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| INTERNATIONAL TELECOMMUNICATION UNION | | **STUDY GROUP 15** |
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This TD includes the draft of Revised Optical Transport Networks & Technologies Standardization Work Plan, Issue 15.

**Optical Transport Networks & Technologies Standardization Work Plan**

**Issue 15, December 2011**

# 1. General

Optical and other Transport Networks & Technologies Standardization Work Plan is a living document. It may be updated even between meetings. The latest version can be found at the following URL.

<http://www.itu.int/ITU-T/studygroups/com15/otn/>

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# 2. Introduction

Today's global communications world has many different definitions for Optical and other Transport networks and many different technologies that support them. This has resulted in a number of different Study Groups within the ITU-T, e.g. SG 11, 12, 13, and 15 developing Recommendations related to Optical and other Transport. Moreover, other standards development organizations (SDOs), forums and consortia are also active in this area.

Recognising that without a strong coordination effort there is the danger of duplication of work as well as the development of incompatible and non-interoperable standards, WTSA-08 designated Study Group 15 as Lead Study Group on Optical and other Transport Networks and Technology, with the mandate to:

* study the appropriate core Questions (Question 6, 7, 9, 10, 11, 12, 13, 14 and 15/15),
* define and maintain overall (standards) framework, in collaboration with other SGs and SDOs),
* coordinate, assign and prioritise the studies done by the Study Groups (recognising their mandates) to ensure the development of consistent, complete and timely Recommendations,

Study Group 15 entrusted WP 3/15, under Question 3/15, with the task to manage and carry out the Lead Study Group activities on Optical and other Transport Networks and Technology. To maintain differentiation from the standardized Optical Transport Network (OTN) based on Recommendation G.872, this Lead Study Group Activity is titled Optical and other Transport Networks & Technologies (OTNT).

# 3. Scope

As the mandate of this Lead Study Group role implies, the standards area covered relates to Optical and other Transport networks and technologies. The Optical and other Transport functions include:

* client adaptation functions
* multiplexing functions
* cross connect and switching functions, including grooming and configuration
* management and control functions
* physical media functions
* network synchronization and distribution functions
* test and measurement functions.

The outcome of the Lead Study Group activities is twofold, consisting of a:

* standardization plan
* work plan,

written as this single document until such time as the distinct pieces warrant splitting it into two.

Apart from taking the Lead Study Group role within the ITU-T, Study Group 15 will also endeavour to cooperate with other relevant organizations, including ATIS, ETSI, , ISO/IEC, IETF, IEEE, MEF, OIF and TIA, etc.

# 4. Abbreviations

|  |  |
| --- | --- |
| ANSI  ASON | American National Standards Institute  Automatically Switched Optical Network |
| ATIS | Alliance for Telecommunications Industry Solutions |
| EoT | Ethernet frames over Transport |
| ETSI | European Telecommunications Standards Institute |
| IEC  IEEE  IETF | International Electrotechnical Commission  Institute of Electrical and Electronics Engineers  Internet Engineering Task Force |
| ISO  MEF | International Organization for Standardization  Metro Ethernet Forum |
| MON  MPLS  MPLS-TP  OIF | Metropolitan Optical Network  Multiprotocol Label Switching  MPLS Transport Profile  Optical Internetworking Forum |
| OTN | Optical Transport Network |
| OTNT | Optical and other Transport Networks & Technologies |
| SDH | Synchronous Digital Hierarchy |
| SONET  TIA  TMF  T-MPLS | Synchronous Optical NETwork  Telecommunications Industry Association  TeleManagement Forum  Transport MPLS |
| WSON | Wavelength Switched Optical Network |
| WTSA | World Telecommunications Standardization Assembly |

# 5. Definitions & Descriptions

One of the most complicated factors in coordinating work among multiple organizations in the area of OTNT is differing terminology. Often multiple different groups are utilising the same terms with different definitions. This section briefly explain the progress and planning of the standardization in each technologies including definitions relevant to this document. See Annex A for more information on how common terms are used in different organizations.

## 5.1 Optical and other Transport Networks & Technologies (OTNT)

The transmission of information over optical media in a systematic manner is an optical transport network. The optical transport network consists of the networking capabilities and the technologies required to support them. For the purposes of this standardization and work plan, all new optical transport networking functionality and the related other transport technologies will be considered as part of the OTNT Standardization Work Plan. The focus will be the transport and networking of digital client payloads and optical channel over fiber optic cables. Though established optical transport mechanisms such as Synchronous Digital Hierarchy (SDH) , Optical Transport Network (OTN), Ethernet frames over Transport(EoT), Automatically Switched Optical Network(ASON), NW synchronization may fall within this broad definition, only standardization efforts relating to new networking functionality of OTN extension(e.g. all optical network(AON) and above 100G), EoT extension(PBB modelling), MPLS-TP and packet-based timing/time distribution will be actively considered as part of this Lead Study Group activity.

## 5.2 Optical Transport Network (OTN)

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 Recommendation G.872.

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 Recommendation G.805, 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 5-1.

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



**FIGURE 5-1/OTNT: Boundary Of An Optical Transport Network And Client-Server Relationship**

There is two separate aspects in optical transport network (OTN) evolution. One describes the “digital” aspects of the optical channel data unit (ODU) and the other describes the wavelength division multiplexing (WDM) and media aspects.

“Digital aspects” will reflect revisions of the G.709 optical transport hierarchy. With the widespread of Ethernet, new ODU was specified such as ODU0, ODU2e and ODU4 for GbE, 10GbE and 100GbE transport, respectively. In addition to the new ODUs for Ethernet transport, ODU with flexible bit rate, ODUflex, was also specified for the client signals with any bit rate. Any CBR client signals can be mapped into ODUflex. Recently, a new Recommendation G.7044 was standardized, which specify a mechanism of hitless adjustment of ODUflex(GFP) (HAO) that is used to hitlessly increase or decrease the bandwidth of an ODUflex(GFP) in an OTN network.

On the other hand, “optical aspect including WDM and media” are being discussed. One major effort was the architectural description of “media networks” and the other is all optical network (AON) which is related to wavelength switched optical network (WSON) in IETF.

Two separate draft recommendations had been developed recently, that is, a digital part (new G.872) and a optical part(G.aon). However, as a result of discussion, it was decided to combine G.aon and G.872 by revising G.872.

In AON, a number of extensions are discussed. One of them is a flexible DWDM grid. One of the motivations for the flexible grid is to allow a mixed bit rate or mixed modulation format transmission system to allocate frequency slots with different widths. As a result, they can be optimized for the bandwidth requirements of the particular bit rate and modulation scheme of the individual channels. Another topic is OTN extensions for black link which is specified in G.698.2. The objective of the black link is to allow the optical transmitter (attached to the S reference point) the optical link and the optical receiver (attached to the R reference point) to be provided by different vendors. In addition, the discussion of above 100G has been started recently.

## 5.3 Metropolitan Optical Network (MON)

A metropolitan optical network is a network subset, often without significant differentiation or boundaries. Therefore an explicit definition is under study. As a result, this section offers more of a description than a formal definition for those who wish to better understand what is commonly meant by “metropolitan optical networks.”

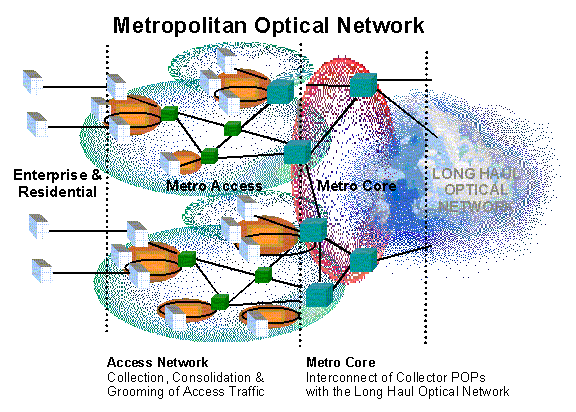
While the existence of metropolitan networks is longstanding, the need for identification of these networks as distinct from the long haul networks in general, as well as the enterprise and access networks is recent. The bandwidth requirements from the end customers have been increasing substantially and many are implementing high bandwidth optical access connections. The resulting congestion and complexity has created a growing demand for higher bandwidth interfaces for inter office solutions. This aggregation of end customer traffic comprises a Metropolitan Optical Network (MON). MONs now have the technology to be optical based and thus, in theory, use the same technology over the fibres as other portions of the network. However, this is not always the case as there are various market forces that drive which technologies will be deployed in which part of the network. As a result, it is appropriate to describe the MON in a way that is agnostic to the various technology approaches. In spite of the many similarities, there are several distinctions between metropolitan and long haul optical networks (LHONs) that result from the aggregation of traffic from enterprise to metro to long haul networks as shown in Figure 5-2.

* The first distinction is that MONs are inherently designed for short to medium length distances in metropolitan areas. That is, typically, within the limits of a single optical span and often less than 200km distance. As a result, topics such as signal regeneration, in-line amplification and error correction are of lesser importance than in LHONs.
* Secondly, the driving requirement for MONs is maximized coverage commensurate with low cost connectivity (as opposed to grooming for performance with LHONs). As a result, for example, standardization focuses on the adaptation of local area network technologies to be effectively managed by service providers, on ‘insertion loss’ amplification to recover from all the connection points, and on ring deployment to leverage existing fibre plant.
* Another key difference is that of service velocity. The demand for fast provisioning results in the circuit churn rate being generally higher in MONs than LHON. That combined with the wider variety of client signals is a key driver for flexible aggregation (e.g., 100Mb-1Gb rate, all 8B/10B formats with one card).
* A final distinction is that in the MON there are service requirements (e.g., bandwidth-on-demand services, and multiple classes-of-services) that lead to further topology and technical considerations that are not a priority for LHONs.

While there are many combinations of technologies that can be used in MONs, the following are common examples:

* SONET/SDH
* DWDM, CWDM
* Optical Ethernet
* Resilient Packet Ring
* A-PON, B-PON, G-PON, and E-PON

As a result of the importance of MONs, SG15 has redefined several of its Questions work programs to specifically include metro characteristics of optical networks.



**FIGURE 5-2/OTNT: Possible Relationship of MON and LHON**

## 5.4 Ethernet Frames over Transport

Ethernet is today the dominant LAN technology in the private and enterprise sector. It is defined by a set of IEEE 802 standards. Emerging multi-protocol/multi-service Ethernet services are also offered over public transport networks. Public Ethernet services and Ethernet frames over transport standards and implementation agreements continue being developed in the ITU-T and other organizations. Specifically, the ITU-T SG15 is focused on developing Recommendations related to the support and definition of Ethernet services over traditional telecommunications transport, such as PDH, SDH, and OTN. Ethernet can be described in the context of three major components: *services aspects*, *network layer*, and *physical layer*. This description is meant to provide a brief overview of Public Ethernet considering each of the above aspects.

The Public Ethernet *services aspects* (for service providers) include the different service markets, topology options, and ownership models. Public Ethernet services are defined to a large extent by the type(s) of topologies used and ownership models employed. The topology options can be categorized by the three types of services they support: Line services, LAN services and Access services. Line services are point-to-point in nature and include services like Ethernet private and virtual lines. LAN services are multi-point-to-multi-point (such as virtual LAN services). Access services are of hub-and-spoke nature and enable single ISP/ASP to serve multiple, distinct, customers. (Due to the similar aspects from a public network perspective, Line and Access services may be essentially the same.)

The services can be provided with different service qualities. A circuit switched technology like SDH provides always a guaranteed bit rate service while a packet switched technology like MPLS can provide various service qualities from best effort traffic to a guaranteed bit rate service. Ethernet services can be provided for the Ethernet MAC layer or Ethernet physical layer.

The Ethernet *network layer* is the Ethernet MAC layer that provides end-to-end transmission of Ethernet MAC frames between Ethernet end-points of individual services, identified by their MAC addresses. Ethernet MAC layer services can be provided as Line, LAN and Access services over circuit switched technologies like SDH VCs and OTN ODUs or over packet switched technologies like MPLS and RPR. For the Ethernet LAN service Ethernet MAC bridging might be performed within the public transport network in order to forward the MAC frames to the correct destination. Ethernet MAC services can be provided at any bit rate. They are not bound to the physical data rates (i.e. 10 Mbit/s, 100 Mbit/s, 1 Gbit/s, 10 Gbit/s) defined by IEEE.

IEEE has defined a distinct set of *physical layer* data rates for Ethernet with a set of interface options (electrical or optical). An Ethernet physical layer service transports such signals transparently over a public transport network. Examples are the transport of a 10 Gbit/s Ethernet WAN signal over an OTN or the transport of a 1 Gbit/s Ethernet signal over SDH using transparent GFP mapping. Ethernet physical layer services are point-to-point only and are always at the standardized data rates. They are less flexible compared to Ethernet MAC layer services, but offer lower latencies.

## 5.5 Overview of the standardization of carrier class Ethernet

## 5.5.1 Evolution of "carrier-class" Ethernet

Ethernet became to be used widely in network operator's backbone or metro area network. Although Ethernet was originally designed to be used in LAN environment, it has been enhanced in several aspects so that it can be used in network operators' network. In addition, Ethernet can easily realize multipoint to multipoint connectivity, which would require n\*(n-1)/2 connections if an existing point to point transport technology. The following subclauses explain enhancements which have been adopted in Ethernet networks thus far.

### 5.5.1.1 High bit rate and long reach interfaces

Up to 10Gbit/s and up to 40km Ethernet interfaces have been standardized by IEEE 802.3 WG. In addition to LAN-PHY (10GBASE-R), WAN-PHY (10GBASE-W) has been standardized. WAN-PHY can be connected to SDH/SONET interfaces.

In addition, within the IEEE 802.3, the 802.3ba Task Force completed the standards for both 40 Gbit/s and 100 Gbit/s Ethernet in 2010. As a result, 40GBASE-LR4 (at least 10km), 100GBASE-LR4(at least 10km), and 100GBASE-ER4(at least 40km) on single-mode fiber (SMF) were newly standardized, based on the following objectives.

* Support full-duplex operation only
* Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
* Preserve minimum and maximum FrameSize of current 802.3 standard
* Support a BER better than or equal to 10-12 at the MAC/PLS service interface

Regarding Passive Optical Network (PON), IEEE 802.3av (10Gbit/s Ethernet Passive Optical Network: 10G EPON) has been standardized in September 2009.

A new 40GBASE-FR (2km serial) interface was standardized by IEEE Std 802.3bg-2011 this year. This interface was specified expecting that devices compliant with this specification could also be used for application VSR2000-3R2 as defined in ITU-T G.693.

### 5.5.1.2 Ethernet-based access networks

Ethernet capabilities as access networks have been enhanced by IEEE 802.3 WG originally as IEEE 802.3ah. which has been incorporated into the base IEEE Std 802.3-2008. This includes point-to-point and point-to-multipoint (PON) optical transmission methods as well as link level Ethernet OAM. In addition, IEEE 802.3av(10G-EPON) has also been standardized.

#### 5.5.1.3 Enhancement of scalability

VLAN technology is widely used to provide customers with logically independent networks while sharing network resource physically. However, since 12bit VLAN ID must be a unique value throughout the network, the customer accommodation is limited to 4094 (2 values, 0 and 4095, are reserved for other purposes).

In order to expand this limitation, a method which uses two VLAN IDs in a frame has been standardized by IEEE 802.1ad (Provider Bridges) in October 2005. This method allows the network to provide up to 4094 Service VLANs, each of which can accommodate up to 4094 Customer VLANs.

### 5.5.1.4 Scalable Ethernet-based backbone

In order to realize further scalable network, IEEE 802.1ah (Backbone Provider Bridges) specifies a method which uses B-Tag, I-Tag and C-Tag. B-Tag and C-Tag include 12 bit VLAN ID. I-Tag includes 20bit Service ID (note: the size of the Service ID under study). One VLAN ID identifies a Customer VLAN. Service ID identifies a service in a provider network. Another VLAN ID identifies a Backbone VLAN. This allows the network to use 12bit VLAN ID space and 20 bit service ID space as well as its own MAC address space. IEEE 802.1ah was approved in June 2008.

### 5.5.1.5 The number of MAC addresses to be learned by bridges

Bridges in a network automatically learn the source MAC addresses of incoming frames. When the number of stations is large, this learning process consumes a lot of resources of each bridge. In order to alleviate this burden, IEEE 802.1ah (Backbone Provider Bridges) is standardizing a method which encapsulates MAC addresses of user stations by backbone MAC addresses so that bridges inside the backbone network do not learn MAC addresses of user stations.

### 5.5.1.6 Network level OAM

In order to enable network operators to detect, localize and verify defects easily and efficiently, network level Ethernet OAM functions have been standardized by ITU-T SG13 (Q.5/13) and IEEE 802.1ag under a close cooperation. ITU-T Recommendation Y.1731 was approved in May 2006 and revised in February 2008. IEEE 802.1ag was approved in September 2007. IEEE 802.1ag covers fault management functions only while Y.1731 covers both fault management and performance management. Ethernet services performance parameters were standardized by ITU-T SG12 (Q.17/12) in Recommendation Y.1563, approved in January 2009. Service OAM Framework is standardized as MEF17.It was decided to move Q.5/13 (OAM) to SG15 at the WTSA-08 in October. As such, work on Ethernet OAM is conducted by SG15 in 2009-2012 Study Period.

### 5.5.1.7 Fast survivability technologies

In order to realize fast and simple protection switching in addition to Link Aggregation and Rapid Spanning Tree Protocol, a Recommendation on Ethernet linear protection switching mechanism (G.8031) was approved in June 2006. A Recommendation on Ethernet ring protection (G.8032) was approved in June 2008. The revised recommendation G.8032v2 adding interconnected and multiple rings, operator commands and non-revertive mode was approved in March 2010.

IEEE 802.1 WG is developing a standard on Shortest Path Bridging (IEEE 802.1aq) to optimize restoration capabilities. In addition, they completed in June 2009 a standard on Provider Backbone Bridge Traffic Engineering (IEEE 802.1Qay), which includes linear protection switching. IEEE 802.17 WG is developing standards on Resilient Packet Ring (RPR). The latest 802.17 project has been IEEE P802.17c: "Protected Inter-Ring Connection". This project extends the property of fast (50 ms) restoration time, associated with an individual RPR ring, to dual-interconnected rings. This project reached IEEE Sponsor Ballot approval stage in July 2009.

### 5.5.1.8 QoS/traffic control/traffic conditioning

QoS, traffic control and traffic conditioning issues are being studied by ITU-T (SG12 and SG13), IEEE 802.3 and Metro Ethernet Forum (MEF). IEEE 802.1 completed work in June 2009 on Provider Backbone Bridge Traffic Engineering (IEEE 802.1Qay). MEF has developed MEF 10.2: "Amendment to Ethernet Services Attributes Phase 2", completed in September 2009.

#### 5.5.1.9 Status of IEEE 802.1 and IEEE 802.3

#### The following projects are currently active within the IEEE 802.1 working group:

#### Interworking

#### 802-REV - Overview & Architecture revision

#### 802.1AC - Media Access Control Service revision

#### 802.1aq - Shortest Path Bridging

#### 802.1Qbf - PBB-TE Infrastructure Segment Protection

#### 802.1AXbk - Link Aggregation: Protocol Addressing

#### 802.1Qbp - Equal Cost Multiple Paths

#### 802.1AXbq - Link Aggregation: Distributed Resilient Network Interconnect

#### Audio/Video Bridging

#### 802.1ASbt - Timing and Synchronisation: Enhancements and Performance Improvements

#### Data Center Bridging

#### 802.1Qbg - Edge Virtual Bridging

#### 802.1BR - Bridge Port Extension

#### The following projects are currently active within the IEEE 802.3 working group:

#### IEEE P802.3 (IEEE 802.3bh) (Revision to IEEE Std 802.3-2008 Task Force), is currently in the working group ballot phase. This is expected to lead to a 2012 revision of the standard, incorporating the amendments 802.3av, 802.3bc, 802.3at, 802.3-2008/Cor 1, 802.3ba, 802.3az, 802.3bg, 802.3bf, plus maintenance items into the text of IEEE 802.3.

#### IEEE P802.3.1 (IEEE 802.3.1a) (Revision to IEEE Std 802.3.1-2011 Ethernet MIBs Task Force), is expected to lead to a revision of IEEE Std 802.3.1-2011 which incorporates MIBs for all of the amendments to IEEE Std 802.3-2008. This project has just begun the working group ballot phase.

#### IEEE P802.3bj (100 Gb/s Backplane and Copper Cable Task Force) is currently considering technical choices that will lead to a first draft for task force review.

#### The Next Generation 100 Gb/s Optical Ethernet Study Group is studying approaches to reducing the size, cost and power of the next generation of Optical Ethernet Interfaces.

#### The Extended EPON Study Group is adding new power budget class(es) for 1G-EPON, 10/1G-EPON, and/or 10/10G-EPON, including extension to PMD specs and alternative mechanisms such as reach extenders to achieve longer reach and/or higher split ratios. This Study Group has proposed a PAR, 5-criteria responses, and objectives which have been endorsed by the 802.3 working group, to be considered by the IEEE 802 Executive Committee at the March 2012 plenary before Standards Board approval of the PAR.

#### A new EPON over Coax PHY Study Group has been created to investigate the possibility to specify a new PHY for operating the EPON protocol over Coaxial Distribution Networks (EPoC).

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## 5.5.2 Standardization activities on Ethernet

Standardization work on "carrier-class" Ethernet is conducted within ITU-T SG15, IEEE 802.1 WG, IEEE 802.3 WG, IETF and Metro Ethernet Forum. The table below summarizes current standardization responsibilities on "carrier-class" Ethernet. Table 7-5 lists the current status of individual Ethernet related ITU-T Recommendations. Latest Ethernet Services that are specified in MEF 6.1 and MEF 10.2 haven’t been completely covered in G.8011.x series at the moment. Q10/15 is planning to update G.811.x series aligning with MEF specification in next SG15 meeting.

Table 5-1 Standardization on "carrier-class" Ethernet.

|  |  |  |  |
| --- | --- | --- | --- |
| # | Standard body | Q/SG (WG) | Study items |
| 1 | ITU-T SG12 | Q.17/12 | Ethernet services performance |
| 2 | ITU-T SG15 | Q.3/15 | Coordination on OTN including optical Ethernet |
| Q.9/15 | Ethernet protection and equipment functional architecture |
| Q.10/15 | Ethernet OAM mechanisms |
| Q.11/15 | Ethernet Service description and frame mapping (GFP) |
| Q.12/15 | Ethernet architecture |
| Q.13/15 | Synchronous Ethernet |
| Q14/15 | Management aspects of Ethernet |
| Q15/15 | Synchronous Ethernet test equipment |
| 3 | IEEE 802 | 802.1 | Higher layers above the MAC (including Network level Ethernet OAM mechanisms, Provider bridges, Provider backbone bridges) |
| 802.3 | Ethernet (including Ethernet in the First Mile (completed in June 2004), 10G-EPON (completed in September 2009) and 40G/100G Ethernet) |
| 4 | IETF | CCAMP WG | common control plane and measurement plane solutions and GMPLS mechanisms/protocol extensions to support source-controlled and explicitly-routed  Ethernet data paths for Ethernet data planes |
| MPLS WG | many elements of the support of Ethernet "carrier-class" pseudowires over MPLS and MPLS-TP networks |
| L2VPN WG | Layer 2 Virtual Private Networks |
| PWE3 WG | encapsulation, transport, control, management, interworking  and security of Ethernet services emulated over MPLS enabled IP packet switched networks |
| 5 | Metro Ethernet Forum | Technical Committee | Service attributes including traffic and performance parameters, service definitions, Aggregation and E-NNI interfaces, management interfaces, performance monitoring, and test specifications. |

## 5.5.3 Further details

Further details about standardization of Ethernet can be obtained the website of ITU-T SG13, SG15, IEEE 802.1, IEEE 802.3, IETF and Metro Ethernet Forum as below:

ITU-T SG13: <http://www.itu.int/ITU-T/studygroups/com13/index.asp>

ITU-T SG15: <http://www.itu.int/ITU-T/studygroups/com15/index.asp>

IEEE 802.1 WG: <http://www.ieee802.org/1/>

IEEE 802.3 WG: <http://www.ieee802.org/3/>

IETF: <http://www.ietf.org/>

Metro Ethernet Forum: [http://metroethernetforum.org/](http://www.metroethernetforum.org/)

# 5.6 Standardization on MPLS/MPLS-TP (T-MPLS)

In order to use MPLS technology in operators' network, standardization for enhancing MPLS is conducted by ITU-T SG13 and SG15. In addition to “normal” MPLS, Transport MPLS (T-MPLS) has been studied actively. In 2007-2008 timeframe, several meetings were held to discuss the working method on T-MPLS between ITU-T (in particular, SG13 and SG15) and IETF. In a SG15 plenary meeting in February 2008, it was decided to set up a Joint Work Team (JWT) to discuss this matter intensively. At the December 2008 plenary meeting SG 15 agreed to use the term MPLS-TP to refer to the extensions to MPLS technology being developed by the IETF to meet the requirements of the transport network. The meeting also agreed the plan to migrate the existing T-MPLS Recommendations to MPLS-TP provided in Migration of T-MPLS Recommendations to MPLS-TP. In October 2009, MPLS-TP steering committee has been established to provide MPLS-TP project management coordination between IETF and ITU-T. Figure 5-4 shows the structure of the relationship between IETF and ITU-T.



**Figure 5-4 Structure of the Joint Working Team (JWT) and related Sub-Groups**

The JWT recommended that:

* Jointly agree to work together and bring transport requirements into the IETF and extend IETF MPLS forwarding, OAM, survivability, network management and control plane protocols to meet those requirements through the IETF Standards Process
* The Joint Working Team believes this would fulfill the mutual goal of improving the functionality of the transport networks and the internet and guaranteeing complete interoperability and architectural soundness
* Refer to the technology as the Transport Profile for MPLS (MPLS-TP)
* Therefore, we recommend that future work should focus on:
  + In the IETF: Definition of the MPLS “Transport Profile” (MPLS-TP)
  + In the ITU-T:
    - Integration of MPLS-TP into the transport network
    - Alignment of the current T-MPLS Recommendations with MPLS-TP and,
    - Terminate the work on current T-MPLS

Further details can be found at:

<http://ties.itu.int/ftp/public/itu-t/ahtmpls/readandwrite/doc_exchange/overview/MPLS-TP_overview-22.ppt>

The table below summarizes current standardization responsibilities on MPLS-TP.

Table 5-2 Standardization on MPLS-TP.

|  |  |  |  |
| --- | --- | --- | --- |
| # | Standard body | Q/SG (WG) | Study items |
| 1 | ITU-T SG15 | Q.3/15 | Terms and definitions for MPLS-TP |
| Q.9/15 | MPLS-TP protection/survivability and equipment functional architecture |
| Q.10/15 | MPLS-TP interfaces, OAM architecture and mechanisms |
| Q.12/15 | MPLS-TP network architecture |
| Q.14/15 | MPLS-TP network management and control |
| 2 | IETF | BFD WG | Bidirectional Forwarding Detection (bfd) extntions for MPLS-TP |
| CCAMP WG | Common control plane and measurement plane solutions and GMPLS mechanisms/protocol extensions for MPLS transport profile (MPLS-TP), Automatically Switched Optical Networks (ASON) and Wavelength Switched Optical Networks (WSON) |
| L2VPN WG | Extensions to L2VPN protocols and RFC's necessary to create an  MPLS Transport Profile (MPLS-TP) |
| MPLS WG | Requirements, mechanisms, protocols and framework for MPLS-TP |
| OPSAWG | Definition of the OAM acronym |
| PCE WG | Specification of Path Computation Element  (PCE) based architecture for the computation of paths for MPLS and GMPLS LSPs |
| PWE3 WG | Extensions to the PWE3 protocols and RFCs  necessary to create an MPLS Transport Profile (MPLS-TP) |

### 5.6.1 MPLS/MPLS-TP OAM

Within the ITU-T, MPLS OAM was originally described by SG13 (Q.5/13).. Recommendations on OAM requirements (Y.1710), mechanisms (Y.1711), OAM under ATM-MPLS interworking (Y.1712) and misbranch detection (Y.1713) have been published. IETF is also standardizing MPLS OAM. The usage of the "OAM Alert label" is described in RFC3429. RFC4377 describes OAM MPLS OAM requirements. RFC4378 describes MPLS OAM framework. RFC4379 specifies methods for defect detection (LSP ping and traceroute).

It was decided to move Q.5/13 (OAM) to SG15 at the WTSA-08 in October, 2008. Q.10/15 is allocated to do this work. As such, work on MPLS/MPLS-TP OAM has been conducted by Q.10/15 in 2009-2012 Study Period. Regarding MPLS-TP OAM, new Recommendation (G.tpoam) is planned to be consent in February 2011.

### 5.6.2 MPLS/MPLS-TP protection switching

MPLS protection switching has been standardized by ITU-T SG15 (Q.9/15). Revised Recommendation on MPLS protection switching (Y.1720) was approved in December 2006. T‑MPLS linear protection switching (G.8131) was approved in December 2006. IETF is also standardizing MPLS survivability techniques. RFC3469 describes MPLS recovery framework. RFC4090 specifies Fast ReRoute (FRR).

Regarding MPLS-TP, MPLS-TP linear protection switching (revised G.8131) and MPLS-TP ring protection switching (new G.8132) has been developed with cooperation with IETF based on the agreement of JWT. Both Recommendations are planned to be consent in December 2011.

## 5.6.3 MPLS interworking

Interworking with MPLS networks has been studied by ITU-T SG13 (Q.7/13). Recommendations on ATM-MPLS interworking (cell mode: Y.1411, frame mode: Y.1412), TDM-MPLS interworking (Y.1413), Voice services – MPLS interworking (Y.1414) and Ethernet-MPLS network interworking (Y.1415) have been published.

## 5.6.4 MPLS-TP network architecture

MPLS layer network architecture (G.8110) was approved by ITU-T SG15 in January 2005. Transport MPLS (T-MPLS) network architecture (G.8110.1) was approved by ITU-T SG15 (Q.12/15) in November 2006. Regarding MPLS-TP, Architecture of MPLS-TP Layer Network is planned to be consent June 2010 and has been being developed.

## 5.6.5 MPLS-TP equipment functional architecture

T-MPLS equipment functional architecture (G.8121) was approved within ITU-T SG15 (Q.9/15) in March 2006 and amended October 2007. MPLS-TP equipment functional architecture (revised G.8121) is planned to be consent in February 2011.

## 5.6.6 MPLS-TP equipment network management

T-MPLS equipment network management (G.8151) was approved within ITU-T SG15 (Q.14/15) in October 2007. MPLS-TP network management (revised G.8151) is planned to be consent in February 2011.

## 5.6.7 MPLS-TP interface

G.8112, “Interfaces for the Transport MPLS (T-MPLS) hierarchy” was approved by ITU-T SG15 (Q.11/15) in October 2006. In December 2008, the packet transport work of Question 11/15 will be moved to new Question 10/15 in order to balance the load among questions of Working Party 3/15. As a result, MPLS-TP interface(revised G.8112) has been being developed in Q10/15. The Recommendation is planned to be consent in February 2011.

## 5.6.7 Further details

Table 7-6 lists the current status of individual MPLS related ITU-T Recommendations. Table 7-7 lists the current status of individual MPLS-TP (T-MPLS) related IETF RFCs, internet drafts and ITU-T Recommendations.

Further details about standardization of MPLS/MPLS-TP can be obtained from the websites of ITU-T SG15 as below:

<http://www.itu.int/ITU-T/studygroups/com15/index.asp>

Further details about standardization of MPLS-TP can be obtained from the following website of ITU-T SG15.

http://www.itu.int/ITU-T/studygroups/com15/ahmpls-tp/

The dependancy between the draft revised MPLS-TP Recommendations and the MPLS-TP drafts and RFCs can be found at

http://www.itu.int/oth/T0906000002/en

# 5.7 Standardization on NGN related issues

## 5.7.1 Relationships between OTN standardization and NGN standardization

Standardization work on the Next Generation Network (NGN) is conducted by several groups within ITU-T, in particular, by SG13, SG11 and GSI (Global Standardization Initiative). The overview and the definition of the NGN is given by ITU-T Recommendation Y.2000[1]. Further details of the NGN are described by a set of related Recommendations. NGN-FG worked on several NGN related documents until November 2005. These documents were transferred to appropriate SGs based on the subjects. Also, GSI (Global Standardization Initiative) was established to facilitate collaboration among SGs. Table 7-8 lists the current status of NGN related ITU-T Recommendations.

One of the characteristics of the NGN is that it consists of a service stratum and a transport stratum (see Figure 5-3). Transport technologies such as OTN, ATM and SDH (developed by SG15) can be a means to realize a transport stratum. In addition to these, Ethernet and MPLS/MPLS-TP can also construct the transport stratum based on the recent standardization work for enhancing these technologies toward "carrier-class" Ethernet and MPLS/MPLS-TP.



Figure 5-3 NGN architecture overview

This architecture enables service and transport technologies evolve independently keeping the interfaces between them consistent. However, close cooperation between these efforts is nevertheless important.

## 5.7.2 Standardization status for transport stratum

Various technologies such as PDH, SDH, ATM, OTN, Ethernet and MPLS/MPLS-TP can provide capabilities for transport stratum. The following table summarizes the standardization status for each technology in terms of various aspects.

Table 5-3 − Standardization status on the various aspects of PDH, SDH, ATM, OTN, Ethernet, MPLS and MPLS-TP (T-MPLS)(note 3)

| Topic | Generic | PDH | SDH | ATM | OTN | Ethernet | MPLS | MPLS-TP (T-MPLS) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Architectural aspects | G.800,  G.805, G.809 |  | G.803, G.805 | G.805, I.326 | G.872, | G.809, G.8010,  [IEEE] 802.3, 802.1D, 802.1Q, 802.1Qbc,802.1ad, 802.1ah  [MEF]  MEF 4 MEF 12.1 | G.8110,  [IETF]  RFC 3031 | G.8110.1 |
| Structures and mapping |  | G.704, G.73x, G.74x, G.75x (note 1), G.804, G.7043, G.8040 | G.707, G.832, G.7041, G.7042 | I.361, I.362, I.363 | G.709, G.7041, G.7042 | G.7041, G.7042,  [IEEE] 802.3, 802.1AX | [IETF]  RFC3032 | G.8112 |
| Service aspects |  |  |  |  |  | G.8011 G8011.1 G.8011.2 G.8011.3 G.8011.4 G.8011.5  [MEF] MEF 6.1 MEF 10.2 MEF 17 MEF 26 |  |  |
| Equipment functional characteristics | G.806 | G.706, G.73x, G.74x, G.75x (note 1) | G.783, G.784, G.806, G.813, | I.731, I.732 | G.798, G.806 | G.8021 |  | G.8121 |
| OAM and protection switching | G.808.1 |  | G.707, G.783, G.841, G.842 | I.610, I.630 | G.873.1 | Y.1730, Y.1731, G.8031, G.8032 [IEEE] 802.1ag, 802.3, 802.3av,, 802.1aq, 802.1Qay 802.1Qbf | Y.1710, Y.1711, Y.1712, Y.1713, Y.1720,  [IETF]  RFC3429, RFC4377, RFC4378, RFC4379, RFC3469, RFC4090 | G.8131  [SG13]  Y.Sup4 |
| Management aspects | G.7710G.7712  M.3010  M.3013 |  | G.774-x, G.784, G.831, G.7710, M.3100 am3 | I.751 | G.874, G.874.1, G.875, G.7710, M.3100 am3 | G.8051,  G.8052  [IEEE] 802.1ap,  802.1Qbe,  802.3.1 | Y.1714  [IETF]  RFC4221 | G.8151 |
| Physical layer characteristics |  | G.703 | G.664, G.691,  G.692, G.693, G.703, G.957 | G.703, G.957, I.432 | G.664, G.680, G.693, G.698.1 G.698.2 G.959.1 | [IEEE] 802.3, 802.3av  802.3ba  802.3bg |  |  |
| Performance |  | G.821, G.822, G.826, G.823, G.824 | G.826, G.827, G.828, G.829, G.783, G.825 | I.356, I.357  [IETF]  RFC3116 | G.8201, G.8251 | Y.1563  Y.1730, Y.1731 | Y.1561  [IETF]  RFC5695 |  |
| Terminology | G.870 |  | G.780 |  | G.870, G.8081 | G.8001 |  | G.8101 |

Note 1: G.73x, G.74x, G.75x denote series of Recommendations of which numbers start with G.73, G.74 or G.75.

Note 2: Y-series Recommendation numbers are assigned to NGN related Recommendations in addition to their original Recommendation numbers.

Note 3: The next update of the T-MPLS related Recommendations shown in the right-most column of above table will only describe MPLS-TP and will include normative references to the IETF MPLS-TP RFCs under development to meet ITU-T transport requirements. Following RFCs will be added when MPLS-TP related Recommendations are approved.

-Architectural Aspects of MPLS-TP: RFC 5921, RFC 5950, RFC 5960

-Equipment Functional Characteristics of MPLS-TP: RFC 5960

-OAM and Protection Switching of MPLS-TP: RFC 5860

-Management Aspects of MPLS-TP: RFC 5950, RFC 5951

Note 4: ASON related Recommendations are shown in Table 7-4-2: Estimated mapping of protocol-specific documents in ITU-T ASON Recommendations.

Note4: Timing and synchronization aspects needs to be considered in table 5-3. If such a row were included in table 5-3 of a future revision, it should include 802.3bf.

## 5.7.3 Further details

Further details about NGN standardization can be obtained from SG13, SG11 and FG-NGN websites as below.

ITU-T SG13: <http://www.itu.int/ITU-T/studygroups/com13/index.asp>

ITU-T SG11: <http://www.itu.int/ITU-T/studygroups/com11/index.asp>

# 6. OTNT Correspondence and Liaison Tracking

## 6.1 OTNT Related Contacts

The International Telecommunication Union - Telecommunications Sector (ITU-T) maintains a strong focus on global OTNT standardization. It is supported by other organizations that contribute to specific areas of the work at both the regional and global levels. Below is a list of the most notable organizations recognised by the ITU-T and their URL for further information.

ATIS - Alliance for Telecommunications Industry Solutions: <http://www.atis.org>

TIA - Telecommunications Industry Association: <http://www.tiaonline.org>

IEC - International Electrotechnical Commission: <http://www.iec.ch/>

IETF - Internet Engineering Task Force: <http://www.ietf.org>

IEEE 802 LAN/MAN Standards Committee: http://grouper.ieee.org/groups/802/index.shtml

Optical Internetworking Forum (OIF) Technical Committee: http://www.oiforum.com/public/techcommittee.html

Broadband (ex. IP/MPLS) Forum: http://www.broadband-forum.org/

Metro Ethernet Forum (MEF) Technical Committee: http://metroethernetforum.org/

TMF- TeleManagement Forum: <http://www.tmforum.org/browse.aspx>

Overview of existing standards and activity

With the rapid progress on standards and implementation agreements on OTNT, it is often difficult to find a complete list of the relevant new and revised documents. It is also sometimes difficult to find a concise representation of related documents across the different organizations that produce them. This section attempts to satisfy both of those objectives by providing concise tables of the relevant documents.

## 7.1 New or Revised OTNT Standards or Implementation Agreements

Many documents, at different stages of completion, address the different aspect of the OTNT space. The table below lists the known drafts and completed documents under revision that fit into this area. The table does not list all established documents which might be under review for slight changes or addition of features.

Three major families of documents (and more) are represented by fields in the following table, SDH/SONET, OTN Transport Plane, and ASON Control Plane. All of the recommendations and standards of these three different families are included in tables in later sections of this document.

TABLE 7-1-1/OTNT: OTNT Related Standards and Industry Agreements (ITU-T Recommendations)

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| ITU-T (SG2) | M.2401 | Error Performance Limits and Procedures for Bringing-Into-Service and Maintenance of multi-operator international paths and sections within Optical Transport Networks | 12/2003 |
| ITU-T (Q.17/12) | G.1563 | Ethernet frame transfer and availability performance | 01/2009 |
| ITU-T (Q.2/15) | G.983.1 | Broadband optical access systems based on Passive Optical Networks (PON) | 01/2005 |
| ITU-T (Q.2/15) | G.983.1 (Amend.1) | PICS for OLT and ONU – published in English only | 05/2005 |
| ITU-T (Q.2/15) | G.983.2 | ONT management and control interface specification for ATM PON | 07/2005 |
| ITU-T (Q.2/15) | G.983.2 (Amend. 1) | Omnibus improvements for OMCI | 03/2006 |
| ITU-T (Q.2/15) | G.983.2 (Amend. 2) | Various Enhancements to OMCI | 01/2007 |
| ITU-T (Q.2/15) | G.Imp983.2 | Implementer's Guide to G.983.2 | 02/2006 |
| ITU-T (Q.2/15) | G.983.3 | A broadband optical access system with increased service capability by wavelength allocation | 03/2001 |
| ITU-T (Q.2/15) | G.983.3 (Amend. 1) | A broadband optical access system with increased service capability by wavelength allocation | 02/2002 |
| ITU-T (Q.2/15) | G.983.3 (Amend. 2) | A broadband optical access system with increased service capability by wavelength allocation | 07/2005 |
| ITU-T (Q.2/15) | G.983.4 | A Broadband Optical Access System with increased service capability using Dynamic Bandwidth Assignment | 11/2001 |
| ITU-T (Q.2/15) | G.983.4 (Amend. 1) | New Annex A – Performance monitoring parameters | 12/2003 |
| ITU-T (Q.2/15) | G.983.4 (Corrig. 1) | New Annex A – Performance monitoring parameters | 01/2005 |
| ITU-T (Q.2/15) | G.983.5 | A Broadband Optical Access System with enhanced survivability | 01/2002 |
| ITU-T (Q.2/15) | G.984.1 | Gigabit-capable Passive Optical Networks (GPON): General characteristics | 03/2008 |
| ITU-T (Q.2/15) | G.984.2 | Gigabit-capable Passive Optical Networks (GPON): Physical Media Dependent (PMD) layer specification | 03/2003 |
| ITU-T (Q.2/15) | G.984.2 (Amend. 1) | New Appendix III – Industry best practice for 2.488 Gbit/s downstream, 1.244 Gbit/s upstream | 02/2006 |
| ITU-T (Q.2/15) | G.984.2 (Amend. 2) | Enhancement to support optical layer supervision and a new optical line termination (OLT) | 03/2008 |
| ITU-T (Q.2/15) | G.984.3 | Gigabit-capable Passive Optical Networks (GPON): Transmission Convergence layer specification | 03/2008 |
| ITU-T (Q.2/15) | G.984.3 (Amend. 1) | Specification of the ONU registration method and various clarifications | 02/2009 |
| ITU-T (Q.2/15) | G.984.3 (Amend.2) | Specification of the ONU registration method and various clarifications | 11/2009 |
| ITU-T (Q.2/15) | G.984.4 | Gigabit-capable Passive Optical Networks (GPON): ONT Management and Control Interface specification | 02/2008 |
| ITU-T (Q.2/15) | G.Imp984.4 | Implementer’s Guide to G.984.4 | 12/2008 |
| ITU-T (Q.2/15) | G.984.4 (Amend. 1) | Gigabit-capable Passive Optical Networks (GPON): ONT Management and Control Interface specification | 06/2009 |
| ITU-T (Q.2/15) | G.984.4 (Corrig. 1) | Gigabit-capable Passive Optical Networks (GPON): ONT Management and Control Interface specification | 03/2010 |
| ITU-T (Q.2/15) | G.984.5 | Gigabit-capable Passive Optical Networks (G-PON): Enhancement band | 09/2007 |
| ITU-T (Q.2/15) | G.984.6 | Gigabit-capable passive optical networks (GPON): Reach extension | 03/2008 |
| ITU-T (Q.2/15) | G.984.6 (Amend. 1) | Gigabit-capable passive optical networks (GPON): Reach extension | 11/2009 |
| ITU-T (Q.2/15) | G.985 | 100 Mbit/s point-to-point Ethernet based optical access system | 03/2003 |
| ITU-T (Q.2/15) | G.985 (Corrig. 1) | 100 Mbit/s point-to-point Ethernet based optical access system | 01/2005 |
| ITU-T (Q.2/15) | G.985 (Amend. 1) | Silent start function of optical network terminals | 01/2009 |
| ITU-T (Q.3/15) | G.780/Y.1351 | Terms and definitions for synchronous digital hierarchy (SDH) networks | 08/2010 |
| ITU-T (Q.3/15) | G.870/Y.1352 | Terms and definitions for Optical Transport Networks (OTN) | 07/2010 |
| ITU-T (Q.3/15) | G.8081/Y.1353 | Terms and definitions for Automatically Switched Optical Networks (ASON) | 0/2008 |
| ITU-T (Q.3/15) | G.8001/Y.1354 | Terms and definitions for Ethernet Frames Over Transport Networks | 07/2011 |
| ITU-T (Q.3/15) | G.8101/Y.1355 | Terms and definitions for MPLS Transport Profile (MPLS-TP) | 07/2010 |
| ITU-T (Q.5/15) | G.650.1 | Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable | 06/2004 |
| ITU-T (Q.5/15) | G.650.2 | Definitions and test methods for statistical and non-linear attributes of single-mode fibre and cable | 07/2007 |
| ITU-T (Q.5/15) | G.650.3 | Test methods for installed single-mode optical fibre cable links | 03/2008 |
| ITU-T (Q.5/15) | G.651.1 | Characteristics of a 50/125 µm multimode graded index optical fibre cable for the optical access network | 07/2007 |
| ITU-T (Q.5/15) | G.652 | Characteristics of a single-mode optical fibre cable | 11/2009 |
| ITU-T (Q.5/15) | G.653 | Characteristics of a dispersion-shifted single-mode optical fibre and cable | 12/2006 |
| ITU-T (Q.5/15) | G.654 | Characteristics of a cut-off shifted single-mode optical fibre and cable | 12/2006 |
| ITU-T (Q.5/15) | G.655 | Characteristics of a non-zero dispersion shifted single-mode optical fibre and cable | 11/2009 |
| ITU-T (Q.5/15) | G.656 | Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport | 12/2006 |
| ITU-T (Q.5/15) | G.657 | Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network | 11/2009 |
| ITU-T (Q.5/15) | G.Sup40 | Optical fibre and cable recommendations and standards guideline | 11/2006 |
| ITU-T (Q.6/15) | G.664 | Optical safety procedures and requirements for optical transport systems | 03/2006 |
| ITU-T (Q.6/15) | G.680 | Physical transfer functions of optical network elements | 07/2007 |
| ITU-T (Q.6/15) | G.691 | Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers | 03/2006 |
| ITU-T (Q.6/15) | G.692 | Optical interfaces for multichannel systems with optical amplifiers | 10/1998 |
| ITU-T (Q.6/15) | G.692 (Corrig. 1) | Optical interfaces for multichannel systems with optical amplifiers | 01/2000 |
| ITU-T (Q.6/15) | G.692 (Corrig. 2) | Optical interfaces for multichannel systems with optical amplifiers | 06/2002 |
| ITU-T (Q.6/15) | G.692 (Amend. 1) | Optical interfaces for multichannel systems with optical amplifiers | 01/2005 |
| ITU-T (Q.6/15) | G.693 | Optical interfaces for intra-office systems | 11/2009 |
| ITU-T (Q.6/15) | G.694.1 | Spectral grids for WDM applications: DWDM frequency grid | 06/2002 |
| ITU-T (Q.6/15) | G.694.2 | Spectral grids for WDM applications: CWDM wavelength grid | 12/2003 |
| ITU-T (Q.6/15) | G.695 | Optical interfaces for Coarse Wavelength Division Multiplexing applications | 12/2006 |
| ITU-T (Q.6/15) | G.696.1 | Intra-Domain DWDM applications | 07/2005 |
| ITU-T (Q.6/15) | G.697 | Optical monitoring for DWDM system | 06/2004 |
| ITU-T (Q.6/15) | G.698.1 | Multichannel DWDM applications with single-channel optical interfaces | 11/2009 |
| ITU-T (Q.6/15) | G.698.2 | Amplified multichannel DWDM applications with single channel optical interfaces | 11/2009 |
| ITU-T (Q.6/15) | G.911 | Parameters and calculation methodologies for reliability and availability of fibre optic systems | 04/1997 |
| ITU-T (Q.6/15) | G.957 | Optical interfaces for equipments and systems relating to the synchronous digital hierarchy | 03/2006 |
| ITU-T (Q.6/15) | G.959.1 | Optical transport network physical layer interfaces | 11/2009 |
| ITU-T (Q.6/15) | G.959.1(Amend. 1) | Optical transport network physical layer interfaces | 04/2011 |
| ITU-T (Q.6/15) | G.Sup39 | Optical system design and engineering considerations | 12/2008 |
| ITU-T (Q.7/15) | G.671 | Transmission characteristics of optical components and subsystems | 01/2009 |
| ITU-T (Q.9/15) | G.781 | Synchronization layer functions | 09/2008 |
| ITU-T (Q.9/15) | G.781(Corrig. 1) | Synchronization layer functions | 11/2009 |
| ITU-T (Q.9/15) | G.783 | Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks | 03/2006 |
| ITU-T (Q.9/15) | G.783 (Errata 1) | Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks | 11/2006 |
| ITU-T (Q.9/15) | G.783 (Amend. 1) | Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks | 05/2008 |
| ITU-T (Q.9/15) | G.783 (Amend. 2) | Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks | 03/2010 |
| ITU-T (Q.9/15) | G.798 | Characteristics of Optical Transport Network Hierarchy Equipment Functional Blocks | 10/2010 |
| ITU-T (Q.9/15) | G.798(Corrig. 1) | Characteristics of Optical Transport Network Hierarchy Equipment Functional Blocks | 4/2011 |
| ITU-T (Q.9/15) | G.798(Amend. 1) | Characteristics of Optical Transport Network Hierarchy Equipment Functional Blocks | 7/2011 |
| ITU-T (Q.9/15) | G.798.1 | Types and characteristics of optical Transport Network (OTN) Equipment | 4/2011 |
| ITU-T (Q.9/15) | G.Imp798 | Implementer's Guide to G.798 | 05/2005 |
| ITU-T (Q.9/15) | G.806 | Characteristics of transport equipment – Description methodology and generic functionality | 01/2009 |
| ITU-T (Q.9/15) | G.806(Errata 1) | Characteristics of transport equipment – Description methodology and generic functionality | 03/2010 |
| ITU-T (Q.9/15) | G.806(Amend. 1) | Characteristics of transport equipment – Description methodology and generic functionality | 06/2011 |
| ITU-T (Q.9/15) | G.808.1 | Generic protection switching – Linear trail and subnetwork protection | 02/2010 |
| ITU-T (Q.9/15) | G.Imp808.1 | Implementer's Guide to G.808.1 | 05/2005 |
| ITU-T (Q.9/15) | G.841 | Types and characteristics of SDH network protection architectures | 10/1998 |
| ITU-T (Q.9/15) | G.841 (Corrig. 1) | Types and characteristics of SDH network protection architectures | 08/2002 |
| ITU-T (Q.9/15) | G.842 | Interworking of SDH network protection architectures | 04/1997 |
| ITU-T (Q.9/15) | G.873.1 | Optical Transport network (OTN) - Linear Protection | 03/2006 |
| ITU-T (Q.9/15) | G.Imp873.1 | Implementer's Guide to G.873.1 | 05/2005 |
| ITU-T (Q.9/15) | G.8021/Y.1341 | Characteristics of Ethernet transport network equipment functional blocks | 10/2010 |
| ITU-T (Q.9/15) | G.8021/Y.1341 (Amend. 1) | Characteristics of Ethernet transport network equipment functional blocks | 07/2011 |
| ITU-T (Q.9/15) | G.8031/Y.1342 | Ethernet linear protection switching | 06/2011 |
| ITU-T (Q.9/15) | G.8032/Y.1344 | Ethernet ring protection switching | 03/2010 |
| ITU-T (Q.9/15) | G.8032/Y.1344  (Corrig. 1) | Ethernet ring protection switching | 07/2010 |
| ITU-T (Q.9/15) | G.8032/Y.1344 (Amend. 2) | Ethernet ring protection switching | 02/2011 |
| ITU-T (Q.9/15) | G.8121/Y.1381 \* | Characteristics of Transport MPLS equipment functional blocks | 03/2006 |
| ITU-T (Q.9/15) | G.8121/Y.1381 \* (Corrig. 1) | Characteristics of Transport MPLS equipment functional blocks | 12/2006 |
| ITU-T (Q.9/15) | G.8121/Y.1381 \* (Amend. 1) | Characteristics of Transport MPLS equipment functional blocks | 10/2007 |
| ITU-T (Q.9/15) | G.8131/Y.1382 \* | Linear protection switching for transport MPLS (T-MPLS) networks | 02/2007 |
| ITU-T (Q.9/15) | G.8131/Y.1382 \* (Amend. 1) | Linear protection switching for transport MPLS (T-MPLS) networks | 09/2007 |
| ITU-T (Q.9/15) | G.8201 | Error performance parameters and objectives for multi-operator international paths within the Optical Transport Network (OTN) | 04/2011 |
| ITU-T (Q.9/15) | Y.1720 | Protection switching for MPLS networks | 12/2006 |
| ITU-T (Q.9/15) | Y.1720 (Amend. 1) | Protection switching for MPLS networks | 02/2008 |
| ITU-T (Q.10/15) | G.8011/Y.1307 | Ethernet service characteristics | 01/2009 |
| ITU-T (Q.10/15) | G.8011.1/Y.1307.1 | Ethernet Private Line Service | 01/2009 |
| ITU-T (Q.10/15) | G.8011.2/Y.1307.2 | Ethernet Virtual Private Line Service | 01/2009 |
| SG15(Q.10/15) | G.8011.3/Y.1307.3 | Ethernet Virtual Private LAN Service | 02/2010 |
| SG15(Q.10/15) | G.8011.4/Y.1307.4 | Ethernet Virtual Private Routed Multipoint Service | 02/2010 |
| SG15(Q.10/15) | G.8011.5/Y.1307.5 | Ethernet Private LAN service | 02/2010 |
| ITU-T (Q.10/15) | G.8012/Y.1308 | Ethernet UNI and Ethernet NNI | 08/2004 |
| ITU-T (Q.10/15) | G.8012/Y.1308 (Amend. 1) | Ethernet UNI and Ethernet NNI | 05/2006 |
| ITU-T (Q.10/15) | G/8013/Y.1731 | OAM functions and mechanisms for Ethernet based networks | 07/2011 |
| ITU-T (Q.10/15) | G/8013/Y.1731 (Corrig. 1) | OAM functions and mechanisms for Ethernet based networks | 10/2011 |
| ITU-T (Q.10/15) | G.8112/Y.1371 \* | Interfaces for the Transport MPLS (T-MPLS) hierarchy | 10/2006 |
| ITU-T (Q.10/15) | G.8112/Y.1371) \* (Corrig. 1) | Interfaces for the Transport MPLS (T-MPLS) hierarchy | 01/2007 |
| ITU-T (Q.10/15) | Y.1710 | Requirements for OAM functionality for MPLS networks | 11/2002 |
| ITU-T (Q.10/15) | Y.1711 | Operation & Maintenance mechanism for MPLS networks | 02/2004 |
| ITU-T (Q.10/15) | Y.1711 (Corr. 1) | Operation & Maintenance mechanism for MPLS networks | 02/2005 |
| ITU-T (Q.10/15) | Y.1711 (Amend. 1) | Operation & Maintenance mechanism for MPLS networks | 10/2005 |
| ITU-T (Q.10/15) | Y.1712 | OAM functionality for ATM-MPLS interworking | 01/2004 |
| ITU-T (Q.10/15) | Y.1713 | Misbranching detection for MPLS networks | 03/2004 |
| ITU-T (Q.10/15) | Y.1714 | MPLS management and OAM framework | 01/2009 |
| ITU-T (Q.10/15) | Y.1730 | Requirements for OAM functions in Ethernet-based networks and Ethernet services | 01/2004 |
| ITU-T (Q.10/15) | Y.1731 | OAM functions and mechanisms for Ethernet based networks | 02/2008 |
| ITU-T (Q.10/15) | Y.1731 (Amend. 1) | OAM functions and mechanisms for Ethernet based networks | 07/2010 |
| ITU-T (Q.11/15) | G.707/Y.1322 | Network node interface for the synchronous digital hierarchy (SDH) | 01/2007 |
| ITU-T (Q.11/15) | G.707/Y.1322 (Amend. 1) | Network node interface for the synchronous digital hierarchy (SDH) | 07/2007 |
| ITU-T (Q.11/15) | G.707/Y.1322 (Amend. 2) | Network node interface for the synchronous digital hierarchy (SDH) | 11/2009 |
| ITU-T (Q.11/15) | G.709/Y.1331 | Interfaces for the optical transport network (OTN) | 12/2009 |
| ITU-T (Q.11/15) | G.709/Y.1331 (Erratum. 1) | Interfaces for the optical transport network (OTN) | 05/2010 |
| ITU-T (Q.11/15) | G.709/Y.1331 (Amend. 1) | Interfaces for the optical transport network (OTN) | 07/2010 |
| ITU-T (Q.11/15) | G.709/Y.1331 (Corrig. 1) | Interfaces for the optical transport network (OTN) | 07/2010 |
| ITU-T (Q.11/15) | G.709/Y.1331 (Amend. 2) | Interfaces for the optical transport network (OTN) | 04/2011 |
| ITU-T (Q.11/15) | G.Imp709/Y.1331 | Implementer's Guide to G.709 | 05/2005 |
| ITU-T (Q.11/15) | G.7041/Y.1303 | Generic framing procedure (GFP) | 04/2011 |
| ITU-T (Q.11/15) | G.7042/Y.1305 | Link capacity adjustment scheme (LCAS) for virtual concatenated signals | 03/2006 |
| ITU-T (Q.11/15) | G.7043/Y.1343 | Virtual Concatenation of PDH Signals | 07/2004 |
| ITU-T (Q.11/15) | G.7043/Y.1343 (Amend. 1) | Virtual Concatenation of PDH Signals | 01/2005 |
| ITU-T (Q.11/15) | G.7043/Y.1343 (Corrig.. 1) | Virtual Concatenation of PDH Signals | 12/2006 |
| ITU-T (Q.11/15) | G.Sup43 | Transport of IEEE 10GBASE-R in optical transport networks (OTN) | 02/2011 |
| ITU-T (Q.12/15) | G.800 | Unified functional architecture of transport networks | 09/2007 |
| ITU-T (Q.12/15) | G.800 (Amend. 1) | Techniques to enhance the availability of transport networks | 03/2009 |
| ITU-T (Q.12/15) | G.800 (Amend. 2) | Techniques to enhance the availability of transport networks | 07/2010 |
| ITU-T (Q.12/15) | G.805 | Generic functional architecture of transport networks | 03/2000 |
| ITU-T (Q.12/15) | G.872 | Architecture of optical transport networks | 11/2001 |
| ITU-T (Q.12/15) | G.872 (Amend. 1) | Architecture of optical transport networks | 12/2003 |
| ITU-T (Q.12/15) | G.872 (Corrig. 1) | Architecture of optical transport networks | 01/2005 |
| ITU-T (Q.12/15) | G.872 (Amend. 2) | Architecture of optical transport networks | 07/2010 |
| ITU-T (Q.12/15) | G.Imp872 | Implementer's Guide to G.872 | 05/2005 |
| ITU-T (Q.12/15) | G.8080/Y.1304 | Architecture for the Automatically Switched Optical Network (ASON) | 06/2006 |
| ITU-T (Q.12/15) | G.8080/Y.1304 (Err. 1) | Architecture for the Automatically Switched Optical Network (ASON) | 04/2007 |
| ITU-T (Q.12/15) | G.8080/Y.1304 (Corrig. 1) | Architecture for the Automatically Switched Optical Network (ASON) | 09/2007 |
| ITU-T (Q.12/15) | G.8080/Y.1304 (Amend. 1) | Architecture for the Automatically Switched Optical Network (ASON) | 03/2008 |
| ITU-T (Q.12/15) | G.8080/Y.1304 (Amend. 2) | Architecture for the Automatically Switched Optical Network (ASON) | 07/2010 |
| ITU-T (Q.12/15) | G.Imp8080/ Y.1304 | Implementer's Guide to G.8080/Y.1304 | 06/2007 |
| ITU-T (Q.12/15) | G.8010/Y.1306 | Ethernet Layer Network Architecture | 02/2004 |
| ITU-T (Q.12/15) | G.8010/Y.1306 (Amend 1) | Ethernet Layer Network Architecture | 05/2006 |
| ITU-T (Q.12/15) | G.8010/Y.1306 (Err. 1) | Ethernet Layer Network Architecture | 09/2007 |
| ITU-T (Q.12/15) | G.8010/Y.1306 (Err. 2 | Ethernet Layer Network Architecture | 10/2007 |
| ITU-T (Q.12/15) | G.8010/Y.1306 (Amend. 2) | Ethernet Layer Network Architecture | 07/2010 |
| ITU-T (Q.12/15) | G.8110/Y.1370 | MPLS Layer Network Architecture | 01/2005 |
| ITU-T (Q.12/15) | G.8110.1/Y.1370.1 \* | Architecture of Transport MPLS (T-MPLS) layer network | 11/2006 |
| ITU-T (Q.12/15) | G.8110.1/Y.1370.1 \* (Amend. 1) | Architecture of Transport MPLS (T-MPLS) layer network | 07/2007 |
| ITU-T (Q.13/15) | G.813 | Timing Characteristics of SDH Equipment Slave Clocks (SEC) | 03/2003 |
| ITU-T (Q.13/15) | G.813 (Corrig. 1) | Timing Characteristics of SDH Equipment Slave Clocks (SEC) | 06/2005 |
| ITU-T (Q.13/15) | G.8251 (Amend. 1) | The Control of Jitter and Wander within the Optical Transport Network (OTN) | 07/2010 |
| ITU-T (Q.13/15) | G.8251 | The Control of Jitter and Wander within the Optical Transport Network (OTN) | 04/2011 |
| ITU-T (Q13/15) | G.8260 | Definitions and terminology for synchronization in packet networks | 07/2010 |
| ITU-T (Q.13/15) | G.8261/Y.1361 | Timing and synchronization aspects in packet networks | 04/2008 |
| ITU-T (Q.13/15) | G.8261/Y.1361(Amend. 1) | Timing and synchronization aspects in packet networks | 07/2010 |
| ITU-T (Q.13/15) | G.8262/Y.1362 | Timing characteristics of synchronous Ethernet equipment slave clock (EEC) | 07/2010 |
| ITU-T (Q.13/15) | G.8264/Y.1364 | Distribution of timing information through packet networks | 10/2008 |
| ITU-T (Q.13/15) | G.8264/Y.1364 (Corrig. 1) | Distribution of timing information through packet networks | 11/2009 |
| ITU-T (Q.13/15) | G.8264/Y.1364 (Amend. 1) | Distribution of timing information through packet networks | 07/2010 |
| ITU-T (Q.13/15) | G.8265/Y.1365 | Architecture and requirements for packet based frequency delivery | 07/2010 |
| ITU-T (Q.13/15) | G.8265.1/Y.1365.1 | Precision Time Protocol Telecom Profile for frequency synchronization | 10/2010 |
| ITU-T (Q.13/15) | G.8265.1/Y.1365.1 (Amedn. 1) | Precision Time Protocol Telecom Profile for frequency synchronization | 04/2011 |
| ITU-T (Q.14/15) | G.784 | Management aspects of synchronous digital hierarchy (SDH) transport network elements | 03/2008 |
| ITU-T (Q.14/15) | G.874 | Management aspects of optical transport network elements | 07/2010 |
| ITU-T (Q.14/15) | G.874 (Corrig. 1) | Management aspects of optical transport network elements | 06/2011 |
| ITU-T (Q.14/15) | G.Imp874 | Implementer's Guide to G.874 | 05/2005 |
| ITU-T (Q.14/15) | G.874.1 | Optical Transport Network (OTN) Protocol-Neutral Management Information Model For The Network Element View | 01/2002 |
| ITU-T (Q.14/15) | G.Imp874.1 | Implementer's Guide to G.874.1 | 05/2005 |
| ITU-T (Q.14/15) | G.7710/Y.1701 | Common equipment management function requirements | 07/2007 |
| ITU-T (Q.14/15) | G.7710/Y.1701 (Corrig. 1) | Common equipment management function requirements | 11/2009 |
| ITU-T (Q.14/15) | G.7710/Y.1701 (Amend. 1) | Common equipment management function requirements | 07/2010 |
| ITU-T (Q.14/15) | G.7710/Y.1701 (Erratum. 1) | Common equipment management function requirements | 05/2011 |
| ITU-T (Q.14/15) | G.7710/Y.1701 (Corrig. 1) | Common equipment management function requirements | 04/2011 |
| ITU-T (Q.14/15) | G.7712/Y.1703 | Architecture and specification of data communication network | 07/2010 |
| ITU-T (Q.14/15) | G.7713/Y.1704 | Distributed call and connection management (DCM) | 11/2009 |
| ITU-T (Q.14/15) | G.Imp7713/ Y.1704 | Implementer's Guide to G.7713/Y.1704 | 05/2005 |
| ITU-T (Q.14/15) | G.7713.1/ Y.1704.1 | Distributed Call and Connection Management (DCM) based on PNNI | 03/2003 |
| ITU-T (Q.14/15) | G.Imp7713.1/ Y.1704.1 | Implementer's Guide to G.7713.1/Y.1704.1 | 05/2005 |
| ITU-T (Q.14/15) | G.7713.2/ Y.1704.2 | Distributed Call and Connection Management: Signalling mechanism using GMPLS RSVP-TE | 03/2003 |
| ITU-T (Q.14/15) | G.Imp7713.2/ Y.1704.2 | Implementer's Guide to G.7713.2/Y.1704.2 | 05/2005 |
| ITU-T (Q.14/15) | G.7713.3/ Y.1704.3 | Distributed Call and Connection Management: Signalling mechanism using GMPLS CR-LDP | 03/2003 |
| ITU-T (Q.14/15) | G.Imp7713.3/ Y.1704.3 | Implementer's Guide to G.7713.3/Y.1704.3 | 05/2005 |
| ITU-T (Q.14/15) | G.7714/Y.1705 | Generalized automatic discovery for transport entities | 08/2005 |
| ITU-T (Q.14/15) | G.7714.1/ Y.1705.1 | Protocol for automatic discovery in SDH and OTN networks | 04/2003 |
| ITU-T (Q.14/15) | G.7714.1/ Y.1705.1 (Amend. 1) | Protocol for automatic discovery in SDH and OTN networks | 07/2010 |
| ITU-T (Q.14/15) | G.Imp7714.1/ Y.1705.1 | Implementer's Guide to G.7714.1/Y.1705.1 | 05/2005 |
| ITU-T (Q.14/15) | G.7715/Y.1706 | Architecture and requirements for routing in automatically switched optical networks | 06/2002 |
| ITU-T (Q.14/15) | G.7715/Y.1706 (Amend. 1) | Architecture and requirements for routing in automatically switched optical networks | 02/2007 |
| ITU-T (Q.14/15) | G.7715.1/Y.1706.1 | ASON routing architecture and requirements for link state protocols | 02/2004 |
| ITU-T (Q.14/15) | G.7715.2/Y.1706.2 | ASON routing architecture and requirements for remote route query | 02/2007 |
| ITU-T (Q.14/15) | G.7716/Y.1707 | Architecture of Control Plane Operations | 01/2010 |
| ITU-T (Q.14/15) | G.7718/Y.1709 | Framework for ASON management | 07/2010 |
| ITU-T (Q.14/15) | G.7718.1/Y.1709.1 | Protocol-neutral management information model for the control plane view | 12/2006 |
| ITU-T (Q.14/15) | G.8051/Y.1345 | Management aspects of the Ethernet-over-Transport (EoT) capable network element | 11/2009 |
| ITU-T (Q.14/15) | G.8051/Y.1345 (Amend. 1) | Management aspects of the Ethernet-over-Transport (EoT) capable network element | 06/2011 |
| ITU-T (Q.14/15) | G.8151/Y.1374 \* | Management aspects of the T-MPLS network element | 10/2007 |
| ITU-T (Q.15/15) | O.172 | Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH) | 04/2005 |
| ITU-T (Q.15/15) | O.172 (Erratum 1) | Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH) | 10/2005 |
| ITU-T (Q.15/15) | O.172 (Amend. 1) | Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH) | 06/2008 |
| ITU-T (Q.15/15) | O.172 (Amend. 1) | Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH) | 07/2010 |
| ITU-T (Q.15/15) | O.173 | Jitter measuring equipment for digital systems which are based on the Optical Transport Network (OTN) | 03/2007 |
| ITU-T (Q.15/15) | O.173 (Amend. 1) | Jitter measuring equipment for digital systems which are based on the Optical Transport Network (OTN) | 07/2010 |
| ITU-T (Q.15/15) | O.174 | Jitter and wander measuring equipment for a synchronous packet network | 11/2009 |
| ITU-T (Q.15/15) | O.174 (Corrig. 1) | Jitter and wander measuring equipment for a synchronous packet network | 07/2010 |
| ITU-T (Q.15/15) | O.174 (Amend. 1) | Jitter and wander measuring equipment for a synchronous packet network | 04/2011 |
| ITU-T (Q.15/15) | O.182 | Equipment to assess error performance on Optical Transport Network interfaces | 07/2007 |
| ITU-T (Q.15/15) | O.182 (Amend. 1) | Equipment to assess error performance on Optical Transport Network interfaces | 01/2009 |
| ITU-T (Q.15/15) | O.201 | Q-factor test equipment to estimate the transmission performance of optical channels | 07/2003 |

\* The next update of these Recommendations will only describe MPLS-TP and will include normative references to IETF MPLS-TP RFCs under development to meet ITU-T transport requirements.

Table 7-1-2 below lists IETF RFCs and Internet Drafts. It should be noted that all Internet-Drafts should be identified as "work in progress". This request is made, as standard, by the IETF in the following text at the head of every Internet-Draft:

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

TABLE 7-1-2/OTNT: OTNT Related Standards and Industry Agreements (IETF RFCs and Internet Drafts)

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| IETF (mpls) | RFC5317 | JWT Report on MPLS Architectural Considerations for a Transport Profile | 02/2009 |
| IETF (mpls) | RFC5586 | MPLS Generic Associated Channel | 06/2009 |
| IETF (mpls) | RFC5654 | MPLS-TP Requirements | 08/2009 |
| IETF (mpls) | RFC5718 | An Inband Data Communication Network For the MPLS Transport Profile | 08/2009 |
| IETF (mpls) | RFC5860 | Requirements for OAM in MPLS Transport Networks | 03/2010 |
| IETF (mpls) | RFC5921 | A Framework for MPLS in Transport Networks | 07/2010 |
| IETF (mpls) | RFC5951 | MPLS TP Network Management Requirements | 9/2010 |
| IETF (mpls) | RFC6372 | Multiprotocol Label Switching Transport Profile Survivability Framework | 09/2011 |
| IETF (mpls) | RFC6371 | Operations, Administration and Maintenance Framework for MPLS-based Transport Networks | 09/2011 |
| IETF (mpls) | RFC5950 | MPLS-TP Network Management Framework | 09/2010 |
| IETF (mpls) | RFC6291 | Guidelines for the use of the OAM acronym in the IETF | 06/2011 |
| IETF (mpls) | RFC5960 | MPLS Transport Profile Data Plane Architecture | 08/2010 |
| IETF (mpls) | RFC6370 | MPLS-TP Identifiers | 9/2011 |
| IETF() | RFC6373 | MPLS-TP Control Plane Framework | 09/2011 |
| IETF (ccamp) | RFC 3468 | The Multiprotocol Label Switching (MPLS) Working Group decision on MPLS signaling protocols | 02/2003 |
| IETF (ccamp) | RFC 3609 | Tracing Requirements for Generic Tunnels | 09/2003 |
| IETF (ccamp) | RFC 3945 | Generalized Multi-Protocol Label Switching Architecture | 10/2004 |
| IETF (ccamp) | RFC 4003 | GMPLS Signaling Procedure For Egress Control – updates RFC 3473 | 02/2005 |
| IETF (ccamp) | RFC 4139 | Requirements for Generalized MPLS (GMPLS) Signaling Usage and Extensions for Automatically Switched Optical Network (ASON) | 07/2005 |
| IETF (ccamp) | RFC 4201 | Link Bundling in MPLS Traffic Engineering (TE) | 10/2005 |
| IETF (ccamp) | RFC 4202 | Routing Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS) | 10/2005 |
| IETF (ccamp) | RFC 4203 | OSPF Extensions in Support of Generalized Multi-Protocol Label Switching – updates RFC 3630 | 10/2005 |
| IETF (ccamp) | RFC 4204 | Link Management Protocol (LMP) | 10/2005 |
| IETF (ccamp) | RFC 4207 | Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH) Encoding for Link Management Protocol (LMP) Test Messages | 10/2005 |
| IETF (ccamp) | RFC4208 | Generalize Multiprotocol Label Switching(GMPLS) User-Network Interface (UNI): Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Support for the Overlay Model | 10/2005 |
| IETF (ccamp) | RFC4209 | Link Management Protocol (LMP) for Dense Wavelength Division Multiplexing (DWDM) Optical Line Systems | 10/2005 |
| IETF (ccamp) | RFC4258 | Requirements for Generalized Multi-Protocol Label Switching (GMPLS) Routing for the Automatically Switched Optical Network (ASON) | 11/2005 |
| IETF (ccamp) | RFC4257 | Framework for Generalized Multi-Protocol Label Switching (GMPLS)-based Control of Synchronous Digital Hierarchy/Synchronous Optical Networking (SDH/SONET) Networks | 12/2005 |
| IETF (ccamp) | RFC4328 | Generalized Multi-Protocol Label Switching (GMPLS) Signaling Extensions for G.709 Optical Transport Networks Control – updates RFC 3471 | 01/2006 |
| IETF (ccamp) | RFC4394 | A Transport Network View of the Link Management Protocol | 02/2006 |
| IETF (ccamp) | RFC4397 | A Lexicography for the Interpretation of Generalized Multiprotocol Label Switching (GMPLS) Terminology within The Context of the ITU-T's Automatically Switched Optical Network (ASON) Architecture | 02/2006 |
| IETF (ccamp) | RFC4426 | Generalized Multi-Protocol Label Switching (GMPLS) Recovery Functional Specification | 03/2006 |
| IETF (ccamp) | RFC4427 | Recovery (Protection and Restoration) Terminology for Generalized Multi-Protocol Label Switching (GMPLS) | 03/2006 |
| IETF (ccamp) | RFC4428 | Analysis of Generalized Multi-Protocol Label Switching (GMPLS)-based Recovery Mechanisms (including Protection and Restoration) | 03/2006 |
| IETF (ccamp) | RFC4558 | Node ID based RSVP Hello: A Clarification Statement | 06/2006 |
| IETF (ccamp) | RFC4606 | Generalized Multi-Protocol Label Switching (GMPLS) Extensions for Synchronous Optical Network (SONET) and Synchronous Digital Hierarchy (SDH) Control | 08/2006 |
| IETF (ccamp) | RFC4631 | Link Management Protocol (LMP) Management Information Base (MIB) – updates RFC4327 | 09/2006 |
| IETF (ccamp) | RFC4652 | Evaluation of existing Routing Protocols against ASON routing requirements | 10/2006 |
| IETF (ccamp) | RFC4726 | A Framework for Inter-Domain MPLS Traffic Engineering | 11/2006 |
| IETF (ccamp) | RFC4736 | Reoptimization of Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) loosely routed Label Switch Path (LSP) | 11/2006 |
| IETF (ccamp) | RFC4783 | GMPLS – Communication of Alarm Information | 12/2006 |
| IETF (ccamp) | RFC4801 | Definitions of Textual Conventions for Generalized Multiprotocol Label Switching (GMPLS) Management | 02/2007 |
| IETF (ccamp) | RFC4802 | Generalized Multiprotocol Label Switching (GMPLS) Traffic Engineering Management Information Base | 02/2007 |
| IETF (ccamp) | RFC4803 | Generalized Multiprotocol Label Switching (GMPLS) Label Switching Router (LSR) Management Information Base | 02/2007 |
| IETF (ccamp) | RFC4872 | RSVP-TE Extensions in support of End-to-End Generalized Multi-Protocol Label Switching (GMPLS)-based Recovery | 05/2007 |
| IETF (ccamp) | RFC4873 | GMPLS Based Segment Recovery | 05/2007 |
| IETF (ccamp) | RFC4874 | Exclude Routes – Extension to RSVP-TE | 04/2007 |
| IETF (ccamp) | RFC4920 | Crankback Signaling Extensions for MPLS and GMPLS RSVP-TE | 07/2007 |
| IETF (ccamp) | RFC4972 | Routing extensions for discovery of Multiprotocol (MPLS) Label Switch Router (LSR) Traffic Engineering (TE) mesh membership | 07/2007 |
| IETF (ccamp) | RFC4974 | Generalized MPLS (GMPLS) RSVP-TE Signaling Extensions in support of Calls | 08/2007 |
| IETF (ccamp) | RFC4990 | Use of Addresses in Generalized Multi-Protocol Label Switching (GMPLS) Networks | 09/2007 |
| IETF (ccamp) | RFC5063 | Extensions to GMPLS RSVP Graceful Restart | 10/2007 |
| IETF (ccamp) | RFC5073 | IGP Routing Protocol Extensions for Discovery of Traffic Engineering Node Capabilities | 12/2007 |
| IETF (ccamp) | RFC5145 | Framework for MPLS-TE to GMPLS Migration | 03/2008 |
| IETF (ccamp) | RFC5146 | Interworking Requirements to Support Operation of MPLS-TE over GMPLS Networks | 03/2008 |
| IETF (ccamp) | RFC5150 | Label Switched Path Stitching with Generalized Multiprotocol Label Switching Traffic Engineering (GMPLS TE) | 02/2008 |
| IETF (ccamp) | RFC5151 | Inter-Domain MPLS and GMPLS Traffic Engineering -- Resource Reservation Protocol-Traffic Engineering (RSVP-TE) Extensions | 02/2008 |
| IETF (ccamp) | RFC5152 | A Per-Domain Path Computation Method for Establishing Inter-Domain Traffic Engineering (TE) Label Switched Paths (LSPs) | 02/2008 |
| IETF (ccamp) | RFC5212 | Requirements for GMPLS-Based Multi-Region and Multi-Layer Networks (MRN/MLN) | 07/2008 |
| IETF (ccamp) | RFC5298 | Analysis of Inter-Domain Label Switched Path (LSP) Recovery | 08/2008 |
| IETF (ccamp) | RFC5316 | ISIS Extensions in Support of Inter-Autonomous System (AS) MPLS and GMPLS Traffic Engineering | 12/2008 |
| IETF (ccamp) | RFC5339 | Evaluation of Existing GMPLS Protocols against Multi-Layer and Multi-Region Networks (MLN/MRN) | 09/2008 |
| IETF (ccamp) | RFC5392 | OSPF Extensions in Support of Inter-Autonomous System (AS) MPLS and GMPLS Traffic Engineering | 01/2009 |
| IETF (ccamp) | RFC5420 (replaces RFC4420) | Encoding of Attributes for MPLS LSP Establishment Using Resource Reservation Protocol Traffic Engineering (RSVP-TE) | 02/2009 |
| IETF (ccamp) | RFC5467 | GMPLS Asymmetric Bandwidth Bidirectional Label Switched Paths (LSPs) | 03/2009 |
| IETF (ccamp) | RFC5493 | Requirements for the Conversion between Permanent Connections and Switched Connections in a Generalized Multiprotocol Label Switching (GMPLS) Network | 04/2009 |
| IETF (ccamp) | RFC5495 | Description of the Resource Reservation Protocol - Traffic-Engineered (RSVP-TE) Graceful Restart Procedures | 03/2009 |
| IETF (ccamp) | RFC5553 | Resource Reservation Protocol (RSVP) Extensions for Path Key Support | 05/2009 |
| IETF (ccamp) | [draft-ietf-ccamp-gmpls-g-694-lambda-labels-04.txt](http://www.ietf.org/internet-drafts/draft-ietf-ccamp-gmpls-g-694-lambda-labels-02.txt) | Generalized Labels for G.694 Lambda-Switching Capable Label Switching Routers | 03/2009 |
| IETF (ccamp) | draft-ietf-ccamp-ethernet-traffic-parameters-08.txt | Ethernet Traffic Parameters | 04/2009 |
| IETF (ccamp) | draft-ietf-ccamp-wson-impairments-00.txt | A Framework for the Control of Wavelength Switched Optical Networks (WSON) with Impairments | 06/2009 |
| IETF (ccamp) | draft-ietf-ccamp-ethernet-gmpls-provider-reqs-02.txt | Service Provider Requirements for Ethernet control with GMPLS | 06/2009 |
| IETF (ccamp) | draft-ietf-ccamp-rwa-wson-encode-02.txt | Routing and Wavelength Assignment Information Encoding for Wavelength Switched Optical Networks | 07/2009 |
| IETF (ccamp) | draft-ietf-ccamp-pc-spc-rsvpte-ext-03.txt | RSVP-TE Signaling Extension For Management Plane To Control Plane LSP Handover In A GMPLS Enabled Transport Network | 07/2009 |
| IETF (ccamp) | draft-ietf-ccamp-gmpls-mln-extensions-07.txt | Generalized Multi-Protocol Label Switching (GMPLS) Protocol Extensions for Multi-Layer and Multi-Region Networks (MLN/MRN) | 08/2009 |
| IETF (ccamp) | RFC5787 | OSPFv2 Routing Protocols Extensions for ASON Routing | 03/2010 |
| IETF (ccamp) | draft-ietf-ccamp-confirm-data-channel-status-07.txt | Data Channel Status Confirmation Extensions for the Link Management Protocol | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-rwa-wson-framework-03.txt | Framework for GMPLS and PCE Control of Wavelength Switched Optical Networks (WSON) | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-lsp-dppm-08.txt | Label Switched Path (LSP) Dynamic Provisioning Performance Metrics in Generalized MPLS Networks | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-rwa-info-04.txt | Routing and Wavelength Assignment Information Model for Wavelength Switched Optical Networks | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-gmpls-ethernet-arch-05.txt | Generalized Multi-Protocol Label Switching (GMPLS) Ethernet Label Switching Architecture and Framework | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-mpls-graceful-shutdown-10.txt | Graceful Shutdown in MPLS and Generalized MPLS Traffic Engineering Networks | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-gmpls-vcat-lcas-08.txt | Operating Virtual Concatenation (VCAT) and the Link Capacity Adjustment Scheme (LCAS) with Generalized Multi-Protocol Label Switching (GMPLS) | 07/2009 |
| IETF (ccamp) | draft-ietf-ccamp-gmpls-ted-mib-05.txt | Traffic Engineering Database Management Information Base in support of GMPLS | 01/2009 |
| IETF (ccamp) | draft-ietf-ccamp-rwa-info-04.txt | Routing and Wavelength Assignment Information Model for Wavelength Switched Optical Networks | 09/2009 |
| IETF (ccamp) | draft-ietf-ccamp-oam-configuration-fwk-03 | OAM Configuration Framework and Requirements for GMPLS RSVP-TE | 01/2010 |
| IETF (pce) | RFC 4655 | A Path Computation Element (PCE) Based Architecture | 08/2006 |
| IETF (pce) | RFC 4657 | Path Computation Element (PCE) Communication Protocol Generic Requirements | 09/2006 |
| IETF (pce) | RFC 4674 | Requirements for Path Computation Element (PCE) Discovery | 10/2006 |
| IETF (pce) | RFC4927 | PCE Communication Protocol (PCECP) Specific Requirements for Inter-Area Multi Protocol Label Switching (MPLS) and Generalized MPLS (GMPLS) Traffic Engineering | 07/2007 |
| IETF (pce) | RFC 5088 | OSPF Protocol Extensions for Path Computation Element (PCE) Discovery | 01/2008 |
| IETF (pce) | RFC 5089 | IS-IS Protocol Extensions for Path Computation Element (PCE) Discovery | 01/2008 |
| IETF (pce) | RFC 5376 | Inter-AS Requirements for the Path Computation Element Communication Protocol (PCECP) | 11/2008 |
| IETF (pce) | RFC 5394 | Policy-Enabled Path Computation Framework | 12/2008 |
| IETF (pce) | RFC 5440 | Path Computation Element (PCE) Communication Protocol (PCEP) | 03/2009 |
| IETF (pce) | RFC 5441 | A Backward-Recursive PCE-Based Computation (BRPC) Procedure to Compute Shortest Constrained Inter-Domain Traffic Engineering Label Switched Paths | 04/2009 |
| IETF (pce) | RFC 5455 | Diffserv-Aware Class-Type Object for the Path Computation Element Communication Protocol | 03/2009 |
| IETF (pce) | draft-ietf-pce-vpn-req-00.txt | PCC-PCE Communication Requirements for VPNs | 03/2009 |
| IETF (pce) | RFC 5520 | Preserving Topology Confidentiality in Inter-Domain Path Computation Using a Path-Key-Based Mechanism | 04/2009 |
| IETF (pce) | RFG 5521 | Extensions to the Path Computation Element Communication Protocol (PCEP) for Route Exclusions | 04/2009 |
| IETF (pce) | RFC 5541 | Encoding of Objective Functions in the Path Computation Element Communication Protocol (PCEP) | 06/2009 |
| IETF (pce) | draft-ietf-pce-monitoring-05.txt | A set of monitoring tools for Path Computation Element based Architecture | 06/2009 |
| IETF (pce) | RFC 5557 | Path Computation Element Communication Protocol (PCEP) Requirements and Protocol Extensions in Support of Global Concurrent Optimization | 07/2009 |
| IETF (pce) | draft-ietf-pce-gmpls-aps-req-01.txt | Requirements for GMPLS applications of PCE | 07/2009 |
| IETF (pce) | draft-ietf-pce-manageability-requirements-07.txt | Inclusion of Manageability Sections in PCE Working Group Drafts | 07/2009 |
| IETF (pce) | draft-ietf-pce-vendor-constraints-00.txt | Conveying Vendor-Specific Constraints in the Path Computation Element Protocol | 07/2009 |
| IETF (pce) | draft-ietf-pce-pcep-svec-list-02.txt | The use of SVEC (Synchronization VECtor) list for Synchronized dependent path computations | 08/2009 |
| IETF (pce) | draft-ietf-pce-inter-layer-req-10.txt | PCC-PCE Communication Requirements for Inter-Layer Traffic Engineering | 08/2009 |
| IETF (pce) | draft-ietf-pce-inter-layer-frwk-10.txt | Framework for PCE-Based Inter-Layer MPLS and GMPLS Traffic Engineering | 03/2009 (awaiting RFC #) |
| IETF(opsawg) | draft-ietf-opsawg-mpls-tp-oam-def-05.txt | "The OAM Acronym Soup" | 05/2010 |

TABLE 7-1-3/OTNT: OTNT Related Standards and Industry Agreements (IEEE 802 standards)

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| IEEE 802 | IEEE802 | IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture | 02/2002 |
| IEEE 802.1 | IEEE Std. 802.1D-2004 | Media access control (MAC) Bridges (Incorporates IEEE 802.1t-2001 and IEEE 802.1w) | 06/2004 |
| IEEE 802.1 | IEEE Std. 802.1Q-2005 | Virtual Bridged Local Area Networks—Revision | 05/2006 |
| IEEE 802.1 | IEEE 802.1Q-2005/Cor1-2008 | Virtual Bridged Local Area Networks - Corrigendum 1: Corrections to the Multiple Registration Protocol | 10/2008 |
| IEEE 802.1 | IEEE Std. 802.1ad-2005 | Amendment to IEEE 802.1Q-2005. Virtual Bridged Local Area Networks—Revision—Amendment 4: Provider Bridges | 05/2006 |
| IEEE 802.1 | IEEE Std. 802.1ag-2007 | Virtual Bridged Local Area Networks Amendment 5: Connectivity Fault Management | 12/2007 |
| IEEE 802.1 | IEEE Std. 802.1ah-2008 | Virtual Bridged Local Area Networks Amendment 6: Provider Backbone Bridges | 08/2008 |
| IEEE 802.1 | IEEE 802.1ak-2007 | Amendment 7: Multiple Registration Protocol | 06/2007 |
| IEEE 802.1 | IEEE 802.1ap-2008 | Virtual Bridged Local Area Networks - Amendment 8: Management Information Base (MIB) Definitions for VLAN Bridges | 03/2009 |
| IEEE 802.1 | IEEE Std 802.1 AX-2008 | Link Aggregation | 11/2008 |
| IEEE 802.1 | IEEE Std. 802.1Qaw-2009 | Virtual Bridged Local Area Networks -Amendament 9: Management of Data Driven and Data Dependent Connectivity Faults – | 07/2009 |
| IEEE 802.1 | IEEE Std. 802.1Qay-2009 | Virtual Bridged Local Area Networks - Amendment 10: Provider Backbone Bridge Traffic Engineering | 06/2009 |
| IEEE 802.1 | IEEE Std 802.1aj | Virtual Bridged Local Area Networks –Amendament 11, Two-Port Media Access Control (MAC) Relay | 12/2009 |
| IEEE 802.3 | IEEE Std. 802.3-2008 | Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications | 12/2008 |
| IEEE 802.3 | IEEE Std 802.3at-2009 | Amendment to 802.3： Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements | 10/2009 |
| IEEE 802.3 | IEEE Std. 802.3av-2009 | Amendment to 802.3: Physical Layer Specifications and Management Parameters for 10 Gb/s Passive Optical Networks | 10/2009 |
| IEEE802.3 | IEEE Std 802.3ba | 40Gb/s and 100Gb/s Ethernet | 06/2010 |
| IEEE802.3 | IEEE Std 802.3az | Energy Efficient Ethernet | 10/2010 |
| IEEE 802.3 | IEEE Std 802.3bc-2009 | Amendament to 802.3: Ethernet Organizationally Specific Type, Lengh, Value(TLVs) | 09/2009 |
| IEEE 802.3 | IEEE Std 802.3-2008/Cor1-2009 | Corrigendum to 802.3: Timing Considerations for PAUSE Operation | 02/2010 |
| IEEE 802.17 | IEEE Std. 802.17-2004 | Resilient packet ring (RPR) access method and physical layer specifications | 09/2004 |
| IEEE 802.17 | IEEE Std. 802.17a-2004 | Media Access Control (MAC) Bridges - Amendment 1: Bridging of IEEE Std 802.17 | 09/2004 |
| IEEE 802.17 | IEEE Std. 802.17b-2007 | Resilient packet ring (RPR) access method and physical layer specifications - Amendment 2: Spatially aware sublayer | 07/2007 |
| IEEE 802.17 | IEEE Std. 802.17c-2009 | Resilient Packet Ring (RPR) Access Method and Physical Layer Specifications - Amendment 3 - Protected Inter-Ring Connection | 09/2009 (Sponsor Ballot) |

TABLE 7-1-4/OTNT: OTNT Related Standards and Industry Agreements (OIF documents)

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| OIF | OIF-TL-01.1 | Implementation Agreement for Common Software Protocol, Control Syntax, and Physical (Electrical and Mechanical) Interfaces for Tunable Laser Modules. | 11/2002 |
| OIF | OIF-TLMSA-01.0 | Multi-Source Agreement for CW Tunable Lasers. | 05/2003 |
| OIF | OIF-ITLA-MSA-01.0 | Integratable Tunable Laser Assembly Multi-Source Agreement. | 06/2004 |
| OIF | OIF-ITLA-MSA-01.1 | Integrable Tunable Laser Assembly Multi Source Agreement | 11/2005 |
| OIF | OIF-ITLA-MSA-01.2 | Integrable Tunable Laser Assembly Multi Source Agreement | 06/2008 |
| OIF | OIF-ITTA-MSA-01.0 | Integrable Tunable Transmitter Assembly Multi Source Agreement | 11/2008 |
| OIF | OIF-UNI-01.0 | User Network Interface (UNI) 1.0 Signaling Specification | 10/2001 |
| OIF | OIF-UNI-01.0-R2-Common | User Network Interface (UNI) 1.0 Signaling Specification, Release 2: Common Part | 02/2004 |
| OIF | OIF-UNI-01.0-R2-RSVP | RSVP Extensions for User Network Interface (UNI) 1.0 Signaling, Release 2 | 02/2004 |
| OIF | OIF-UNI-02.0-Common | User Network Interface (UNI) 2.0 Signaling Specification: Common Part | 02/2008 |
| OIF | OIF-UNI-02.0-RSVP | User Network Interface (UNI) 2.0 Signaling Specification: RSVP Extensions for User Network Interface (UNI) 2.0 | 02/2008 |
| OIF | OIF-CDR-01.0 | Call Detail Records for OIF UNI 1.0 Billing | 04/2002 |
| OIF | OIF-SEP-01.0 | Security Extension for UNI and NNI | 05/2003 |
| OIF | OIF-SEP-02.1 | Addendum to the Security Extension for UNI and NNI | 03/2006 |
| OIF | OIF-SLG-01.0 | OIF Control Plane Logging and Auditing with Syslog | 11/2007 |
| OIF | OIF-E-NNI-Sig-01.0 | Intra-Carrier E-NNI Signaling Specification | 02/2004 |
| OIF | OIF-E-NNI-Sig-02.0 | E-NNI Signaling Specification | 04/2009 |
| OIF | OIF-ENNI-OSPF-01.0 | External Network-Network Interface (E-NNI) OSPF-based Routing - 1.0 (Intra-Carrier) Implementation Agreement | 01/2007 |
| OIF | OIF-G-Sig-IW-01.0 | OIF Guideline Document: Signaling Protocol Interworking of ASON/GMPLS Network Domains | 06/2008 |
| OIF | OIF-SMI-01.0 | Security Management Interfaces to Network Elements | 09/2003 |
| OIF | OIF-SMI-02.1 | Addendum to the Security for Management Interfaces to Network Elements | 03/2006 |
| OIF | OIF-VSR4-01.0 | Very Short Reach (VSR) OC-192 Interface for Parallel Optics | 12/2000 |
| OIF | OIF-VSR4-03.0 | Very Short Reach (VSR) OC-192 Four Fiber Interface Based on Parallel Optics | 07/2003 |
| OIF | OIF-VSR4-04.0 | Serial Shortwave Very Short Reach (VSR) OC-192 Interface for Multimode Fiber | 01/2001 |
| OIF | OIF-VSR4-05.0 | Very Short Reach (VSR) OC-192 Interface Using 1310 Wavelength and 4 and 11 dB Link Budgets | 10/2002 |
| OIF | OIF-VSR5-01.0 | Very Short Reach Interface Level 5 (VSR-5): SONET/SDH OC-768 Interface for Very Short Reach (VSR) Applications | 09/2002 |
| OIF | OIF-LRI-02.0 | Interoperability for Long Reach and Extended Reach 10 Gb/s Transponders and Transceivers | 07/2006 |
| OIF | OIF-FD-100G-DWDM-01.0 | 100G Ultra Long Haul DWDM Framework Document | 06/2009 |

TABLE 7-1-5/OTNT: OTNT Related Standards and Industry Agreements (MEF documents)

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| MEF | MEF 4 | Metro Ethernet Network Architecture Framework Part 1: Generic Framework | 05/2004 |
| MEF | MEF6 .1 | Metro Ethernet Services Definitions Phase 2 | 04/2008 |
| MEF | MEF 10.2 | MEF 10.2 Ethernet Services Attributes Phase 2 | 10/2009 |
| MEF | MEF12.1 | Carrier Ethernet Network Architecture Framework Part 2: Ethernet Services Layer - Basic Elements | 04/2010 |
| MEF | MEF17 | Service OAM Framework and Requirements | 04/2007 |
| MEF | MEF26 | External Network Network Interface (ENNI)–Phase 1 | 01/2010 |

## 7.2 SDH & SONET Related Recommendations and Standards

The following table lists all the known documents specifically related to SDH and SONET.

TABLE 7-2/OTNT: SDH & SONET Recommendations & Industry Standards

|  | | **ITU-T Published  Recommendation** | | **Published or Draft (Revised)  ETS or EN** | | **Published or Draft (Revised)  ATIS/ANSI** | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Internet Document Source | | http://www.itu.int/publications/itut.htm | | http://www.etsi.org/WebSite/Standards/Standard.aspx | | http://www.atis.org/docstore/default.aspx | |
| Physical Interfaces | | G.703 (11/01), Cor. 1 (03/08) G.957 (3/06),  G.692 (10/98), Cor.1(01/00),Cor.2(06/02), Amd1(01/05)  G.691 (03/06) | | ETS 300 166 ETS 300 232, ETS 300 232(A1) ETS 300 166 (09/99) | | ATIS-0900102.1993(R2005)  ATIS-0900105.06.2002 (R2007) ATIS-0600416.1999(R2005) ATIS-0600416.01.1999 (R2005) ATIS-0600416.02.1999 (R2005) ATIS-0600416.03.1999 (R2005) | |
| Network Architecture | | G.805 (03/00) G.803 (03/00), Amd1 (06/05) | | ETR 114 | | ATIS-0900105.04.1995 (R2005) | |
| Structures & Mappings | | G.704 (10/98)  G.707 (01/07) , Amd1(07/07), Amd2(11/09)  G.7041 (10/08), Amd1 (01/09)  G.7042 (03/06)  G.708 (07/99)  G.832 (10/98), Amd1 (06/04) | | ETS 300 167 (08/93), (09/99) ETS 300 147 Ed.3 ETS 300 337 Ed.2 | | ATIS-0900105.2008 (01/08)  ATIS-0900105.02.2007 (09/07) | |
| Equipment Functional Characteristics | | G.781 (09/08), Corr1(11/09) G.783 (03/06), Err1(11/06), Amd1(05/08), Amd2(03/10) G.806 (01/09) | | EN 300 417-x-y (x=1-7,9 y=1-2) ETS 300 635 ETS 300 785 RE/TM-1042-x-1 (x=1-5) MI/TM-4048 (9712) | | - | |
| Laser Safety | | G.664 (03/06) | | - | | - | |
| Transmission Protection | | G.841 (10/98), Corr1 (08/02) G.842 (04/97)  G.808.1 (02/10) M.2102 (02/00) | | ETS 300 746 ETS 300 417-1-1 ETS 300 417-3-1 ETS 300 417-4-1 TS 101 009 TS 101 010 RE/TM-1042 TR/TM-03070 | | ATIS-0900105.01.2000 (R2005) | |
| Equipment Protection | | M.3100 (04/05) | | - | | - | |
| Restoration | | - | | DTR/TM-3076 | | - | |
| Equipment Management | | G.784 (03/08) | | EN 301 167 EN 300 417-7-1 DE/TM-2210-3 | | - | |
| Management Communications Interfaces | |  | |  | | ATIS-0900105.04.1995 (R2005) | |
| Information Model | | G.773 (03/93) G.774 (02/01) G.774.1 (02/01) G.774.2 (02/01) G.774.3 (02/01) G.774.4 (02/01) G.774.5 (02/01) G.774.6 (02/01) G.774.7 (02/01) G.774.8 (02/01) G.774.9 (02/01) G.774.10 (02/01) | | ETS 300 304 Ed.2 ETS 300 484 ETS 300 413 ETS 300 411 ETS 300 493 prEN 301 155 | | ATIS-0900119.2006 (07/06) ATIS-0900119.01.2006 (06/06) ATIS-0900119.02.2006 (06/06) ATIS-0300245.1997 (R2008) | |
| Network Management | | G.831 (03/00) G.85x.y (11/96) | | ETS 300 810 | | ATIS-0300204.2008 (06/08) | |
| Error Performance [network level view] | | G.826 (12/02) G.827 (09/03) G.828 (03/00), Corr1 (07/01) G.829 (12/02), Corr1 (07/07) M.2101 (06/03) M.2102 (02/00) M.2110 (07/02) M.2120 (07/02) M.2130 (02/00) M.2140 (02/00) | | EN 301 167 | | ATIS-0900105.05.2002 (R2008) ATIS-0100514.2009 (03/09) | |
| Error Performance [equipment level view] | | G.783 (03/06), Err1 (11/06), Amd1(05/08), Amd2(03/10) G.784 (03/08) | | EN 300 417-x-1 RE/TM-1042 | | - | |
| Jitter & Wander Performance | | G.813 (03/03), Corr1 (06/05) G.822 (11/88) G.823 (03/00)  G.824 (03/00) G.825 (03/00), Err1 (08/01), Amd1 (05/08) G.783 (03/06), Err1 (11/06), Amd1(05/08) , Amd2(03/10)  O.171 (04/97)  O.172 (04/05), Err1 (10/05), Amd1 (06/08) | | EN 300 462-5-1 EN 302 084 (01/99) DEN/TM-1079 (05/98) | | ATIS-0900105.03.2003 (R2008) | |
| Leased Lines | | M.1301 (01/01) | | EN 301 164 EN 301 165 | | - | |
| Synchronisation [Clocks & Network Architecture] | | G.803 (03/00), Amd1 (06/05) G.810 (08/96), Corr1 (11/01) G.811 (09/97) G.812 (06/04), Err1 (03/05) G.813 (03/03), Corr1 (06/05) | | EN 300 462-1 EN 300 462-2 EN 300 462-3 EN 300 462-4 EN 300 462-5 EN 300 462-6 EN 300 417-6-1 DEG/TM-01080 (03/99) | | ATIS-0900101.2006 (11/06) ATIS-0900105.09.1996 (R2008) | |
| Test signals | | O.150 (05/96), Corr1 (05/02) O.181 (05/02) | | - | | - | |

## 7.3 ITU-T Recommendations on the OTN Transport Plane

The following table lists all of the known ITU-T Recommendations specifically related to the OTN Transport Plane. Many also apply to other types of optical networks.

TABLE 7-3/OTNT: ITU-T Recommendations on the OTN Transport Plane

|  | **ITU-T Published Recommendations** | **Publ.** |
| --- | --- | --- |
| Definitions | **G.870** Definitions and Terminology for Optical Transport Networks (OTN) | 03/08 |
| Framework for Recommendations | **G.871/Y.1301** Framework for Optical Transport Network Recommendations | 10/00 |
| Architectural Aspects | **G.872** Architecture of Optical Transport Networks | 11/01 |
| **G.872 Amendment 1** Architecture of Optical Transport Networks | 12/03 |
| Control Plane | ASTN/ASON recommendations are moved to specific ASTN/ASON standards page. |  |
| Structures & Mapping | **G.709/Y.1331** Network node interface for the optical transport network (OTN) | 12/09 |
|  | **G.709/Y.1331** Erratum 1 | 05/10 |
|  | **G.975** Forward Error Correction | 10/00 |
|  | **G.798** Characteristics of optical transport network (OTN) equipment functional blocks | 12/06 |
|  | **G.798 Amendment 1** | 12/08 |
|  | **G.798 Corrigendum 1** | 01/09 |
|  | **G.806** Characteristics of transport equipment - Description Methodology and Generic Functionality | 01/09 |
|  | **G.7041**Generic Framing Procedure | 10/08 |
|  | **G.7041 Amendment 1** | 01/09 |
|  | **G.7042** Link capacity adjustment scheme (LCAS) for virtual concatenated signals | 03/06 |
|  | **G.Sup43** Transport of IEEE 10GBASE-R in optical transport networks (OTN) | 01/09 |
| Protection Switching | **G.808.1** Generic protection switching - Linear trail and subnetwork protection | 03/06 |
| **G.808.1 Amendment 1** | 01/09 |
| **G.873.1** Optical Transport network (OTN) - Linear Protection | 03/06 |
| **G.Imp873.1** Implementer's Guide | 05/05 |
| Management Aspects | **G.874** Management aspects of the optical transport network element | 03/08 |
| **G.Imp874** Implementer's Guide | 05/05 |
| **G.874.1** Optical Transport Network (OTN) Protocol-Neutral Management Information Model For The Network Element View | 01/02 |
| **G.Imp874.1** Implementer's Guide | 05/05 |
| **G.7710/Y.1701** Common Equipment Management Requirements | 07/07 |
| **G.7714/Y.1705** Generalized automatic discovery for transport entities | 08/05 |
| **G.7714.1/Y.1705.1** Protocol for automatic discovery in SDH and OTN networks | 04/03 |
| **G.7714.1/Y.1705.1 Amendment 1** | 02/06 |
| Data Communication Network (DCN) | **G.7712/Y.1703** Architecture and specification of data communication network | 06/08 |
| Error Performance | **G.8201** Error performance parameters and objectives for multi-operator international paths within the Optical Transport Network (OTN) | 09/03 |
| **M.2401** Error Performance Limits and Procedures for Bringing-Into-Service and Maintenance of multi-operator international paths and sections within Optical Transport Networks | 12/03 |
| Jitter & Wander Performance | **G.8251** The control of jitter and wander within the optical transport network (OTN) | 11/01 |
| **G.8251 Corrigendum 1** | 06/02 |
| **G.8251 Amendment 1** The control of jitter and wander within the optical transport network (OTN) | 06/02 |
| **G.8251 Corrigendum 2** The control of jitter and wander within the optical transport network (OTN) | 05/08 |
| Physical-Layer Aspects | **G.664** General Automatic Power Shut-Down Procedures for Optical Transport Systems | 03/06 |
| **G.691** Optical Interfaces for single-channel STM-64 and other SDH systems with Optical Amplifiers, | 03/06 |
| **G.692** Optical Interfaces for Multichannel Systems with Optical Amplifiers | 10/98 |
| **G.692 Corrigendum 1** | 01/00 |
| **G.692 Corrigendum 2** | 06/02 |
| **G.692 Amendment 1** | 01/05 |
| **G.693** Optical interfaces for intra-office systems | 05/06 |
| **G.694.1** Spectral grids for WDM applications: DWDM frequency grid | 06/02 |
| **G.694.2** Spectral grids for WDM applications: CWDM wavelength grid | 12/03 |
| **G.695** Optical interfaces for Coarse Wavelength Division Multiplexing applications | 12/06 |
| **G.696.1** Intra-Domain DWDM applications | 07/05 |
| **G.696. 1 Erratum 1** | 03/06 |
| **G.697** Optical monitoring for DWDM system | 04/06 |
| **G.698.1** Multichannel DWDM applications with single-channel optical interfaces | 12/06 |
| **G.698.2** Amplified multichannel DWDM applications with single channel optical interfaces | 07/07 |
| **G.959.1** Optical Transport Networking Physical Layer Interfaces | 03/08 |
| **G.Sup.39** Optical System Design and Engineering Considerations | 12/08 |
| Fibres | **G.651.1** Characteristics of a 50/125 µm multimode graded index optical fibre cable for the optical access network | 07/07 |
| **G.652** Characteristics of a single-mode optical fibre and cable | 06/05 |
| **G.653** Characteristics of a dispersion-shifted single mode optical fibre and cable | 12/06 |
| **G.654** Characteristics of a cut-off shifted single-mode fibre and cable | 12/06 |
| **G.655** Characteristics of a non-zero dispersion shifted single-mode optical fibre and cable | 03/06 |
| **G.656** Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport | 12/06 |
| **G.657** Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network | 12/06 |
| **G.Sup40** Optical fibre and cable Recommendations and standards guideline | 11/06 |
| Components & Sub-systems | **G.661** Definition and test methods for the relevant generic parameters of optical amplifier devices and subsystems | 07/07 |
| **G.662** Generic characteristics of optical amplifier devices and subsystems | 07/05 |
| **G.663** Application related aspects of optical amplifier devices and subsystems | 04/00 |
| **G.663 Amendment 1** | 01/03 |
| **G.665** Generic characteristics of Raman amplifiers and Raman amplified subsystems | 01/05 |
| **G.671** Transmission characteristics of optical components and subsystems | 01/09 |

## 7.4 Standards on the ASTN/ASON Control Plane

The following table lists ITU-T Recommendations specifically related to the ASTN/ASON Control Plane.

TABLE 7-4-1/OTNT: Standards on the ASTN/ASON Control Plane

| **Topic** | **Title** | **Publ.** |
| --- | --- | --- |
| Definitions | **G.8081/Y.1353** Definitions and Terminology for Automatically Switched Optical Networks (ASON) | 03/08 |
| Architecture | **G.8080/Y.1304** Architecture for the Automatic Switched Optical Network (ASON) | 06/06 |
| **G.8080/Y.1304 Erratum 1** | 04/07 |
| **G.8080/Y.1304 Corrigendum 1** | 09/07 |
| **G.8080/Y.1304 (2001) Amendment 1** | 03/08 |
| **G.Imp8080** Implementer's Guide | 05/05 |
|  |  |
| Protocol Neutral Specifications for key signalling elements | **G.7713/Y.1704** Distributed Call and Connection Management (DCM) | 05/06 |
| **G.Imp7713/Y.1704 Implementer's Guide** | 05/05 |
| **G.7713.1/Y.1704** Distributed Call and Connection Management based on PNNI | 03/03 |
| **G.Imp7713.1/Y.1704** Implementer's Guide | 05/05 |
| **G.7713.2/Y.1704** Distributed Call and Connection Management: Signalling mechanism using GMPLS RSVP-TE | 03/03 |
| **G.Imp7713.2/Y.1704** Implementer's Guide | 05/05 |
| **G.7713.3/Y.1704** Distributed Call and Connection Management : Signalling mechanism using GMPLS CR-LDP | 03/03 |
| **G.Imp7713.3/Y.1704** Implementer's Guide | 05/05 |
| **G.7714/Y.1705** Generalised automatic discovery for transport entities | 08/05 |
| **G.7714.1/Y.1705.1** Protocol for automatic discovery in SDH and OTN networks | 04/03 |
| **G.7714.1/Y.1705.1 Amendment 1** | 02/06 |
| **G.Imp7714.1** Implementer's Guide | 05/05 |
| **G.7715/Y.1706** Architecture and requirements for routing in automatically switched optical networks | 06/02 |
| **G.7715/Y.1706 Amendment 1** | 02/07 |
| **G.Imp7715** Implementer's Guide | 05/05 |
| **G.7715.1/Y.1706.1** ASON routing architecture and requirements for link state protocols | 02/04 |
| **G.Imp7715.1** Implementer's Guide | 05/05 |
| **G.7715.2/Y.1706.2** ASON routing architecture and requirements for remote route query | 02/07 |
| **G.7718/Y.1709** Framework for ASON Management | 02/05 |
| **G.7718.1/Y.1709.1** Protocol-neutral management information model for the control plane view | 12/06 |
| Data Communication Network (DCN) | **G. 7712/Y.1703** Architecture and specification of data communication network | 06/08 |

Table 7-4-2 shows the mapping of existing protocol-specific documents between ITU-T Recommendations and ones that were received from other organizations.



Table 7-4-2: Estimated mapping of protocol-specific documents in ITU-T ASON Recommendations

## 7.5 Standards on the Ethernet Frames, MPLS, Transport MPLS and MPLS-TP

The following tables 7-5, 7-6 and 7-7 list ITU-T Recommendations specifically related to Ethernet, MPLS and T-MPLS.

Table 7-5 Ethernet related Recommendations

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| SG12 (Q.17/12) | G.1563 | Ethernet frame transfer and availability performance | 01/2009 |
| SG13(Q.7/13) | Y.1415 | Ethernet-MPLS network interworking - User plane interworking | 02/2005 |
| SG15(Q.10/15) | Y.1730 | Requirements for OAM functions in Ethernet-based networks and Ethernet services | 01/2004 |
| SG15(Q.10/15) | Y.1731 | OAM functions and mechanisms for Ethernet based networks | 02/2008 |
| SG15(Q.3/15) | G.8001 | Terms and definitions for Ethernet frames over transport | 03/2008 |
| SG15(Q.12/15) | G.8010/Y.1306 | Architecture of Ethernet Layer Networks | 02/2004 |
| SG15(Q.12/15) | G.8010/Y.1306 | Amendment 1 to Recommendation G.8010/Y.1306 | 05/2006 |
| SG15(Q.12/15) | G.8010/Y.1306 | Erratum 1 to Recommendation G.8010/Y.1306 | 09/2007 |
| SG15(Q.12/15) | G.8010/Y.1306 | Erratum 2 to Recommendation G.8010/Y.1306 | 10/2007 |
| SG15(Q.10/15) | G.8011/Y.1307 | Ethernet service characteristics | 01/2009 |
| SG15(Q.10/15) | G.8011.1/Y.1307.1 | Ethernet private line service | 01/2009 |
| SG15(Q.10/15) | G.8011.2/Y.1307.2 | Ethernet Virtual Private Line Service | 01/2009 |
| SG15(Q.10/15) | G.8011.3/Y.1307.3 | Ethernet Virtual Private LAN Service | 02/2010 |
| SG15(Q.10/15) | G.8011.4/Y.1307.4 | Ethernet Virtual Private Routed Multipoint Service | 02/2010 |
| SG15(Q.10/15) | G.8011.5/Y.1307.5 | Ethernet Private LAN service | 02/2010 |
| SG15(Q.10/15) | G.8012/Y.1308 | Ethernet UNI and Ethernet NNI | 08/2004 |
| SG15(Q.10/15) | G.8012/Y.1308 | Amendment 1 to Recommendation G.8012/Y.1308 | 05/2006 |
| SG15(Q.9/15) | G.8021/Y.1341 | Characteristics of Ethernet transport network equipment functional blocks | 12/2007 |
| SG15(Q.9/15) | G.8021/Y.1341 (Amend. 1) | Amendment 1 to Recommendation G.8021/Y.1341 | 01/2009 |
| SG15(Q.9/15) | G.8021/Y.1341 (Amend. 2) | Amendment 2 to Recommendation G.8021/Y.1341 | 02/2010 |
| SG15(Q.9/15) | G.8031/Y.1342 | Ethernet linear protection switching | 11/2009 |
| SG15(Q.9/15) | G.8032/Y.1344 | Ethernet ring protection switching | 03/2010 |
| SG15(Q.14/15) | G.8051/Y.1345 | Management aspects of the Ethernet-over-Transport (EoT) capable network element | 11/2009 |
| SG15(Q.13/15) | G.8262/Y.1362 | Timing characteristics of synchronous Ethernet equipment slave clock (EEC) | 08/2007 |
| SG15(Q.13/15) | G.8262/Y.1362 (Amend 1) | Timing characteristics of synchronous Ethernet equipment slave clock (EEC) | 04/2008 |
| ITU-T (Q.13/15) | G.8262/Y.1362 (Amend. 2) | Timing characteristics of synchronous Ethernet equipment slave clock (EEC) | 01/2010 |

Table 7-6 MPLS related Recommendations

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| SG13(Q.3/13) | Y.1311.1 | Network-based IP VPN over MPLS architecture | 07/2001 |
| SG12 (Q.17/12) | Y.1561 | Performance and availability parameters for MPLS networks | 05/2004 |
| SG13(Q.4/13) | Y.2174 | Distributed RACF architecture for MPLS networks | 06/2008 |
| SG13(Q.4/13) | Y.2175 | Centralized RACF architecture for MPLS core networks | 11/2008 |
| SG13(Q.12/13) | Y.1411 | ATM-MPLS network interworking - Cell mode user plane interworking | 02/2003 |
| SG13(Q.12/13) | Y.1412 | ATM-MPLS network interworking - Frame mode user plane interworking | 11/2003 |
| SG13(Q.12/13) | Y.1413 | TDM-MPLS network interworking - User plane interworking | 03/2004 |
| SG13(Q.12/13) | Y.1413 (Corr. 1) | TDM-MPLS network interworking - User plane interworking | 10/2005 |
| SG13(Q.12/13) | Y.1414 | Voice services - MPLS network interworking | 07/2004 |
| SG13(Q.12/13) | Y.1415 | Ethernet-MPLS network interworking - User plane interworking | 02/2005 |
| SG13(Q.12/13) | Y.1415 (Amend. 1) | Ethernet-MPLS network interworking – User plane interworking | 04/2007 |
| SG13(Q.12/13) | Y.1416 | Use of virtual trunks for ATM/MPLS client/server control plane interworking | 06/2007 |
| SG13(Q.12/13) | Y.1417 | ATM and frame relay/MPLS control plane interworking: Client-server | 06/2007 |
| SG15(Q.10/15) | Y.1710 | Requirements for OAM functionality for MPLS networks | 11/2002 |
| SG15(Q.10/15) | Y.1711 | Operation & Maintenance mechanism for MPLS networks | 02/2004 |
| SG15(Q.10/15) | Y.1711 (Corr. 1) | Operation & Maintenance mechanism for MPLS networks | 02/2005 |
| SG15(Q.10/15) | Y.1711 (Amend. 1) | Operation & Maintenance mechanism for MPLS networks | 10/2005 |
| SG15(Q.10/15) | Y.1712 | OAM functionality for ATM-MPLS interworking | 01/2004 |
| SG15(Q.10/15) | Y.1713 | Misbranching detection for MPLS networks | 03/2004 |
| SG15(Q.10/15) | Y.1714 | MPLS management and OAM framework | 01/2009 |
| SG15(Q.9/15) | Y.1720 | Protection switching for MPLS networks | 12/2006 |
| SG15(Q.9/15) | Y.1720 (Amend. 1) | Protection switching for MPLS networks | 02/2008 |
| SG15(Q.12/15) | G.8110/Y.1370 | MPLS Layer Network Architecture | 01/2005 |

Table 7-7 T-MPLS related Recommendations

The next updates of the ITU-T Study Group Recommendations in Table 7-7 will only describe MPLS-TP and will include normative references to IETF MPLS-TP RFCs under development to meet ITU-T transport requirements.

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| SG15(Q.3/15) | G.8101/Y.1355 | Terms and Definitions for Transport MPLS | 12/2006 |
| SG15(Q.12/15) | G.8110.1/Y.1370.1 | Architecture of Transport MPLS (T-MPLS) layer network | 11/2006 |
| SG15(Q.12/15) | G.8110.1/Y.1370.1 (Amend. 1) | Architecture of Transport MPLS (T-MPLS) layer network | 07/2007 |
| SG15(Q.10/15) | G.8112/Y.1371 | Interfaces for the Transport MPLS (T-MPLS) hierarchy | 10/2006 |
| SG15(Q.10/15) | G.8112/Y.1371 (Corrig. 1) | Interfaces for the Transport MPLS (T-MPLS) hierarchy | 01/2007 |
| SG13(Q.5/13) | Y.Sup4 | Supplement on transport requirements for T-MPLS OAM and considerations for the application of IETF MPLS technology | 01/2008 |
| SG15(Q.9/15) | G.8121/Y.1381 | Characteristics of Transport MPLS (T-MPLS) equipment functional blocks | 03/2006 |
| SG15(Q.9/15) | G.8121/Y.1381 (Corrig. 1) | Characteristics of Transport MPLS (T-MPLS) equipment functional blocks | 12/2006 |
| SG15(Q.9/15) | G.8121/Y.1381 (Amend. 1) | Characteristics of Transport MPLS (T-MPLS) equipment functional blocks | 10/2007 |
| SG15(Q.9/15) | G.8131/Y.1382 | Linear protection switching for transport MPLS (T-MPLS) networks | 02/2007 |
| SG15(Q.9/15) | G.8131/Y.1382 (Amend. 1) | Linear protection switching for transport MPLS (T-MPLS) networks | 09/2007 |
| SG15(Q.14/15) | G.8151/Y.1374 | Management aspects of the T-MPLS network element | 10/2007 |
| SG15(Q.14/15) | G.8152/Y.1375 | Protocol-neutral management information model for the T-MPLS network element | Planned 2010 |

The following Table 7-8 lists the IETF MPLS-TP RFCs and Internet Drafts specifically related to the ITU-T MPLS-TP Recommendations.

Table 7-8 MPLS-TP-related IETF RFCs and Internet Drafts

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| IETF (mpls) | RFC 5379 | Joint Working Team (JWT) Report on MPLS Architectural Considerations for a Transport Profile | 02/2009 |
| IETF (mpls) | RFC 5586 | MPLS Generic Associated Channel | 06/2009 |
| IETF (mpls) | RFC 5564 | Requirements of an MPLS Transport Profile | 09/2009 |
| IETF (mpls) | RFC 5704 | Uncoordinated Protocol Development Considered Harmful | 11/2009 |
| IETF (mpls) | RFC 5718 | An In-Band Data Communication Network For the MPLS Transport Profile | 01/2010 |
| IETF (mpls) | RFC 5860 | Requirements for Operations, Administration, and Maintenance (OAM) in MPLS Transport Networks | 05/2010 |
| IETF (mpls) | RFC 5921 | A Framework for MPLS in Transport Networks | 07/2010 |
| IETF (mpls) | RFC 5950 | Network Management Framework for MPLS-based Transport Networks | 09/2010 |
| IETF (mpls) | RFC 5951 | Network Management Requirements for MPLS-based Transport Networks | 09/2010 |
| IETF (mpls) | RFC 5960 | MPLS Transport Profile Data Plane Architecture | 08/2010 |
| IETF (mpls) | RFC 6215 | MPLS Transport Profile User-to-Network and Network-to-Network Interfaces | 04/2011 |
| IETF (mpls) | RFC 6291 | Guidelines for the Use of the "OAM" Acronym in the IETF | 06/2011 |
| IETF (mpls) | RFC 6370 | MPLS Transport Profile (MPLS-TP) Identifiers | 09/2011 |
| IETF (mpls) | RFC 6371 | Operations, Administration, and Maintenance Framework for MPLS-Based Transport Networks | 09/2011 |
| IETF (mpls) | RFC 6372 | MPLS Transport Profile (MPLS-TP) Survivability Framework | 09/2011 |
| IETF (ccamp) | RFC 6373 | MPLS Transport Profile (MPLS-TP) Control Plane Framework | 09/2011 |
| IETF (mpls) | RFC 6375 | A Packet Loss and Delay Measurement Profile for MPLS-Based Transport Networks | 09/2011 |
| IETF (mpls) | RFC 6378 | MPLS Transport Profile (MPLS-TP) Linear Protection | 10/2011 |
| IETF (pwe) | RFC 6423 | Using the Generic Associated Channel Label for Pseudowire in the MPLS Transport Profile (MPLS-TP) | 11/2011 |
| IETF (mpls) | RFC 6426 | MPLS On-Demand Connectivity Verification and Route Tracing | 11/2011 |
| IETF (mpls) | RFC 6427 | MPLS Fault Management Operations, Administration, and Maintenance (OAM) | 11/2011 |
| IETF (mpls) | RFC 6428 | Proactive Connectivity Verification, Continuity Check, and Remote Defect Indication for the MPLS Transport Profile | 11/2011 |
| IETF (mpls) | RFC 6435 | MPLS Transport Profile Lock Instruct and Loopback Functions | 11/2011 |
| IETF (mpls) | draft-ietf-ccamp-mpls-tp-rsvpte-ext-associated-lsp-02 | RSVP-TE Extensions for Associated Bidirectional LSPs |  |
| IETF (mpls) | draft-ietf-ccamp-rsvp-te-mpls-tp-oam-ext-07 | Configuration of Pro-Active Operations, Administration, and Maintenance (OAM) Functions for MPLS-based Transport Networks using RSVP-TE |  |
| IETF (mpls) | draft-ietf-mpls-lsp-ping-mpls-tp-oam-conf-03 | Configuration of Pro-Active Operations, Administration, and Maintenance (OAM) Functions for MPLS-based Transport Networks using LSP Ping |  |
| IETF (mpls) | draft-ietf-mpls-tp-csf-02 | Indication of Client Failure in MPLS-TP |  |
| IETF (mpls) | draft-ietf-mpls-tp-itu-t-identifiers-02 | MPLS-TP Identifiers Following ITU-T Conventions |  |
| IETF (mpls) | draft-ietf-mpls-tp-mib-management-overview-05 | Multiprotocol Label Switching Transport Profile (MPLS-TP) MIB-based Management Overview |  |
| IETF (mpls) | draft-ietf-mpls-tp-oam-analysis-06 | An Overview of the OAM Tool Set for MPLS based Transport Networks |  |
| IETF (mpls) | draft-ietf-mpls-tp-ring-protection-00 | Applicability of MPLS-TP Linear Protection for Ring Topologies |  |
| IETF (mpls) | draft-ietf-mpls-tp-rosetta-stone-04 | A Thesaurus for the Terminology used in Multiprotocol Label Switching Transport Profile (MPLS-TP) drafts/RFCs and ITU-T's Transport Network Recommendations |  |
| IETF (mpls) | draft-ietf-mpls-tp-security-framework-02 | MPLS-TP Security Framework |  |
| IETF (mpls) | draft-ietf-mpls-tp-te-mib-00 | MPLS-TP Traffic Engineering (TE) Management Information Base (MIB) |  |

## 7.6 Standards on the NGN

The following table lists ITU-T Recommendations specifically related to the NGN. ITU-T Study Group 13 also maintains an NGN project management tool at URL <http://www.itu.int/ngnproject/> that contains the status of all items related to the NGN.

Table 7-9 NGN related Recommendations

| **Organisation (Subgroup responsible)** | **Number** | **Title** | **Publication Date** |
| --- | --- | --- | --- |
| SG3 | D.271 | Charging and accounting principles for NGN | 04/2008 |
| SG13 | Y.2001 | General overview of NGN | 12/2004 |
| SG13 | Y.2006 | Description of capability set 1 of NGN release 1 | 02/2008 |
| SG13 | Y.2011 | General principles and general reference model for next generation networks | 10/2004 |
| SG13 | Y.2012 | Functional requirements and architecture of the NGN release 1 | 09/2006 |
| SG13 | Y.2013 | Converged services framework functional requirements and architecture | 12/2006 |
| SG13 | Y.2014 | Network attachment control functions in next generation networks | 05/2008 |
| SG13 | Y.2015 | General requirements for ID/locator separation in NGN | 01/2009 |
| SG13 | Y.2016 | Functional requirements and architecture of the NGN for applications and services using tag-based identification | 08/2009 |
| SG13 | Y.2021 | IMS for Next Generation Networks | 09/2006 |
| SG13 | Y.2031 | PSTN/ISDN emulation architecture | 09/2006 |
| SG13 | Y.2091 | Terms and definitions for Next Generation Networks | 02/2008 |
| SG13 | Y.2111 | Resource and admission control functions in Next Generation Networks | 11/2008 |
| SG13 | Y.2112 | A QoS control architecture for Ethernet-based IP access network | 06/2007 |
| SG13 | Y.2113 | Ethernet QoS control for next generation networks | 01/2009 |
| SG13 | Y.2121 | Requirements for the support of flow-state-aware transport technology in NGN | 01/2008 |
| SG13 | Y.2122 | Flow aggregate information exchange functions in NGN | 06/2009 |
| SG13 | Y.2171 | Admission control priority levels in Next Generation Networks | 09/2006 |
| SG13 | Y.2172 | Service restoration priority levels in Next Generation Networks | 06/2007 |
| SG13 | Y.2173 | Management of performance measurement for NGN | 09/2008 |
| SG13 | Y.2201 | NGN release 1 requirements | 04/2007 |
| SG13 | Y.2205 | Next Generation Networks – Emergency telecommunications – Technical considerations |  |
| SG13 | Y.2211 | IMS-based real-time conversational multimedia services over NGN | 10/2007 |
| SG13 | Y.2212 | Requirements of managed delivery services | 02/2008 |
| SG13 | Y.2213 | NGN service requirements and capabilities for network aspects of applications and services using tag-based identification | 09/2008 |
| SG13 | Y.2215 | Requirements and framework for the support of VPN services in NGN, including the mobile environment | 06/2009 |
| SG13 | Y.2232 | NGN convergence service model and scenario using web services | 01/2008 |
| SG13 | Y.2233 | Requirements and framework allowing accounting and charging capabilities in NGN | 01/2008 |
| SG13 | Y.2234 | Open service environment capabilities for NGN | 09/2008 |
| SG13 | Y.2235 | Converged web-browsing service scenarios in NGN | 11/2008 |
| SG13 | Y.2261 | PSTN/ISDN evolution to NGN | 09/2006 |
| SG13 | Y.2271 | Call server based PSTN/ISDN emulation | 09/2006 |
| SG2 | M.3060/ Y.2401 | Principles for the Management of the Next Generation Networks | 03/2006 |
| SG13 | Y.2601 | Fundamental characteristics and requirements of future packet based networks | 12/2006 |
| SG13 | Y.2611 | High level architecture of future packet based networks | 12/2006 |
| SG13 | Y.2612 | Generic requirements and framework of addressing, routing and forwarding in future, packet-based networks | 01/2009 |
| SG13 | Y.2701 | Security requirements for NGN release 1 | 04/2007 |
| SG13 | Y.2702 | Authentication and authorization requirements for NGN release 1 | 09/2008 |
| SG13 | Y.2703 | The application of AAA service in NGN | 01/2009 |
| SG13 | Y.2720 | NGN identity management framework | 01/2009 |
| SG13 | Y.2801 | Mobility management requirements for NGN | 11/2006 |
| SG13 | Q.1762/ Y.2802 | Fixed-mobile convergence general requirements | 09/2007 |
| SG13 | Q.1763/ Y.2803 | FMC service using legacy PSTN or ISDN as the fixed access network for mobile network users | 10/2007 |
| SG13 | Q.1707/ Y.2804 | Generic framework of mobility management for next generation networks | 02/2008 |
| SG13 | Q.1708/ Y.2805 | Framework of location management for NGN | 10/2008 |
| SG13 | Q.1709/ Y.2806 | Framework of handover control for NGN | 10/2008 |
| SG13 | Y.2807 | MPLS-based mobility capabilities in NGN | 01/2009 |
| SG13 | Y.2901 | The carrier grade open environment reference model | 12/2006 |
| SG13 | Y.2902 | Carrier grade open environment components | 11/2008 |
| SG13 | Y. Sup1 | NGN release 1 scope | 07/2006 |
| SG13 | Y.Sup6 | Use of DSL-based systems in next generation networks | 09/2008 |
| SG13 | Y.Sup7 | NGN release 2 scope | 09/2008 |
| SG11 | Q.3900 | Methods of testing and model network architecture for NGN technical means testing as applied to public telecommunication networks | 09/2006 |

# Overview of existing holes/overlaps/conflicts

Considering the number and diversity of different organizations working on standardising aspects of OTNT, it is inevitable that some areas will be missed. For the same reasons, some aspects will be addressed in multiple groups, resulting in possible conflicts based on different applications, priorities, or technical expertise. These items need to be identified and addressed as appropriate. The following table lists those that have been identified, the recommended action, and the status of that action.

TABLE 8-1/OTNT: Known OTNT Standardization Holes/Overlaps/Conflicts

| **No** |  | **Issue** | **Action** | **Status** |
| --- | --- | --- | --- | --- |
| 1. |  | WSON(wavelength switched optical network) is now under discussion between IETF ccamp and ITU-T SG15. While ITU-T SG15 is specifying architecture and transport plane aspects, IETF ccamp is specifying control plane standard | Liaisons to and from the IETF ccamp, continuing work by Q.6 & 12/15 | Ongoing |
| 2. |  | Parallel work by ITU-T on permanent virtual circuit based on NNI with work at IETF work on both soft switch service based on optical UNI and soft permanent virtual connections based on optical NNI |  | Inactive |
| 3. |  | OTN Routing and how to deal with physical impairments on logical routing decisions. This issue is related to item No.5. | Possible proposals should be considered in Q.6/15, Q12 & Q.14/15, | Ongoing |
| 4. |  | Optical Supervisory Channel (OSC) has slightly different definitions and views of standardization among the different questions. What is necessary? | Possible proposals should be considered by Q.12/15 and Q.6/15 | Inactive |
| 5. |  | Optical control plane protocols to support ASON are currently being discussed, revised, or defined in several organizations, including ITU-T SG15, the IETF(ccamp wg and pce wg), the OIF, and the ATM Forum. | Formal communications, Cross-pollination by company representatives and liaisons | Ongoing collaboration by representatives and liaisons, IETF Design Team working to align routing requirements |
| 6 |  | **Interconnection of core & access transport of time & SSM issues**  Timing distribution method over access technologies such as GPON/xPON and XDSL for directly passing time and phase information from the ONU to the base stations are requested and investigated. Technical details and approaches are under discussion. | Possible proposals should be considered in Q.2/15, Q4/15 and Q13/15 | On-going |
| 7 |  | **Ethernet over OTN (E-OTN) issues**  The use of Ethernet technology in PTN requires an extension of the tagging option defined in 802.1Q to support VC, VP, VS stacking in single and multi-domain scenarios. The necessity of the new transport tag option, PTN Layer Hierarchy (the 3 packet layer) and the role of each layer are still under discussion. PB and PBB models are also need to be considered. | Liaisons to and from the IEEE 802.1, continuing work by Q.9/15 and Q12/15 | On-going |
| 8 |  | **Updating Recommendations of terms and definitions**  Some of the terms and definitions Recommendations haven’t been kept up to date aligning with source Recommendations. Therefore, there is a possibility that duplication of definitions could exist. Some implementer’s guides haven’t been reflected to source Recommendations and some source recommendations haven’t referred to the terms and definitions Recommendation. | Follow the procedure of the guidance made by Q3(TDxxx/WP3) and keep good communication with other editors | On-going |
| 9 |  | **Jitter requirements for OTU3&4 multilane interface**  The maximum permissible levels of jitter at OTL3.4 and OTL4.4 interfaces are under discussion. The jitter specification of G.8251 should be aligned as far as possible with that of IEEE 802.3ba for cost-effectiveness. | Correspondence work in Q6 and Q13 | Resolved |
| 10 |  | **Transport of CPRI interface over OTN**  Transport of CPRI over OTN is proposed. A definition of the applicable OTN hypothetical reference model (HRM) is required. Further clarifications of the requirements are undergoing discussion. | Contribution is invited in Q11 and Q13 | On-going |
| 11 | new | **DWDM Flexible Grid**  It is recognized that potential impacts of revised G.694.1 on the Recommendations on architecture, equipment, management and control planes and so on. | Joint work between Q6/Q7/Q9/Q10/Q11/Q12/Q14 | On-going |
| 12 | new | **Multilayer converged transport network**  The main objective to study this itme is to reduce costs and save energy in transport networks. The initial work will focus on the technology independent aspects and will include the development of some multi-layer network examples that include both fully integrated and distributed node implementations. | Each Question discuss this topic first and identify the potential study items related to other Questions  Q9/Q10/Q11/Q12/Q14 | On-going |

Annex A - Terminology Mapping

The terminology used by different organizations working on similar or overlapping technical areas of standardization has complicated attempts to co-ordinate work between different groups. The same terms are often used, with different meanings by multiple organizations. Question 3 of ITU-T Study Group 15 is responsible for maintaining “Terms and definitions” Recommendations on a number of established major categories of optical networks and technologies, as listed in Table 7‑1‑1. Readers are warned to verify the definitions before assuming a common understanding of the terms. Specific appendices have been included in ITU-T Recommendations G.7713.x to assist the reader in mapping signalling protocol terminology used in those document to the similar terms used in other well know references. Documents for terminology mapping in IETF such as RFC4397 and draft-ietf-mpls-tp-rosetta-stone can also be referred.

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