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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Transmission media and optical systems characteristics –
Characteristics of optical systems

Longitudinally compatible intra-domain DWDM applications

Recommendation ITU-T G.696.1



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Recommendation ITU-T G.696.1

Longitudinally compatible intra-domain DWDM applications

Summary

Recommendation ITU-T G.696.1 provides physical layer specifications for intra-domain (IaD) DWDM optical networking applications. Longitudinally compatible applications inside a single administrative domain are described for point-to-point, multichannel line systems with or without line amplifiers. The application codes in this Recommendation provide a set of categories for DWDM transmission systems and fibre links. The primary purpose is to enable multiple vendors to design DWDM transmission equipment for fibre links that are compliant with this Recommendation.

In this version of this Recommendation, the following topics have been added with respect to the version from 07/2005:

- Client class 100G;
- Additional text for clause 8 "Optical safety considerations";
- Comprehensive revision of Appendix I including new clauses I.2.6, I.3.6, I.3.7, I.4, I.5 and additional text for some clauses.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.696.1	2005-07-14	15
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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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Recommendation ITU-T G.696.1

Longitudinally compatible intra-domain DWDM applications

1 Scope

This Recommendation provides physical layer specifications for intra-domain (IaD) DWDM optical networking applications. These specifications are provided for point-to-point, multichannel line systems with or without line amplifiers. The goal is to enable longitudinally compatible applications inside an administrative domain. The primary purpose is to enable multiple vendors to provide transmission equipment for fibre links that are compliant with this Recommendation.

In order to provide a framework for IaD application specifications, this Recommendation includes a generic reference model for the physical layer applications. The specifications are organized according to application codes, which take into account parameters such as operating wavelength ranges of the optical amplifiers, combinations of channel counts, client classes, span distances, fibre types and system configurations.

This initial Recommendation focuses on IaD applications without intervening optical switching elements. It is expected that future versions and/or other new Recommendations may address more complex physical layer configurations and/or support a higher level of compatibility. For these applications, different parameters beyond those specified for a point-to-point configuration may be required.

This Recommendation presumes that the optical tributary signals transported within optical channels are digital rather than analogue. Specifications for systems enabling transport of analogue optical tributary signals are for further study.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.650.2] Recommendation ITU-T G.650.2 (2007), *Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable.*
- [ITU-T G.652] Recommendation ITU-T G.652 (2009), *Characteristics of a single-mode optical fibre and cable.*
- [ITU-T G.653] Recommendation ITU-T G.653 (2006), *Characteristics of a dispersion-shifted single-mode optical fibre and cable.*
- [ITU-T G.654] Recommendation ITU-T G.654 (2006), *Characteristics of a cut-off shifted single-mode optical fibre and cable.*
- [ITU-T G.655] Recommendation ITU-T G.655 (2009), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable.*
- [ITU-T G.663] Recommendation ITU-T G.663 (2000), *Application related aspects of optical amplifier devices and subsystems* plus Amendment 1 (2003), *Amendments to Appendix II.*

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- [ITU-T G.664] Recommendation ITU-T G.664 (2006), *Optical safety procedures and requirements for optical transport systems*.
- [ITU-T G.665] Recommendation ITU-T G.665 (2005), *Generic characteristics of Raman amplifiers and Raman amplified subsystems*.
- [ITU-T G.691] Recommendation ITU-T G.691 (2006), *Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers*.
- [ITU-T G.707] Recommendation ITU-T G.707/Y.1322 (2007), *Network node interface for the synchronous digital hierarchy (SDH)*.
- [ITU-T G.709] Recommendation ITU-T G.709/Y.1331 (2009), *Interfaces for the Optical Transport Network (OTN)*.
- [ITU-T G.870] Recommendation ITU-T G.870/Y.1352 (2010), *Terms and definitions for optical transport networks (OTN)*.
- [ITU-T G.872] Recommendation ITU-T G.872 (2001), *Architecture of optical transport networks* plus Amendment 1 (2003) and Corrigendum 1 (2005).
- [ITU-T G.957] Recommendation ITU-T G.957 (2006), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*.
- [ITU-T G.959.1] Recommendation ITU-T G.959.1 (2009), *Optical transport network physical layer interfaces*.
- [IEC 60825-1] IEC 60825-1 (2007), *Safety of laser products – Part 1: Equipment classification and requirements*.
- [IEC 60825-2] IEC 60825-2 (2007), *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined in [ITU-T G.872]:

3.1.1 intra-domain interface (IaDI);

3.1.2 3R regeneration.

This Recommendation uses the following term defined in [ITU-T G.870]:

3.1.3 optical channel data unit (ODUk).

This Recommendation uses the following term defined in [ITU-T G.959.1]:

3.1.4 optical tributary signal.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 client class: The client class refers to a class of bit rates of the client signal of a single optical tributary signal that is placed within an optical channel for transport across the optical network. In the context of this Recommendation, the client bit rate is the bit rate of a continuous digital signal before any additional FEC bytes have been added. In the case of a signal in accordance with [ITU-T G.707], this would be the rate of the ODUk.

3.2.2 client class 1.25G: Applies to a continuous digital signal with a client bit rate from nominally 622 Mbit/s to nominally 1.25 Gbit/s. The client class 1.25G includes a signal with STM-4 bit rate according to [ITU-T G.707].

3.2.3 client class 2.5G: Applies to a continuous digital signal with a client bit rate from nominally 622 Mbit/s to nominally 2.5 Gbit/s. The client class 2.5G includes a signal with STM-16 bit rate according to [ITU-T G.707] and ODU1 bit rate according to [ITU-T G.709].

3.2.4 client class 10G: Applies to a continuous digital signal with a client bit rate from nominally 2.4 Gbit/s to nominally 10.5 Gbit/s. The client class 10G includes a signal with STM-64 bit rate according to [ITU-T G.707] and ODU2 bit rate according to [ITU-T G.709].

3.2.5 client class 40G: Applies to a continuous digital signal with a client bit rate from nominally 9.9 Gbit/s to nominally 42 Gbit/s. The client class 40G includes a signal with STM-256 bit rate according to [ITU-T G.707] and ODU3 bit rate according to [ITU-T G.709].

3.2.6 client class 100G: Applies to a continuous digital signal with a client bit rate from nominally 39 Gbit/s to nominally 105 Gbit/s. The client class 100G includes a signal with ODU4 bit rate according to [ITU-T G.709].

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

3R	(Regeneration) Re-amplification, Reshaping and Retiming
APR	Automatic Power Reduction
ASE	Amplified Spontaneous Emission
ASK	Amplitude Shift Keying
BER	Bit Error Ratio
DCM	Dispersion Compensation Module
DEMUX	Demultiplexer
DGD	Differential Group Delay
DP	Dual Polarization
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
DRA	Distributed Raman Amplification
DWDM	Dense WDM
EDFA	Erbium Doped Fibre Amplifier
FEC	Forward Error Correction
FWM	Four-Wave Mixing
IaD	Intra-Domain
IaDI	Intra-Domain Interface
MPI	Main Path Interface
MUX	Multiplexer
NCG	Net Coding Gain
NRZ	Non-Return to Zero
OA	Optical Amplifier
ODB	Optical Duobinary