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Purpose: Proposal

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Abstract: The document contains the editor version of draft new Recommendation G.8152.1 “OAM Information/Data Models for MPLS-TP Network Element”, v0.05.

Document history:

Version	Date	Description
0.01	WD1214-19 (01/2019 Wuhan)	Initial version based on wd1214-31, wd1214-33 and wd1214-35 (01/2019).
0.02	WD14-20 (04/2019) Xi’an TD377/3 (7/2019) Geneva	Modified Clause 6 and Clause 7 according to wd14-34, wd14-36 and discussion suggestion

Version	Date	Description
0.03	WD14-20 (07/2019) Geneva	● Modified Clause 4 according to C-1232 and discussion suggestion ● Add Clause 6.1 to 6.4 according to C-1232 and discussion suggestion ● Modified Clause 7.1 and 7.3 according to C-1233 and C-1444 and discussion suggestion ● Add Appendix I according to C-1233 discussion suggestion
0.04	WD14-15 (09/2019) Gothenburg	● Modified Figure 7-5 and Table 7-4 in Clause 7 according to WD14-28 ● Modified Table 6-1 according to WD14-25 and discussion ● Moving Table7-1 ~ Table7-4 to Appendix **II** according to discussion
0.05	TD486R1 (01/2020) Geneva	● As per C1784: • Add high-level description and diagrams to clause 7 • Update the text and diagrams of clause 7 • Update the Appendix II with Table II-5 • Use the UML model files to update sub-clause 7.4 ● As per C1804: add initial version of YANG model

Contents

Recommendation ITU-T G.8152.1

OAM Information/Data Models for MPLS-TP Network Element

Summary

Keywords

MPLS-TP, OAM, Protocol-Neutral, Transport Resource, Information Model, UML, Data Model, YANG

1 Scope

This Recommendation will specify the OAM information models and data models for MPLS-TP transport Network Element (NE) to support specific interface protocols and specific management and control functions. The information models will be interface protocol neutral and will be derived through pruning and refactoring from the G.7711 core information model and G.8152 foundation MPLS-TP NE information model. The data models will be interface protocol specific and will be translated from these information models. The specific interface protocols considered include, but not limited to, NETCONF/YANG. The specific management and control functions covered by this Recommendation are the G.8113.1 specific OAM functions.

The eventual YANG modules of this Recommendation are aimed to be compatible with and when necessary extend the relevant base generic YANG modules from the IETF for the G.8113.1 OAM functionality.

2 References

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

[ITU-T G.7711] Recommendation ITU-T G.7711/Y.1702 (3/2018), *Generic protocol-neutral information model for transport resources.*

[ITU-T G.8113.1] Recommendation ITU-T G.8113.1/Y.1372.1 (8/2015), *Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks.*

~~[ITU-T G.8113.2] Recommendation ITU-T G.8113.2/Y.1372.2 (11/2015), *Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks using the tools for MPLS.*~~

[ITU-T G.8121] Recommendation ITU-T G.8121/Y.1381 (11/2018), *Characteristics of MPLS-TP equipment functional blocks.*

[ITU-T G.8121.1] Recommendation ITU-T G.8121.1/Y.1381.1 (11/2018), *Characteristics of MPLS-TP equipment functional blocks supporting ITU-T G.8113.1/Y.1372.1 OAM mechanisms.*

[ITU-T G.8151] Recommendation ITU-T G.8151/Y.1374 (10/2018), Management aspects of the MPLS-TP network element.

[ITU-T G.8152] Recommendation ITU-T G.8152/Y.1735 (10/2018), *Protocol-neutral management information model for the MPLS-TP network element.*

[mpls-tp-oam-yang] draft-zhang-mpls-tp-yang-oam-05 (10/2017), *YANG Data Model for MPLS-TP Operations, Administration, and Maintenance (OAM).* <Editor note: By the time of consenting G.8152.1 if this Internet Draft has been progressed to RFC, this reference will be replaced by the RFC reference. Otherwise, this Internet Draft reference will become an entry in the Bibliography at the end of the Recommendation.>

[IETF RFC 5860] IETF RFC5860 (05/2010), *Requirements for Operations, Administration, and Maintenance (OAM) in MPLS Transport Networks*.

[IETF RFC 6371] IETF RFC6371 (09/2011), *Operations, Administration, and Maintenance Framework For MPLS-Based Transport Networks.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

~~<Editor Note: Details are to be provided. >~~

3.1.1 **maintenance entity (ME)**: [ITU-T G.8001]
3.1.2 **maintenance entity group (MEG)**: [ITU-T G.8001]
3.1.3 **maintenance entity group end point (MEP) compound source function**: [ITU-T G.8001]
3.1.4 **maintenance entity group intermediate point (MIP) compound function**: [ITU-T G.8001]
3.1.5 **on-demand monitoring**: [ITU-T G.8001]
3.1.6 **proactive monitoring**: [ITU-T G.8001]

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

<Editor Note: Details are to be provided. >

3.2.1 **<Term 1>**: <definition>.

<Editor Note: Details are to be provided. >

4 Abbreviations and acronyms

~~<Editor Note: modified this clause based on clause 6 modification~~Details ~~are to be provided. >~~

This Recommendation uses the following abbreviations and acronyms:

1DM One-way Delay Measurement

1DMo On-demand one-way Delay Measurement

1DMp Proactive one-way Delay Measurement

TH One-way Throughput Test

AIS Alarm Indication Signal

APS Automatic Protection Switching

CCM Continuity Check Message

~~CD Current Data~~

~~CORBA Common Object Request Broker Architecture~~

CTP Connection Termination Point

~~CW Control Word~~

~~DEG Degraded~~

DM Delay Measurement

DMo On-demand Delay Measurement

DMp Proactive Delay Measurement

DMM Delay Measurement Message

DMR Delay Measurement Reply

DT Diagnostic Test

~~DP Data Plane~~

~~ECC Embedded Communication Channel~~

~~EMS Element Management System~~

~~ETH Ethernet MAC layer network~~

~~G-ACh Generic Associated Channel~~

~~GAL Generic Associated Channel (G-ACh) Label~~

~~GFP Generic Framing Procedure~~

~~HD History Data~~

~~IDL Interface Definition Language~~

LCK Locked

LM Loss Measurement

LMo On-demand Loss Measurement

LMp Proactive Loss Measurement

LMM Loss Measurement Message

LMR Loss Measurement Reply

LOC Loss of Continuity

LSP Label Switched Path

LT Link Trace

~~MAC Medium Access Control~~

MCC Management Communication Channel

ME Maintenance Entity

MEG Maintenance Entity Group

MEP Maintenance entity group End Point

MI Management Information

MIB Management Information Base

MIP Maintenance entity group Intermediate Point

MPLS Multi-Protocol Label Switching

MPLS-TP Multi-Protocol Label Switching – Transport Profile

~~MT Multi-Protocol Label Switching – Transport Profile~~

~~MTD MPLS-TP Diagnostic function~~

~~MTDi MPLS-TP Diagnostic function within MTx MIP~~

~~MTS MPLS-TP Section~~

NC Network Connection

~~NCM Network Connection Monitoring~~

NE Network Element

OAM Operation, Administration and Maintenance

PDU Protocal Data Unit

~~PHB Per Hop Behaviour~~

PM Performance Monitoring

PW Pseudowire

~~PRI Priority~~

~~PSC PHB Scheduling Class~~

~~QoS Quality of Service~~

RDI Remote Defect Indication

RT Route Trace

SCC Signalling Communication Channel

~~SCC Type Signalling Communication Channel Type~~

~~SES Severely Errored Second~~

Sk Sink

SLA Service Level Agreement

SL Synthetic Loss Measurement

SLp Proactive Synthetic Loss Measurement

SLo On-demand Synthetic Loss Measurement

SN Sub-Network

SNC Sub-Network Connection

SNCP Sub-Network Connection Protection

SNMP Simple Network Management Protocol

So Source

SQ Sequence

~~TC Traffic Class~~

TCM Tandem Connection Monitoring

TCS Traffic Conditioning and Shaping

TH Throughput

TST Test

~~TMN Telecommunications Management Network~~

TP Termination Point

~~TSNUM Tributary Slot Number~~

TT Trail Termination

TTL Time-To-Live

TTP Trail Termination Point

~~UAS Unavailable Second~~

UML Unified Modelling Language

YANG Yet Another New Generation

5 Conventions

5.1 Information modeling conventions

See clause 5.1 of [ITU-T G.7711].

5.1.1 UML modelling conventions

See clause 5.1 of [ITU-T G.7711].

5.1.2 Model Artefact Lifecycle Stereotypes conventions

See clause 5.2 of [ITU-T G.7711].

5.1.3 Forwarding entity terminology conventions

See clause 5.3 of [ITU-T G.7711].

5.1.4 Conditional package conventions

See clause 5.4 of [ITU-T G.7711].

5.1.5 Pictorial diagram conventions

See clause 5.5 of [ITU-T G.7711].

5.2 Equipment function conventions

5.2.1 Maintenance entity group end point (MEP) [ITU-T G.8121]

See clause 5.2.1 of [ITU-T G.8152].

5.2.2 Maintenance entity group intermediate point (MIP) [ITU-T G.8121]

See clause 5.2.2 of [ITU-T G.8152].

5.2.3 MEPs and MIPs along a Maintenance Entity

See clause 5.2.3 of [ITU-T G.8152].

5.3 Color Conventions

See clause 5.3 of [ITU-T G.8152].

6 Functions of MPLS-TP OAM

<Editor Note: Also look at clauses 7.1 and 7.2 of G.8152.>

<Briefly describe the function and point to G.8121, ~~and~~ G.8121.1 and G.8113.1 for the OAM PDU formate and processes of the MPLS-TP OAM function.>

~~The specific management and control functions covered by this Recommendation are the [ITU-T G.8113.1] specific OAM functions. The OAM functions and the OpCodes in [ITU-T G.8113.1] are listed in the Table 7-1 and Table 8-2 of [ITU-T G.8113.1]. The OAM functions of [ITU-T G.8113.1], corresponding OpCode, OAM PDU type and the relevance with MEP and MIP are summarised in Table 6-1.~~

~~Table 6-1 MPLS-TP OAM PDU types and applications~~

~~OpCode value~~	**~~OAM PDU type~~**	**~~OAM application (Refer to [RFC 5860])~~**	**~~OpCode relevance for MEPs/MIPs (Refer to [ITU-T G.8113.1])~~**
~~1~~	~~CCM~~	~~*Continuity check Message*~~ ~~Proactive CC (Continuity check),~~ ~~Proactive CV (Connectivity verification),~~ ~~Proactive RDI (Remote defect indication),~~ ~~Proactive packet LM (Loss measurement)~~	~~MEPs~~
~~3~~	~~LBM~~	~~*Loopback (Unicast & Multicast) Message*~~ ~~On-demand bidirectional CV~~ ~~Bidirectional in-service or out-of-service DT~~ ~~Route tracing (RT)~~	~~MEPs and MIPs (connectivity verification)~~
~~2~~	~~LBR~~	~~*Loopback (Unicast & Multicast) Reply*~~ ~~On-demand bidirectional CV~~ ~~Bidirectional in-service or out-of-service DT~~ ~~Route tracing (RT)~~	~~MEPs and MIPs (connectivity verification)~~
~~33~~	~~AIS~~	~~*Alarm indication signal (AIS)*~~ ~~Alarm reporting~~	~~MEPs~~
~~35~~	~~LCK~~	~~*Locked signal*~~ ~~Lock reporting~~	~~MEPs~~
~~37~~	~~TST~~	~~*Test*,~~ ~~Unidirectional in-service or out-of-service Diagnostic Test~~	~~MEPs~~
~~39~~	~~APS~~	~~*Automatic protection switching*~~	~~Outside the scope of~~

			[ITU-T G.8113.1]
43	LMM	*Loss measurement message* On-demand and proactive packet Loss Measurement	MEPs
42	LMR	*Loss measurement reply* On-demand and proactive packet Loss Measurement	MEPs
45	1DM	*One-way delay measurement* On-demand and proactive packet one-way Delay Mesurement	MEPs
47	DMM	*Delay measurement message* On-demand and proactive packet two-way Delay Measurement	MEPs
46	DMR	*Delay measurement reply* On-demand and proactive packet two-way Delay Measurement	MEPs
49	EXM	*Experimental Message*	Outside the scope of [ITU-T G.8113.1]
48	EXR	*Experimental Reply*	Outside the scope of [ITU-T G.8113.1]
51	VSM	*Vendor-specific Message*	Outside the scope of [ITU-T G.8113.1]
50	VSR	*Vendor-specific Reply*	Outside the scope of [ITU-T G.8113.1]
52	CSF	*Client signal fail* Client failure indication (CFI)	MEPs

6.1 Continuity check and connectivity verification

<Editor Note: Details are to be provided. >

The source (So) MEP sends continuity check/connectivity verification (CC/CV) OAM packets periodically at the configured rate, Then the sink (Sk) MEP monitors the arrival of these CC/CV OAM packets at the configured rate and detects the defect of loss of continuity (LOC).The transmission periods are as followed tabel 6-2.

Table 6-2 – CCM Period values

Flags[3:1]	Period value	Comments
000	Invalid value	Invalid value for CCM PDUs
001	3.33 ms	300 frames per second
010	10 ms	100 frames per second
011	100 ms	10 frames per second
100	1 s	1 frame per second
101	10 s	6 frames per minute
110	1 min	1 frame per minute
111	10 min	6 frames per hour

For fault management, there are include proactive CC/CV and on demand CV.Procative CC/CV function can detect the defects include Mismerge (MMG),Unexpected MEP (UNM) and Unexpected periodicity (UNP).On demand CV can be used to check either the entire MEG (end-to-end) or just between an MEP and a specific MIP.

6.2 Remote defect indication

<Editor Note: Details are to be provided. >

Remote defect indication (RDI) is an indicator which can be used by a MEP to communicate to its peer MEPs. When an MEP detects a signal fail condition, it sends an RDI to its peer MEPs. An RDI is used only when proactive CC/CV bidirectional transmission is enabled.

6.3 Alarm indication

<Editor Note: Details are to be provided. >

The alarm indication (AI) function is used to suppress alarms following detection of defect conditions at the server (sub-) layer. When a server MEP detects signal fail, it sets a flag that results in generation of OAM packets with alarm indication signal (AIS) information that are forwarded in the downstream direction to the sink MEP in the client (sub-)layer, which ensures that its MEG level corresponds to its own MEG level and allows the suppression of secondary alarms (LOC, etc.) in the client (sub-)layer.Transmission of frames with AI information can be enabled or disabled on a server MEP and an AIS transmission period of 1 second is recommended.

6.4 Locked signal

<Editor Note: Details are to be provided. >

The locked signal (LCK) function is used to communicate to the client (sub-)layer MEPs the administrative locking of a server (sub-)layer MEP and consequential interruption of data traffic

forwarding in the client (sub-)layer. A server (sub-)layer MEP, when administratively locked, transmits LCK frames in a direction opposite to its peer client (sub-)layer MEP(s). if client (sub-)layer MEP no LCK frames are received within an interval of 3.5 times the LCK transmission period indicated in the LCK frames received before, the client (sub-)layer MEP clears the LCK condition.

6.5 Client signal fail

<Editor Note: Details are to be provided. >

The Client signal fail(CSF) function is used to process client defects and propagate a client signal defect to the associated remote MEPs using OAM packets. This function is usually used when the client of the MPLS-TP trail does not support a native defect/alarm indication mechanism.

6.6 Connectivity verification

<Editor Note: Details are to be provided. >

6.7 Loss measurement

The loss measurement (LM) function is used to measure packet loss on a connection. The LM has two kinds of applications. One is the proactive LM which is for performance monitoring purposes, It is performed continuously and its result is used to verify the performance of the connection against the service level agreement (SLA). The other is the on-demand LM which is for maintenance purposes, It is performed during a configured specific time interval and its result can be used for diagnosis and analysis.

The LM function can be performed by two methods: Single-ended LM and Dual-ended LM .

6.7.1 Single-ended Loss measurement

<Editor Note: Details are to be provided. >

Single-ended LM is used as on-demand OAM that a source MEP sends frames with LM request information to its peer sink MEP and receives frames with LM reply information from its peer sink MEP to carry out loss measurements. The PDU used for single-ended LM request is LMM.

6.7.2 Dual-ended Loss measurement

<Editor Note: Details are to be provided. >

Dual-ended LM is used as proactive OAM that each MEP sends periodic dual-ended frames with LM information to its peer MEP in a point-to-point ME to facilitate frame loss measurements at the peer MEP. Each MEP terminates the dual-ended frames with LM information and makes the near-end and far-end loss measurements. The PDU used for dual-ended LM information is CCM.

6.8 Delay measurement

The delay measurement (DM) function is used to measure packet delay (PD) and packet delay variation (PDV) on a connection. The DM has two kinds of applications. One is the proactive DM which is for performance monitoring purposes, It is performed continuously and its result is used to verify the performance of the connection against the service level agreement (SLA). The other is the on-demand DM which is for maintenance purposes, It is performed during a configured specific time interval and its result can be used for diagnosis and analysis.

The DM function can be performed by two methods: one-way DM and two-way DM .If one-way DM is used to measure packet delay (PD),the clocks between the two MEPs should be synchronized.

6.8.1 one-way Delay measurement

<Editor Note: Details are to be provided. >

A source MEP sends a frame with one-way DM information to its peer sink MEP in a point-to-point ME to facilitate one-way frame delay and/or one-way frame delay variation measurements at the peer sink MEP. The one-way delay measurement (1DM) PDU is defined in [ITU-T G.8013].

6.8.2 two-way Delay measurement

<Editor Note: Details are to be provided. >

A source MEP sends frames with delay measurement message(DMM) to its peer sink MEP and receives frames with DM reply(DMR) information from its peer sink MEP to carry out two-way frame delay and two-way frame delay variation measurements. The DMM/DMR PDUs are defined in [ITU-T G.8013].

6.9 Diagnostic test

The diagnostic test(TST) function allows performing on-demand in-service or out-of-service one-way diagnostic tests between a pair of peer MEPs in point-to-point MPLS-TP connections. This includes verifying bandwidth throughput, detecting bit errors, etc.

The TST PDU format is defined in detail in clause 9.9 of [ITU-T G.8013].

6.9.1 Out-of-service test

<Editor Note: Details are to be provided. >

An out-of-service TST function disrupts the client data traffic in the diagnosed ME. The MEP configured for the out-of-service test transmits LCK packets, in the immediate client (sub-) layer.With the out-of-service test, the transmitter MEP generates LCK frames at the immediate client MEG level in the same direction where TST frames are transmitted and the receiving MEP also generates LCK frames at the client MEG level in the direction in which the TST frames are received.

6.9.2 In-service test

<Editor Note: Details are to be provided. >

~~An in-service TST function doesn't disrupt the client data traffic and the packets with TST information are transmitted in a limited part of the service bandwidth. The periodicity for packets with TST information is pre-determined.~~

~~6.10 Route tracing~~

~~<Editor Note: Details are to be provided. >~~

The specific functions covered by this recommendation are OAM functions of [ITU-T G.8121],[ITU-T G.8121.1] and [ITU-T G.8113.1]. The OAM capability support is listed in followed table 6-1. The third Column is used to describe the OAM functions involved in which object instances.

Table 6-1 – OAM capability support

Consolidation of Tables 7-1/G.8152, 7-1/G.8113.1,

OAM function [ITU-T G.8113.1]			**OAM mechanism** [ITU-T G.8121] and [ITU-T G.8121.1]	**Involved Object Instances**
Proactive performance measurement (PM)	Loss measurement (LM)	Direct Near-end Loss ~~&~~ ~~Far-end Loss~~	CCM (Dual-ended) 8.8.4/G.8121 8.8.1/G.8121.1 8.2.1/G.8113.1	Both the A-end MEP and Z-end MEP
		Direct Near-end Loss & Far-end Loss	LM (Single-ended) 8.8.4/G.8121 8.8.4/G.8121.1 8.2.6/G.8113.1	Single MEP
		Synthetic Near-end Loss	-- (FFS)	
		Synthetic Near-end Loss & Far-end Loss	-- (FFS)	
	Delay measurement	1-way near-end delay	1DM (dual-ended) 8.8.6/G.8121 8.8.6/G.8121.1 8.2.7/G.8113.1	Both the A-end MEP and Z-end MEP
		● 2-way delay, ● 1-way near-end delay ● 1-way far-end delay	DM (single-ended) 8.8.6/G.8121 8.8.6/G.8121.1 8.2.8/G.8113.1	Single MEP
On-demand performance measurement (PM)	Loss measurement	Direct Near-end Loss & Far-end Loss	LM (single-ended) 8.8.5/G.8121 8.8.5/G.8121.1 8.2.6/G.8113.1	Single MEP

		Synthetic Near-end Loss	-- (FFS)	
		Synthetic Near-end Loss & Far-end Loss	-- (FFS)	
	Delay measurement	1-way near-end delay	1DM (dual-ended) 8.8.7/G.8121 8.8.7/G.8121.1 8.2.7/G.8113.1	Both the A-end MEP and Z-end MEP
		● 1-way near-end delay, ● 1-way far-end delay, ● 2-way delay	DM (single-ended) 8.8.7/G.8121 8.8.7/G.8121.1 8.2.8/G.8113.1	Single MEP
	Throughput	1-way throughput test (1TH)	TST (dual-ended) 8.8.8/G.8121, 8.8.8/G.8121.1 8.2.5/G.8113.1	Both the A-end MEP and Z-end MEP
Proactive fault management (FM)	Continuity check and connectivity verification (CC/CV)		CCM 8.8.1/G.8121.1 8.2.1/G.8113.1)	Gen: A-end MEP of the LSP (or PW or TCM or Section) to Z-end MEP Rec: Z-end MEP
	Remote defect indication (RDI)		RDI bit of CCM 8.8.2/ G.8121.1 8.2.1/G.8113.1)	Gen: Z-end MEP of the LSP (or PW or TCM or Section) to A-end MEP Rec: A-end MEP
	Alarm indication signal (AIS)		AIS 8.6.2 & 8.8.10/G.8121, 8.6.2 & 8.8.10/G.8121.1,8.2.3/G.8113.1)	Gen: Intermediate TP of the LSP (or PW or TCM) to downstream Rec: Downstream MEP
	Locked signal (Lock report) (LCK)		LCK 8.6.3 & 8.8.10/G.8121, 8.6.3 & 8.8.10/G.8121.1, 8.2.4/G.8113.1	Gen: Intermediate TP of the LSP (or PW or TCM) to both up/down stream Rec: Downstream MEP Rec: Upstream MEP
	Client Signal Failure (CSF)		CSF 8.7.3/G.8121 8.7.3/G.8121.1 8.2.9/G.8113.1	Gen: A-end MEP to Z-end MEP Rec: Z-end MEP
On-demand fault management	Connectivity verification (CV)		) LB 8.8.3/G.8121	Gen: A-end MEP of the LSP (or PW or TCM or Section) to Z-end MEP

(FM)		8.8.3/G.8121.1 8.2.2/G.8113.1	Rec: Z-end MEP or Intermediate MIP
	Lock instruction (LKI) – Out of scope of G.8152.1		-
	Route Tracing (RT) – For further study	RT 8.8.9/G.8121 8.8.9/G.8121.1 7.2.1.3/G.8113.1	For further study
	Diagnostic Test (DT)	LB (bidirectional) -/G.8121 8.8.3/G.8121.1 8.2.2/G.8113.1 TST (unidirectional) -/G.8121 8.8.8/G.8121.1 8.2.5/G.8113.1)	Gen: A-end MEP of the LSP (or PW or TCM or Section) to Z-end MEP Rec: Z-end MEP and Respond back to A-end MEP
OAM for other applications	Automatic protection switching (APS) – Out of scope of G.8152.1		-
	Management communication channel (MCC)/ Signalling communication channel (SCC) – Out of scope of G.8152.1		-

In table 6-1, there are five types of MPLS-TP OAM, include proactive OAM for performance measurement, on-demand OAM for performance measurement, proactive OAM for fault management and on-demand OAM for fault management and OAM for other applications. The functions of OAM for other applicaitons are out of scope of G.8152.1. All these MPLS-TP OAM functions are applicable to MPLS-TP sections, label switched paths (LSPs) and pseudowires (PWs).

6.1 Proactive OAM for performance measurement

The proactive OAM for performance measurement is used to performance monitoring purposes. There are two types of functions in table 6-1: proactive loss measurement and proactive delay measurement.

6.1.1 Proactive loss measurement (LM)

The proactive loss measurement (LM) function is used to measure packet loss on a connection for performance-monitoring purposes. It is performed continuously and its result is used to verify the performance of the connection against the service level agreement (SLA). This function can be performed by two methods: dual-ended proactive LM by CCM and single-ended proactive LM by LMM/LMR. The CCM process for dual-ended proactive LM is defined in clause 8.8.4 of [ITU-T G.8121] and 8.8.1 of [ITU-T G.8121.1]. This process calculates the number of transmitted and lost packets per second. The LMM/LMR process for single-ended LM is defined in clause 8.8.4 of [ITU-T G.8121.1]. This process counts the number of transmitted and received packets.

6.1.2 Proactive delay measurement

The proactive delay measurement is used to measure packet delay (PD) and packet delay variation (PDV) on a connection for performance-monitoring purposes. It is performed continuously and its result is used to verify the performance of the connection against the service level agreement (SLA).

This function can be performed by two methods: single-ended DM by DMM/DMR and dual-ended DM by 1DM. The DMM/DMR process for single-ended proactive DM is defined in clause 8.8.6.3-8.8.6.6 of [ITU-T G.8121.1]. A source MEP sends frames with delay measurement message(DMM) to its peer sink MEP and receives frames with DM reply(DMR) information from its peer sink MEP to carry out two-way frame delay and two-way frame delay variation measurements. The 1DM process for dual-ended proactive DM is defined in clause 8.8.6 of [ITU-T G.8121] and 8.8.6.7-8.8.6.10 of [ITU-T G.8121.1]. A source MEP sends frames with 1DM packet to its peer sink MEP and sink MEP enables 1DM to calculate one-way frame delay and one-way frame delay variation. This method needs the clocks between the two MEPs should be synchronized.

6.2 On-demand for performance measurement

The on-demand OAM for performance measurement is used to maintenance purposes. It is performed during a configured specific time interval and its result can be used for diagnosis and analysis. There are three types of functions ~~ —~~in table 6-1: on-demand loss measurement, on-demand delay measurement and throughput measurement.

6.2.1 On-demand loss measurement

The On-demand loss measurement ~~is~~ is used to measure packet loss~~–~~ for direct near-end and far-end. This function commonly ~~–~~be performed by the method of single-ended on demand LM with LMM/LMR. The LMM/LMR process for single-ended LM is defined in clause 8.8.5 of [ITU-T G.8121]&[ITU-T G.8121.1] and OAM PDU ~~formates~~formats is defined in clause 8.2.6 of [ITU-T G.8113.1].

6.2.2 On-demand delay measurement

The on-demand delay measurement is used to measure packet delay for near-end and far-end. This function can be performed by two methods: single-ended DM by DMM/DMR and dual-ended DM by 1DM. The DMM/DMR process for single-ended proactive DM is defined in clause 8.8.7.3-8.8.7.6 of [ITU-T G.8121.1] and OAM PDU format is defined in clause 8.2.8 of [ITU-T G.8113.1]. A source MEP sends frames with delay measurement message (DMM) to its peer sink MEP and receives frames with DM reply (DMR) information from its peer sink MEP to carry out two-way frame delay and two-way frame delay variation measurements. The 1DM process for dual-ended proactive DM is defined in clause 8.8.7 of [ITU-T G.8121] and 8.8.7.7-8.8.7.10 of [ITU-T G.8121.1] and OAM PDU format is defined in clause 8.2.7 of [ITU-T G.8113.1]. A source MEP sends frames with 1DM packet to its peer sink MEP and sink MEP enables 1DM to calculate one-way frame delay and one-way frame delay variation. This method needs the clocks between the two MEPs should be synchronized.

6.2.3 Throughput measurement

Throughput measurement is a test function for measuring the rate of receiving packet percentage at sink MEP when source MEP sends OAM test packets at an increasing rate. This function can be performed by two methods: single-ended throughput and dual-ended throughput. This function commonly ~~be~~is performed by the method of dual-ended throughput through TST (1TH). The TST(1TH) process for dual-ended throughput is defined in clause 8.8.8 of [ITU-T G.8121] and

8.8.8.2-8.8.8.5 of [ITU-T G.8121.1] and OAM PDU format is defined in clause 8.2.5 of [ITU-T G.8113.1].

6.3 Proactive fault management

The proactive OAM for fault measurement is used to fault management for monitoring purposes. In table 6-1, there are five types of functions: CC/CV, RDI, AIS, LCK~~, CSF~~and CSF.

6.3.1 Continuity check and connectivity verification (CC/CV)

The proactive Continuity check and connectivity verification (CC/CV) function is used to fault monitoring. The source (So) MEP sends continuity check/connectivity verification (CC/CV) OAM packets periodically at the configured rate. Then the sink (Sk) MEP monitors the arrival of these CC/CV OAM packets at the configured rate and detects the defect of loss of continuity (LOC). The CC/CV function is defined in clause 7.2.1.1.1 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.1 of [ITU-T G.8113.1]. The CCM process is defined in clause 8.8.1.2-8.8.1.3 of [ITU-T G.8121.1].

6.3.2 Remote defect indication (RDI)

The proactive remote defect indication (RDI) is an indicator which can be used by a MEP to communicate to its peer MEPs. When a MEP detects a signal fail condition, it sends an RDI to its peer MEPs. An RDI is used only when proactive CC/CV bidirectional transmission is enabled. The RDI function is defined in clause 7.2.1.1.2 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.1 of [ITU-T G.8113.1]. The CCM process for RDI is defined in clause 8.8.1.2-8.8.1.3 of [ITU-T G.8121.1].

6.3.3 Alarm indication signal (AIS)

The proactive alarm indication signal(AIS) function is used to suppress alarms from a server MEP to the downstream sink client MEP. The AIS function is defined in clause 7.2.1.1.3 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.3 of [ITU-T G.8113.1]. The AIS process is defined in clause 8.6.2&8.8.10 of [ITU-T G.8121] and [ITU-T G.8121.1].

6.3.4 Locked signal (Lock report) (LCK)

The proactive locked signal (LCK) function is used to communicate to the client (sub-)layer MEPs the administrative locking of a server (sub-)layer MEP and consequential interruption of data traffic forwarding in the client (sub-)layer. The LCK function is defined in clause 7.2.1.1.4 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.4 of [ITU-T G.8113.1]. The LCK process is defined in clause 8.6.3&8.8.10 of [ITU-T G.8121] and [ITU-T G.8121.1].

6.3.5 Client signal failure (CSF)

The proactive client signal fail (CSF) function is used to process client defects and propagate a client signal defect to the associated remote MEPs using OAM packets. This function is usually used when the client of the MPLS-TP trail does not support a native defect/alarm indication mechanism. The CSF function is defined in clause 7.2.1.1.5 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.9 of [ITU-T G.8113.1]. The CSF process is defined in clause 8.7.3 of [ITU-T G.8121] and [ITU-T G.8121.1].

6.4 On-demand fault management

The on-demand OAM for fault measurement is used to fault management for maintenance purposes. In table 6-1, there are six types of functions : CV, LKI, RT, DT. LKI is out of scope G.8152.1 and RT is for further study.

6.4.1 Connectivity verification (CV)

On-demand connectivity verification (CV) function is used to detect failures in the path for trouble-shooting purposes. It can be used to check in end-to-end MEG or just between an MEP and a specific MIP. This function is defined in clause 7.2.1.2.1 of [ITU-T G.8113.1] and OAM PDU format is defined in clause 8.2.1 of [ITU-T G.8113.1]. The CVM/CVR process is defined in clause 8.8.3 of [ITU-T G.8121] and [ITU-T G.8121.1].

6.4.2 Diagnostic test (DT)

The on-demand DT function is used to estimate fault location by sending OAM DT packets on one direction of the MEG, such as packet loss and bit errors estimation. DT can be performed by two methods: bidirectional loopback (LB) and unidirectional TST. LB procedure for DT is defined in clause 9.1.2 of [ITU-T G.8113.1] and its OAM PDU format is defined in clause 8.2.2 of [ITU-T G.8113.1]. TST process is defined in clause 8.8.8 of [ITU-T G.8121.1] and its OAM PDU format is defined in clause 8.2.5 of [ITU-T G.8113.1].

7 Information Model of MPLS-TP OAM

This clause contains the UML information model of the MPLS-TP OAM functions identified in Clause 6. This information model is derived through pruning and refactoring the Recommendation G.7711/Y.1702 core information model and Recommendation G.8152/Y.1375 foundation MPLS-TP NE information model.

<Editor Note: The scope of G.8152.1 is for supporting the G.8113.1 OAM functions and the G.8121 & G.8121.1 equipment behaviours. So what we need to do is to take the G.8152 information model as the base and prune out the G.8113.2 and G.8121.2 specific object classes and attributes and operations. >

In order to extract G.8113.1 OAM specific properties from G.8152 , and to simplify the models of G.8152.1, a few Pacs are pruned & refactored from G.8152 models to specify the TerminationSpec and ConnectionPointAndAdapterSpec with G.8152 specific TTP and CTP, following G.8152's usage of G.7711 models.

The G.8152.1 UML models are pruned & re-factored from G.8152 UML models for retaining only G.8113.1 OAM attributes and operations. There are a few kinds of object classes:

a. OAM function Pacs:

They are re-factored from Mep, MT TTP and MT CTP of G.8152, see Table II-2 and Table II-3 of G.8152.1. These classes are used to manage oam functions defined in clause 6.

b. Measurement Job Pacs:

They are re-factored from measurement job classes of G.8152, see Figure 7-3. These classes are used to manage oam functions defined in clause 6.

c. Mep and Mip:

Because G.8113.1 OAM related properties are all pruned & refactored from G.8152 models, the Mep of G.8152 retains few attributes, such as megId and mepId. It is suggested that a MepG8152Dot1 object class pruned from Mep of G.8152 is used in G.8152.1 instead of Mep.

For Mip of G.8152.1 are the same with G.8152, because there's no attributes pruned or refactored from Mip.

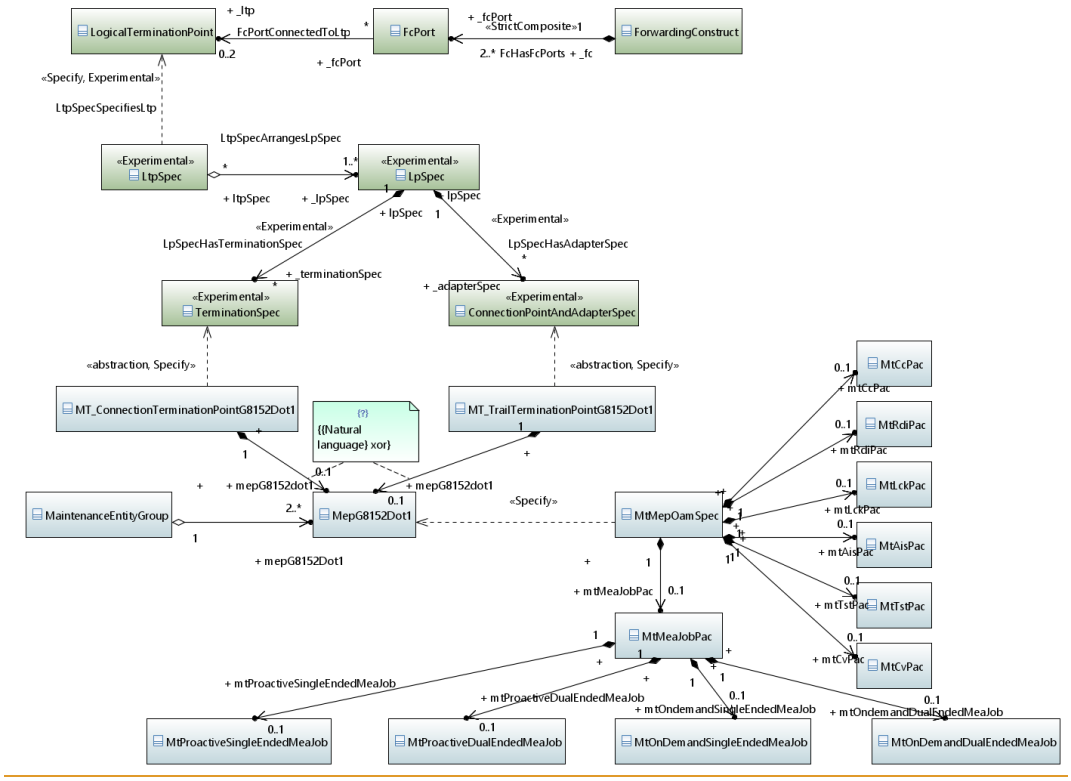


Figure 7-1 High-level Sketch of G.8152.1 Object Classes

From clause 7.1 to clause 7.4, the intent of all these clauses is to prune & refactor G.8113.1 OAM properties from G.8152 UML model.

7.1 Required Object Classes

To manage the carrier MPLS-TP OAM functions identified in Clause 6, the following object classes are required:

- MT_TrailTerminationPoint/Bidirectional/Sink/Source *and the subordinate Pacs*
- MT_ConnectionTerminationPoint/Bidirectional/Sink/Source *and the subordinate Pacs*
- Mep/ Bidirectional/Sink/Source
- Mip/ Bidirectional/Sink/Source
- MepControl

- MipControl
- OnDemandMeasurementJobControl
- OnDemandSingleEndedMeasuremnetJobControl
- OnDemandSingleEndedMeasuremnetJobControlSource
- OnDemandDualEndedMeasurementJobControlSink
- ProactiveMeasurementJobControl
- ProactiveDualEndedMeasurementJobControlSink
- ProactiveDualEndedMeasurementJobControlSource
- ProactiveSingleEndedMeasurementJobControlSink
- ProactiveSingleEndedMeasurementJobControlSource
- ProactiveSingleEndedMeasurementJobControlSinkG8113Dot1
- ProactiveSingleEndedMeasurementJobControlSourceG8113Dot1
- MT_CurrentData
- ProactiveDmCurrent/HistoryData
- ProactiveLmCurrentData/HistoryData
- Proactive1LmCurrentData/HistoryData
- Proactive1DmCurrentData/HistoryData
- ThresholdProfile

The concepts ME, MEG, MEP, and MIP are described in both of G.8113.1 and RFC6371. Note that the information model in G.8152 is an NE-view information model and therefore it doesn't explicitly model the ME and MEG, which are beyond the scope of an NE-view. Rather, the MEP object class has the attribute megId, which identifies the MEG that the MEP is belonging to, like the following Figure 7-1 depicts.

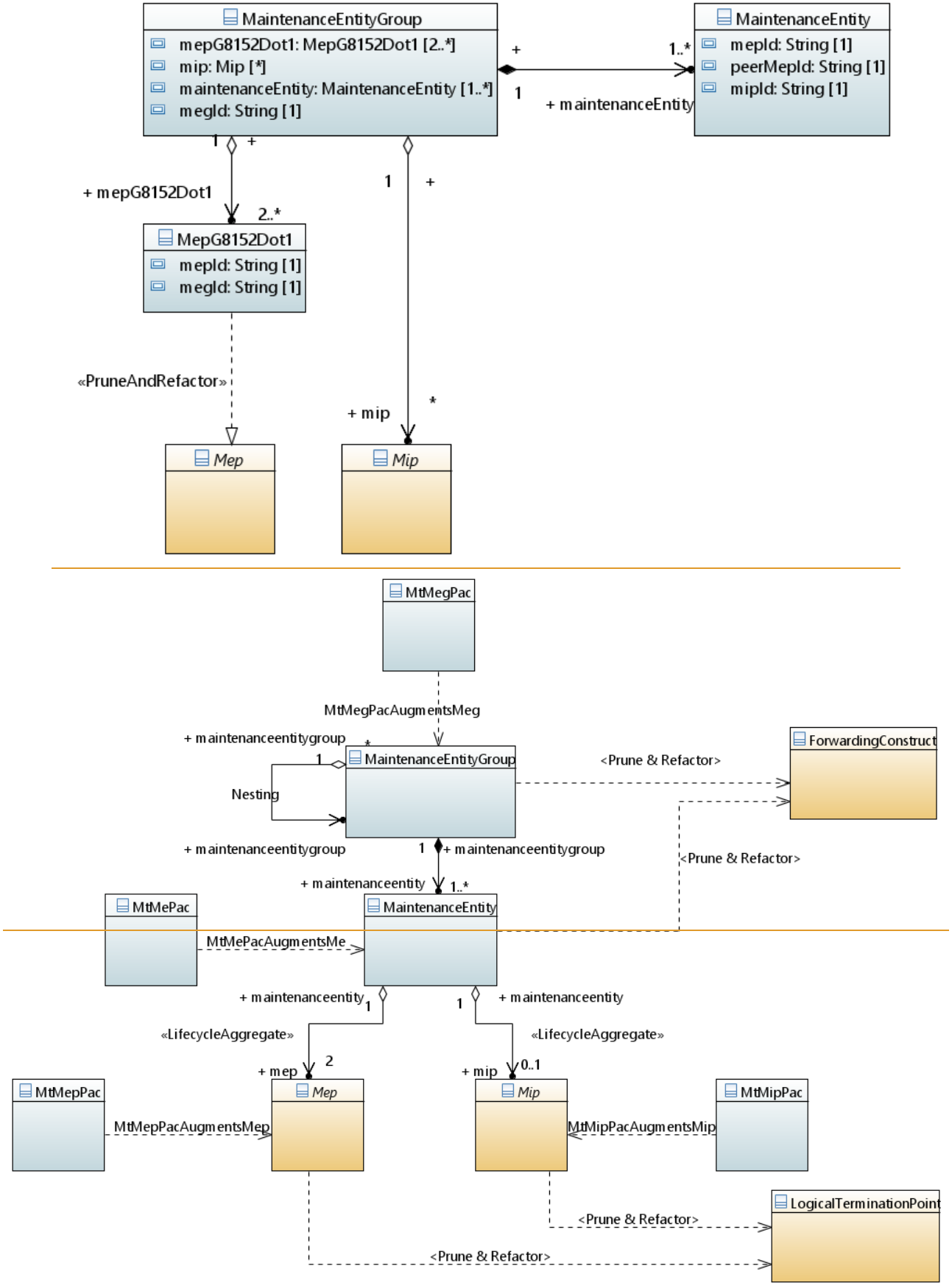


Figure 7-~~21~~ High-level MEG Class Diagram

– From the definition in G.8113.1, a MEP is the end point of a MEG rather than a ME, and a MIP is a point between the two MEPs within a MEG rather than a ME.~~ME prunes/refactors the core FC and then it is augmented/specified with MPLS-TP specific Pac (MtMePac) for MPLS-TP specific properties.~~
– From the definition in G.8113.1, a ME can be viewed as an association between two MEPs~~MEG prunes/refactors the core FC and then it is augmented with MPLS-TP specific Pac (MtMegPac) for MPLS-TP specific properties.~~.
– A ME may contain zero or more MIP.~~MEP prunes/refactors the core LTP, with LP=MPLS-TP OAM (not MPLS-TP, i.e., it is not the TP of the traffic LSP, but the TP of the OAM LSP that is co-routed with the monitored traffic LSP), and then it is augmented/specified with a MtMepPac for MPLS-TP specific properties.~~
– A MEG contain MEP and MIP instances, leaving ME only references of MEP and MIP.~~MIP prunes/refactors the core LTP, with LP=MPLS-TP OAM (not MPLS-TP, i.e., it is not the TP of the traffic LSP, but the TP of the OAM LSP that is co-routed with the monitored traffic LSP), and then it is augmented/specified with a MtMipPac for MPLS-TP specific properties.~~
– An attribute ‘mepId’ is defined in MEP class of G.8152, it could identify the MEP instances. So a ‘mepId’ is a good candidate for referring to a MEP instance, two of which could represent an association between two MEPs.~~ME aggregates (instead of contains) with stereotype lifecycleAggregate Mep.~~
– ~~ME aggregates (instead of contains) with stereotype lifecycleAggregate Mip.~~

The required object classes and their relationships are shown in ~~Figure 7-1~~Figure 7-3~~2~~.

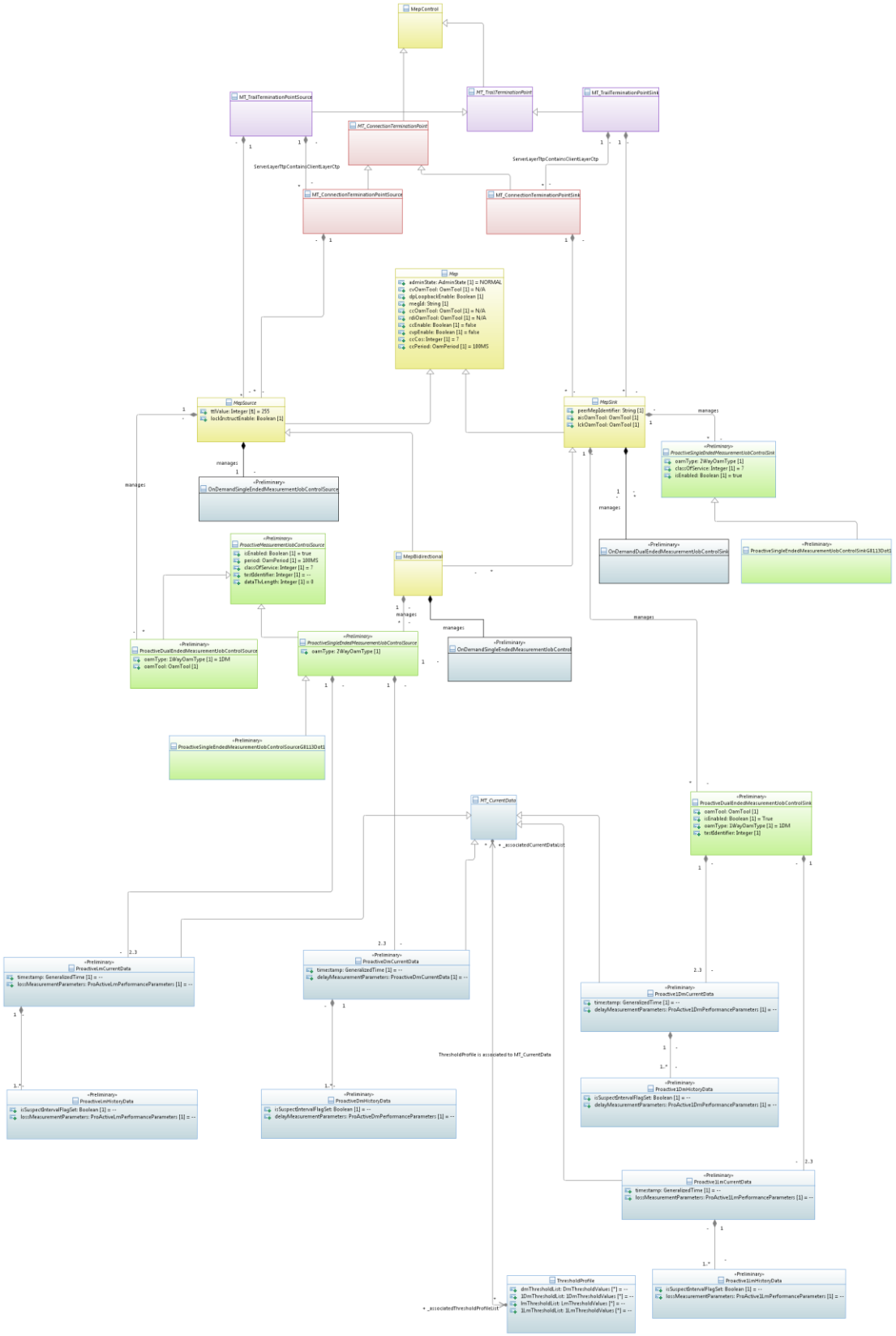

MepControl
MT_TrailTerminationPointSource
MT_TrailTerminationPoint
MT_TrailTerminationPointSink
MT_ConnectionTerminationPoint
ServerLayerTpContainsClientLayerCtp
MT_ConnectionTerminationPointSource
MT_ConnectionTerminationPointSink
Mep
MepSource
MepSink
manages
«Preliminary»
OnDemandSingleEndedMeasurementJobControlSource
ProactiveMeasurementJobControlSource
MepBidirectional
ProactiveDualEndedMeasurementJobControlSource
ProactiveSingleEndedMeasurementJobControlSource
MT_CurrentData
ProactiveDualEndedMeasurementJobControlSink
ProactiveSingleEndedMeasurementJobControlSink
ProactiveLmCurrentData
ProactiveDmCurrentData
Proactive1DmCurrentData
ProactiveLmHistoryData
ProactiveDmHistoryData
Proactive1DmHistoryData
Proactive1LmCurrentData
Proactive1LmHistoryData
ThresholdProfile
ThresholdProfile is associated to MT_CurrentData

Figure 7-~~1~~32 **Required Object Classes for MPLS-TP OAM**

7.2 Required attributes and operations

This section identifies which attributes and operations of the section 7.1 object classes should be pruned and which should remain.

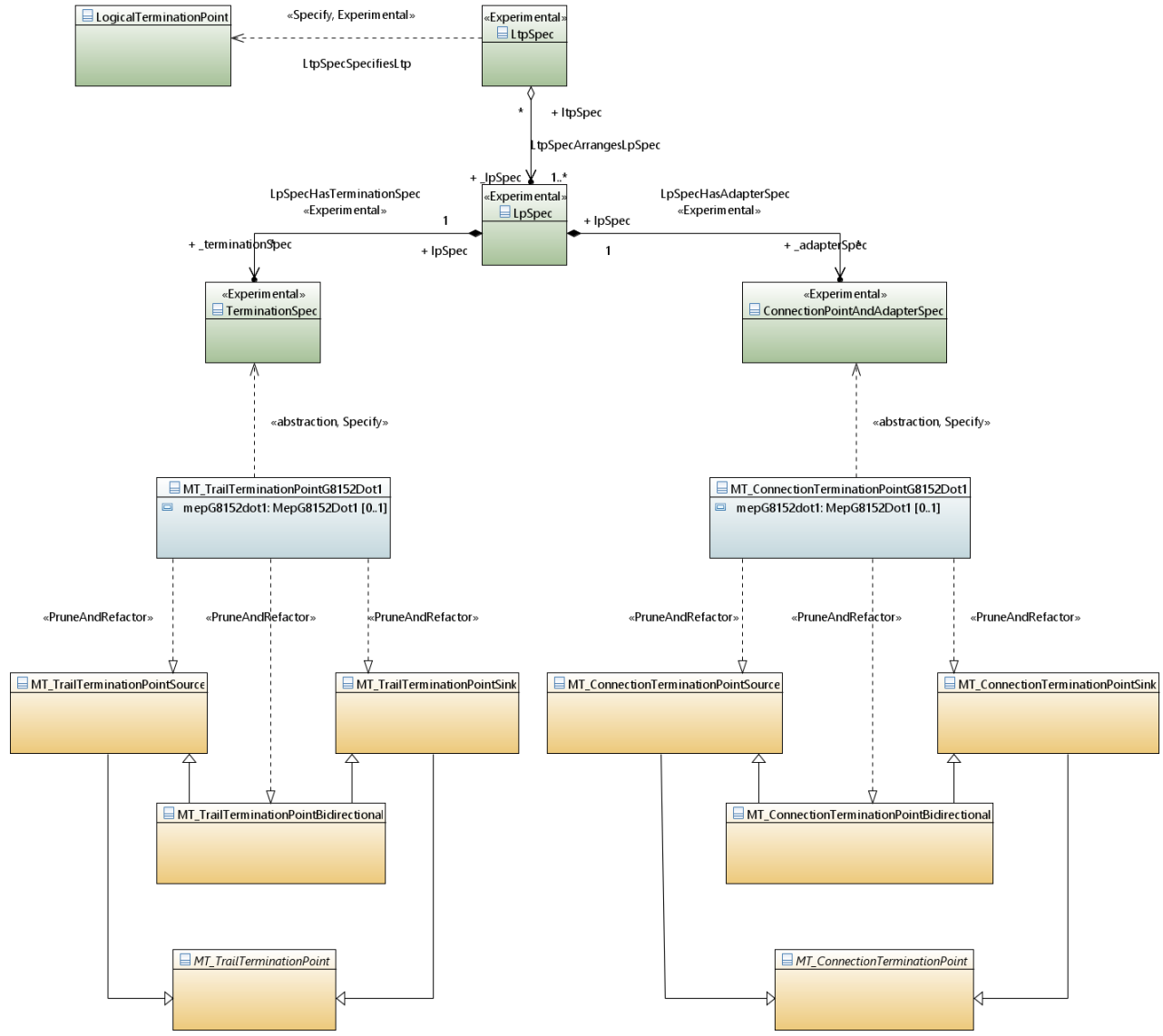
<Editor Note: The Pacs defined in this clause should be consistent with the ones in Table 6-1. >

7.2.1 Termination points

The required object classes are pruned and refactored from the G.8152 information model, which augment the TerminationSpec and ConnectionPointAndAdapterSpec of LpSpec of G.7711 with the MPLS-TP TTP and CTP as shown in Figure 7-~~Figure 7-2~~.

~~The object classes MtTtpSoPac, MtTtpBiPac, MtTtpSiPac augment the TerminationSpec. And the object classes MtCtpSoPac, MtCtpBiPac, MtCtpSiPac augment the ConnectionPointAndAdapter Spec.~~

<Editor Note: The LSP interface yang model from IETF should be re-engineered into an UML models which these Pacs could be specified to. >


LogicalTerminationPoint
«Specify, Experimental»
«Experimental»
LtpSpec
LtpSpecSpecifiesLtp
* + ltpSpec
LtpSpecArrangesLpSpec
+ _lpSpec 1..*
LpSpecHasTerminationSpec
«Experimental»
1
+ _terminationSpec
+ lpSpec
«Experimental»
LpSpec
+ lpSpec
1
LpSpecHasAdapterSpec
«Experimental»
+ _adapterSpec
«Experimental»
TerminationSpec
«Experimental»
ConnectionPointAndAdapterSpec
«abstraction, Specify»
«abstraction, Specify»
MT_TrailTerminationPointG8152Dot1
mepG8152dot1: MepG8152Dot1 [0..1]
MT_ConnectionTerminationPointG8152Dot1
mepG8152dot1: MepG8152Dot1 [0..1]
«PruneAndRefactor»
«PruneAndRefactor»
«PruneAndRefactor»
«PruneAndRefactor»
«PruneAndRefactor»
«PruneAndRefactor»
MT_TrailTerminationPointSource
MT_TrailTerminationPointSink
MT_ConnectionTerminationPointSource
MT_ConnectionTerminationPointSink
MT_TrailTerminationPointBidirectional
MT_ConnectionTerminationPointBidirectional
MT_TrailTerminationPoint
MT_ConnectionTerminationPoint

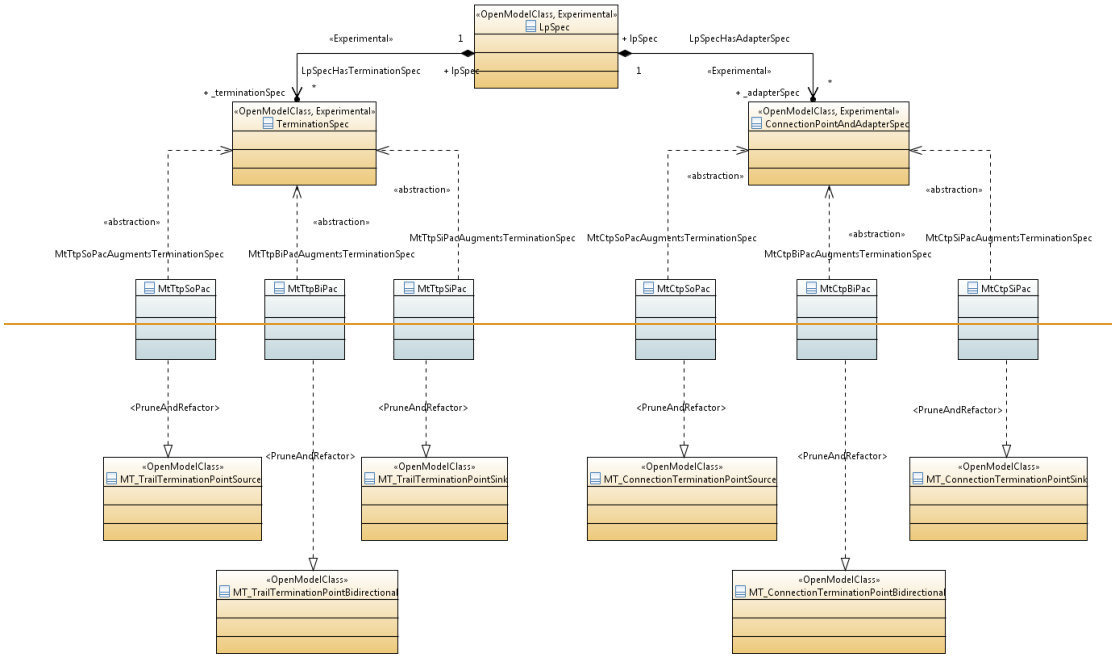


Figure 7-~~2~~3 **Termination Point augmentation and pruning/refactoring**

– OAM related attributes of TTP and CTP are refactored into OAM function Pacs (showed in Figure 7-4), such as MtCcPac, MtAisPac or MtTstPac, and other attributes are pruned.
– G.8152 MT Bi TTP and MT Bi CTP both have attributes _mepBidirectional and _mipBidirectional in order to manage Mep and Mip. MT So TTP (CTP) and MT Si TTP (CTP) do not have attributes refer to MepSource or MepSink. It is implicit that G.8152 only support bidirectional MEP.

Figure 7-3 provides a few Pacs to prune & refactor attributes from TTP and CTP object classes, and Table II-1 of appendix II has listed all attributes to be pruned & refactored in details.~~The pruning/refactoring of the attributes of Termination Point is listed in the Table II 7-1.~~

<Editor Note: The pruning and refactoring of the attributes in the following Table II ~~7~~-1 have not been reviewed yet. Any suggestions are invited. >

~~**Table 7-1 Pruning/refactoring of TP Attributes**~~**MT TTP and CTP Pruning/Refactoring**

~~Source artifact~~	~~To be pruned or moved to~~	~~Rationale~~
~~MT_TrailTerminationPointSource::~~		
~~ttlValue~~		
~~MT_TrailTerminationPointSink::~~		
~~lmTfMin~~	~~MtLmPac~~	
~~lmDegm~~	~~MtLmPac~~	
~~lmM~~	~~MtLmPac~~	
~~lmDegThr~~	~~MtLmPac~~	

currentProblemList		
MT_TrailTerminationPointBidirectional::		
_sccTp		
_mccTp		
_mtConnectionTerminationPointBidirectional		
_mepBidirectional		
_ethConnectionTerminationPoint		
MT_ConnectionTerminationPointSource::		
phb2TcMapping		
qosEncodingMode		
apsOamCos		
MT_ConnectionTerminationPointSink::		
tc2PhbMapping		
qosEncodingMode		
lckOamTool	MtLckPac	
lckPeriod	MtLckPac	
lckCoS	MtLckPac	
aisOamTool	MtAisPac	
aisPeriod	MtAisPac	
aisCoS	MtAisPac	
MT_ConnectionTerminationPointBidirectional::		
_mepBidirectional		
_mipBidirectional		

Source artifact	To be pruned or moved to	Rationale
Inherited by MT_ConnectionTerminationPoint/Sink/Source/Bidirectional		
Address::address	Pruned	Not needed.
G8152LocalClass::localIdList	Pruned	Not needed.
LocalClass::localId	Retained	For identifying the instance.
G8152LayerProtocol::layerProtocolName	pruned	Not needed.
G8152LayerProtocol::_lpSpec	pruned	No Spec is needed so far.
G8152LayerProtocol::configuredClientCapacity	pruned	Not needed. This attribute is

		from the core model LayerProtocol. The client LTP association should provide all necessary detail hence this attribute is questionable, even in the core model.
G8152LayerProtocol::lpDirection	pruned	Not needed. Already have explicit Bi/Sink/Source object class instances (although in most case is Bidirectional), so no need for the attribute lpDirection (which is Bi/Si/So/UndefinedOrUnknown)
G8152LayerProtocol::terminationState	pruned	Indicates whether the layer is terminated and if so how. For MT CTP, it is not terminated.
State_Pac::lifecycleState	pruned	It can be inherited from the LTP.
State_Pac::administrativeState	pruned	It can be inherited from the LTP.
State_Pac::administrativeControl	pruned	It can be inherited from the LTP.
State_Pac::operationalState	pruned	It can be inherited from the LTP.
Extension::extension	retained	
Label::label	retained	
Name::name	retained	
ClientLayerSpecificAdaptationMi_Pac::clientlayerspecificadaptationmi_pac	Pruned	Not needed.
AdminState::adminState	retained	
MT_ConnectionTerminationPointSink		
tc2PhbMapping	pruned	Qos is out of scope of G.8152.1

~~qosDecodingMode~~	~~pruned~~	~~Qos is out of scope of G.8152.1~~
~~lckOamTool~~ ~~lckOamTool:OamTool → move to G.8152.1 MtLckPac~~	~~refactored: MtLckPac~~	~~MT CTP Sink Pac aggregates (new extended composite) new MtLckSiPac, which has three attributes: lckOamTool:OamTool, lckPeriod::LckAisPeriod and lckCos::Integer~~
~~lckPeriod~~ ~~lckPeriod::LckAisPeriod → move to G.8152.1 MtLckPac~~	~~refactored: MtLckPac~~	
~~lckCos~~ ~~lckCos::Integer → move to G.8152.1 MtLckPac~~	~~refactored: MtLckPac~~	
~~aisOamTool~~ ~~aisOamTool:OamTool → move to G.8152.1 MtAisPac~~	~~refactored: MtAisPac~~	~~MT CTP Sink Pac aggregates (new extended composite) new MtAisSiPac, which has three attributes: aisOamTool:OamTool, aisPeriod::LckAisPeriod and aisCos::Integer~~
~~aisPeriod~~ ~~aisPeriod:LckAisPeriod → move to G.8152.1 MtAisPac~~	~~refactored: MtAisPac~~	
~~aisCos~~ ~~aisCos:Integer → move to G.8152.1 MtAisPac~~	~~refactored: MtAisPac~~	
~~MT_ConnectionTerminationPointSource~~		
~~tc2PhbMapping~~	~~pruned~~	~~Qos is out of scope of G.8152.1~~
~~qosDecodingMode~~	~~pruned~~	~~Qos is out of scope of G.8152.1~~
~~apsOamCos~~	~~pruned~~	~~APS is out of scope of G.8152.1~~
~~MT_ConnectionTerminationPointBidirectional~~		
~~mepBidirectional~~	~~retained~~	
~~mipBidirectional~~	~~retained~~	

Inherited by MT_TrailTerminationPoint/Sink/Source/Bidirectional		
G8152LocalClass::localId	Retained	For identifying the instance
G8152GlobalClass::localIdList	pruned	This is not needed
G8152LocalClass::localIdList	pruned	This is not needed
G8152GlobalClass::uuid	Retained	For identifying the instance
G8152LayerProtocol::layerProtocolName	pruned	The object class already indicates it is MT TTP
G8152LayerProtocol::_lpSpec	pruned	No Spec is needed so far.
G8152LayerProtocol::configuredClientCapacity	pruned	Not needed. This attribute is from the core model LayerProtocol. The client LTP association should provide all necessary detail hence this attribute is questionable, even in the core model.
G8152LayerProtocol::lpDirection	pruned	Not needed. Already have explicit Bi/Sink/Source object class instances (although in most case is Bidirectional), so no need for the attribute lpDirection (which is Bi/Si/So/UndeficdOrUnknown).
G8152LayerProtocol::terminationState	pruned	Not needed. MT TTP is terminated.
Pacs::Tp_Pac::alarmStatus	Retained	Retained for MT TTP Sink
Pacs::Tp_Pac::crossConnectionObjectPointer	pruned	Not needed
Pacs::Tp_Pac::currentProblemList	retained	Retained for MT TTP Sink

Pacs::Tp_Pac::alarmSeverityAssignmentProfilePointer	Retained	Retained for MT_TTP_Sink
Serverlayerspecificadaptationmi_pac	pruned	Not needed
mt_connectionterminationpoint	retained	
MT_TrailTerminationPointSink		
lmTfMin lmTfMin:Boolean → move to G.8152.1 MtLmPac	refactored: MtLmPac	MT_TTP_Sink Pac aggregates (new extended composite) new MtLmSiPac, which has four attributes: lmTfMin:Boolean lmDegm:Integer lmM:Integer lmDegThr:Integer
lmDegm lmDegm:Integer → move to G.8152.1 MtLmPac	refactored: MtLmPac	
lmM lmM:Integer → move to G.8152.1 MtLmPac	refactored: MtLmPac	
lmDegThr lmDegThr:Integer → move to G.8152.1 MtLmPac	refactored: MtLmPac	
currentProblemList	retained	
MT_TrailTerminationPointSource		
ttlValue	retained	
MT_TrailTerminationPointBidirectional		
_sccTp	pruned	Assume not in the scope of G.8152.1
_mccCtp	pruned	Assume not in the scope of G.8152.1
_mepBidirectional	retained	
_ethConnectionTerminationPoint	retained	

7.2.2 MEP attributes

The required object classes that supporting the MPLS-TP OAM functions for CC/CV, AIS, LCK, CSF, DM and LM are listed as following and shown in the Figure 7-~~Figure 7-3~~.

ProactiveSingleEndedMeaJob uses four proactive measurement job classes:

a) ProactiveSingleEndedMeasurementJobControlSource
b) ProactiveSingleEndedMeasurementJobControlSink
c) ProactiveSingleEndedMeasurementJobControlSourceG8113Dot1
d) ProactiveSingleEndedMeasurementJobControlSinkG8113Dot1

ProactiveDualEndedMeaJob uses two proactive measurement job classes:

a) ProactiveDualEndedMeasurementJobControlSource
b) ProactiveDualEndedMeasurementJobControlSink

OnDemandSingleEndedMeaJob use one ondemand measurement job class:

OnDemandSingleEndedMeasurementJobControlSource

OnDemandDualEndedMeaJob use one ondemand measurement job class:

OnDemandDualEndedMeasurementJobControlSink

MtAisPac, MtLckPac, MtDmPac, MtLmPac, MtCcPac, MtCvPac and MtCsfPac are used to package MPLS-TP OAM related attributes.

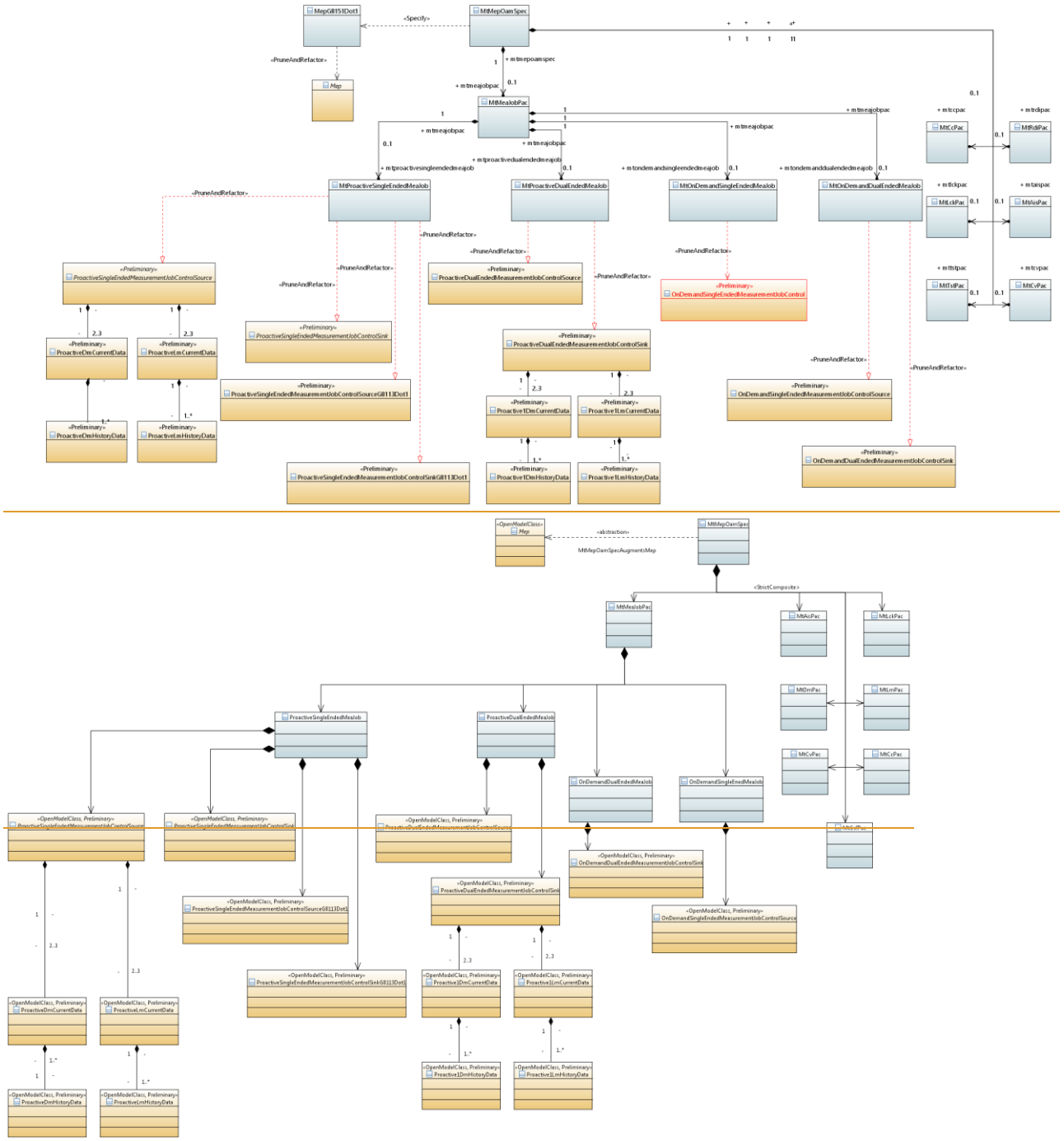


Figure 7-~~34~~ **MPLS-TP MEP OAM augmentation & pruning/refactoring**

The pruning/refactoring of the attributes of MEP is listed in the ~~Table~~ **II** ~~7-2~~.

<Editor Note: The pruning and refactoring of the attributes in the following Table **II** ~~7~~-2 have not been reviewed yet. The pruning and refactoring of MeasurementJob classes' attributes should be further provided.Any suggestions are invited. >

Table 7-2 MT MEP Classes Pruning/Refactoring

Source artifact	To be pruned or moved to	Rationale
ProactiveSingleEndedMeasurementJobControlSource::		
oamType		
ProactiveSingleEndedMeasurementJobControlSink::		
oamType		
classOfService		
isEnabled		
ProactiveDualEndedMeasurementJobControlSource::		
oamType		
oamTool	refactor	
ProactiveDualEndedMeasurementJobControlSink::		
oamType		
oamTool	refactor	
isEnabled		
testIdentifier		
OnDemandDualEndedMeasurementJobControlSink::		
oamType		
onDemandPerformanceData		
startTime		
stopTime		
testIdentifier		
OnDemandDualEndedMeasurementJobControlSource::		
oamType		

Source artifact	To be pruned or moved to	Rationale
G8152LocalClass::localId	All OAM Pacs	Moved to (refactored into) to all the OAM Pacs
MEP		
Mep::adminState	retained	
Mep::mepMac	retained	
Mep::mel	retained	

G8152LocalClass::localIdList	pruned	
Mep::megId	retained	
Mep::mepId	retained	
Mep::cvOamTool	MtCcCvPac	
Mep::cvpEnable	MtCcCvPac	
Mep::ccEnable	MtCcCvPac	
Mep::ccPeriod	MtCcCvPac	
Mep::ccCos	MtCcCvPac	
Mep::ccOamTool	MtCcCvPac	
Mep::dpLoopbackEnable	Pruned	dpLoopback is for G.8113.2, is out of scope of G.8113.1.
Mep::rdiOamTool	MtRdiPac	
Mep::1ThOamTool	MtLmPac	
MEP Sink		
MepSink::peerMepIdentifier	retained	
MepSink::aisOamTool	MtAisPac	Moved to (refactored into) to MtAisPac
MepSink::lckOamTool	MtLckPac	Moved to (refactored into) to MtLckPac
MepSink::remoteLockRequest	MtLckPac	Moved to (refactored into) to MtLckPac
MEP Source		
MepSource::ttlValue	retained	
MepSource::lockInstructEnable	MtLckPac	Moved to (refactored into) to MtLckPac
MepSource::adminState	retained	

MEP Bidirectional		

7.2.3 MIP attributes

The object class MtMipPac for MPLS-TP OAM functions is pruned and refactored from MipBidirectional used by MtMipOamSpec to augment Mip object class.

Since Mip class of G.8152 already have mipId and isFullMip attributes, it is much convenient to direcly use G.8152's Mip class in G.8152.1 model.

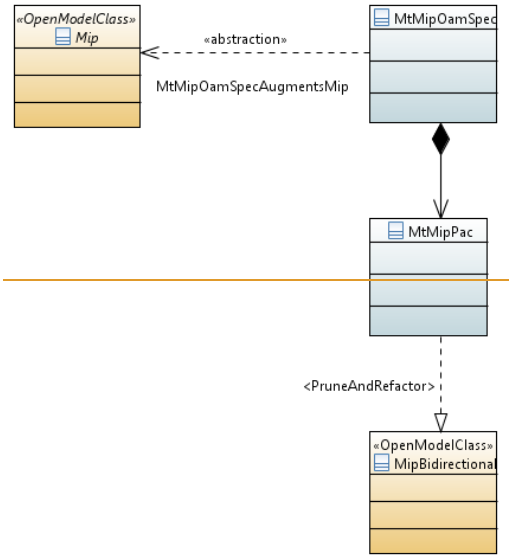


Figure 7-4 **MPLS-TP MIP OAM augmentation & pruning/refactoring**

The pruning/refactoring of the attributes of MEP is listed in the Table **II** 7-3.

<Editor Note: The pruning and refactoring of the attributes in the following Table **II** 7-3 have not been reviewed yet. Any suggestions are invited. >

Table 7-3 Pruning/refactoring of MIP Attributes**MT MIP Classes Pruning/Refactoring**

Source artifact	**To be pruned or moved to**	**Rationale**
MipBidirectional::		
isFullMip		

Source artifact	**To be pruned or moved to**	**Rationale**
G8152LocalClass::localId		Moved to (refactored into) to all

	All OAM Pacs	the OAM Pacs
MIP		
G8152LocalClass::localIdList	pruned	
Mip::mipId	retained	
Mip::ttlValue	retained	
Mip::cvOamTool	MtCcCvPac	
Mip::dpLoopbackEnable	Pruned	It is defined in G.8113.2, is out of scope of G.8113.1.
MIP Sink		
MIP Source		
MIP Bidirectional		
Mip::isFullMip	retained	

7.2.4 MEP and MIP operations

The required operations to support MPLS-TP OAM functions for CC/CV, AIS, LCK, CSF, DM and LM are shown in the Figure 7-5.

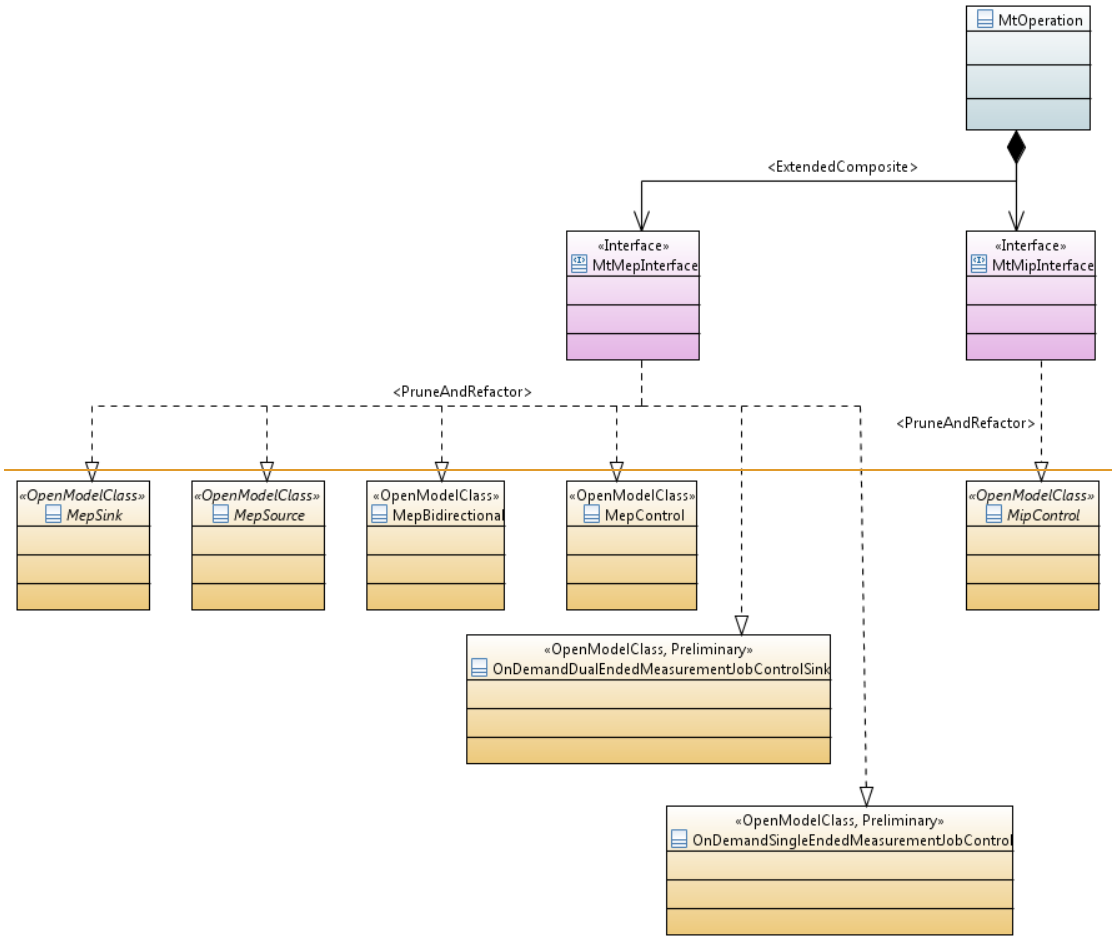
MtMepInterface packages MPLS-TP OAM related Mep operations by pruning and refactoring from Mep related classes.

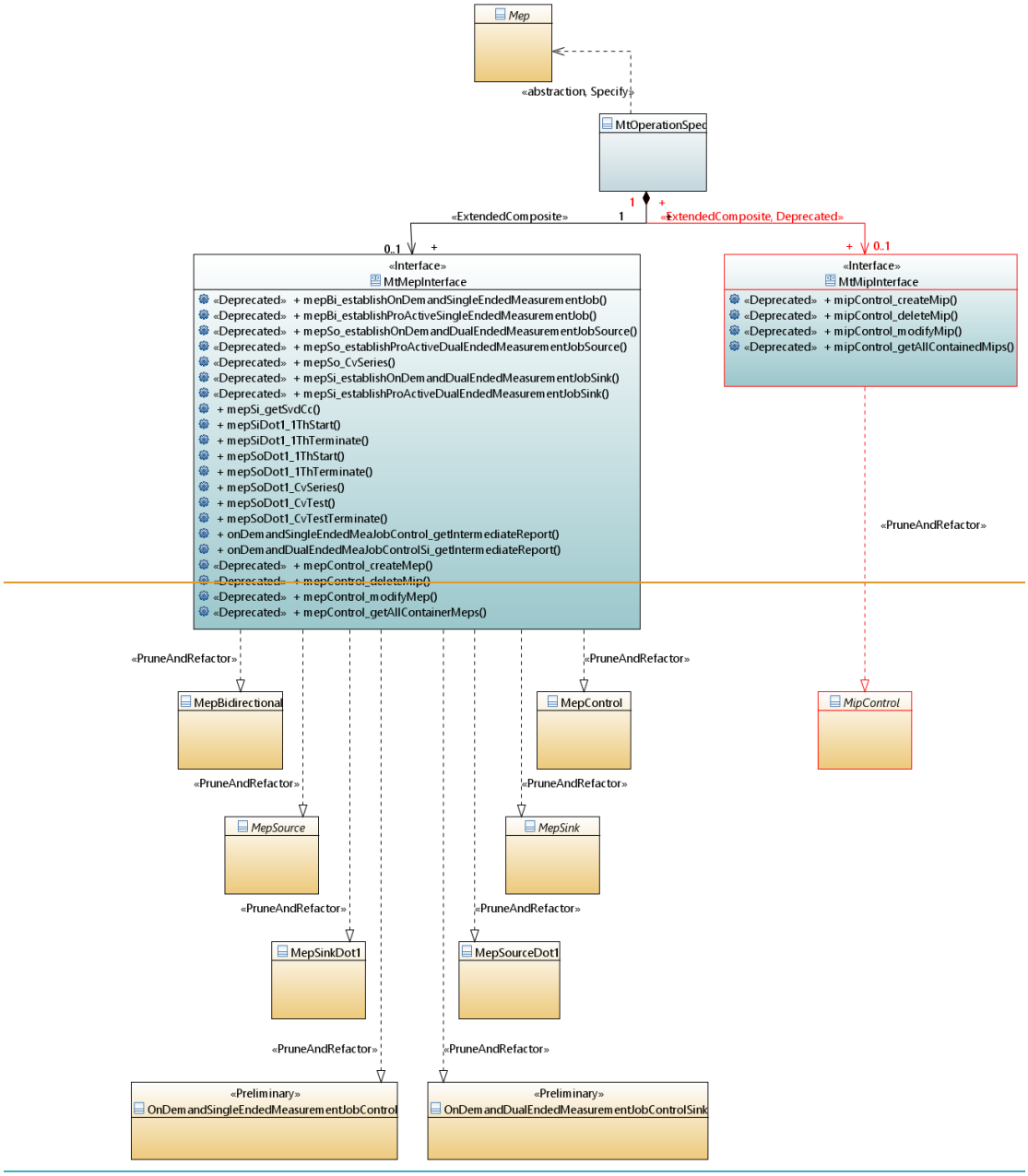
MtMipInterface packages MPLS-TP OAM related Mip operations by pruning and refactoring from Mip related classes.

<Editor Note: The pruning and refactoring of the operations should be further considered. Any suggestions are invited. >

The MtOperationSpec class consists of the MtMepInterface and MtMipInterface interface classes.

Since all the operations are refactored into OAM maintenance functions Pacs (such as MtTstPac, MtCcPac, MtCvPac) and Measurement Job Pacs (such as OnDemandSingleEndedMeaJob and OnDemandDualEndedMeaJob), MtOperationSpec is not needed which could be removed from the model.


MtOperation
<ExtendedComposite>
«Interface»
MtMepInterface
«Interface»
MtMipInterface
<PruneAndRefactor>
<PruneAndRefactor>
«OpenModelClass»
MepSink
«OpenModelClass»
MepSource
«OpenModelClass»
MepBidirectional
«OpenModelClass»
MepControl
«OpenModelClass»
MipControl
«OpenModelClass, Preliminary»
OnDemandDualEndedMeasurementJobControlSink
«OpenModelClass, Preliminary»
OnDemandSingleEndedMeasurementJobControl



~~Figure 7-5~~ **~~MPLS-TP Operation pruning/refactoring~~**

The pruning/refactoring of the operations of MEP and MIP is listed in the ~~Table~~ **II** ~~7-4~~.

~~Table 7-4 Pruning/refactoring of MEP/MIP operations~~

~~**Source artifact**~~	~~**To be pruned or moved to**~~	~~**Rationale**~~
~~MepSink::~~		
~~establishOnDemandDualEndedMeasurementJobSink~~		
~~establishProactiveDualEndedMeasurementJobSink~~		

~~getSvdCc~~		
~~MepSource::~~		
~~establishOnDemandDualEndedMeasurementJobSource~~		
~~establishProactiveDualEndedMeasurementJobSource~~		
~~CvSeries~~		
~~MepBidirectional::~~		
~~establishOnDemandDualEndedMeasurementJob~~		
~~establishProactiveDualEndedMeasurementJob~~		
~~MepControl::~~		
~~createMep~~		
~~modifyMep~~		
~~deleteMep~~		
~~getAllContainedMeps~~		
~~OnDemandDualEndedMeasurementJobControlSink::~~		
~~getIntermediateReport~~		
~~OnDemandSingleEndedMeasurementJobControl::~~		
~~getIntermediateReport~~		
~~MipControl::~~		
~~createMip~~		
~~modifyMip~~		
~~deleteMip~~		
~~getAllContainedMips~~		

7.3 OAM functions modelling

<Editor Note: Details are ~~to be~~ provided. >

7.3.1 Proactive OAM for performance measurement

The procative OAM for performance measurement functions mainly use two object classes: MtProactiveDualEndedMeasurementJobPac and MtProactiveSingleEndedMeasurementJobPac. They are pruned and refactored from object classes of G.8152 as following.

MtProactiveDualEndedMeasurementJobPac

– ProactiveMeasurementJobControlSource::isEnabled

– ProactiveMeasurementJobControlSource::period
– ProactiveMeasurementJobControlSource::classOfService
– ProactiveMeasurementJobControlSource::testOfIdentifier
– ProactiveMeasurementJobControlSource::dataTlvLength
– ProactiveDualEndedMeasurementJobControlSource::oamType
– ProactiveDualEndedMeasurementJobControlSource::oamTool
– ProactiveDualEndedMeasurementJobControlSink::oamTool
– ProactiveDualEndedMeasurementJobControlSink::isEnabled
– ProactiveDualEndedMeasurementJobControlSink::oamType
– ProactiveDualEndedMeasurementJobControlSink::testIdentifier

MtProactiveSingleEndedMeasurementJobPac

– ProactiveMeasurementJobControlSource::isEnabled
– ProactiveMeasurementJobControlSource::period
– ProactiveMeasurementJobControlSource::classOfService
– ProactiveMeasurementJobControlSource::testOfIdentifier
– ProactiveMeasurementJobControlSource::dataTlvLength
– ProactiveSingleEndedMeasurementJobControlSource::oamType
– ProactiveSingleEndedMeasurementJobControlSink::oamType
– ProactiveSingleEndedMeasurementJobControlSink::classOfService
– ProactiveSingleEndedMeasurementJobControlSink::isEnabled

7.3.1.1 Proactive loss measurement (LM)

The dual-ended proactive LM by CCM uses MtProactiveDualEndedMeasurementJobPac and single-ended proactive LM by LMM/LMR uses MtProactiveSingleEndedMeasurementJobPac.

7.3.1.2 Proactive delay measurement (DM)

The single-ended DM by DMM/DMR uses MtProactiveSingleEndedMeasurementJobPac and dual-ended DM by 1DM uses MtProactiveDualEndedMeasurementJobPac.

7.3.2 On-demand OAM for performance measurement

The functions of On-demand OAM for performance measurement mainly use two object classes: MtOnDemandDualEndedMeasurementJobPac and MtOnDemandSingleEndedMeasurementJobPac . They are pruned and refactored from object classes of G.8152 as following.

MtOnDemandDualEndedMeasurementJobPac

– OnDemandMeasurementJobControl::startTime
– OnDemandMeasurementJobControl::stopTime
– OnDemandMeasurementJobControl::oamPduGenerationType
– OnDemandMeasurementJobControl::measurementInterval
– OnDemandMeasurementJobControl::messagePeriod
– OnDemandMeasurementJobControl::repetitionPeriod

– OnDemandMeasurementJobControl::classOfService
– OnDemandMeasurementJobControl::testIdentifier
– OnDemandMeasurementJobControl::dataTlvLength
– OnDemandDualEndedMeasurementJobControlSink::oamType
– OnDemandDualEndedMeasurementJobControlSink::onDemandPerformanceData
– OnDemandDualEndedMeasurementJobControlSink::startTime
– OnDemandDualEndedMeasurementJobControlSink::stopTime
– OnDemandDualEndedMeasurementJobControlSink::testIdentifier

MtOnDemandSingleEndedMeasurementJobPac

– OnDemandMeasurementJobControl::startTime
– OnDemandMeasurementJobControl::stopTime
– OnDemandMeasurementJobControl::oamPduGenerationType
– OnDemandMeasurementJobControl::measurementInterval
– OnDemandMeasurementJobControl::messagePeriod
– OnDemandMeasurementJobControl::repetitionPeriod
– OnDemandMeasurementJobControl::classOfService
– OnDemandMeasurementJobControl::testIdentifier
– OnDemandMeasurementJobControl::dataTlvLength
– OnDemandSingleEndedMeasurementJobControlSource::oamType
– OnDemandSingleEndedMeasurementJobControlSink::oamType
– OnDemandSingleEndedMeasurementJobControlSink::onDemandPerformanceData

7.3.2.1 On-demand loss measurement

This function commonly be performed by the method of single-ended on demand LM with LMM/LMR, so only MtOnDemandSingleEndedMeasurementJobPac is used.

7.3.2.2 On-demand delay measurement

The single-ended DM by DMM/DMR uses MtOnDemandSingleEndedMeasurementJobPac and dual-ended DM by 1DM uses MtOnDemandDualEndedMeasurementJobPac.

7.3.2.3 Throughput measurement

The single-ended throughput function uses MtOnDemandSingleEndedMeasurementJobPac and the dual-ended throughput function uses MtOnDemandDualEndedMeasurementJobPac.

7.3.3 Proactive fault management

The attributes of this function can be set as MepControl creates the Mep instances by using createMep operation.

7.3.3.1 Continuity check and connectivity verification (CC/CV)

This function mainly uses two object classes: MtCcPac and MtCvPac. They are pruned and refactored from G.8152 information models as followings.

MtCcPac

– Mep::ccEnable
– Mep::ccPeriod
– Mep::ccCos
– Mep::ccOamTool

MtCvPac

– Mep::cvOamTool
– Mep::cvpEnable
– Mip::cvOamTool
– MepSourceDot1::CvSeries()

Note 1 - The ccOamTool and cvOamTool can only support G.8121.1, because G.8121.2 is out of scope of this Recommandation.

7.3.3.2 Remote defect indication (RDI)

This function mainly uses object class MtRdiPac. It is pruned and refactored from G.8152 information model as followings.

MtRdiPac

– Mep::rdiOamTool

7.3.3.3 Alarm indication signal (AIS)

This function mainly uses object class MtAisPac. It is pruned and refactored from G.8152 information model as followings.

MtAisPac

– MT_CtpSi::aisOamTool
– MT_CtpSi::aisPeriod
– MT_CtpSi::aisCos
– MepSi::aisOamTool

Note 1 - The aisOamTool can only support G.8121.1, because G.8121.2 is out of scope of this recommandation.

7.3.3.4 Locked signal (Lock report)

This function mainly uses object class MtLckPac. It is pruned and refactored from G.8152 information model as followings.

MtLckPac

– MT_CtpSi::lckOamTool
– MT_CtpSi::lckPeriod
– MT_CtpSi::lckCos
– MepSi::lckOamTool

Note 1 - The lckOamTool can only support G.8121.1, because G.8121.2 is out of scope of this recommandation.

7.3.3.5 Client signal failure (CSF)

The MtCcPac for CSF is defined in 7.3.3.1 can be used.

7.3.4 On-demand fault management

7.3.4.1 Connectivity verification (CV)

The MtCvPac for proactive CV is defined in 7.3.3.1 can be used.

7.3.4.2 Diagnostic test (DT)

Bidirectional loopback(LB) for DT, the MtCvPac defined in 7.3.3.1 can be used.

Unidirectional TST for DT, the MtTstPac is pruned and refactored from G.8152 information model as followings.

MtTstPac

- Mep::1ThOamTool
- MepSo::ttlValue
- Mip::ttlValue
- MepSourceDot1::1ThStart()
- MepSourceDot1::1ThTermination()
- MepSinkDot1::1ThStart()
- MepSinkDot1::1ThTermination()

~~**7.3.1 Continuity check and connectivity verification (CC/CV)**~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~**7.3.2 Alarm indication signal (AIS)**~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~**7.3.3 Client signal fail (CSF)**~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~**7.3.4 Locked signal (Lock report)**~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~**7.3.5 Delay measurement**~~

~~**7.3.5.1 Delay measurement 1-way**~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~**7.3.5.2 Delay measurement 2-way**~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~7.3.6 Loss measurement~~

~~7.3.6.1 Loss measurement 1-way~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~7.3.6.2 Loss measurement 2-way~~

~~<Editor Note: : There is just a sample. Details are to be provided.>~~

~~7.3.7 Diagnostic test~~

~~<Editor Note: Details are to be provided. >~~

~~7.3.8 Route tracing~~

~~<Editor Note: Details are to be provided. >~~

7.4 UML model files

This sub-clause contains the UML model files developed using .the Papyrus open-source modelling tool.

G.8152.1_v0.04.zip

This zip contains the ITU-T G.8152.1 model files (i.e., the .project, .di, .notation and .uml files) and the profiles.

The G.8152.1 0.04 model uses the following modelling tool and profiles

- Eclipse 4.9 (i.e. version 2018.09)
- Papyrus 4.1.0,
- OpenModel_Profile 0.2.17,
- OpenInterfaceModel_Profile 0.0.10,
- ProfileLifecycle_Profile 0.0.4, and
- Gendoc v0.7.1

<Editor Note: detail uml models are to be provided. >

8 Data Models of MPLS-TP OAM

This clause contains the interface-protocol-specific data models of the MPLS-TP OAM functions identified in Clause 6. These data models are translated from the interface-protocol-neutral UML information specified in Clause 7.

8.1 YANG Data Models

This clause contains the G.8152.1 YANG data model.

The YANG file and tree are attached as:

g.-8152.1-v-0.04@2020-02-05.yang

g.-8152.1-v-0.04@2020-02-05.tree

The G.8152.1 YANG model is translated, from the interface-protocol-neutral UML information provided in Clause 7.3. The translation is done with the assistance of the Open Source translation tooling xmi2yang, which is developed according to the [b-ONF TR-531] Mapping Guidelines.

8.2 Others Data Models

For further study.

(This appendix does not form an integral part of this Recommendation.)

Annex A

<Editor Note: detail annex A is to be provided. >

<Annex Title>

(This annex forms an integral part of this Recommendation.)

<Body of annex A>

Appendix I

Overview of the MPLS-TP OAM model configuration cases

(This appendix does not form an integral part of this Recommendation.)

The information model of G.8152.1 contains ME,MEG,MEP,MIP, and several OAM function Pacs. In a specific case of OAM configuration, it is necessary to describe how these object classes are used.

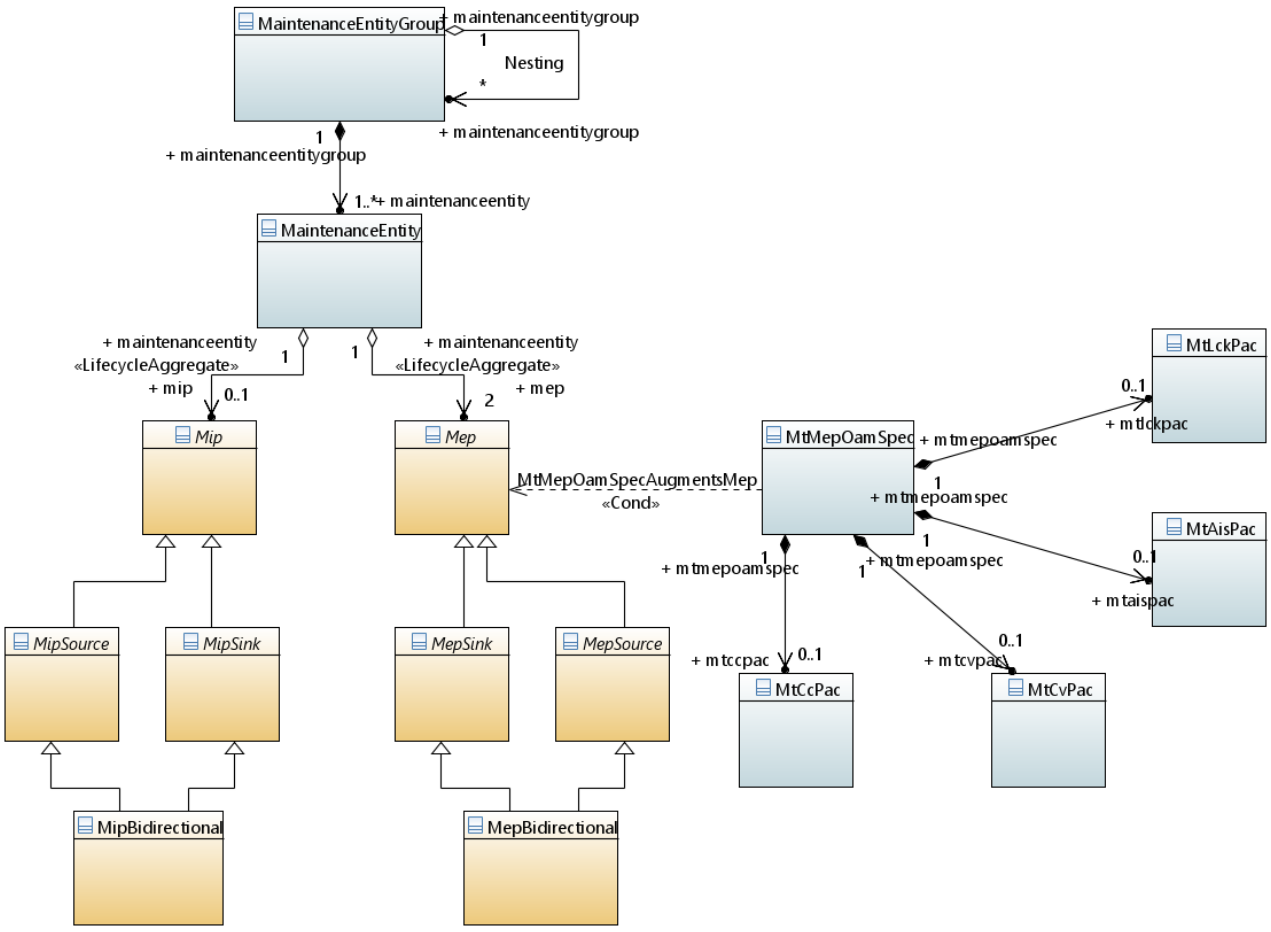


Figure I-1 OAM configuration

From the figure I-1, some constraint need to be considered:

From the figure I-1, some constraint need to be considered:

- In case of an unidirectinal ME, it uses a MepSource at the head-end and MepSink at the tail-end, the MepBidirectional is not used.
- In case of a bidirectional ME, it uses a MepBidirectional at the head-end and the tail-end, the MepSource and MepSink are not used.
- In case of point-to-multipoint MEG, several MEs could share MepSource at root end.

I.1 MEP and MIP configuration

The RFC6371 provided four type of ME and the G.8110.1 provided point-to-point and point-to-multipoint MEG, the following table concludes all configuration cases.

Table I-1 MEP and MIP configuration

Case	ME & MEG	MEP	MIP
A unidirectional point-to-point transport path	A single unidirectional ME in the point-to-point MEG	A pair of MepSource and MepSink (the MepSource is at the head-end of the path and the MepSink is at the tail-end of the path).	Zero or several pairs of MipSink and MipSource
Associated bidirectional point-to-point transport paths	Two independent unidirectional MEs in the point-to-point MEG	A pair of MepSource and MepSink for each direction of the path (the MepSource is at the head-end of the path and the MepSink is at the tail-end of the path).	Zero or several pairs of MipSink and MipSource
Co-routed bidirectional point-to-point transport paths	A single bidirectional ME in the point-to-point MEG	A pair of MepBidirectional	Zero or serveral MepBidirectional

Unidirectional point-to-multipoint transport path	A single unidirectional ME for each leaf in point-to-multipoint MEG	A pair of MepSource and MepSink for the path of each of the leaves (the MepSource is at the root and the MepSink is at the leaf. Can use/share a common MepSource at the root.).	Zero or several pairs of MipSink and MipSource

Note 1 - The OAM mechanism in G.8113.1 only supports co-routed bidirectional point-to-point MPLS-TP connections.

Note 2 - Unidirectional point-to-point and point-to-multipoint MPLS-TP connections will be addressed in a future edition of G.8113.1.

Note 3 - Associated bidirectional point-to-point MPLS-TP connections is not specified in current G.8113.1.

I.2 OAM Pac configuration

All OAM function attributes are pruned & refactored from G.8152 model to form MtCc/Cv/Lck/AisPacs in G.8152.1, and anchor to the MtMepOamSpec class. When configuring an specific OAM function on a transport path, Mep could be enhanced by using one or more Pacs of MtMepOamSpec.

Appendix IIAnalysis of G.8152 attributes & operations for G.8152.1

(This appendix does not form an integral part of this Recommendation.)

This appendix summarized the analysis and disposition of the attributes and operations of the base G.8152 model on whether they should be retained, refactored or pruned for G.8152.1, and the rationale of doing so.

Table II-1 MT TTP and CTP Pruning/Refactoring

Source artifact	To be pruned or moved to	Rationale
Inherited by MT_ConnectionTerminationPoint/Sink/Source/Bidirectional		
Address::address	Pruned	Not needed.
G8152LocalClass::localIdList	Pruned	Not needed.

LocalClass::localId	Retained	For identifying the instance.
G8152LayerProtocol::layerProtocolName	pruned	Not needed.
G8152LayerProtocol::_lpSpec	pruned	No Spec is needed so far.
G8152LayerProtocol::configuredClientCapacity	pruned	Not needed. This attribute is from the core model LayerProtocol. The client LTP association should provide all necessary detail hence this attribute is questionable, even in the core model.
G8152LayerProtocol::lpDirection	pruned	Not needed. Already have explicit Bi/Sink/Source object class instances (although in most case is Bidirectional), so no need for the attribute lpDirection (which is Bi/Si/So/UndefinedOrUnknown)
G8152LayerProtocol::terminationState	pruned	Indicates whether the layer is terminated and if so how. For MT CTP, it is not terminated.
State_Pac::lifecycleState	pruned	It can be inherited from the LTP.
State_Pac::administrativeState	pruned	It can be inherited from the LTP.
State_Pac::administrativeControl	pruned	It can be inherited from the LTP.
State_Pac::operationalState	pruned	It can be inherited from the LTP.
Extension::extension	retained	
Label::label	retained	
Name::name	retained	
ClientLayerSpecificAdaptationMi_Pac::clientlayerspecificadaptationmi_pac	Pruned	Not needed.

AdminState::adminState	retained	
MT_ConnectionTerminationPointSink		
tc2PhbMapping	pruned	Qos is out of scope of G.8152.1
qosDecodingMode	pruned	Qos is out of scope of G.8152.1
lckOamTool lckOamTool:OamTool → move to G.8152.1 MtLckPac	refactored: MtLckPac	MT CTP Sink Pac aggregates (new extended composite) new MtLckSiPac, which has three attributes: lckOamTool:OamTool, lckPeriod::LckAisPeriod and lckCos::Integer
lckPeriod lckPeriod::LckAisPeriod → move to G.8152.1 MtLckPac	refactored: MtLckPac	
lckCos lckCos::Integer → move to G.8152.1 MtLckPac	refactored: MtLckPac	
aisOamTool aisOamTool:OamTool → move to G.8152.1 MtAisPac	refactored: MtAisPac	MT CTP Sink Pac aggregates (new extended composite) new MtAisSiPac, which has three attributes: aisOamTool:OamTool, aisPeriod::LckAisPeriod and aisCos::Integer
aisPeriod aisPeriod:LckAisPeriod → move to G.8152.1 MtAisPac	refactored: MtAisPac	
aisCos aisCos:Integer → move to G.8152.1 MtAisPac	refactored: MtAisPac	
MT_ConnectionTerminationPointSource		
tc2PhbMapping	pruned	Qos is out of scope of G.8152.1
qosDecodingMode	pruned	Qos is out of scope of G.8152.1
apsOamCos	pruned	APS is out of scope of G.8152.1

MT_ConnectionTerminationPointBidirectional		
_mepBidirectional	retained	
_mipBidirectional	retained	
Inherited by MT_TrailTerminationPoint/Sink/Source/Bidirectional		
G8152LocalClass::localId	Retained	For identifying the instance
G8152GlobalClass::localIdList	pruned	This is not needed
G8152LocalClass::localIdList	pruned	This is not needed
G8152GlobalClass::uuid	Retained	For identifying the instance
G8152LayerProtocol::layerProtocolName	pruned	The object class already indicates it is MT TTP
G8152LayerProtocol::_lpSpec	pruned	No Spec is needed so far.
G8152LayerProtocol::configuredClientCapacity	pruned	Not needed. This attribute is from the core model LayerProtocol. The client LTP association should provide all necessary detail hence this attribute is questionable, even in the core model.
G8152LayerProtocol::lpDirection	pruned	Not needed. Already have explicit Bi/Sink/Source object class instances (although in most case is Bidirectional), so no need for the attribute lpDirection (which is Bi/Si/So/UndefiedOrUnknown).
G8152LayerProtocol::terminationState	pruned	Not needed. MT TTP is terminated.

Pacs::Tp_Pac::alarmStatus	Retained	Retained for MT TTP Sink
Pacs::Tp_Pac::crossConnectionObjectPointer	pruned	Not needed
Pacs::Tp_Pac::currentProblemList	retained	Retained for MT TTP Sink
Pacs::Tp_Pac::alarmSeverityAssignmentProfilePointer	Retained	Retained for MT TTP Sink
Serverlayerspecificadaptationmi_pac	pruned	Not needed
mt_connectionterminationpoint	retained	
MT_TrailTerminationPointSink		
lmTfMin lmTfMin:Boolean → move to G.8152.1 MtLmPac	refactored: MtLmPac	MT TTP Sink Pac aggregates (new extended composite) new MtLmSiPac, which has four attributes: lmTfMin:Boolean lmDegm:Integer lmM:Integer lmDegThr:Integer
lmDegm lmDegm:Integer → move to G.8152.1 MtLmPac	refactored: MtLmPac	
lmM lmM:Integer → move to G.8152.1 MtLmPac	refactored: MtLmPac	
lmDegThr lmDegThr:Integer → move to G.8152.1 MtLmPac	refactored: MtLmPac	
currentProblemList	retained	
MT_TrailTerminationPointSource		
ttlValue	retained	
MT_TrailTerminationPointBidirectional		
_sccTp	pruned	Assume not in the scope of G.8152.1
_mccCtp	pruned	Assume not in the scope of G.8152.1

_mepBidirectional	retained	
_ethConnectionTerminationPoint	retained	

Table II-12 MT MEP Classes Pruning/Refactoring

Source artifact	To be pruned or moved to	Rationale
G8152LocalClass::localId	All OAM Pacs	Moved to (refactored into) to all the OAM Pacs
MEP		
Mep::adminState	retained	
Mep::mepMac	retained	
Mep::mel	retained	
G8152LocalClass::localIdList	pruned	
Mep::megId	retained	
Mep::mepId	retained	
Mep::cvOamTool	MtCcCvPac	
Mep::cvpEnable	MtCcCvPac	
Mep::ccEnable	MtCcCvPac	
Mep::ccPeriod	MtCcCvPac	
Mep::ccCos	MtCcCvPac	
Mep::ccOamTool	MtCcCvPac	
Mep::dpLoopbackEnable	Pruned	dpLoopback is for G.8113.2, is out of scope of G.8113.1.
Mep::rdiOamTool	MtRdiPac	
Mep::1ThOamTool	MtLmPac	
MEP Sink		

MepSink::peerMepIdentifier	retained	
MepSink::aisOamTool	MtAisPac	Moved to (refactored into) to MtAisPac
MepSink::lckOamTool	MtLckPac	Moved to (refactored into) to MtLckPac
MepSink::remoteLockRequest	MtLckPac	Moved to (refactored into) to MtLckPac
MEP Source		
MepSource::ttlValue	retained	
MepSource::lockInstructEnable	MtLckPac	Moved to (refactored into) to MtLckPac
MepSource::adminState	retained	
MEP Bidirectional		

Table II-23 MT MIP Classes Pruning/Refactoring

Source artifact	To be pruned or moved to	Rationale
G8152LocalClass::localId	All OAM Pacs	Moved to (refactored into) to all the OAM Pacs
MIP		
G8152LocalClass::localIdList	pruned	
Mip::mipId	retained	
Mip::ttlValue	retained	
Mip::cvOamTool	MtCcCvPac	

Mip::dpLoopbackEnable	Pruned	It is defined in G.8113.2, is out of scope of G.8113.1.
MIP Sink		
MIP Source		
MIP Bidirectional		
Mip::isFullMip	retained	

Table II-34 Pruning/refactoring of MEP/MIP operations

Source artifact	**To be pruned or moved to**	**Rationale**
MtMepInterface		
mepSi_establishOnDemandDualEndedMeasurementJobSink	Pruned	Achieved via object creation of an instance of OnDemandDualEndedMeaJob and a subtending OnDemandDualEndedMeasurementJobControl instance
mepSi_establishProactiveDualEndedMeasurementJobSink	Pruned	Achieved via object creation of an instance of ProactiveDualEndedMeaJob and a subtending ProactiveDualEndedMeasurementJobControl instance
mepSi_getSvdCc	Retained	Cc is a Proactive FM function using CCM which is an ITU-T OAM mechanism
mepSo_establishOnDemandDualEndedMeasurementJobSource	Pruned	Achieved via object creation of an instance of OnDemandDualEndedMeaJob and a subtending OnDemandDualEndedMeasure

		mentJobControl instance
mepSo_establishProactiveDualEndedMeasurementJobSource	Pruned	Achieved via object creation of an instance of ProactiveDualEndedMeaJob and a subtending ProactiveDualEndedMeasurementJobControl instance
mepSo_CvSeries	Pruned	Achieved via mepSoDot1_CvSeries
mepBi_establishOnDemandDualEndedMeasurementJob	Pruned	Achieved via object creation of an instance of OnDemandDualEndedMeaJob and a subtending OnDemandDualEndedMeasurementJobControl instance
mepBi_establishProactiveDualEndedMeasurementJob	Pruned	Achieved via object creation of an instance of ProactiveDualEndedMeaJob and a subtending ProactiveDualEndedMeasurementJobControl instance
mepSoDot1_1ThStart	Retained	1Th is an On-demand PM function using TST which is an ITU-T OAM mechanism
mepSoDot1_1ThTerminate	Retained	1Th is an On-demand PM function using TST which is an ITU-T OAM mechanism
mepSoDot1_CvSeries	Retained	Cv is a Proactive FM function using CCM or an On-demand FM function using LB which both are ITU-T OAM mechanisms
mepSoDot1_CvTest	Retained	Cv is a Proactive FM function using CCM or an On-demand FM function using LB which both are ITU-T OAM mechanisms
mepSoDot1_CvTestTerminate	Retained	Cv is a Proactive FM function using CCM or an On-demand FM function using LB which

		both are ITU-T OAM mechanisms
mepSiDot1_1ThStart	Retained	1Th is an On-demand PM function using TST which is an ITU-T OAM mechanism
mepSiDot1_1ThTerminate	Retained	1Th is an On-demand PM function using TST which is an ITU-T OAM mechanism
mepControl_createMep	Pruned	Achieved via object creation of an instance of Mep
mepControl_deleteMep	Pruned	Achieved via object deletion of an instance of Mep
mepControl_getAllContainedMeps	Pruned	Achieved via retrieval of all object instances of Mep
mepControl_modifyMep	Pruned	Achieved via object modification of an instance of Mep
onDemandDualEndedMeaJobControl_getIntermediateReport	Retained	This is an ITU-T measurement job
onDemandSingleEndedMeaJobControl_getIntermediateReport	Retianed	This is an ITU-T measurement job
MtMipInterface		
mipControl_createMip	Pruned	Achieved via object creation of an instance of Mip
mipControl_modifyMip	Pruned	Achieved via object modification of an instance of Mip
mipControl_deleteMip	Pruned	Achieved via object deletion of an instance of Mip
mipControl_getAllContainedMips	Pruned	Achieved via retrieval of all contained instances of Mip

Table II-5 MT Measurement Job Classes Pruning/Refactoring

Source artifact	To be pruned or moved to	Rationale
Inherited by ProactiveSingleEndedMeasurementJobControlSource/Sink/SourcG8113Dot1/SinkG8113Dot1		
G8152LocalClass::localIdList	Pruned	Not needed.
State_Pac::lifecycleState	pruned	It can be inherited from the LTP.
State_Pac::administrativeState	pruned	It can be inherited from the LTP.
State_Pac::administrativeControl	pruned	It can be inherited from the LTP.
State_Pac::operationalState	pruned	It can be inherited from the LTP.
Extension::extension	pruned	Not needed.
Label::label	pruned	Not needed.
Name::name	pruned	Not needed.
ProactiveSingleEndedMeasurementJobControlSource		
oamType ProactiveSingleEndedMeasurementJobControlSource::oamType→ move to G.8152.1 ProactiveSingleEndedMeasJob	refactored: ProactiveSingleEndedMeaJob	ProactiveSingleEndedMeaJob is used for 2-way measurement.
isEnabled ProactiveSingleEndedMeasurementJobControlSource::isEnabled→ move to G.8152.1 ProactiveSingleEndedMeasJob	refactored: ProactiveSingleEndedMeaJob	
period ProactiveSingleEndedMeasurementJobControlSource::period→ move to G.8152.1	refactored: ProactiveSingleEndedMeaJob	

ProactiveSingleEndedMeasJob		
classOfService ProactiveSingleEndedMeasurementJobControlSource::classOfService→ move to G.8152.1 ProactiveSingleEndedMeasJob	refactored: ProactiveSingleEndedMeaJob	
testIdentifier ProactiveSingleEndedMeasurementJobControlSource::testIdentifier→ move to G.8152.1 ProactiveSingleEndedMeasJob	refactored: ProactiveSingleEndedMeaJob	
dataTlvLength ProactiveSingleEndedMeasurementJobControlSource::dataTlvLength→ move to G.8152.1 ProactiveSingleEndedMeasJob	refactored: ProactiveSingleEndedMeaJob	
ProactiveSingleEndedMeasurementJobControlSink		
oamType ProactiveSingleEndedMeasurementJobControlSink::oamType→ move to G.8152.1 ProactiveSingleEndedMeaJob	refactored: ProactiveSingleEndedMeaJob	ProactiveSingleEndedMeaJob is used for 2-way measurement.
isEnabled ProactiveSingleEndedMeasurementJobControlSink::isEnabled→ move to G.8152.1 ProactiveSingleEndedMeaJob	refactored: ProactiveSingleEndedMeaJob	
period ProactiveSingleEndedMeasurementJobControlSink::period→ move to G.8152.1 ProactiveSingleEndedMeaJob	refactored: ProactiveSingleEndedMeaJob	
ProactiveSingleEndedMeasurementJobControlSourceG8113Dot1/SinkG8113Dot1		

Inherited by ProactiveDualEndedMeasurementJobSource/Sink		
G8152LocalClass::localIdList	Pruned	Not needed.
State_Pac::lifecycleState	pruned	It can be inherited from the LTP.
State_Pac::administrativeState	pruned	It can be inherited from the LTP.
State_Pac::administrativeControl	pruned	It can be inherited from the LTP.
State_Pac::operationalState	pruned	It can be inherited from the LTP.
Extension::extension	pruned	Not needed.
Label::label	pruned	Not needed.
Name::name	pruned	Not needed.
G8152LocalClass::localIdList	Pruned	Not needed.
State_Pac::lifecycleState	pruned	It can be inherited from the LTP.
State_Pac::administrativeState	pruned	It can be inherited from the LTP.
State_Pac::administrativeControl	pruned	It can be inherited from the LTP.
State_Pac::operationalState	pruned	It can be inherited from the LTP.
Extension::extension	pruned	Not needed.
ProactiveDualEndedMeasurementJobControlSource		
oamType ProactiveDualEndedMeasurementJobControlSource::oamType→ move to G.8152.1	refactored: MtProactiveDualEndedMeaJob	MtProactiveDualEndedMeaJob is used for 1-way measurement.

MtProactiveDualEndedMeaJob		
oamTool ProactiveDualEndedMeasurementJobControlSource::oamType→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
isEnabled ProactiveDualEndedMeasurementJobControlSource::isEnabled→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
period ProactiveDualEndedMeasurementJobControlSource::period→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
classOfService ProactiveDualEndedMeasurementJobControlSource::classOfService→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
testIdentifier ProactiveDualEndedMeasurementJobControlSource::testIdentifier→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
ProactiveDualEndedMeasurementJobControlSink		
oamType ProactiveDualEndedMeasurementJobControlSink::oamType→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	MtProactiveDualEndedMeaJob is used for 1-way measurement.
isEnabled ProactiveDualEndedMeasurementJobControlSink::isEnabled→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
period ProactiveDualEndedMeasurementJobControlSink::period→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	

testIdentifier ProactiveDualEndedMeasurementJobControlSink::testIdentifier→ move to G.8152.1 MtProactiveDualEndedMeaJob	refactored: MtProactiveDualEndedMeaJob	
Inherited by OnDemandSingleEndedMeasurementJobControl		
oamType OnDemandSingleEndedMeasurementJobControl::oamType→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	MtOnDemandSingleEndedMeaJob is used for 2-way measurement.
startTime OnDemandSingleEndedMeasurementJobControl::startTime→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
stopTime OnDemandSingleEndedMeasurementJobControl::stopTime→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
oamPduGenerationType ProactiveDualEndedMeasurementJobControl::oamPduGenerationType→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
classOfService OnDemandSingleEndedMeasurementJobControl::classOfService→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
testIdentifier OnDemandSingleEndedMeasurementJobControl::testIdentifier→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
measurementInterval OnDemandSingleEndedMeasurementJobControl::measurementInterval→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	

messagePeriod OnDemandSingleEndedMeasurementJobControl::messagePeriod→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
dataTlvLength OnDemandSingleEndedMeasurementJobControl::dataTlvLength→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
repetitionPeriod OnDemandSingleEndedMeasurementJobControl::repetitionPeriod→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
onDemandPerformanceData OnDemandSingleEndedMeasurementJobControl::onDemandPerformanceData→ move to G.8152.1 MtOnDemandSingleEndedMeaJob	refactored: MtOnDemandSingleEndedMeaJob	
Inherited by OnDemandSingleEndedMeasurementJobControlSource		
oamType OnDemandSingleEndedMeasurementJobControlSource::oamType→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	MtOnDeamndDualEndedMeaJob is used for 1-way measurement.
startTime OnDemandSingleEndedMeasurementJobControlSource::startTime→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
stopTime OnDemandSingleEndedMeasurementJobControlSource::stopTime→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
oamPduGenerationType OnDemandSingleEndedMeasurementJobControlSource::oamPduGenerationType→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	

classOfService OnDemandSingleEndedMeasurementJobControlSource::classOfService→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
testIdentifier OnDemandSingleEndedMeasurementJobControlSource::testIdentifier→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
measurementInterval OnDemandSingleEndedMeasurementJobControlSource::measurementInterval→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
messagePeriod OnDemandSingleEndedMeasurementJobControlSource::messagePeriod→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
dataTlvLength OnDemandSingleEndedMeasurementJobControlSource::dataTlvLength→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
repetitionPeriod OnDemandSingleEndedMeasurementJobControlSource::repetitionPeriod→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
onDemandPerformanceData OnDemandSingleEndedMeasurementJobControlSource::onDemandPerformanceData→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
Inherited by OnDemandDualEndedMeasurementJobControlSink		
oamType OnDemandDualEndedMeasurementJobControlSink::Type→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	MtOnDeamndDualEndedMeaJob is used for 1-way measurement.

startTime OnDemandDualEndedMeasurementJobControlSink::startTime→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
stopTime OnDemandDualEndedMeasurementJobControlSink::stopTime→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
onDemandPerformanceData OnDemandDualEndedMeasurementJobControlSink::onDemandPerformanceData→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	
testIdentifier OnDemandDualEndedMeasurementJobControlSink::testIdentifier→ move to G.8152.1 MtOnDemandDualEndedMeaJob	refactored: MtOnDemandDualEndedMeaJob	

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