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A Framework for Point-to-Multipoint MPLS in Transport Networks

draft-ietf-mpls-tp-p2mp-framework-04

Abstract

The Multiprotocol Label Switching Transport Profile is the common set

of MPLS protocol functions defined to enable the construction and

operation of packet transport networks. The MPLS-TP supports both

point-to-point and point-to-multipoint transport paths. This

document defines the elements and functions of the MPLS-TP

architecture applicable specifically to supporting point-to-

multipoint transport paths.

Status of This Memo

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**[1](" \l "section-1)**. Introduction

The Multiprotocol Label Switching Transport Profile is the common set

of MPLS protocol functions defined to meet the requirements specified

in [[RFC5654](./rfc5654)]. The MPLS-TP Framework [[RFC5921](./rfc5921)] provides an overall

introduction to the MPLS-TP and defines the general architecture of

the Transport Profile, as well as those aspects specific to point-to-

point transport paths. The purpose of this document is to define the

elements and functions of the MPLS-TP architecture applicable

specifically to supporting point-to-multipoint transport paths.

**[1.1](" \l "section-1.1)**. Scope

This document defines the elements and functions of the MPLS-TP

architecture related to supporting point-to-multipoint transport

paths. The reader is referred to [[RFC5921](./rfc5921)] for those aspects of the

MPLS-TP architecture that are generic, or concerned specifically with

point-to-point transport paths.

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**[1.2](" \l "section-1.2)**. Terminology

Term Definition

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CE Customer Edge

GMPLS Generalized MPLS

LDP Label Distribution Protocol

LSP Label Switched Path

LSR Label Switching Router

MEP Maintenance End Point

MPLS Multiprotocol Label Switching

MPLS-TE MPLS Traffic Engineering

MPLS-TP MPLS Transport Profile

OAM Operations, Administration and Maintenance

OTN Optical Transport Network

P2MP Point-to-multipoint

PW Pseudowire

RSVP-TE Resource Reservation Protocol - Traffic Engineering

SDH Synchronous Digital Hierarchy

T-LDP Targeted LDP

**[1.2.1](" \l "section-1.2.1)**. Additional Definitions and Terminology

Detailed definitions and additional terminology may be found in

[[RFC5921](./rfc5921)] and [[RFC5654](./rfc5654)].

**[1.3](" \l "section-1.3)**. Applicability

The point-to-multipoint connectivity provided by an MPLS-TP network

is based on the point-to-multipoint connectivity provided by MPLS

networks. P2MP MPLS TE-LSP support is discussed in [[RFC4875](./rfc4875)] and

[[RFC5332](./rfc5332)], and P2MP PW support is being developed based on

[[I-D.ietf-pwe3-p2mp-pw-requirements](#ref-I-D.ietf-pwe3-p2mp-pw-requirements)] and

[[I-D.ietf-l2vpn-vpms-frmwk-requirements](#ref-I-D.ietf-l2vpn-vpms-frmwk-requireme)]. MPLS-TP point-to-

multipoint connectivity is analogous to that provided by traditional

transport technologies such as Optical Transport Network point-to-

multipoint [[G.798](#ref-G.798)] and drop-and-continue [[G.780](#ref-G.780)], and thus supports

the same class of traditional applications, e.g., video distribution.

There is no definition for MPLS TE-LSP support of multipoint-to-

multipoint connectivity and none is anticipated.

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**[2](" \l "section-2)**. MPLS Transport Profile Point-to-Multipoint Requirements

The requirements for MPLS-TP are specified in [[RFC5654](./rfc5654)]. This section provides a brief summary of point-to-

multipoint transport requirements as set out in those documents; the

reader is referred to the documents themselves for the definitive and

complete list of requirements. This summary does not include the

[[RFC2119](./rfc2119)] conformance language used in original documents as this

document is not authoritative.

o MPLS-TP must support unidirectional point-to-multipoint transport

paths.

o MPLS-TP must support traffic-engineered point-to-multipoint

transport paths.

o MPLS-TP must be capable of using P2MP server (sub)layer

capabilities as well as P2P server (sub)layer capabilities when

supporting P2MP MPLS-TP transport paths.

o The MPLS-TP control plane must support establishing all the

connectivity patterns defined for the MPLS-TP data plane (i.e.,

unidirectional P2P, associated bidirectional P2P, co-routed

bidirectional P2P, unidirectional P2MP) including configuration of

protection functions and any associated maintenance functions.

o Recovery techniques used for P2P and P2MP should be identical to

simplify implementation and operation.

o Unidirectional 1+1 and 1:n protection for P2MP connectivity must

be supported.

o MPLS-TP recovery in a ring must protect unidirectional P2MP

transport paths.

**[3](" \l "section-3)**. Architecture

The overall architecture of the MPLS Transport Profile is defined in

[[RFC5921](./rfc5921)]. The architecture for point-to-multipoint MPLS-TP

comprises the following additional elements and functions:

o Unidirectional point-to-multipoint LSPs

o Unidirectional point-to-multipoint PWs

o Optional point-to-multipoint LSP and PW control planes

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o Survivability, network management, and Operations, Administration

and Maintenance functions for point-to-multipoint PWs and LSPs

The following subsections summarise the encapsulation and forwarding

of point-to-multipoint traffic within an MPLS-TP network, and the

encapsulation options for delivery of traffic to and from MPLS-TP CE

devices when the network is providing a packet transport service.

**[3.1](" \l "section-3.1)**. MPLS-TP Encapsulation and Forwarding

Packet encapsulation and forwarding for MPLS-TP point-to-multipoint

LSPs is identical to that for MPLS-TE point-to-multipoint LSPs.

MPLS-TE point-to-multipoint LSPs were introduced in [[RFC4875](./rfc4875)] and the

related data-plane behaviour was further clarified in [[RFC5332](./rfc5332)].

MPLS-TP allows for both upstream-assigned and downstream-assigned

labels for use with point-to-multipoint LSPs.

Packet encapsulation and forwarding for point-to-multipoint PWs has

been discussed within the PWE3 Working Group

[[I-D.raggarwa-pwe3-p2mp-pw-encaps](#ref-I-D.raggarwa-pwe3-p2mp-pw-encaps)], but such definition is for

further study.

**[4](" \l "section-4)**. Operations, Administration and Maintenance

The requirements for MPLS-TP OAM are specified in [RFC5860].

The overall OAM architecture for MPLS-TP is defined in [[RFC6371](./rfc6371)], and

P2MP OAM design considerations are described in [Section 3.7](" \l "section-3.7) of that

RFC.

All the traffic sent over a P2MP transport path, including OAM

packets generated by a MEP, is sent (multicast) from the root to all

the leaves, thus OAM Packets is sent to all leaves and processed by all the MEs in a P2MP MEG. If an OAM packet is to be

processed by only a specific leaf, it requires information to

indicate to all other leaves that the packet must be discarded. To

address a packet to an intermediate node in the tree, TTL based

addressing is used to set the radius and additional information in

the OAM payload is used to identify the specific destination. It is worth noting that a MIP and MEP may be instantiated on a node when it is both a branch and leaf node.

P2MP paths are unidirectional; therefore, any return path to an

originating MEP for on-demand transactions will be out-of-band. Out

of band return paths are discussed in [Section 3.8 of [RFC5921]](./rfc5921#section-3.8).

Packet Loss and Delay Measurement for MPLS Networks [[RFC6374](./rfc6374)] already

considers the P2MP case and no change is needed to the MPLS-TP

profile of [[RFC6375](./rfc6375)].

A more detailed discussion of P2MP OAM considerations can be found in

[[I-D.hmk-mpls-tp-p2mp-oam-framework](#ref-I-D.hmk-mpls-tp-p2mp-oam-framework)].

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**[5](" \l "section-5)**. Control Plane

The framework for the MPLS-TP control plane is provided in [[RFC6373](./rfc6373)].

This document reviews MPLS-TP control plane requirements as well as

provides details on how the MPLS-TP control plane satisfies these

requirements. Most of the requirements identified in [[RFC6373](./rfc6373)] apply

equally to P2P and P2MP transport paths. The key P2MP specific

control plane requirements are:

o requirement 6 (P2MP transport paths),

o requirement 34 (use P2P sub-layers),

o requirement 49 (common recovery solutions for P2P and P2MP),

o requirement 59 (1+1 protection),

o requirement 62 (1:n protection),

o and requirement 65 (1:n shared mesh recovery).

[RFC6373] defines the control plane approach used to support MPLS-TP

transport paths. It identifies GMPLS as the control plane for MPLS-

TP LSPs T-LDP as the control plane for PWs. MPLS-TP allows that

either, or both, LSPs and PWs to be provisioned statically or via a

control plane. As noted in [[RFC6373](./rfc6373)]:

The PW and LSP control planes, collectively, must satisfy the MPLS-TP

control-plane requirements. As with P2P services, when P2MP client

services are provided directly via LSPs, all requirements must be

satisfied by the LSP control plane. When client services are

provided via PWs, the PW and LSP control planes can operate in

combination, and some functions may be satisfied via the PW control

plane while others are provided to PWs by the LSP control plane.

This is particularly noteworthy for P2MP recovery.

**[5.1](" \l "section-5.1)**. Point-to-Multipoint LSP Control Plane

The MPLS-TP control plane for point-to-multipoint LSPs uses GMPLS and

is based on RSVP-TE for point-to-multipoint LSPs as defined in

[[RFC4875](./rfc4875)]. A detailed listing of how GMPLS satisfies MPLS-TP control

plane requirements is provided in [[RFC6373](./rfc6373)].

Per [[RFC6373](./rfc6373)], the definitions of P2MP, [[RFC4875](./rfc4875)], and GMPLS

recovery, [[RFC4872](./rfc4872)] and [[RFC4873](./rfc4873)], do not explicitly cover their

interactions. MPLS-TP requires a formal definition of recovery

techniques for P2MP LSPs. Such a formal definition will be based on

existing RFCs and may not require any new protocol mechanisms but,

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nonetheless, should be documented. Protection of P2MP LSPs is also

discussed in [[RFC6372] Section 4.7.3](./rfc6372#section-4.7.3).

**[5.2](" \l "section-5.2)**. Point-to-Multipoint PW Control Plane

The MPLS-TP control plane for point-to-multipoint PWs should be based

on the LDP control protocol used for point-to-point PWs [[RFC4447](./rfc4447)],

with updates as required for P2MP applications. A detailed

specification of the control plane for P2MP PWs is for further study.

**[6](" \l "section-6)**. Survivability

The overall survivability architecture for MPLS-TP is defined in

[[RFC6372](./rfc6372)], and [section 4.7.3](#section-4.7.3) in particular describes the application

of linear protection to unidirectional P2MP entities using 1+1 and

1:1 protection architecture. For 1+1, the approach is for the root

of the P2MP tree to bridge the user traffic to both the working and

protection entities. Each sink/leaf MPLS-TP node selects the traffic

from one entity according to some predetermined criteria. For 1:1,

the source/root MPLS-TP node needs to identify the existence of a

fault condition on any of the leaves of the network. Fault

notification happens from the node identifying the fault to the root

node or from the leaves to the root via an out of band path. In

either case the root then selects the protection transport path for

traffic transfer. More sophisticated survivability approaches such

as partial tree protection and 1:n protection are for further study.

The IETF has no experience with P2MP PW survivability as yet, and

therefore it is proposed that the P2MP PW survivability will

initially rely on the LSP survivability. Further work is needed on

this subject, particularly if a requirement emerges to provide

survivability for P2MP PWs in an MPLS-TP context.

**[7](" \l "section-7)**. Network Management

An overview of network management considerations for MPLS-TP can be

found in [Section 3.14](#section-3.14) of "Framework for MPLS in Transport Networks"

[[RFC5921](./rfc5921)]. The provided description applies equally to P2MP

transport paths.

The network management architecture and requirements for MPLS-TP are

specified in [[RFC5951](./rfc5951)]. They derive from the generic specifications

described in ITU-T G.7710/Y.1701 [[G.7710](#ref-G.7710)] for transport technologies.

They also incorporate the OAM requirements for MPLS Networks

[[RFC4377](./rfc4377)] and MPLS-TP Networks [[RFC5860](./rfc5860)] and expand on those

requirements to cover the modifications necessary for fault,

configuration, performance, and security in a transport network.

[[RFC5951](./rfc5951)] covers all MPLS-TP connection types, including P2MP.

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[RFC6639] provides the MIB-based architecture for MPLS-TP. It

reviews the interrelationships between different non MPLS-TP specific

MIB modules that can be leveraged for MPLS-TP network management, and

identifies areas where additional MIB modules are required. While

the document does not consider P2MP transport paths, it does provide

a foundation for an analysis of areas where MIB module modification

and addition may be needed to fully support P2MP transport paths.

There has also been work in the MPLS working group on a P2MP specific

MIB, [[I-D.ietf-mpls-p2mp-te-mib](#ref-I-D.ietf-mpls-p2mp-te-mib)].

**[8](" \l "section-8)**. Security Considerations

General security considerations for MPLS-TP are covered in [[RFC5921](./rfc5921)].

Additional security considerations for point-to-multipoint LSPs are

provided in [[RFC4875](./rfc4875)]. This document introduces no new security

considerations beyond those covered in those documents.

**[9](" \l "section-9)**. IANA Considerations

There are no requests for IANA actions in this document.

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