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H. van Helvoort, Ed.
L. Andersson, Ed.
Huawei Technologies
N. Sprecher, Ed.
Nokia Solutions and Networks

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A Thesaurus for the Interpretation of Terminology Used in MPLS Transport Profile (MPLS-TP) Internet-Drafts and RFCs in the Context of the ITU-T's Transport Network Recommendations

Abstract

The MPLS Transport Profile (MPLS-TP) is based on a profile of the MPLS and Pseudowire (PW) procedures as specified in the MPLS Traffic Engineering (MPLS-TE), PW, and Multi-Segment Pseudowire (MS-PW) architectures developed by the Internet Engineering Task Force (IETF). The International Telecommunication Union Telecommunication Standardization Sector (ITU-T) has specified a Transport Network architecture.

This document provides a thesaurus for the interpretation of MPLS-TP terminology within the context of the ITU-T Transport Network Recommendations.

It is important to note that MPLS-TP is applicable in a wider set of contexts than just Transport Networks. The definitions presented in this document do not provide exclusive or complete interpretations of MPLS-TP concepts. This document simply allows the MPLS-TP terms to be applied within the Transport Network context.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are a candidate for any level of Internet Standard; see Section 2 of RFC 5741.

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1. Introduction

The MPLS Transport Profile (MPLS-TP) has been developed by the IETF to facilitate the Operations, Administration, and Maintenance (OAM) of Label Switched Paths (LSPs) to be used in a Transport Network environment as defined by the ITU-T.

The ITU-T has specified a Transport Network architecture for the transfer of signals from different technologies. This architecture forms the basis of many Recommendations within the ITU-T.

Because of the difference in historic background of MPLS, and inherently MPLS-TP (the Internet) and the Transport Network (ITU Telecommunication Sector), the terminology used is different.

This document provides a thesaurus (the analogy to the Rosetta Stone has been used within the working groups) for the interpretation of MPLS-TP terminology within the context of the ITU-T Transport Network Recommendations. This allows MPLS-TP documents to be generally understood by those familiar with MPLS RFCs. The definitions presented in this document do not provide exclusive or complete interpretations of the ITU-T Transport Network concepts.

1.1. Abbreviations

CE	Customer Edge
DCC	Data Communication Channel
DCN	Data Communication Network
ECC	Embedded Communication Channel
EMF	Equipment Management Function
EMS	Element Management System
GAL	Generic Associated Channel Label
LER	Label Edge Router
LSR	Label Switching Router
MCC	Management Communication Channel
MCN	Management Communication Network
ME	Maintenance Entity

MEG	Maintenance Entity Group
MEP	Maintenance Entity Group End Point
MIP	Maintenance Entity Group Intermediate Point
MPLS	Multiprotocol Label Switching
MPLS-TP	MPLS Transport Profile
MS-PW	Multi-Segment Pseudowire
NE	Network Element
NEF	Network Element Function
OAM	Operations, Administration, and Maintenance
OSS	Operations Support System
PM	Performance Monitoring
PST	Path Segment Tunnel
PW	Pseudowire
S-PE	Switching Provider Edge
SCC	Signaling Communication Channel
SCN	Signaling Communication Network
SPME	Sub-Path Maintenance Element
T-PE	Terminating Provider Edge
TCM	Tandem Connection Monitoring

2. Terminology

This section provides an overview regarding terminology used in this document.

2.1. MPLS-TP Terminology Sources

MPLS-TP terminology is principally defined in [RFC3031]. Other documents, including [RFC4397], provide further key definitions.

2.2. ITU-T Transport Network Terminology Sources

The ITU-T Transport Network is specified in a number of Recommendations: generic functional architectures and requirements are specified in [ITU-T_G.805], [ITU-T_G.806], and [ITU-T_G.872]. ITU-T Recommendation G.8101/Y.1355 [ITU-T_G.8101] contains an overview of the terms and definitions for transport MPLS.

2.3. Common Terminology Sources

The work in this document builds on the shared view of MPLS requirements. It is intended to provide a source for common MPLS-TP terminology. In general, the original terminology is used.

The following sources are used:

- IETF framework and requirements RFCs: [RFC6371], [RFC6372], [RFC5654], [RFC5921], [RFC5860], [RFC5951], [RFC3031], and [RFC4397].

- ITU-T architecture and requirements Recommendations: [ITU-T_G.8101], [ITU-T_G.805], [ITU-T_G.806], [ITU-T_G.872], [ITU-T_G.7710], and [ITU-T_Y.2611].

3. Thesaurus

3.1. Associated Bidirectional Path

An associated bidirectional path is a path that supports traffic flow in both directions but that is constructed from a pair of unidirectional paths (one for each direction) that are associated with one another at the path's ingress/egress points. An associated bidirectional path need not be a single management and operational entity. The forward and backward directions are set up, monitored, and protected independently. As a consequence, they may or may not follow the same route (links and nodes) across the network.

3.2. Bidirectional Path

A bidirectional path refers to a path that supports traffic flow in two opposite directions, i.e., the forward and backward direction.

3.3. Client-Layer Network

In a client/server relationship (see [ITU-T_G.805]), the client-layer network receives a (transport) service from the lower server-layer network (usually the layer network under consideration).

3.4. Communication Channel

A Communication Channel is a logical channel between network elements (NEs) that can be used, e.g., for management-plane applications or control-plane applications. The physical channel supporting the Communication Channel is technology specific. See [RFC5951], Appendix A.

3.5. Concatenated Segment

A concatenated segment is a serial-compound link connection as defined in [ITU-T_G.805]. A concatenated segment is a contiguous part of an LSP or MS-PW that comprises a set of segments and their interconnecting nodes in sequence. See also "Segment" (Section 3.35).

3.6. Control Plane

Within the scope of [RFC5654], the control plane performs transport path control functions. Through signaling, the control plane sets up, modifies, and releases transport paths and may recover a transport path in case of a failure. The control plane also performs other functions in support of transport path control, such as routing information dissemination. It is possible to operate an MPLS-TP network without using a control plane.

3.7. Co-Routed Bidirectional Path

A co-routed bidirectional path is a path where the forward and backward directions follow the same route (links and nodes) across the network. A co-routed bidirectional path is managed and operated as a single entity. Both directions are set up, monitored, and protected as a single entity. A Transport Network path is typically co-routed.

3.8. Data Communication Network (DCN)

A DCN is a network that supports Layer 1 (physical layer), Layer 2 (data-link layer), and Layer 3 (network layer) functionality for distributed management communications related to the management plane, for distributed routing and signaling communications related to the control plane, and for other operations communications (e.g., order-wire/voice communications, software downloads, etc.).

3.9. Defect

"Defect" refers to the situation for which the density of anomalies has reached a level where the ability to perform a required function has been interrupted. Defects are used as input for Performance Monitoring (PM), the control of consequent actions, and the determination of fault cause. See also [ITU-T_G.806].

3.10. Domain

A domain represents a collection of entities (for example, network elements) that are grouped for a particular purpose, examples of which are administrative and/or managerial responsibilities, trust relationships, addressing schemes, infrastructure capabilities, aggregation, survivability techniques, distributions of control functionality, etc. Examples of such domains include IGP areas and Autonomous Systems.

3.11. Embedded Communication Channel (ECC)

An ECC is a logical operations channel between network elements (NEs) that can be utilized by multiple applications (e.g., management-plane applications, control-plane applications, etc.). The physical channel supporting the ECC is technology specific. An example of a physical channel supporting the ECC is a Data Communication Channel (DCC) within the Synchronous Digital Hierarchy (SDH).

3.12. Equipment Management Function (EMF)

The equipment management function (EMF) provides the means through which an element management system (EMS) and other managing entities manage the network element function (NEF). See [ITU-T_G.7710].

3.13. Failure

A failure is a detected fault. A failure will be declared when the fault cause persisted long enough to consider that a required transport function cannot be performed. The item may be considered as failed; a fault has now been detected. See also [ITU-T_G.806]. A failure can be used as a trigger for corrective actions.

3.14. Fault

A fault is the inability of a transport function to perform a required action. This does not include an inability due to preventive maintenance, lack of external resources, or planned actions. See also [ITU-T_G.806].

3.15. Layer Network

"Layer network" is defined in [ITU-T_G.805]. A layer network provides for the transfer of client information and independent operation of the client OAM. A layer network may be described in a service context as follows: one layer network may provide a (transport) service to a higher client-layer network and may, in turn, be a client to a lower-layer network. A layer network is a logical construction somewhat independent of arrangement or composition of physical network elements. A particular physical network element may topologically belong to more than one layer network, depending on the actions it takes on the encapsulation associated with the logical layers (e.g., the label stack) and thus could be modeled as multiple logical elements. A layer network may consist of one or more sublayers. For additional explanation of how layer networks relate to the OSI concept of layering, see Appendix I of [ITU-T_Y.2611].

3.16. Link

A link as discussed in this document refers to a physical or logical connection between a pair of Label Switching Routers (LSRs) that are adjacent at the (sub)layer network under consideration. A link may carry zero, one, or more LSPs or PWs. A packet entering a link will emerge with the same label-stack entry values.

A link as defined in [ITU-T_G.805] is used to describe a fixed relationship between two ports.

3.17. Maintenance Entity (ME)

A Maintenance Entity (ME) can be viewed as the association of two (or more) Maintenance Entity Group End Points (MEPs) that should be configured and managed in order to bound the OAM responsibilities of an OAM flow across a network or sub-network, i.e., a transport path or segment in the specific layer network that is being monitored and managed. See also Section 3.1 of [RFC6371] and Clause 6.1 of [ITU-T_G.8113.1] and [ITU-T_G.8113.2].

A Maintenance Entity may be defined to monitor and manage bidirectional or unidirectional point-to-point connectivity or point-to-multipoint connectivity in an MPLS-TP layer network.

Therefore, in the context of an MPLS-TP LSP ME or PW ME, Label Edge Routers (LERs) and PW Terminating Provider Edges (T-PEs) can be MEPs, while LSRs and PW Switching Provider Edges (S-PEs) can be MIPs. In the case of an ME for a tandem connection, LSRs and S-PEs can be either MEPs or MIPs.

The following properties apply to all MPLS-TP MEs:

- OAM entities can be nested but not overlapped.

- Each OAM flow is associated with a unique Maintenance Entity.

- OAM packets are subject to the same forwarding treatment as the data traffic, but they are distinct from the data traffic by the Generic Associated Channel Label (GAL).

3.18. Maintenance Entity Group (MEG)

A Maintenance Entity Group is defined, for the purpose of connection monitoring, between a set of connection points within a connection. This set of connection points may be located at the boundary of one administrative domain or a protection domain or the boundaries of two adjacent administrative domains. The MEG may consist of one or more Maintenance Entities (MEs). See also Section 3.1 of [RFC6371] and Clause 6.2 of [ITU-T_G.8113.1] and [ITU-T_G.8113.2].

In an MPLS-TP layer network, a MEG consists of only one ME.

3.19. Maintenance Entity Group End Point (MEP)

Maintenance Entity Group End Points (MEPs) are the end points of a pre-configured (through the management or control planes) ME. MEPs are responsible for activating and controlling all of the OAM functionality for the ME. A source MEP may initiate an OAM packet to be transferred to its corresponding peer MEP (called the sink MEP) or to an intermediate MIP that is part of the ME. See also Section 3.3 of [RFC6371] and Clause 6.3 of [ITU-T_G.8113.1] and [ITU-T_G.8113.2].

A sink MEP terminates all the OAM packets that it receives corresponding to its ME and does not forward them further along the path.

All OAM packets coming into a source MEP are tunneled via label stacking and are not processed within the ME as they belong either to the client network layers or to a higher Tandem Connection Monitoring (TCM) level.

A MEP in a tandem connection is not coincident with the termination of the MPLS-TP transport path (LSP or PW), though it can monitor its connectivity (e.g., counts packets). A MEP of an MPLS-TP network transport path is coincident with transport path termination and monitors its connectivity (e.g., counts packets).

An MPLS-TP sink MEP can notify a fault condition to its MPLS-TP client-layer network.

3.20. Maintenance Entity Group Intermediate Point (MIP)

A Maintenance Entity Group Intermediate Point (MIP) is a point between the two MEPs in an ME and is capable of responding to some OAM packets and forwarding all OAM packets while ensuring fate sharing with data-plane packets. A MIP responds only to OAM packets that are sent on the ME it belongs to and that are addressed to the MIP; it does not initiate OAM messages. See also Section 3.4 of [RFC6371] and Clause 6.4 of [ITU-T_G.8113.1] and [ITU-T_G.8113.2].

3.21. Management Communication Channel (MCC)

A Communication Channel dedicated to management-plane communications is referred to as a Management Communication Channel (MCC).

3.22. Management Communication Network (MCN)

A DCN supporting management-plane communication is referred to as a Management Communication Network (MCN).

3.23. Monitoring

Monitoring is applying OAM functionality to verify and to maintain the performance and the quality guarantees of a transport path. There is a need to not only monitor the whole transport path (e.g., LSP or MS-PW), but also arbitrary parts of transport paths. The connection between any two arbitrary points along a transport path is described in one of three ways:

- as a Path Segment Tunnel,

- as a Sub-Path Maintenance Element, or

- as a Tandem Connection.

3.23.1. Path Segment Tunnel (PST)

A path segment is either a segment or a concatenated segment. Path Segment Tunnels (PSTs) are instantiated to provide monitoring of a portion of a set of co-routed transport paths (LSPs or MS-PWs). PSTs can also be employed to meet the requirement to provide Tandem Connection Monitoring. See "Tandem Connection" (Section 3.23.3).

3.23.2. Sub-Path Maintenance Element (SPME)

To monitor, protect, and manage a portion (i.e., segment or concatenated segment) of an LSP, a hierarchical LSP [RFC3031] can be instantiated. A hierarchical LSP instantiated for this purpose is called a Sub-Path Maintenance Element (SPME). Note that by definition, an SPME does not carry user traffic as a direct client.

An SPME is defined between the edges of the portion of the LSP that needs to be monitored, protected, or managed. The SPME forms an MPLS-TP Section that carries the original LSP over this portion of the network as a client. OAM messages can be initiated at the edge of the SPME and sent to the peer edge of the SPME or to a MIP along the SPME. A P router only pushes or pops a label if it is at the end of an SPME. In this mode, it is an LER for the SPME.

3.23.3. Tandem Connection

A tandem connection is an arbitrary part of a transport path that can be monitored (via OAM) independently from the end-to-end monitoring (OAM). It may be a monitored segment, a monitored concatenated segment, or any other monitored ordered sequence of contiguous hops and/or segments (and their interconnecting nodes) of a transport path.

Tandem Connection Monitoring (TCM) for a given path segment of a transport path is implemented by creating a Path Segment Tunnel that has a 1:1 association with the path segment of the transport path that is to be uniquely monitored. This means that the PST used to provide TCM can carry one and only one transport path, thus allowing direct correlation between all fault-management and performance-monitoring information gathered for the PST and the monitored path segment of the end-to-end transport path. The PST is monitored using normal LSP monitoring. See also Section 3.2 of [RFC6371] and Clause 6.2.1 of [ITU-T_G.8113.1] and [ITU-T_G.8113.2].

3.24. MPLS Section

An MPLS Section is a network segment between two LSRs that are immediately adjacent at the MPLS layer.

3.25. MPLS Transport Profile (MPLS-TP)

An MPLS Transport Profile refers to the set of MPLS functions used to support packet transport services and network operations.

3.26. MPLS-TP NE

A network element (NE) that supports MPLS-TP functions is referred to as an MPLS-TP NE.

3.27. MPLS-TP Network

An MPLS-TP network is a network in which MPLS-TP NEs are deployed.

3.28. MPLS-TP Recovery

3.28.1. End-to-End Recovery

MPLS-TP end-to-end recovery refers to the recovery of an entire LSP, from its ingress to its egress node.

3.28.2. Link Recovery

MPLS-TP link recovery refers to the recovery of an individual link (and hence all or a subset of the LSPs routed over the link) between two MPLS-TP nodes. For example, link recovery may be provided by server-layer recovery.

3.28.3. Segment Recovery

MPLS-TP segment recovery refers to the recovery of an LSP segment (i.e., segment and concatenated segment) between two nodes and is used to recover from the failure of one or more links or nodes.

An LSP segment comprises one or more contiguous hops on the path of the LSP. [RFC5654] defines two terms: a "segment" is a single hop along the path of an LSP, while a "concatenated segment" is more than one hop along the path of an LSP.

3.29. MPLS-TP Ring Topology

In an MPLS-TP ring topology, each LSR is connected to exactly two other LSRs, each via a single point-to-point bidirectional MPLS-TP capable link. A ring may also be constructed from only two LSRs where there are also exactly two links. Rings may be connected to other LSRs to form a larger network. Traffic originating or terminating outside the ring may be carried over the ring. Client network nodes (such as Customer Edges (CEs)) may be connected directly to an LSR in the ring.

3.29.1. MPLS-TP Logical Ring

An MPLS-TP logical ring is constructed from a set of LSRs and logical data links (such as MPLS-TP LSP tunnels or MPLS-TP pseudowires) and physical data links that form a ring topology.

3.29.2. MPLS-TP Physical Ring

An MPLS-TP physical ring is constructed from a set of LSRs and physical data links that form a ring topology.

3.30. OAM Flow

An OAM flow is the set of all OAM packets originating with a specific source MEP that measure the performance of one direction of a MEG (or possibly both in the special case of data-plane loopback).

3.31. Operations Support System (OSS)

An OSS is a system that performs the functions that support processing of information related to Operations, Administration, Maintenance, and Provisioning (OAM&P) for the networks, including surveillance and testing functions to support customer access maintenance.

3.32. Path

See "Transport Path" (Section 3.45).

3.33. Protection Priority

Fault conditions (e.g., signal failed), external commands (e.g, forced switch, manual switch), and protection states (e.g., no request) are defined to have a relative priority with respect to each other. Priority is applied to these conditions/command/states locally at each end point and between the two end points.

3.34. Section-Layer Network

A section layer is a server layer (which may be MPLS-TP or a different technology) that provides for the transfer of the section-layer client information between adjacent nodes in the transport-path layer or transport-service layer. A section layer may provide for aggregation of multiple MPLS-TP clients. Note that [ITU-T_G.805] defines the section layer as one of the two layer networks in a transmission-media-layer network. The other layer network is the physical-media-layer network.

Section-layer networks are concerned with all the functions that provide for the transfer of information between locations in path-layer networks.

Physical-media-layer networks are concerned with the actual fibers, metallic wires, or radio frequency channels that support a section-layer network.

3.35. Segment

A segment is a link connection as defined in [ITU-T_G.805]. A segment is the part of an LSP that traverses a single link or the part of a PW that traverses a single link (i.e., that connects a pair of adjacent S-PEs and/or T-PEs). See also "Concatenated Segment" (Section 3.5).

3.36. Server Layer

A server layer is a layer network in which transport paths are used to carry a customer's (individual or bundled) service (may be point-to-point, point-to-multipoint, or multipoint-to-multipoint services).

In a client/server relationship (see [ITU-T_G.805]), the server-layer network provides a (transport) service to the higher client-layer network (usually the layer network under consideration).

3.37. Server MEPs

A server MEP is a MEP of an ME that is defined in a layer network below the MPLS-TP layer network being referenced. A server MEP coincides with either a MIP or a MEP in the client-layer (MPLS-TP) network. See also Section 3.5 of [RFC6371] and Clause 6.5 of [ITU-T_G.8113.1].

For example, a server MEP can be one of the following:

- A termination point of a physical link (e.g., IEEE 802.3), an SDH Virtual Circuit (VC), or OTN Optical Data Unit (ODU) for the MPLS-TP Section layer network, defined in [RFC6371], Section 4.1;
- An MPLS-TP Section MEP for MPLS-TP LSPs, defined in [RFC6371], Section 4.2;
- An MPLS-TP LSP MEP for MPLS-TP PWs, defined in [RFC6371], Section 4.3; or
- An MPLS-TP TCM MEP for higher-level TCMs, defined in [RFC6371], Section 3.2.

The server MEP can run appropriate OAM functions for fault detection and notifies a fault indication to the MPLS-TP layer network.

3.38. Signaling Communication Channel (SCC)

A Signaling Communication Channel is a Communication Channel dedicated to control-plane communications. The SCC may be used for GMPLS / Automatically Switched Optical Network (ASON) signaling and/or other control-plane messages (e.g., routing messages).

3.39. Signaling Communication Network (SCN)

A DCN supporting control-plane communication is referred to as a Signaling Communication Network (SCN).

3.40. Span

A span is synonymous with a link.

3.41. Sublayer

"Sublayer" is defined in [ITU-T_G.805]. The distinction between a layer network and a sublayer is that a sublayer is not directly accessible to clients outside of its encapsulating layer network and offers no direct transport service for a higher-layer (client) network.

3.42. Transport Entity

A transport entity is a node, link, transport path segment, concatenated transport path segment, or entire transport path.

3.42.1. Working Entity

A working entity is a transport entity that carries traffic during normal network operation.

3.42.2. Protection Entity

A protection entity is a transport entity that is pre-allocated and used to protect and transport traffic when the working entity fails.

3.42.3. Recovery Entity

A recovery entity is a transport entity that is used to recover and transport traffic when the working entity fails.

3.43. Transmission Media Layer

A transmission media layer is a layer network, consisting of a section-layer network and a physical-layer network as defined in [ITU-T_G.805], that provides sections (two-port point-to-point connections) to carry the aggregate of network-transport path or network-service layers on various physical media.

3.44. Transport Network

A Transport Network provides transmission of traffic between attached client devices by establishing and maintaining point-to-point or point-to-multipoint connections between such devices. A Transport Network is independent of any higher-layer network that may exist between clients, except to the extent required to supply this transmission service. In addition to client traffic, a Transport Network may carry traffic to facilitate its own operation, such as that required to support connection control, network management, and OAM functions.

3.45. Transport Path

A transport path is a network connection as defined in [ITU-T_G.805]. In an MPLS-TP environment, a transport path corresponds to an LSP or a PW.

3.46. Transport-Path Layer

A transport-path layer is a (sub)layer network that provides point-to-point or point-to-multipoint transport paths. It provides OAM that is independent of the clients that it is transporting.

3.47. Transport-Service Layer

A transport-service layer is a layer network in which transport paths are used to carry a customer’s (individual or bundled) service (may be point-to-point, point-to-multipoint, or multipoint-to-multipoint services).

3.48. Unidirectional Path

A unidirectional path is a path that supports traffic flow in only one direction.

4. Guidance on the Application of This Thesaurus

As discussed in the introduction to this document, this thesaurus is intended to bring the concepts and terms associated with MPLS-TP into the context of the ITU-T's Transport Network architecture. Thus, it should help those familiar with MPLS to see how they may use the features and functions of the Transport Network in order to meet the requirements of MPLS-TP.

5. Management Considerations

Networks based on MPLS-TP require management. The MPLS-TP specifications described in [RFC5654], [RFC5860], [RFC5921], [RFC5951], [RFC6371], [RFC6372], [ITU-T_G.8110.1], and [ITU-T_G.7710] include considerable efforts to provide operator control and monitoring as well as OAM functionality.

These concepts are, however, out of the scope of this document.

6. Security Considerations

Security is a significant requirement of MPLS-TP. See [RFC6941] for more information.

However, this informational document is intended only to provide a lexicography, and the security concerns are, therefore, out of the scope of this document.

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8. Contributors

The following individuals contributed to this document: Italo Busi, Ben Niven-Jenkins, Enrique Hernandez-Valencia, Lieven Levrau, Dinesh Mohan, Stewart Bryant, Dan Frost, Matthew Bocci, Vincenzo Sestito, Martin Vigoureux, and Yaacov Weingarten.

9. References

9.1. Normative References

[RFC3031] Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol Label Switching Architecture", RFC 3031, January 2001.

[RFC5654] Niven-Jenkins, B., Ed., Brungard, D., Ed., Betts, M., Ed., Sprecher, N., and S. Ueno, "Requirements of an MPLS Transport Profile", RFC 5654, September 2009.

[RFC5860] Vigoureux, M., Ed., Ward, D., Ed., and M. Betts, Ed., "Requirements for Operations, Administration, and Maintenance (OAM) in MPLS Transport Networks", RFC 5860, May 2010.

[RFC5921] Bocci, M., Ed., Bryant, S., Ed., Frost, D., Ed., Levrau, L., and L. Berger, "A Framework for MPLS in Transport Networks", RFC 5921, July 2010.

[RFC5951] Lam, K., Mansfield, S., and E. Gray, "Network Management Requirements for MPLS-based Transport Networks", RFC 5951, September 2010.

[RFC6371] Busi, I., Ed., and D. Allan, Ed., "Operations, Administration, and Maintenance Framework for MPLS-Based Transport Networks", RFC 6371, September 2011.

[RFC6372] Sprecher, N., Ed., and A. Farrel, Ed., "MPLS Transport Profile (MPLS-TP) Survivability Framework", RFC 6372, September 2011.

[ITU-T_G.805] ITU-T Recommendation G.805, "Generic functional architecture of transport networks", March 2000, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.806] ITU-T Recommendation G.806, "Characteristics of transport equipment - Description methodology and generic functionality", March 2006, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.872] ITU-T Recommendation G.872, "Architecture of optical transport networks", November 2001, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.7710]
ITU-T Recommendation G.7710, "Common equipment management function requirements", July 2007, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.8101]
ITU-T Recommendation G.8101/Y.1355, "Terms and definitions for MPLS Transport Profile", September 2013, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.8110.1]
ITU-T Recommendation G.8110.1/Y.1370.1, "Architecture of the Multi-Protocol Label Switching transport profile layer network", December 2011, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.8113.1]
ITU-T Recommendation G.8113.1/Y.1372.1, "Operations, administration and maintenance mechanism for MPLS-TP in packet transport network (PTN)", November 2012, <http://www.itu.int/rec/T-REC/>.

[ITU-T_G.8113.2]
ITU-T Recommendation G.8113.2/Y.1372.2, "Operations, administration and maintenance mechanisms for MPLS-TP networks using the tools defined for MPLS", November 2012, <http://www.itu.int/rec/T-REC/>.

[ITU-T_Y.2611]
ITU-T Recommendation Y.2611, "High-level architecture of future packet-based networks", December 2006, <http://www.itu.int/rec/T-REC/>.

9.2. Informative References

[RFC4397] Bryskin, I. and A. Farrel, "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", RFC 4397, February 2006.

[RFC6941] Fang, L., Ed., Niven-Jenkins, B., Ed., Mansfield, S., Ed., and R. Graveman, Ed., "MPLS Transport Profile (MPLS-TP) Security Framework", RFC 6941, April 2013.

Authors' Addresses

Huub van Helvoort (editor)
Huawei Technologies Co., Ltd.

EMail: Huub.van.Helvoort@huawei.com

Loa Andersson (editor)
Huawei Technologies Co., Ltd.

EMail: loa@mail01.huawei.com

Nurit Sprecher (editor)
Nokia Solutions and Networks

EMail: nurit.sprecher@nsn.com