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ITU-T G.871/Y.1301

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TELECOMMUNICATION
STANDARDIZATION SECTOR
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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital networks – Optical transport networks

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Transport

Framework for optical transport network Recommendations

ITU-T Recommendation G.871/Y.1301

(Formerly CCITT Recommendation)

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TESTING EQUIPMENTS	G.500–G.599
TRANSMISSION MEDIA CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
General aspects	G.800–G.809
Design objectives for digital networks	G.810–G.819
Quality and availability targets	G.820–G.829
Network capabilities and functions	G.830–G.839
SDH network characteristics	G.840–G.849
Management of transport network	G.850–G.859
SDH radio and satellite systems integration	G.860–G.869
Optical transport networks	**G.870–G.879**
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	**Y.1300–Y.1399**
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.871/Y.1301

Framework for optical transport network Recommendations

Summary

This Recommendation concerns the Optical Transport Network (OTN) and gives an overview of the ITU-T Recommendations on the different aspects of OTNs. It provides a framework for their development, indicating the rationale followed in their preparation together with the linkages among them. The time-frame for the development of these Recommendations is also provided.

Source

ITU-T Recommendation G.871/Y.1301 was prepared by ITU-T Study Group 15 (1997-2000) and approved by the World Telecommunication Standardization Assembly (Montreal, 27 September – 6 October, 2000).

Keywords

IP over OTN, IP over WDM, Optical Networking, Optical Transport Network, OTN.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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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, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

		Page
1	Scope	1
2	References	1
3	Terms and definitions	2
3.1	Optical Transport Network	2
3.2	Optical Network Element	2
4	Abbreviations	3
5	Work plan for OTN Recommendations	3
5.1	OTN architectural aspects	5
5.2	OTN structures and mapping	5
5.3	OTN equipment functional characteristics	5
5.4	OTN management aspects	5
5.5	OTN physical layer aspects	5
5.6	Relationship among the OTN Recommendations	6
Annex A – Time-frame for the OTN Recommendations development		6
Annex B – Perspectives on the optical transport of IP		7

ITU-T Recommendation G.871/Y.1301

Framework for optical transport network Recommendations

1 Scope

The purpose of this Recommendation is to provide a framework for coordination among the various activities in ITU-T on Optical Transport Network (OTN), in order to ensure that Recommendations covering the various aspects of OTN be developed in a consistent and exhaustive way. As such, this Recommendation provides references for definitions of high-level characteristics of OTN, along with a description of the relevant ITU-T Recommendations, together with the time-frame for their development (which are either already prepared, or under development). Note that the development of many of these Recommendations will be phased to address the pace of technology.

It is also the purpose of this Recommendation to provide guidance to the reader of OTN Recommendations, indicating the linkages among them and the rationale followed in their preparation.

NOTE – Initially, the OTN Recommendations described will consider only digital client signals.

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.

[1] ITU-T G.661 (1998), *Definition and test methods for the relevant generic parameters of optical amplifier devices and subsystems*.

[2] ITU-T G.662 (1998), *Generic characteristics of optical amplifier devices and subsystems*.

[3] ITU-T G.663 (2000), *Application related aspects of optical amplifier devices and subsystems*.

[4] ITU-T G.664 (1999), *Optical safety procedures and requirements for optical transport systems*.

[5] ITU-T G.671 (2001), *Transmission characteristics of optical components and subsystems*.

[6] ITU-T G.691 (2000), *Optical interfaces for single-channel STM-64, STM-256 and other SDH with optical amplifiers*.

[7] ITU-T G.692 (1998), *Optical interfaces for multichannel systems with optical amplifiers*.

[8] ITU-T G.805 (2000), *Generic functional architecture of transport networks*.

[9] ITU-T G.872 (1999), *Architecture of optical transport networks*.

3 Terms and definitions

The relevant specific terms used in the OTN Recommendations listed in clause 2 are defined therein. For terms concerning general characteristics of OTN the definitions given below apply.

3.1 Optical Transport Network

An Optical Transport Network (OTN) is composed of a set of Optical Network Elements connected by optical fibre links, able to provide functionality of transport, multiplexing, routing, management, supervision and survivability of optical channels carrying client signals, according to the requirements given in ITU-T G.872 [9].

A distinguishing characteristic of the OTN is its provision of transport for any digital signal independent of client-specific aspects, i.e. client independence. As such, according to the general functional modelling described in ITU-T G.805 [8], the OTN boundary is placed across the Optical Channel/Client adaptation, in a way to include the server specific processes and leaving out the client specific processes, as shown in Figure 1.

NOTE – The client specific processes related to Optical Channel/Client adaptation are described within ITU-T G.709.

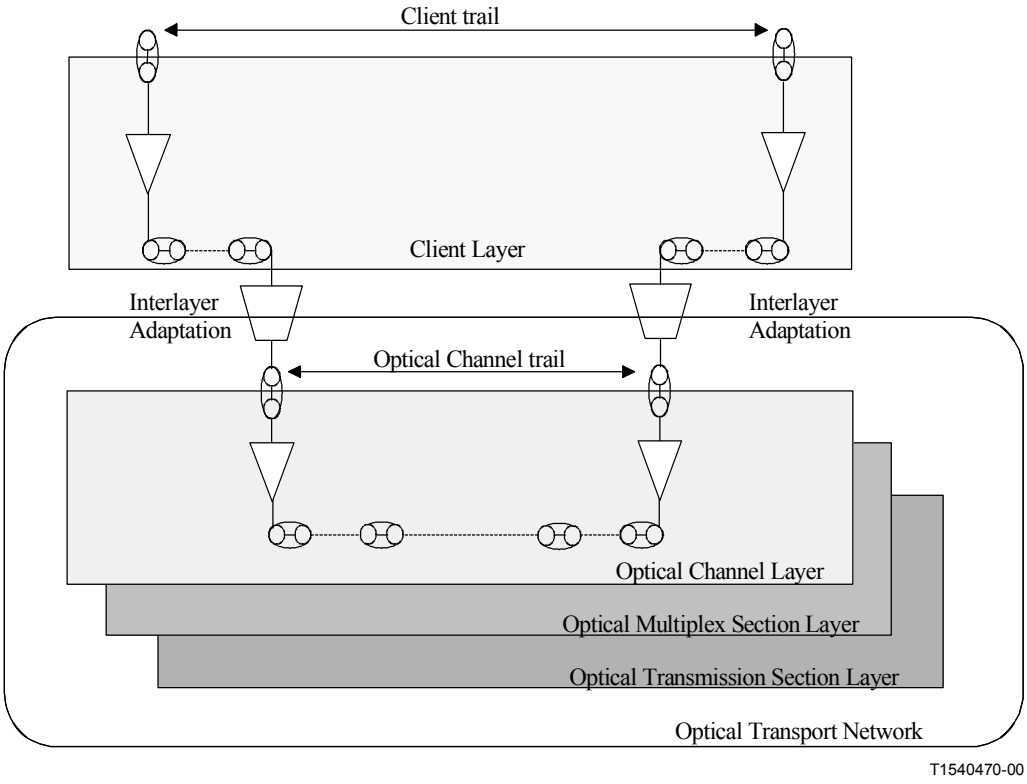

Figure 1/G.871/Y.1301 – Boundary of an optical transport network and client-server relationship

3.2 Optical Network Element

The Optical Network Element (ONE) is that part of a network element that contains transport processing functions from one or more OTN layer networks, as architectural components which process information between its inputs and outputs. An ONE may therefore be a stand-alone physical entity or a subset of a network element.

4 Abbreviations

This Recommendation uses the following abbreviations:

ATM Asynchronous Transfer Mode

IP Internet Protocol

OAM Operation, Administration and Maintenance

OCh Optical Channel

ONE Optical Network Element

OTN Optical Transport Network

PDH Plesiochronous Digital Hierarchy

SDH Synchronous Digital Hierarchy

TDM Time Division Multiplexing

WDM Wavelength Division Multiplexing

5 Work plan for OTN Recommendations

The harmonized development of the Optical Transport Network with full optical networking functionality require the study of a number of subjects pertaining to the different aspects of OTN. These subjects include:

- OTN architectural aspects:
  - network layering and functionality;
  - network capacity, scalability and service transparency;
  - network topologies and survivability architectures;
  - switching optical networking architecture;
  - considerations for optimized IP optical networking.
- OTN structures and mapping:
  - network node interface regarding structure, overhead, and client signal mappings (e.g. IP, SDH, ATM, Ethernet);
  - features to support an automatically switched optical network.
- OTN equipment functional characteristics:
  - optical equipment functions for each layer, including connection, termination, adaptation of various clients (e.g. IP, SDH, ATM, Ethernet);
  - supervision including defects, consequent actions, information flows, generic processes;
  - survivability functions and characteristics, including multilayer survivability considerations;
  - impact on synchronization functions.
- OTN management aspects:
  - connection, configuration, including wavelength administration, fault performance management;
  - management requirements and information models to support the interworking of OTN equipment and systems with those of other technologies (e.g. IP, SDH, ATM, Ethernet).

- OTN physical layer characteristics:
  - specifications for longitudinally and transversely compatible optical systems;
  - optical frequency plan, including optical supervisory channel and wavelength range;
  - optical aspects, such as power level management;
  - application code structures;
  - OTNs utilizing soliton-type transmission;
  - OTN optical components and subsystems.
- OTN general aspects:
  - definition of general terms of OTN;
  - collection of data and definition of objectives for reliability/availability of an OTN.

In order to coordinate the study of these various OTN subjects in ITU-T, such that to ensure that they are developed in a consistent and exhaustive way, a work plan has been agreed. This work plan involves the development of a series of Recommendations covering the various aspects of OTN in a manner analogous to that established for other networks, as summarized in Table 1.

Table 1/G.871/Y.1301 – ITU-T Recommendations (existing and proposed) on the various aspects of PDH, SDH, ATM and OTN

Topic	PDH	SDH	ATM	OTN
Architectural aspects		G.803, G.805 [8]	G.805 [8], I.326	G.872 [9], **G.873, G.ason**
Structures and mapping	G.704, G.73x, G.74x, G.75x, G.804	G.707, G.832	I.361, I.362, I.363, I.610	**G.709**
Equipment functional characteristics	G.706, G.73x, G.74x, G.75x	G.783, G.784, G.813, G.841, G.842	I.731, I.732	**G.798**
Management aspects		G.774-x, G.784, G.831	I.751	**G.874, G.875**
Physical layer characteristics	G.703	G.664 [4], G.691 [6], G.692 [7], G.703, G.957	G.703, G.957, I.432	G.664 [4], **G.959.1, G.dsn**
Components and subsystems	G.661 [1], G.662 [2], G.663 [3], G.671 [5]	G.661 [1], G.662 [2], G.663 [3], G.671 [5]		G.661 [1], G.662 [2], G.663 [3], G.671 [5]
Error performance	G.821, G.822, G.823, G.824, G.826	G.825, G.826, G.958, G.827, G.828, G.829	I.356, I.357	**G.optperf**
Bringing-into-service, maintenance, test	M.2100, O.151, O.171, O.172	M.2101, M.2102, O.181, O.172	M.2201, M.2210, M.2220, O.191	
Framework for Recommendations				**G.871**
NOTE – Entries in bold face type indicate the new OTN Recommendations.				

Furthermore, it is expected that existing Recommendations may be augmented, or new Recommendations defined, to address issues associated with the reliability and availability of OTN systems, and possible interface aspects pertinent to the inclusion of access and submarine systems in OTNs.

5.1 OTN architectural aspects

Specification of network architectural aspects are provided by two Recommendations. A Recommendation on OTN architecture, ITU-T G.872 [9] describes the optical transport network layered structure, characteristic information, client/server layer associations, networking topology, and layer network functionality, including optical signal transmission, multiplexing, routing, supervision, performance assessment, and network survivability. The other Recommendation, ITU-T **G.873**, on OTN requirements will address definition of OTN applications, including interconnection with other networks.

In addition, recognizing the need for network requirements for the Automatic Switched Optical Network (fast set-up and automatic switching of OCh connections), work on a new Recommendation, provisionally named **G.ason**, has been initiated.

Regarding the aspect of OTN error performance, a new Recommendation, provisionally named **G.optperf**, will be subsequently developed to address error and availability aspects of OTN, defining the proper parameters and objectives.

5.2 OTN structures and mapping

Based on the OTN architecture defined in ITU-T G.872 [9], a structure and mappings Recommendation, ITU-T G.709 describes the Network Node Interface necessary to enable the interconnection of ONEs for the transport of different types of client signals in the OTN. This Recommendation therefore defines the optical transport modules, their structures, the functionality of the overheads and the formats for mapping and multiplexing client signals.

5.3 OTN equipment functional characteristics

With ITU-T G.872 [9] and ITU-T G.709 serving as a foundation, ITU-T **G.798** will describe the functional characteristics of equipment containing optical transport network layers. This Recommendation will be based on the functional modelling method defined in general in ITU-T G.805 [8], but taking into account the architecture of OTN as given in ITU-T G.872 [9].

5.4 OTN management aspects

Complementing ITU-T G.798, management information models for network elements of the OTN will be described in ITU-T **G.875**, addressing information models for ONEs.

In addition, ITU-T **G.874**, will capture management aspects of ONEs, specifying management function for fault management, configuration management and performance monitoring, regardless of the client.

5.5 OTN physical layer aspects

As far as OTN physical layer aspects are concerned, ITU-T **G.959.1** provides optical interface specifications for inter-domain interfaces and further discusses a framework for OTN physical interfaces, based on the architectural aspects outlined in ITU-T G.872 [9].

Additionally a new Recommendation, provisionally named **G.dsn**, has been initiated describing design and engineering considerations for unamplified and amplified single-channel and multichannel digital optical line systems supporting PDH, SDH and OTN signals in intra-office, inter-office and long-haul terrestrial networks.

In this context, transmission aspects related to components and subsystems for optical transport network equipment are included in ITU-T G.671 [5], while optical safety procedures and requirements are described in ITU-T G.664 [4].

5.6 Relationship among the OTN Recommendations

The relationships among the core OTN Recommendations, outlined in the previous clauses, are summarized in Figure 2.

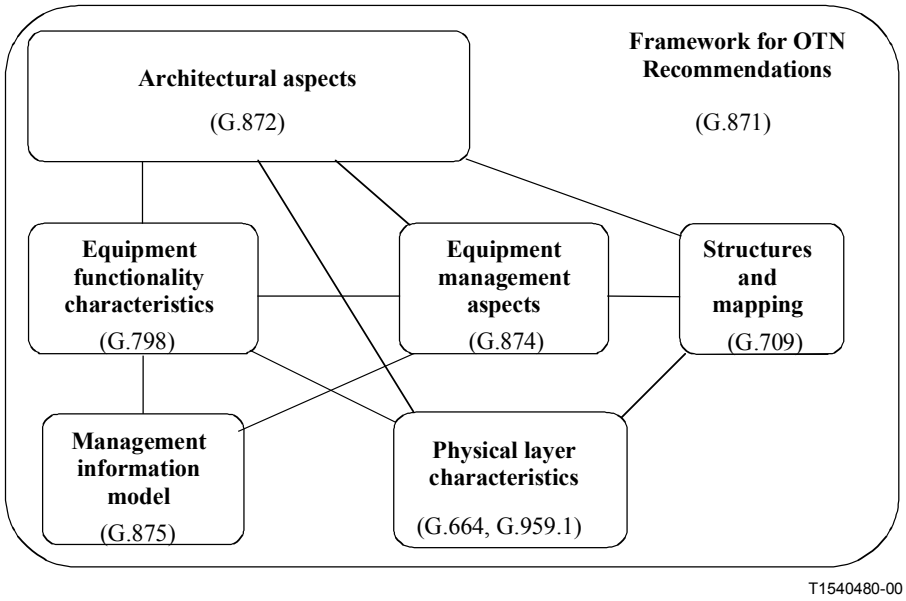

Figure 2/G.871/Y.1301 – Relationship among the core OTN Recommendations

ANNEX A

Time-frame for the OTN Recommendations development

The time-frame agreed for the development of OTN Recommendations is captured in the present annex. It is to be noted that each of the Recommendations for OTN described in clause 5 can be developed using a phased approach, depending upon the maturity of the involved technologies at the time, as well as on the application requirements of the market, as follows:

phase 1: with emphasis on point-to-point line systems;

phase 2: extension to add/drop multiplexing and cross-connection systems; and

phase 3: further extension to optical layer survivability, etc.

It should be recognized that the development of these Recommendations depends on the full scope of study for OTN in Study Groups 13 and 15. In particular, it may be necessary to consider some aspects of the requirements for later phases in developing the earlier ones to assure a smooth evolution path. Figure A.1 shows an expected time-frame for approval of the new OTN Recommendations. In Figure A.1, "phase 1+" indicates that some aspects of phases 2 and 3 may also be captured in the first issue of a document. Note that ITU-T G.871, ITU-T **G.872** [9] and ITU-T **G.959.1** are not subject to this phased approach.

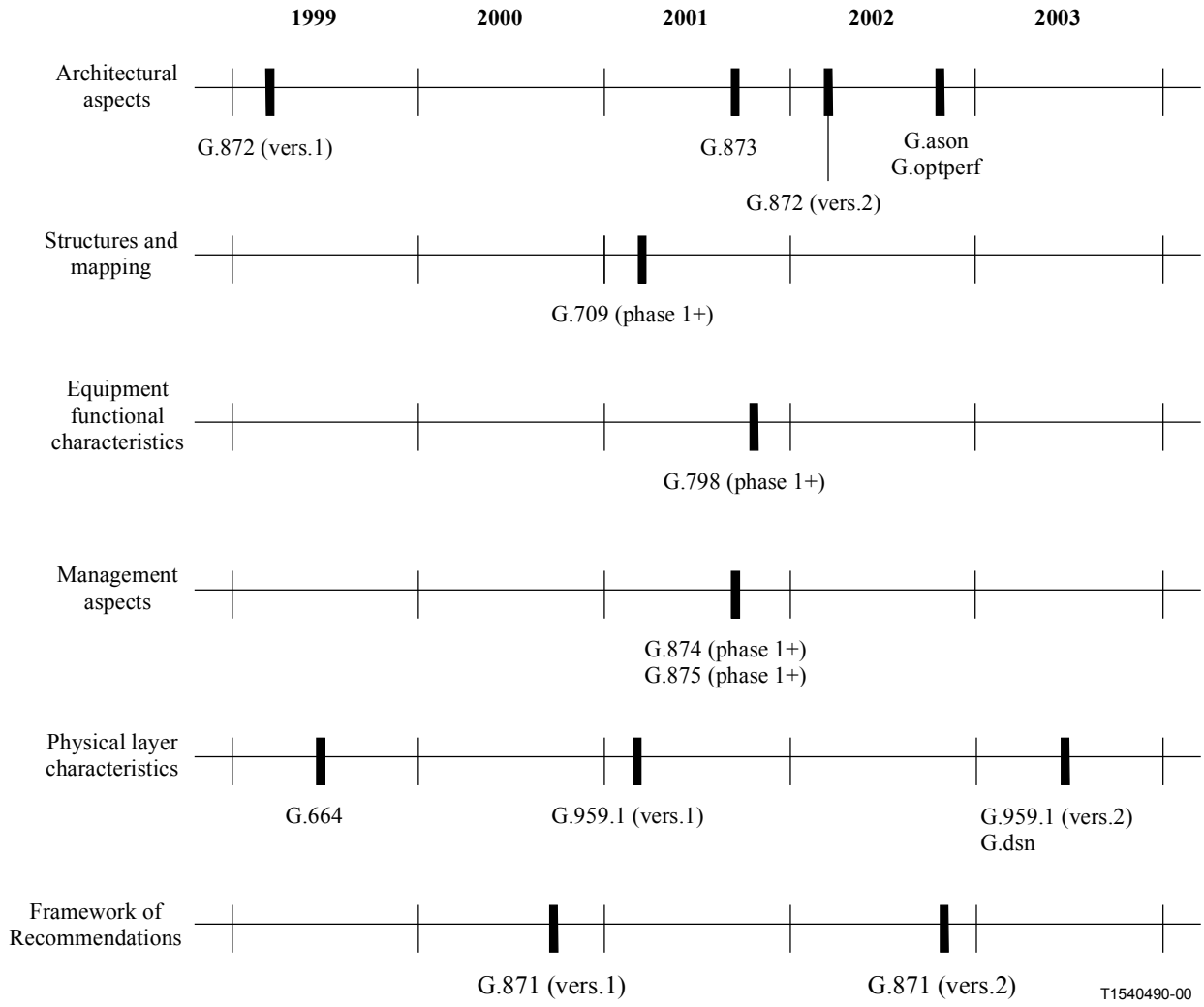

Figure A.1/G.871/Y.1301 – Expected time-frame for approval of the new OTN Recommendations

ANNEX B

Perspectives on the optical transport of IP

One particular promising application of optical networking concerns the possibility to transport IP packets over the OTN (including WDM), namely the so-called "IP over WDM". In this context it is to be stressed that:

– during the last few years an explosion in demand for data traffic has occurred in some countries;

– IP is now considered a common layer 3 protocol for data transport (thus requiring OSI layers 1 and 2 mechanisms);

– data networking equipment (router and switches) are now available with high speed interfaces (bit rates of 2.5 Gbit/s are already available and bit rates of 10 Gbit/s are foreseen in the near future);

– WDM systems allow an efficient use of optical fibres, providing the transport of several high bit rate channels for each fibre pair.

As a consequence, some operators are now interested in considering networks optimized for the transport of IP traffic, where IP routers are directly connected to an OTN in order to reduce the number and type of equipment terminals in the network and therefore the complexity in terms of management.

At present, the transport of IP traffic is generally based on the use of frame relay and/or ATM, typically mapped on SDH signals. In order to improve the efficiency in the use of transmission capacity, recently a direct mapping of IP over SDH is being developed, and now the possible solution of "IP over WDM" has been proposed, via the definition of an adaptation into the OCh that includes an encapsulation mechanism.

Once it is possible to provide such "direct" adaptation, OTN transport of packetized services may be leveraged to support packet-optimized solutions. The impact of possible optical packet transmission is in an area requiring future consideration.

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