Networks (GPON): Physical Media Dependent (PMD) layer specification
ITU-T Rec. G.984.3 (02/2004)	Gigabit-capable Passive Optical Networks (G-PON)**:** Transmission Convergence layer specification
ITU-T Rec. G.8010/Y.1306 (2004)	Architecture of Ethernet layer networks
ITU-T Rec. G.8011/Y.1307 (2004)	Ethernet over transport – Ethernet services framework
ITU-T Rec. G.8012/Y.1308 (2004)	Ethernet UNI and Ethernet NNI

ITU-T Rec. G.8012/Y.1308 (05/2006)	Ethernet UNI and Ethernet NNI Amendment 1
ITU-T Rec. G.8021/Y.1341 (2004)	Characteristics of Ethernet transport network equipment functional blocks
ITU-T Rec. G.8112/Y.1371 (2006)	Interfaces for the Transport MPLS (T-MPLS) hierarchy
ITU-T Rec. I.363.5 (1996)	B-ISDN ATM Adaptation Layer specification: Type 5 AAL
ITU-T Rec. Y.1415 (2005)	Ethernet-MPLS network interworking – User plane interworking
IEC 60825-1 (2001)	Safety of laser products – Part 1: Equipment classification, requirements and user's guide
IEC 60825-2 (2005)	Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)
IEC 60950-1 (2001)	Information Technology Equipment – Safety
IEC CISPR 22: 2003-04	Information Technology Equipment – Radio disturbance characteristics – Limits and methods of measurement
IEEE 802.1ad-2005	IEEE standard for local and metropolitan area networks – Virtual Bridged Local Area Networks – Amendment 4: Provider Bridges
IEEE 802.17-2004	IEEE standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 17: Resilient packet ring (RPR) access method and physical layer specifications
IEEE Std 802.3 – 2005	IEEE Standard for Information Technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
IETF RFC 2684 (1999)	Multiprotocol Encapsulation over ATM Adaptation Layer 5
MEF 1	Ethernet Services Model – Phase 1, 2003

ANNEX D: ADDENDUM/CORRIGENDUM

Replacement of IDA RS SDH 1, RS SDH 2 and RS SDH 3 Issue 2			
Page	**RS Ref.**	**Items Changed**	**Effective Date**
–	–	The Reference Specification for Optical Interfaces (IDA RS OPTIC) is a replacement of the 3 reference specifications for SDH (IDA RS SDH 1, RS SDH 2 and RS SDH 3). This Reference Specification identifies the optical interface requirements common to access networks and intra/inter-office transmission networks that are using the Passive Optical Network (PON) and the Synchronous Digital Hierarchy (SDH) technology respectively. It also identifies the optical interface requirements for the Ethernet transport networks.	2 Jan 07