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Digital networks – Optical transport networks

Management requirements and information model for the optical media network

Recommendation ITU-T G.876

ITU-T

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Recommendation ITU-T G.876

Management requirements and information model for the optical media network

Summary

Recommendation ITU-T G.876 describes the management requirements and the information model for network elements (NEs) that contain optical media layer functions defined by ITU-T equipment Recommendations based on the ITU-T G.807 architecture, e.g., Recommendation ITU-T G.798.

The management requirements are based on Recommendation ITU-T G.7710, and the information model is based on ITU-T G.7711 object classes.

This first version of Recommendation ITU-T G.876 provides only the optical media layer management requirements and information models for the optical transport network (OTN).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.876	2021-08-22	15	11.1002/1000/14713

Keywords

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1 Scope

This Recommendation describes the management requirements and the information model for network elements (NEs) that contain optical media layer functions defined by ITU-T equipment Recommendations based on the ITU-T G.807 architecture, e.g., [ITU-T G.798].

The management requirements are based on [ITU-T G.7710], and the information model (IM) is based on ITU-T G.7711 object classes. Being based on the common IM in [ITU-T G.7711], the information model for the optical media layer can provide consistent operation, administration, maintenance and provisioning of transport networks.

The management of the optical media layer is independent of the digital clients carried across the media network.

This first version of ITU-T G.876 provides only the optical media layer management requirements and information models for the optical transport network (OTN). Other optical media network layer uses can be added in future versions of this Recommendation.

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.694.1] Recommendation ITU-T G.694.1 (2020), *Spectral grids for WDM applications: DWDM frequency grid*.

[ITU-T G.694.2] Recommendation ITU-T G.694.2 (2003), *Spectral grids for WDM applications: CWDM wavelength grid*.

[ITU-T G.697] Recommendation ITU-T G.697 (2016), *Optical monitoring for dense wavelength division multiplexing systems*.

[ITU-T G.698.2] Recommendation ITU-T G.698.2 (2018), *Amplified multichannel dense wavelength division multiplexing applications with single channel optical interfaces*.

[ITU-T G.798] Recommendation ITU-T G.798 (2017), *Characteristics of optical transport network hierarchy equipment functional blocks*.

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

[ITU-T G.806] Recommendation ITU-T G.806 (2012), *Characteristics of transport equipment – Description methodology and generic functionality*.

[ITU-T G.807] Recommendation ITU-T G.807 (2020), *Generic functional architecture of the optical media network*.

[ITU-T G.874] Recommendation ITU-T G.874 (2020), *Management aspects of optical transport network elements.*

[ITU-T G.7710] Recommendation ITU-T G.7710/Y.1701 (2020), *Common equipment management function requirements.*

[ITU-T G.7711] Recommendation ITU-T G.7711/Y.1702 (2018), *Generic protocol-neutral management Information Model for Transport Resources.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 Terms defined in [ITU-T G.805]

– adaptation

– connection

3.1.2 Terms defined in [ITU-T G.806]

– atomic function.

– management point (MP)

3.1.3 Terms defined in [ITU-T M.3010]

– network element (NE)

3.1.4 Terms defined in [ITU-T G.694.1]

– frequency slot

– slot width

3.1.5 Terms defined in [ITU-T G.959.1]

– optical tributary signal (OTSi)

3.1.6 Terms defined in [ITU-T G.807]

– media channel

– media channel group (MCG)

– network media channel (NMC)

– network media channel group (NMCG)

– optical parameter monitor (OPM)

– optical supervisory channel (OSC)

– optical tributary signal assembly (OTSiA)

– optical tributary signal group (OTSiG)

– optical tributary signal group overhead (OTSiG-O)

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BEI Backward Error Indication

CTP	Connection Termination Point
FC	Forwarding Construct
FCAPS	Fault, Configuration, Accounting, Performance, Security
FD	Forwarding Domain
FDI	Forward Defect Indication
FS	Frequency Slot
ILA	In-Line Amplifier
LTP	Logical Termination Point
LP	Layer Protocol
MCC	Management Communication Channel
MCG	Media Channel Group
NMC	Network Media Channel
NMCG	Network Media Channel Group
OAM	Operation, Administration, Maintenance
OMS	Optical Multiplex Section
OMS-O	Optical Multiplex Section Overhead
OPM	Optical Parameter Monitor
OSC	Optical Supervisory Channel
OSME	Optical Signal Maintenance Entity
OTS	Optical Transmission Section
OTS-O	Optical Transmission Section Overhead
OTSi	Optical Tributary Signal
OTSiA	Optical Tributary Signal Assembly
OTSiG	Optical Tributary Signal Group
OTSiG-O	Optical Tributary Signal Group - Overhead
ROADM	Reconfigurable Optical Add/Drop Multiplexer
TP	Termination Point
TTP	Trail Termination Point

5 Conventions

5.1 Information modelling conventions

5.1.1 UML modelling conventions

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

5.1.2 Model artefact lifecycle stereotypes conventions

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

5.1.3 Forwarding entity terminology conventions

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

5.1.4 Conditional package conventions

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

5.1.5 Pictorial diagram conventions

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

6 Optical media layer management requirements

The management of the optical media layer is based upon the common FCAPS function requirements described in [ITU-T G.7710] and the optical media layer architecture described in [ITU-T G.807].

Figure 6-1 provides a high-level overview of the functional model used in this Recommendation as the basis to develop the management requirements for the optical media layer.

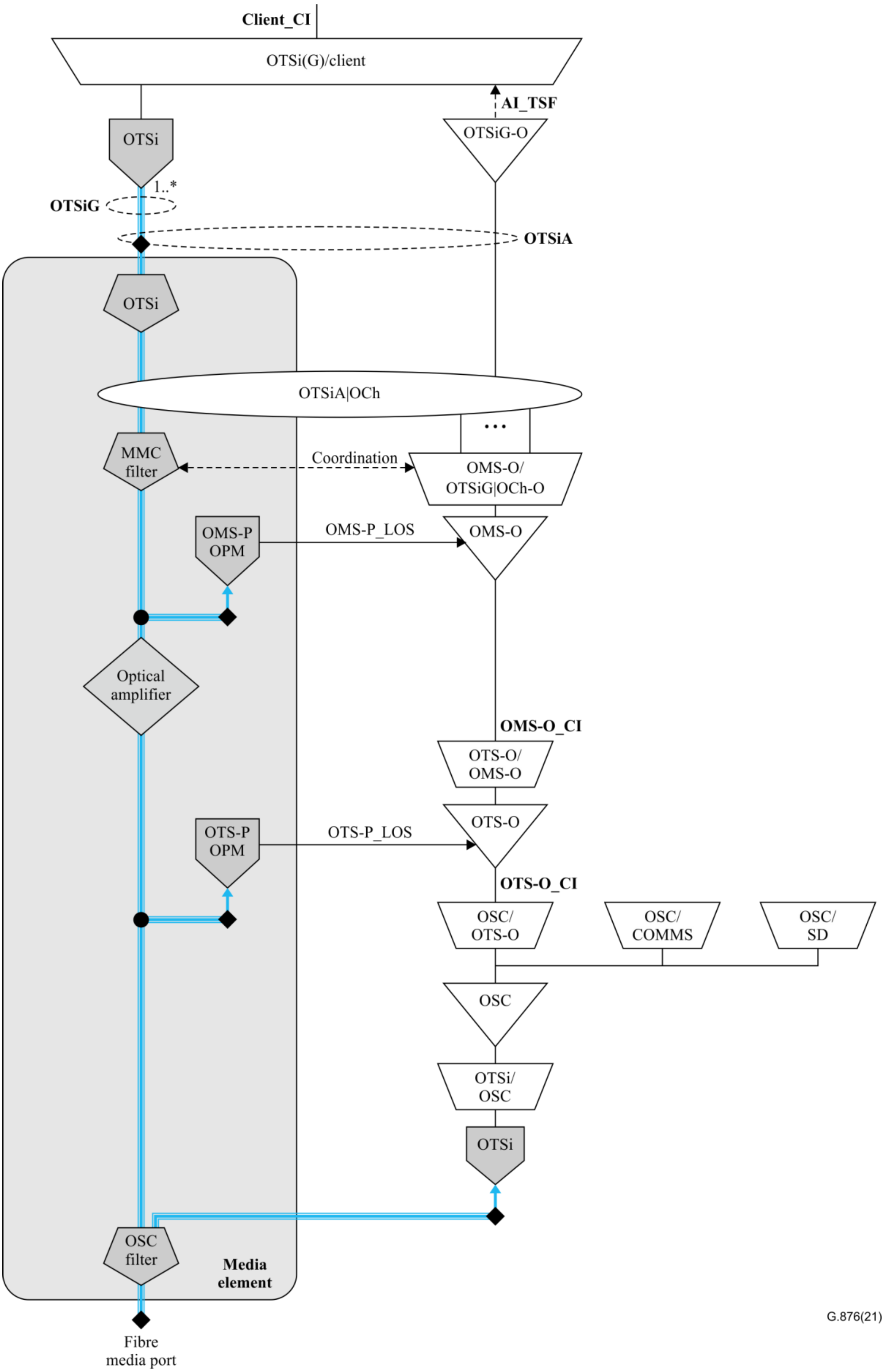

Figure 6-1 – Functional model used for ITU-T G.876 management requirements

Figure VII.1 of [ITU-T G.798] describes the media layer functions of a NE as a media element (ME), hiding the [ITU-T G.807] media constructs. Figure 6-1 is a modification to Figure VII.1 of [ITU-T G.798] for the purpose of showing and describing the media constructs.

To clarify the media constructs inside the ME the following modifications are considered:

– The media constructs within the media element (ME) uses the ITU-T G.807 convention to separate the signal from the digital information.

– The ME has been extended to also cover the OTSiA_C to be aligned with Figure 12-5 of [ITU-T G.798] where the matrix connections are shown within the OTSiA|OCh_C, as well as any other media layer functions that may exist in between the OTSiA_C and the OTSi modulators/demodulators.

– The OTSi filter in Figure VII.1 in [ITU-T G.798] has been renamed as MMC (matric media channel) filter to align with the definitions in clause 12.1 of [ITU-T G.798], considering also that the configuration of the OTSiA_C is based on the MMC frequency-slot, independently from the number of OTSis being carried within the MMC.

– An optical OTSi filter/coupler media construct has been added between the OTSiA_C and the OTSi modulator/demodulator. Since the OTSiA_C configures only the MMC, this filter/coupler is needed to combine/split the different OTSis within the same MMC from/toward each OTSi modulator/demodulator. This OTSi filter/coupler cannot be present when the MMC carries a single OTSi.

The management requirements for the OSC, optical transmission section overhead (OTS-O), optical multiplex section overhead (OMS-O), OCh-O and optical tributary signal group - overhead (OTSiG-O) atomic functions, defined in [ITU T G.798], are defined in [ITU-T G.874].

This clause focuses on additional management requirements for the media element and the OTSi modulator and demodulators in Figure 6-1.

6.1 Fault management

Common fault management requirements are defined in clause 7 of [ITU-T G.7710].

Fault management for the OTN optical media layer is provided by the OTS-O, OMS-O, OCh-O and OTSiG-O atomic functions defined in [ITU-T G.798].

Technology-specific fault management requirements for the optical media layer for OTN are defined in clause 7 of [ITU T G.874].

6.2 Configuration management

Common configuration management requirements are defined in clause 8 of [ITU-T G.7710].

Configuration management requirements for the OTS-O, OMS-O, OCh-O and OTSiG-O atomic functions, defined in [ITU-T G.798], are defined in clause 8 of [ITU-T G.874].

Additional configuration management requirements for the media element in Figure 6-1 are explicitly described in this clause.

6.2.1 Configuration management for the OSC

The OSC application identifier describes the characteristics of the OTSi modulator/demodulator as well as of the media channels which guides the OSC signal through the media element in Figure 6-1.

In case only one OSC application identifier is supported, its configuration is not required. The OSC application identifier in use could be reported for troubleshooting purposes.

6.2.2 Configuration management for a media channel

The media channels used to guide the optical signals through the media element in Figure 6-1 are either pre-configured or configured during OTSiA connection setup.

In case these media channels are configured during OTSiA connection setup, they are configured within the media element in Figure 6-1 by the OMS-O/OTSiG-O|OCh_A and by the OTSiG|OCh-O_A atomic functions, defined in [ITU-T G.798].

6.2.2.1 Frequency slot configuration

The media channels used to guide the optical signals for one OTSiA connection can occupy one or more frequency slots (FS).

The configuration of a frequency slot to provide fixed-/flexi-grid connections encompasses the following attributes:

– Grid type: for a specified optical multiplex section (OMS) MCG, the grid type can be either fixed-dwdm, fixed-cwdm or flexi-dwdm;

– Channel spacing for a specified OMS MCG:
  - Using a fixed-dwdm grid, it represents the channel spacing of a fixed frequency grid (e.g., 50 GHz), as defined in clause 6 of [ITU-T G.694.1];
  - Using a fixed-cwdm grid, it represents the channel spacing of a fixed wavelength grid (e.g., 20 nm), as defined in [ITU-T G.694.2];
  - Using a flexi-dwdm grid, it represents the channel spacing of a flexible frequency grid (e.g., 6.25 GHz), as defined in clause 7 of [ITU-T G.694.1];

– Slot width granularity: for a specified OMS MCG using a flexi-dwdm grid (e.g., 12.5 GHz), as defined in clause 7 of [ITU-T G.694.1];

– n: a positive or negative integer including 0, used to specify the OTSi nominal central frequency or wavelength for a frequency slot:
  - for fixed-dwdm grids, the nominal central frequency is 193.1+ n * channel spacing (in THz), as defined in clause 6 of [ITU-T G.694.1];
  - for fixed-cwdm grids, the nominal central wavelength is 1471 + n * channel spacing (in nm), as defined in [ITU-T G.694.2];

    NOTE – The formula has been defined to produce the values provided in Table 1 of [ITU-T G.694.2] as well as to allow a common structure for the configuration of coarse wavelength division multiplexing (CWDM) and dense wavelength division multiplexing (DWDM) frequency slots.
  - for flexi-dwdm grids, the nominal central wavelength is 193.1+ n * channel spacing (in THz), as defined in clause 7 of [ITU-T G.694.1]

– m: a positive integer used to specify the slot width for a frequency slot within a flexi-dwdm grid:
  - the slot width is m * the slot width granularity (in GHz).

6.2.3 Configuration management for the optical signals

An OTSiA connection can be used by one or more OTSi modulators/demodulators.

Each OTSi modulators/demodulators used by the same OTSiA connection needs to be configured with:

– an application identifier, which may be either a standard application code, defined in [ITU-T G.698.2] or a proprietary application identifier;

– the OTSi central frequency, which may be the same or different than the MMC central frequency.

6.3 Performance management

Common performance management requirements are defined in clause 10 of [ITU-T G.7710].

Performance management requirements for the OTS-O, OMS-O, OCh-O and OTSiG-O atomic functions, defined in [ITU-T G.798], are defined in clause 10 of [ITU-T G.874].

Additional performance management requirements for the media element in Figure 6-1 are explicitly described in this clause.

The media channel does not support performance monitoring. As indicated in [ITU-T G.807], the performance of a media channel may be inferred by observing the properties of a signal in that media channel or from the digital information carried by the signal. It may be necessary to observe the signal at multiple points to determine the performance of the media channel.

The optical performance parameters that can be monitored are described in clause 8 of [ITU-T G.697].

The performance of a media channel group (MCG) may be inferred from the digital information being carried by an OTSiG in that media channel group (e.g., BIP or pre-FEC errors). The pre-forward error correction (FEC), backward error indication (BER) detected by the decoding process in the M-AI/client CI adaptation sink function, as defined in clause 10 of [ITU-T G.807], is an indicator of the quality of the received signals. Pre-FEC degradation could indicate both linear and non-linear distortions to the signals accumulated along the optical media channel.

NOTE – As described in [ITU-T G.807], the encoding process in the M-AI/ client CI adaptation may include the computation and insertion of a forward error correction (FEC) code. Further details of the M-AI/client CI adaptation are described in [ITU-T G.798].

7 Media management model for the optical media layer

7.1 High-level overview

Figure 7-1 provides the mapping between the object classes defined in this Recommendation and the functions model described in Figure 6-1.

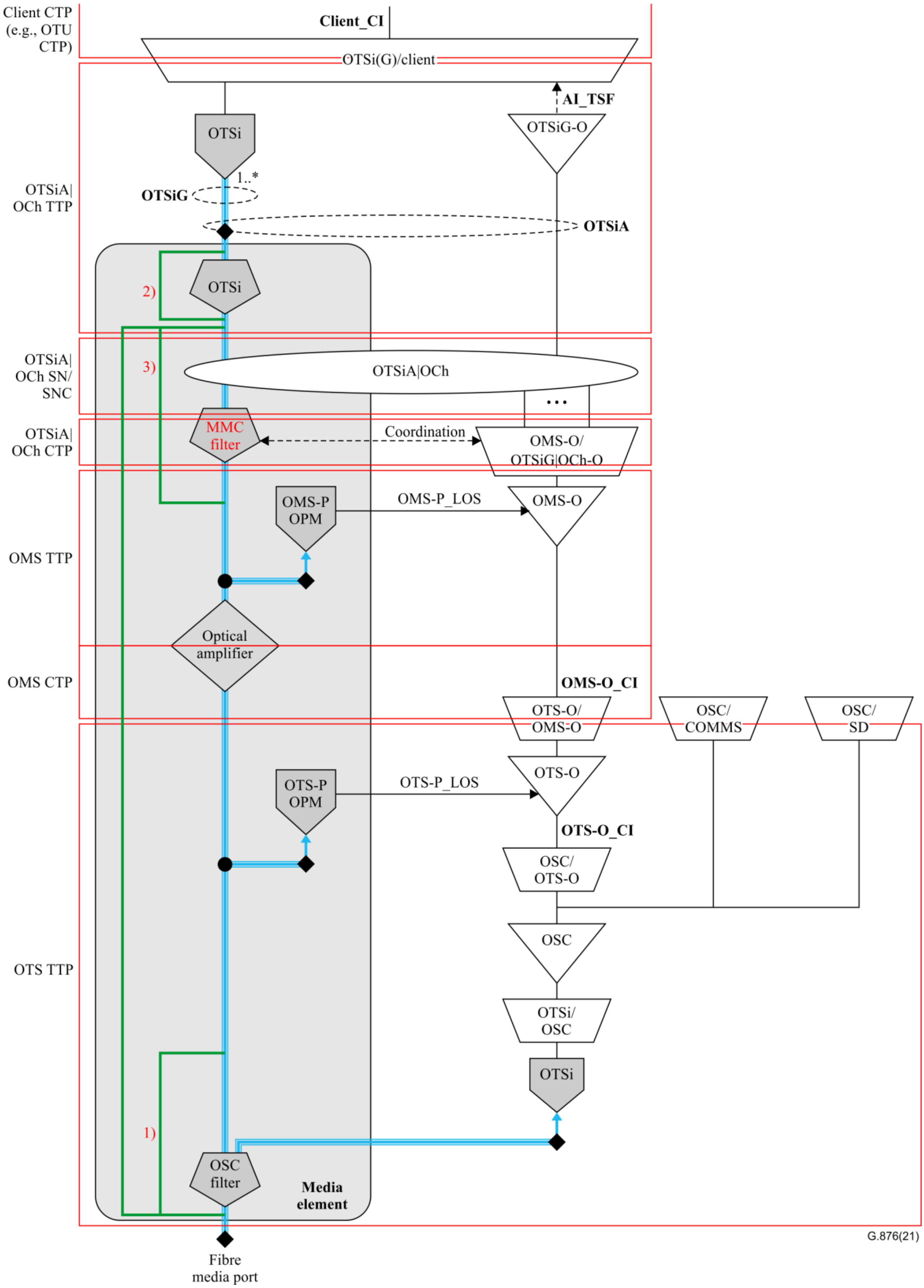

Figure 7-1 – Overview of the object class mapping to a media element and OTN atomic functions

From the management point of view, Figure 7-1 provides the instances to be defined in this Recommendation. They are:

– OTS TTP
– OMS CTP
– OMS TTP
– OTSiA|OCh CTP
– OTSiA|OCh TTP
– OTSiA|OCh SN/SNC (connectivity)

7.2 UML model class diagram

7.2.1 OTS TTP object class

The OTS trail termination point (TTP) object class is defined via pruning and refactoring of the ITU-T G.7711 logical termination point (LTP) and layer protocol (LP) object classes, when the LTP has no server LTP and contains only one LP with layerProtocolName = 'OTS', terminationState = LP_PERMANENTLY_TERMINATED and lpDirection = 'BIDIRECTIONAL'.

Technology-specific attributes are defined within the OTS TTP Pac, as shown in Figure 7-2:

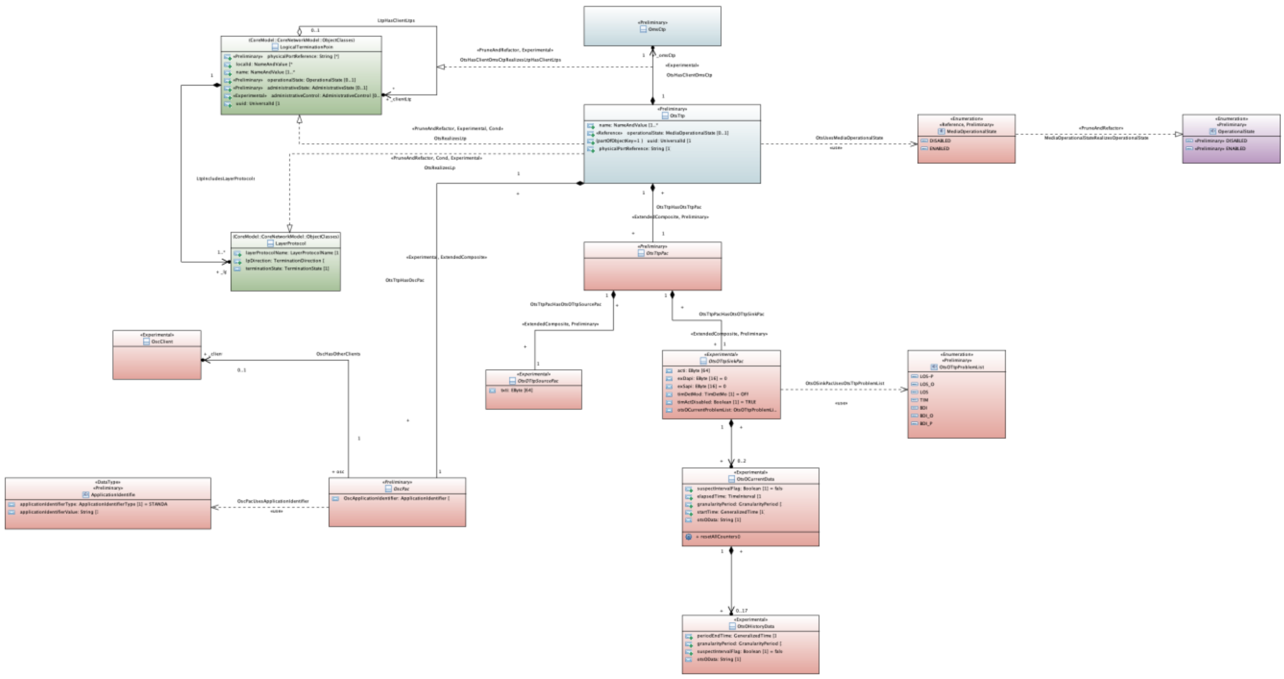

Figure 7-2 – OTS TTP UML diagram

The optical supervisory channel (OSC) is modelled as a Pac for the OTS TTP.

7.2.2 OMS object classes

7.2.2.1 OMS CTP object class

The OMS connection termination point (CTP) object class is defined via pruning and refactoring of the ITU-T G.7711 LTP and LP object classes, when LTP contains only one LP with layerProtocolName = 'OMS' and terminationState = 'LP_CAN_NEVER_TERMINATE' and lpDirection = 'BIDIRECTIONAL'.

Technology-specific attributes are defined within an OMS CTP Pac, as shown in Figure 7-3:

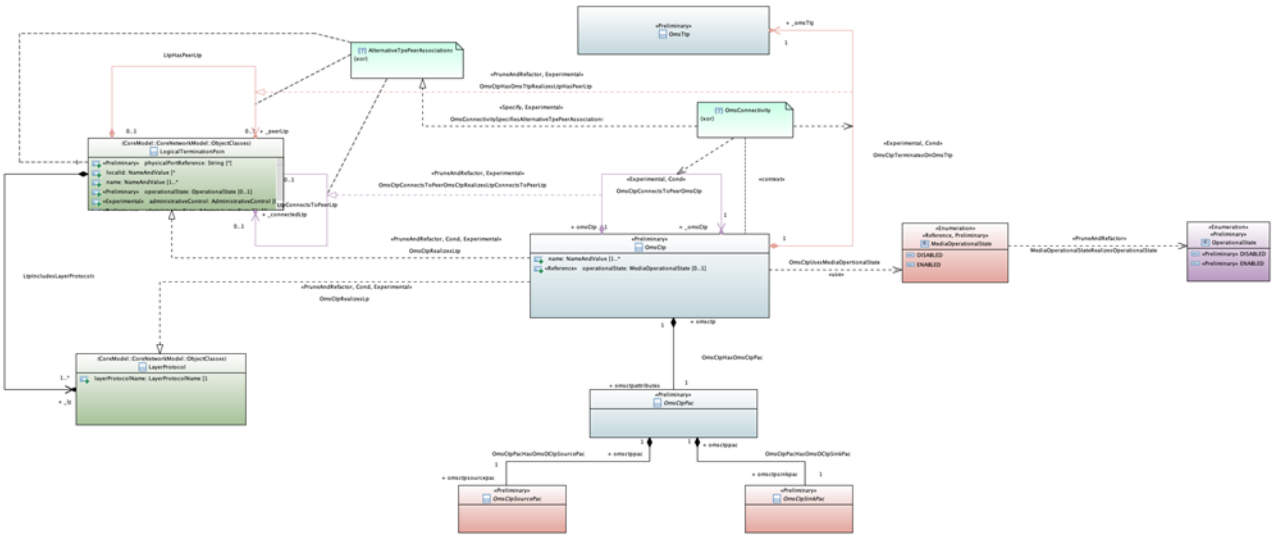

Figure 7-3 – OMS CTP UML diagram

An OMS CTP instance can have fixed connectivity either with:

– A peer OMS CTP instance (e.g., in use case 1, clause III.1 of Appendix III), which is modelled by the OmsCtpConnectsToPeerOmsCtp association, defined via pruning and refactoring of the ITU-T G.7711 LtpConnectsToPeerLtp association.

– An OMS TTP instance (e.g., in use case 2, clause III.2 of Appendix III), which is modelled by the OmsCtpTerminatesOnOmsTtpassociation, is defined via pruning and refactoring of the ITU-T G.7711 LtpHasPeerLtp association.

The alternative (XOR) constraint between these two associations is modelled by the OmsConnectivity constraint, defined via pruning and refactoring of the ITU-T G.7711 AlternativeTpePeerAssociations constraint.

7.2.2.2 OMS TTP object class

The OMS TTP object class is defined via pruning and refactoring of the ITU-T G.7711 LTP and LP object classes, when LTP has no server LTP and it contains only one LP with layerProtocolName = 'OMS' and terminationState = 'LP_PERMANENTLY_TERMINATED' and lpDirection = 'BIDIRECTIONAL'.

Technology-specific attributes are defined within an OMS TTP Pac, as shown in Figure 7-4:

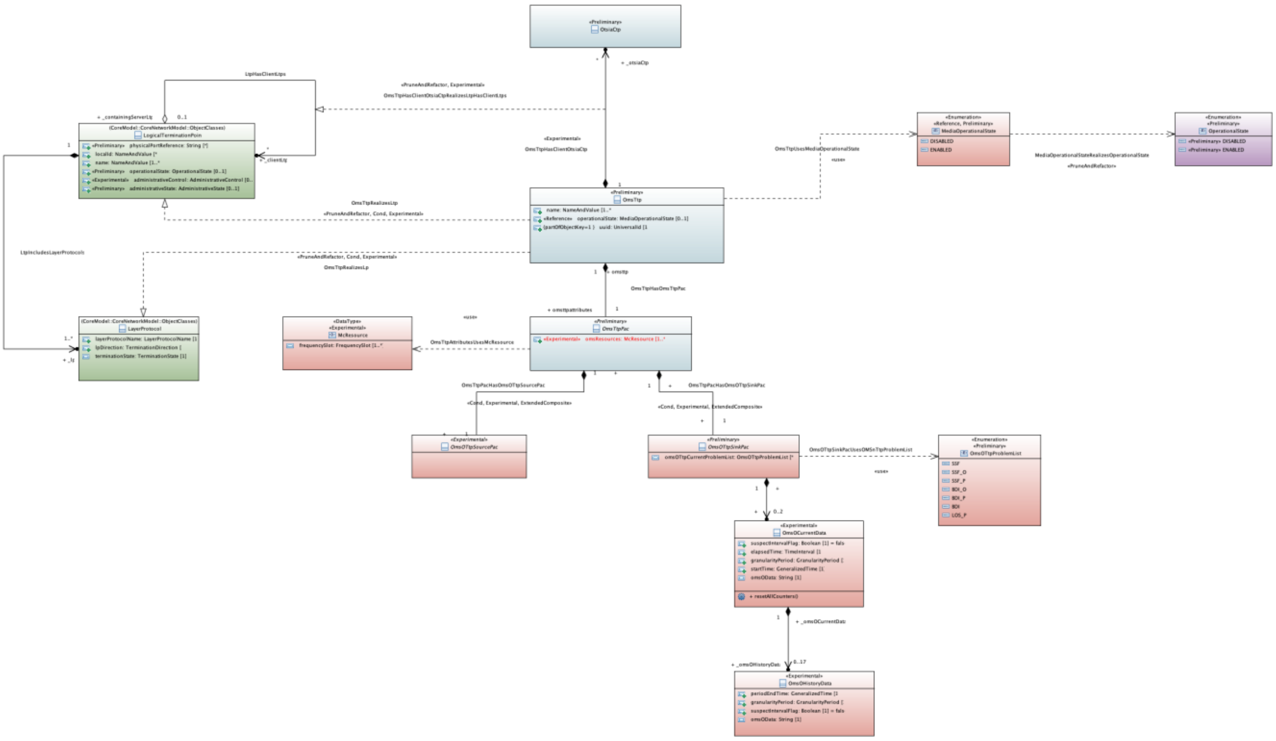

Figure 7-4 – OMS TTP UML diagram

An OMS TTP instance can support zero or more client OTSiA CTP instances (e.g., as shown in Appendix III). This is modelled by the OmsTtpHasClientOtsiaCtp association, defined via pruning and refactoring of the LtpHasClientLtps association, as shown in Figure 7-4.

7.2.2.3 Modelling optical amplifier (OA)

The behaviour of the OA has no impact on the connectivity but on the quality of the signal.

As shown in Figure 7-5, which reproduces Figure 7-5 of [ITU-T G.807], the optical amplifier belongs to the OMS MCG.

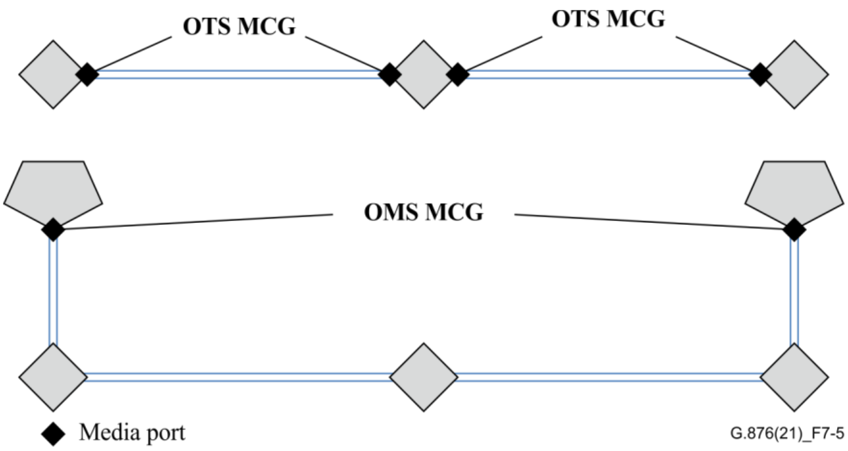

Figure 7-5 – OTS and OMS MCGs with discrete remote optical amplifiers (Figure 7-5 of [ITU-T G.807])

For this reason, the OA has been modelled as an "auxiliary" object class, associated with the OMS CTP and/or the OMS TTP object classes, as shown in Figure 7-6.

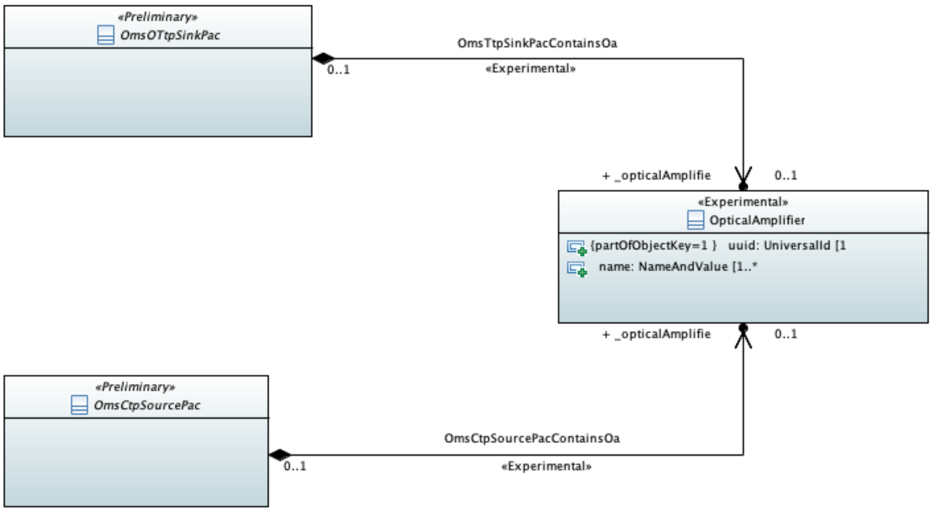

Figure 7-6 – OA "auxiliary" UML diagram

The associations between OA and OMS CTP/TTP are defined within the OMS CTP Source and the OMS TTP Sink Pacs since they are technology-specific associations (i.e., not defined by pruning/refactoring of any ITU-T G.7711 association).

The OA within the OMS CTP Source amplifies the signals being transmitted to the underlying OTS while the OA within the OMS TTP Sink amplifies the signals being received by the OMS TTP.

7.2.3 OTSiA object classes

7.2.3.1 OTSiA CTP object class

The OTSiA CTP object class is defined via pruning and refactoring of the ITU-T G.7711 LTP and LP object classes, when LTP contains only one LP with layerProtocolName = 'OTSiA' and terminationState = 'LP_CAN_NEVER_TERMINATE' and lpDirection = 'BIDIRECTIONAL'.

Technology-specific attributes are defined within the OTSiA CTP Pac, as shown in Figure 7-7 below:

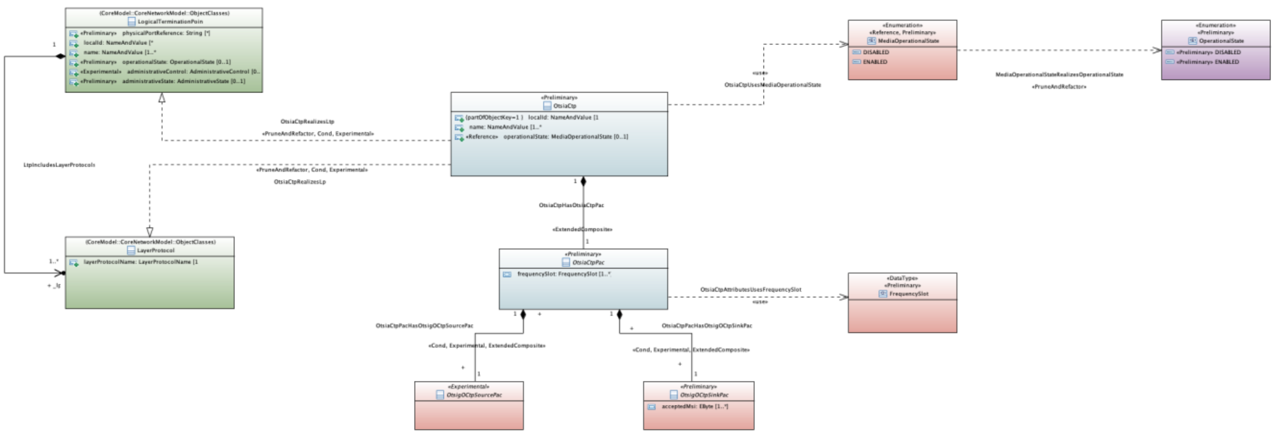

Figure 7-7 – OTSiA CTP UML diagram

The OTSiA CTP Pac object class contains a list of one or more frequency slots associated with the MMCs.

7.2.3.2 OTSiA TTP object class

The OTSiA TTP object class is defined via pruning and refactoring of the ITU-T G.7711 LTP and LP object classes, when LTP has no server and LTP contains only one LP with layerProtocolName = 'OTSiA' and terminationState = 'LP_PERMANENTLY_TERMINATED' and lpDirection = 'BIDIRECTIONAL'.

Technology-specific attributes are defined within an OMS TTP Pac, as shown in Figure 7-8:

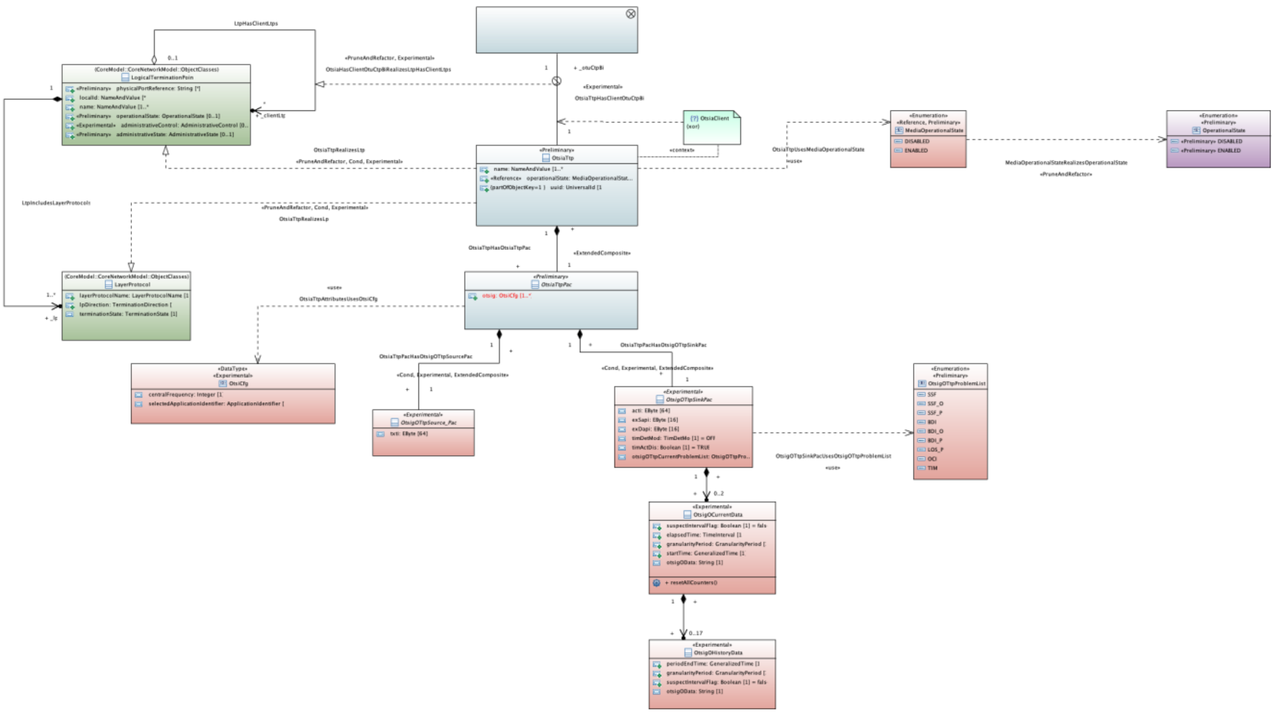

Figure 7-8 – OTSiA TTP UML diagram

The OTSiA TTP Pac contains a list of one or more OTSi's being used to carry the client signal.

The OTSiA TTP can also support one client OTU CTP bidirectional. This can be modelled by the OtsiaTtpHasClientOtuCtpBi association, defined via pruning and refactoring of the ITU-T G.7711 LtpHasClientLtps association.

Since the OTU CTP bidirectional is one possible client for the OTSiA TTP and other clients can be added in the future, the OTSiAClient constraints allow adding new OTSiA clients in the future versions of ITU-T G.876.

7.2.3.3 OTSiA SN/SNC (connectivity)

To model the OTSiA connectivity, the OTSiA SN, SNC and SNC port object classes are defined via pruning and refactoring of the ITU-T G.7711 forwarding domain (FD), forwarding construct (FC), and FC port object classes, as shown in Figure 7-9:

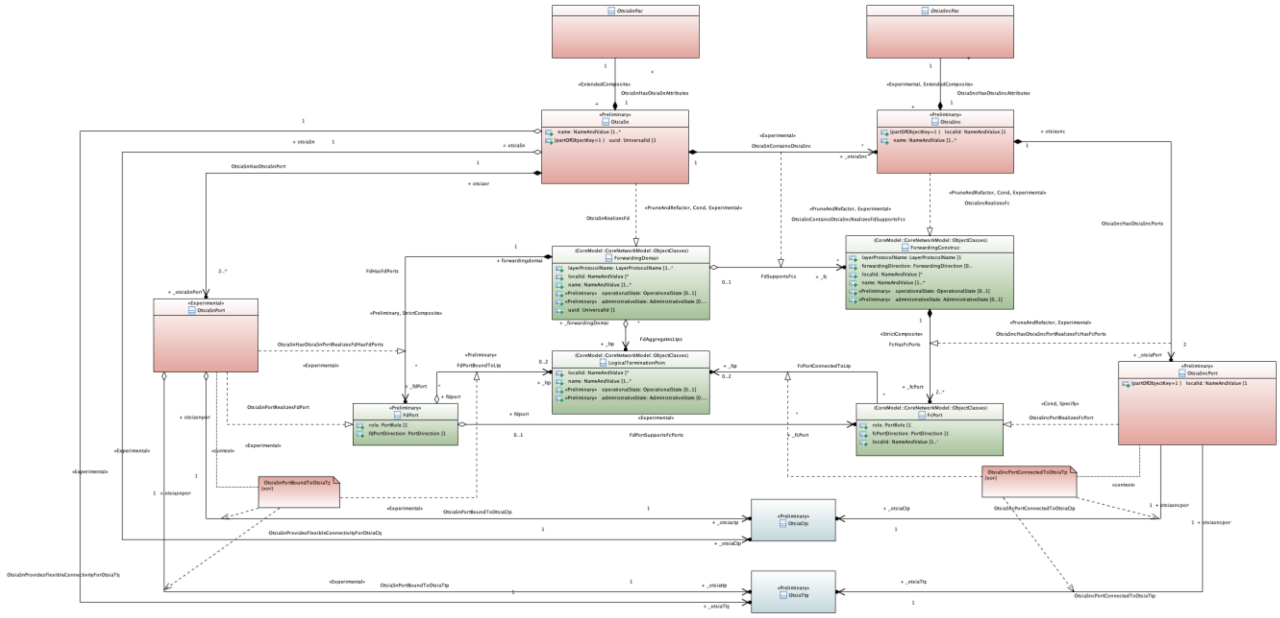

Figure 7-9 – OTSiA connectivity UML diagram

In particular:

– The OTSiA SN object class is defined via pruning and refactoring of the G.7711 FD object class when layerProtocolName = 'OTSiA'.

– The OTSiA SNC object class is defined via pruning and refactoring of the ITU-T G.7711 FC object class when layerProtocolName = 'OTSiA' and forwardingDirection='BIDIRECTIONAL'.

– The OTSiA SNC port object class is defined via pruning and refactoring of the ITU-T G.7711 FC Port object class when the FC instance is an OTSiA SNC instance.

As a consequence, the OtsiaSnContainsOtsiaSnc and the OtsiaSncHasOtsiaSncPorts associations have been defined via pruning and refactoring of, respectively, the ITU-T G.7711 FdAggregatesLtps, FdSupportsFcs and FcHasFcPorts associations.

The relationship between the OTSiA SNC Port and the OTSiA CTP or TTP being connected is modelled by the OtsiaSncPortConnectedToOtsiaTp XOR constraint between the OtsiaSncPortConnectedToOtsiaCtp and OtsiaSncPortConnectedToOtsiaCtp associations, defined via pruning and refactoring of the ITU-T G.7711 FcPortConnectedToLtp association.

8 UML model file for optical media layer

The zip file containing the ITU-T G.876 UML model developed using the Papyrus open-source modelling tool can be downloaded from: https://www.itu.int/ITU-T/formal-language/itu-t/g/g876/2021/g876_v0.14_PAP.zip

This zip file contains the following folders:

- The G.876 folder, which contains the following files:
  - The Papyrus project file.
    - .project
  - The .di, .notation, and .uml files of the G.876.
    - G.876.di
    - G.876.notation

    - G.876.uml
  - The gdITUTemplate-876.docx file, which can be used to generate the data dictionary (DD) form of the ITU-T G.876 UML model.
  - The doc sub-folder, which contains the data dictionary of the ITU-T G.876 UML model.
  - The UmlProfiles sub-folder, which contains the UML profiles that defines the properties of the UML artifacts.
    - The OpenModelProfile folder, which contains the .di, .notation, and uml of the *open model profile*
    - The OpenInterfaceModelProfile folder, which contains the .di, .notation, and uml of the *open model interface profile*
    - The ProfileLifecycleProfile folder, which contains the .di, .notation, and uml of the *profile lifecycle profile*
    - The ClassDiagramStyleSheet.css style sheet
  - The diagrams sub-folder, which contains the PNG images of all the class diagrams.
- The G.7711 folder, which contains the [ITU-T G.7711] core model that is needed (i.e., imported) by the ITU-T G.876 model.

NOTE 1 – If the imported model has been up-versioned or the module name has been changed, then the xmi code of the ITU-T G.876 module will need to be updated.

To load the ITU-T G.876 UML model into an Eclipse Papyrus workspace, follow the steps below:

- In the project explorer / Right click / Import / General / Projects from folder or archive / Next / Archive / Select the G.876 zip file / Open / Select the folders of the models to be loaded (Note 2) / Finish

NOTE 2 – If a supporting (i.e., to be imported by ITU-T G.876) model already exists in the workspace, do not select it for loading.

NOTE 3 – The ITU-T G.876 UML information models and the open model profile are specified using the Papyrus open-source modelling tool. To view and further extend or modify the information model, one will need to install the open-source Eclipse software and the Papyrus tool, which are available at [b-Eclipse-Papyrus]. The installation guide for Eclipse and Papyrus can be found in [b-IISOMI 515].

Appendix I

Use cases for OTSiA connection management

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

The first use case of [ITU-T G.807] is to configure the OTSiA connection with the pre-configured media channels, i.e., the media channels already exist or are pre-configured in advance. The second use case of [ITU-T G.807] is to configure the OTSiA connection without the pre-configured media channels.

For the first use case of establishing an OTSiA connection, the media channels are pre-configured. Clause 10.3.1 in [ITU-T G.807] does not describe the management of the pre-configured media channels (e.g., how they are setup and removed).

This appendix assumes that the management communication channel (MCC) functions can setup pre-configured media channels in advance, without any OTSiG-O, and can later then setup OTSiA connections using these pre-configured media channels. The MCC functions can also remove pre-configured media channels when they are not used by any OTSiA connection.

This appendix describes the following MCC scenarios to support the management of the pre-configured media channels as described in the first use case of [ITU-T G.807]:

– Command: Establish pre-configured media channel
  • Pre-condition: no pre-configured media channel, no OTSiA connection
  • Post-condition: pre-configured media channelcreated, no OTSiA connection
– Command: Remove pre-configured media channel
  • Pre-condition: pre-configured media channelexist, no OTSiA connection
  • Post-condition: pre-configured media channelremoved, no OTSiA connection

This appendix describes the following MCC scenarios to support the management of the OTSiA connections, as described in both use cases of [ITU-T G.807]:

– Command: Establish media channel+ OTSiG-O connection
  • Pre-condition: no OTSiA connections, pre-configured media channels may exist
  • Post-condition: OTSiA connectioncreated using zero, one or more pre-configured media channels and zero, one or more media channels created
– Command: Remove media channel+ OTSiG-O connection
  • Pre-condition: OTSiA connectionexist using zero, one or more pre-configured media channels and zero, one or more media channels created at connection setup
  • Post-condition: OTSiA connectionremoved, media channels created at connection setup removed; pre-configured media channels exist

I.1 Scenarios of use case 1

1.a **Establish a** media channel

The pre-configured media channel and the OTSiA connections are modelled as FC. The MCC function will ask to setup a pre-configured media channel in advance without any OTSiG-O.

– The operation is establishingMc (in aEndLtpList: OTSi_LTP, in zEndLtpList:OMS_LTP, out MCFc:ForwardingConstruct).

Figure I.1 provides the sequence diagram describing the message sequences related to the connection establishment.

In Figure 5 in [ITU-T G.7710], the equipment management function (EMF) interacts with the atomic functions (AF) by exchanging management information (MI) across the management point (MP) reference points. In Figure 1, the MCC interact with the EMF via the management/control interface, and then the EMF interface with the media element atomic function via the MP (management point) using the MI signals defined in [ITU-T G.798].

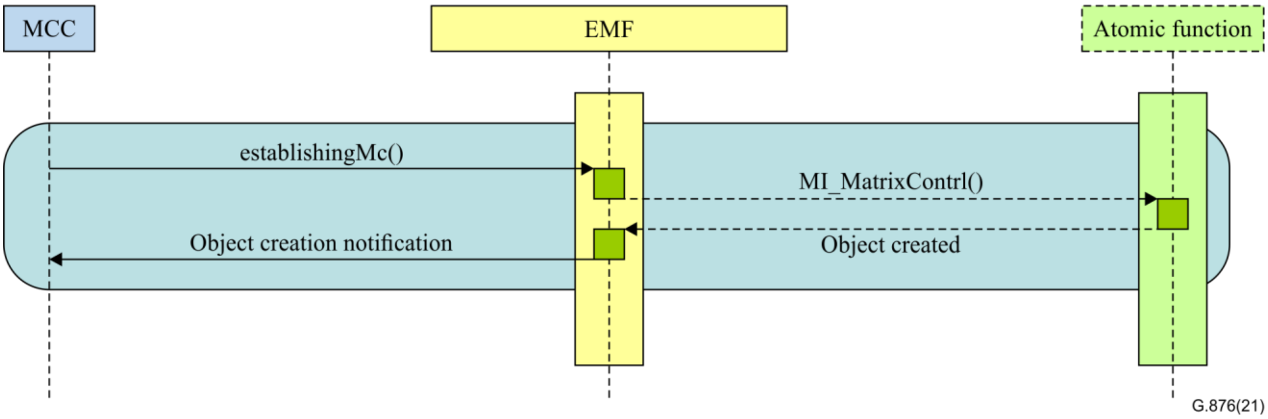

Figure I.1 – Sequence diagram of establishing MMC

1.b **Remove** media channel

Figure I.2 provides the sequence diagram of removing the media channel. For this scenario, MCC functions will ask to remove a pre-configured media channel.

– If the MMC is not used by any OTSiA connection, then the EMF can remove the matric media channel (MMC).

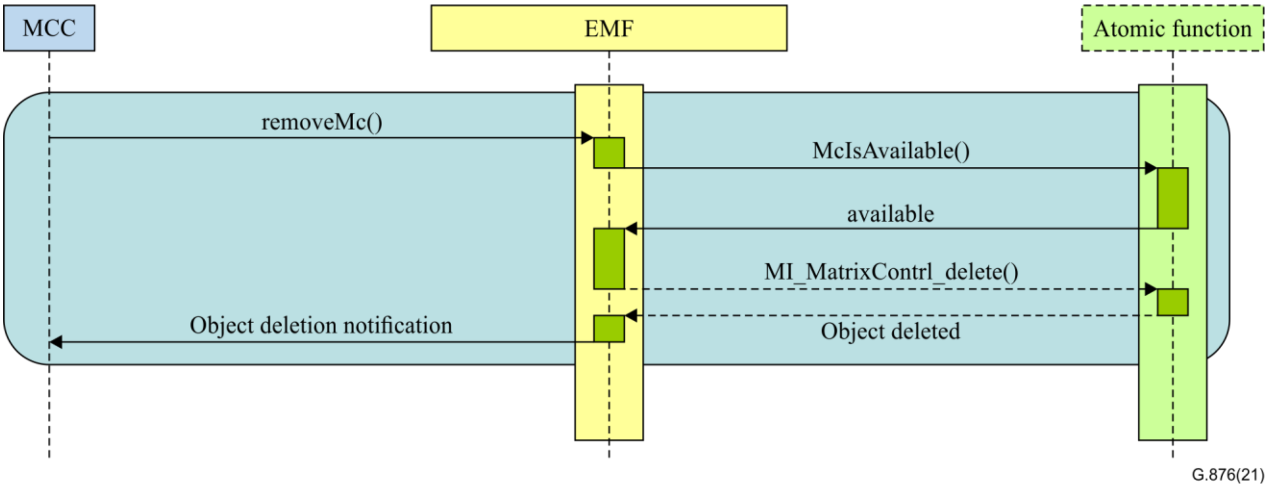

Figure I.2 – Sequence diagram of removing a media channel

1.c **Establish** OTSiG-O connection

Figure I.3 provides the sequence diagram of establishing the OTSiG-O connection.

– The equipment management function (EMF) must verify that the correct ports are connected so that all members (OTSi) of the OTSiG are directed to/from the same OMS port. Therefore the operation verifyFcPorts(in aEndLtpList: OTSiG_LTP|OMS_LTP, in zEndLtpList:OTSiG_LTP|OMS_LTP) could be considered.

– The operation frequencyCompatible(in FcFrequencySlots:integer[*], in OTSiFrequencySlots:integer[*]) checks the frequency slots compatibility between the filters and OTSi.

– If the media channel is available and the OTSiG-O is not available, then MCC functions could establish OTSiG-O with the operation establishingOTSiG-O(in aEndLtp: OTSiG-O_LTP, in zEndLtp:OTSiG-O_LTP, in OMS-O_LTP, out OTSiG-OFc:ForwardingConstruct).

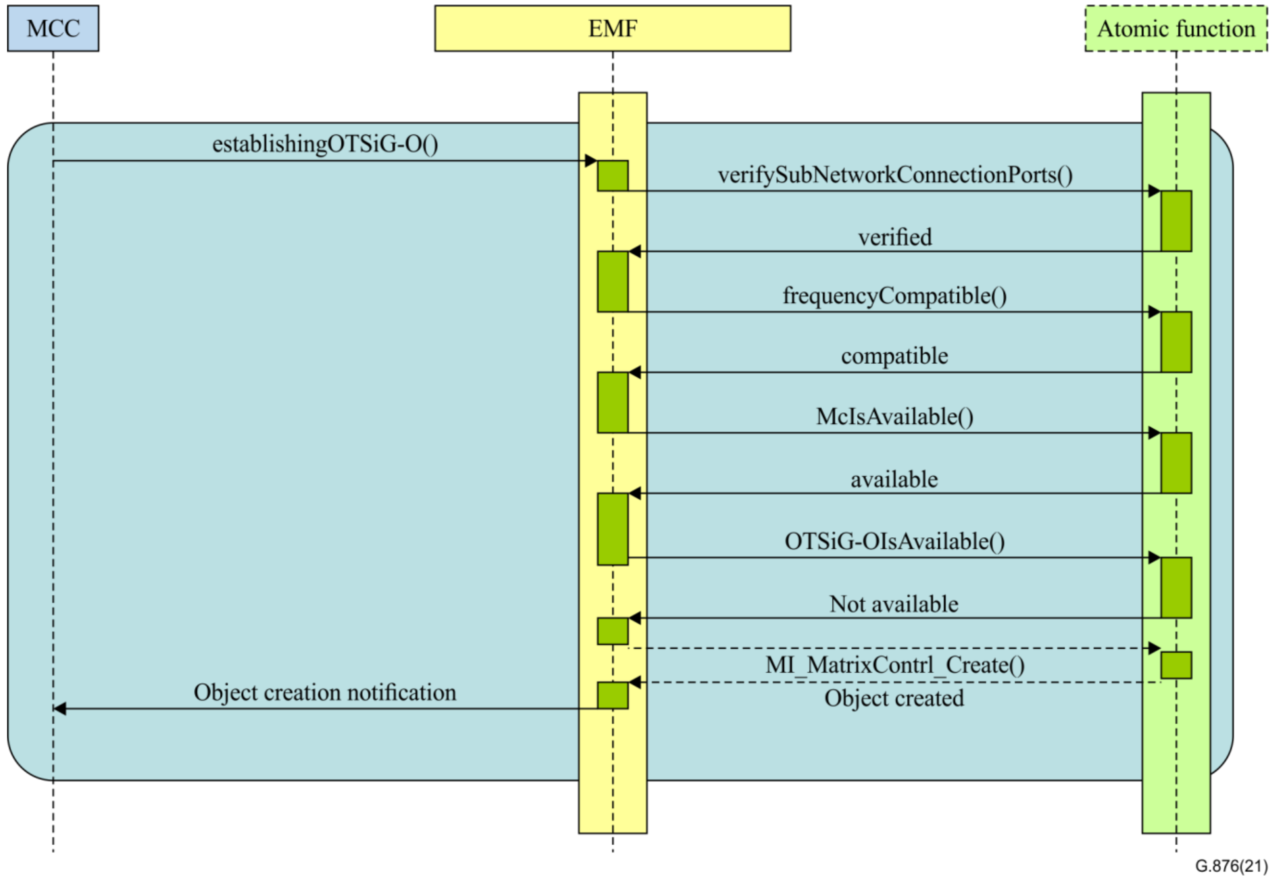

Figure I.3 – Sequence diagram of establishing a OTSiG-O connection

1.d Remove OTSiG-O connection

Figure I.4 provides the sequence diagram of removing the OTSiG-O connection.

When the MCC functions ask to remove the OTSiG-O connection, verification should be performed. If the media channel is available and the OTSiG-O connection is available, then MCC functions could remove the OTSiG-O connection.

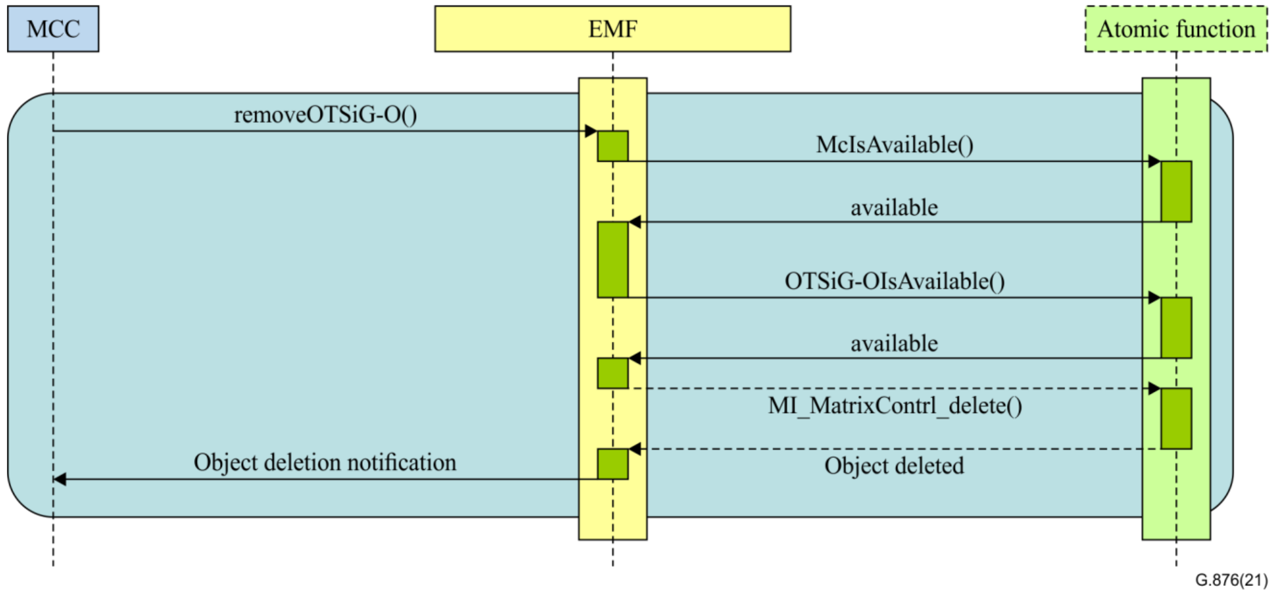

Figure I.4 – Sequence diagram of removing a OTSiG-O connection

I.2 Scenarios of use case 2

2.a Establishing a media channel + OTSiG-O connection

Figure I.5 provides the sequence diagram of establishing a media channel + OTSiG-O connection.

– The requirements of establishing a media channel and OTSiG-O connection are issued by the MCC functions.

– The EMF must verify that the correct ports are connected. It should establish the media channels described above.

– The media channel and OTSiG-O connection could be configured with the operation establishingMcAndOTSiG-O(aEndLtpList: OTSiGO_LTP|OMS_LTP, zEndLtpList:OTSiGO_LTP|OMS_LTP, OTSiG-OFc:ForwardingConstruct).

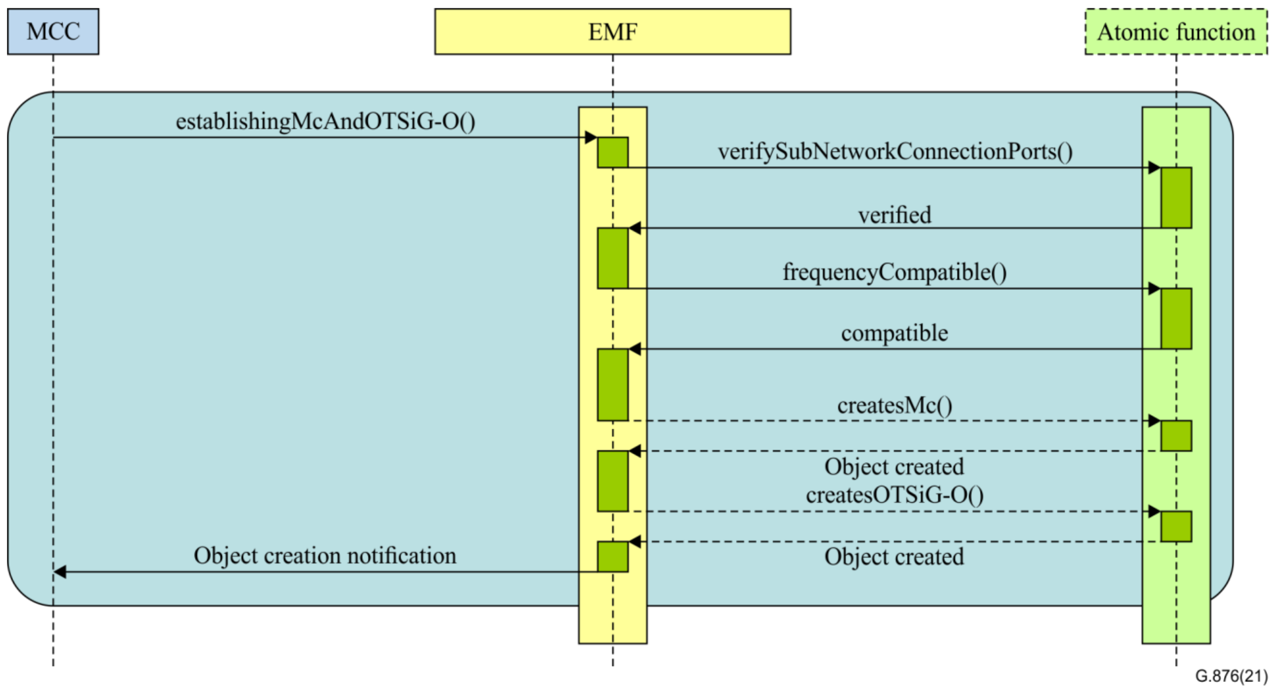

Figure I.5 – Sequence diagram of establishing a media channel + OTSiG-O connection

2.b Remove a media channel + OTSiG-O connection

– As shown in Figure I.6, if the MMC is available, then MCC functions could remove the media channel.

– If the OTSiG-O connection is available, then MCC functions could remove the OTSiG-O connection.

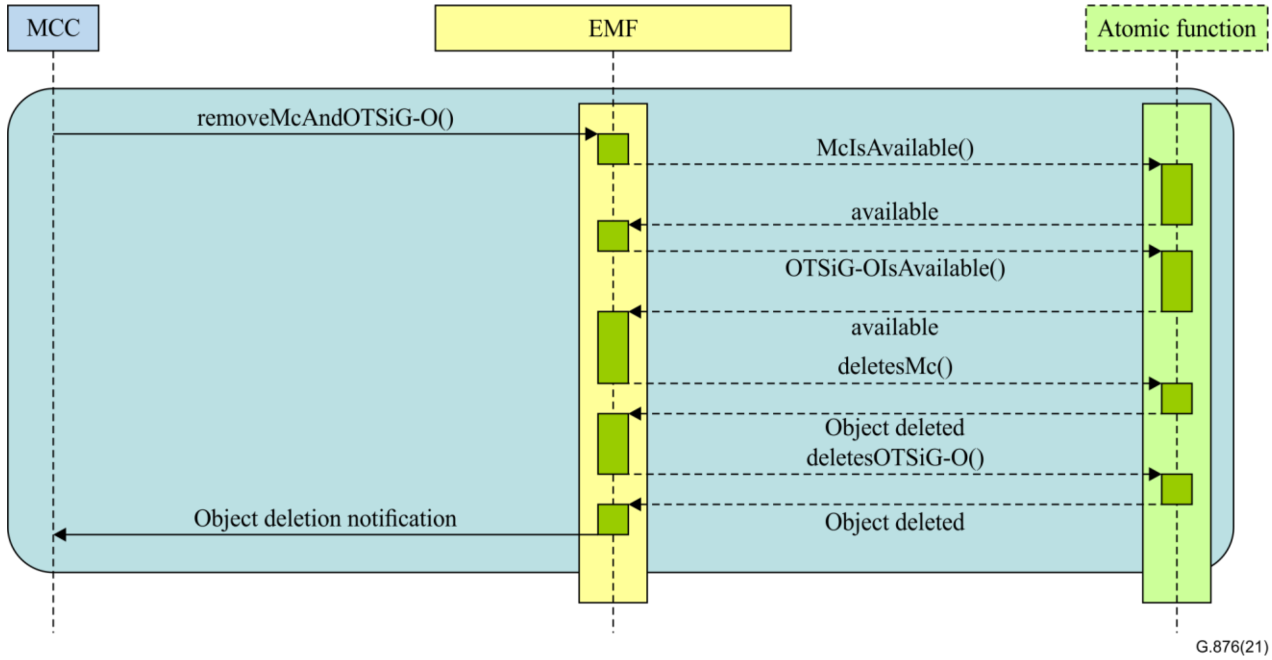

Figure I.6 – Sequence diagram of removing a media channel + OTSiG-O connection

Appendix II

Optical media network examples

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

[b-ITU-T G-sup.72] provides various examples of optical media networks by using the common information model as defined in [ITU-T G.7711].

Appendix III

Model examples and analysis

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

This appendix analyses how the functional model and the managed object classes in Figure 7-1 describes different use cases.

III.1 Use case 1 – in-line amplifiers

Figure III.1 describes the functional model of an in-line amplifier (iLA) and its mapping to ITU-T G.876 object classes:

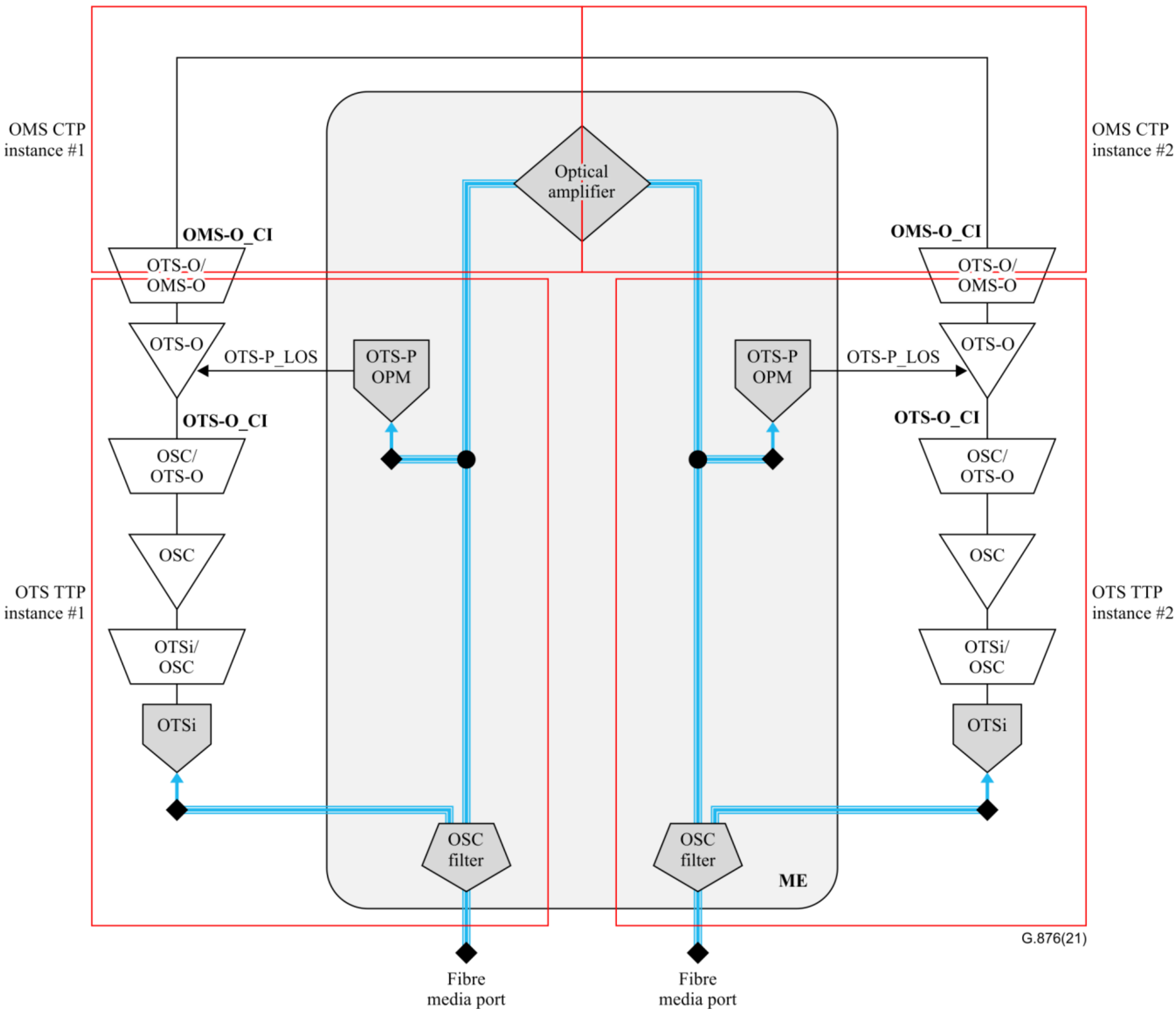

Figure III.1 – in-line amplifier (iLA)

An iLA has two interfaces with fixed connectivity. Therefore, it is modelled using two instances of both OTS TTP and OMS CTP object classes (one for each interface) with fixed connectivity between the two OMS CTP instances.

Since OAs are unidirectional media constructs, within an in-line amplifier (iLA), there are two OAs instances (one for each direction) which are modelled as two "auxiliary" object class instances of the two OMS CTP (source) instances, describing the amplification at each output of the iLA, as shown in Figure III.2 below:

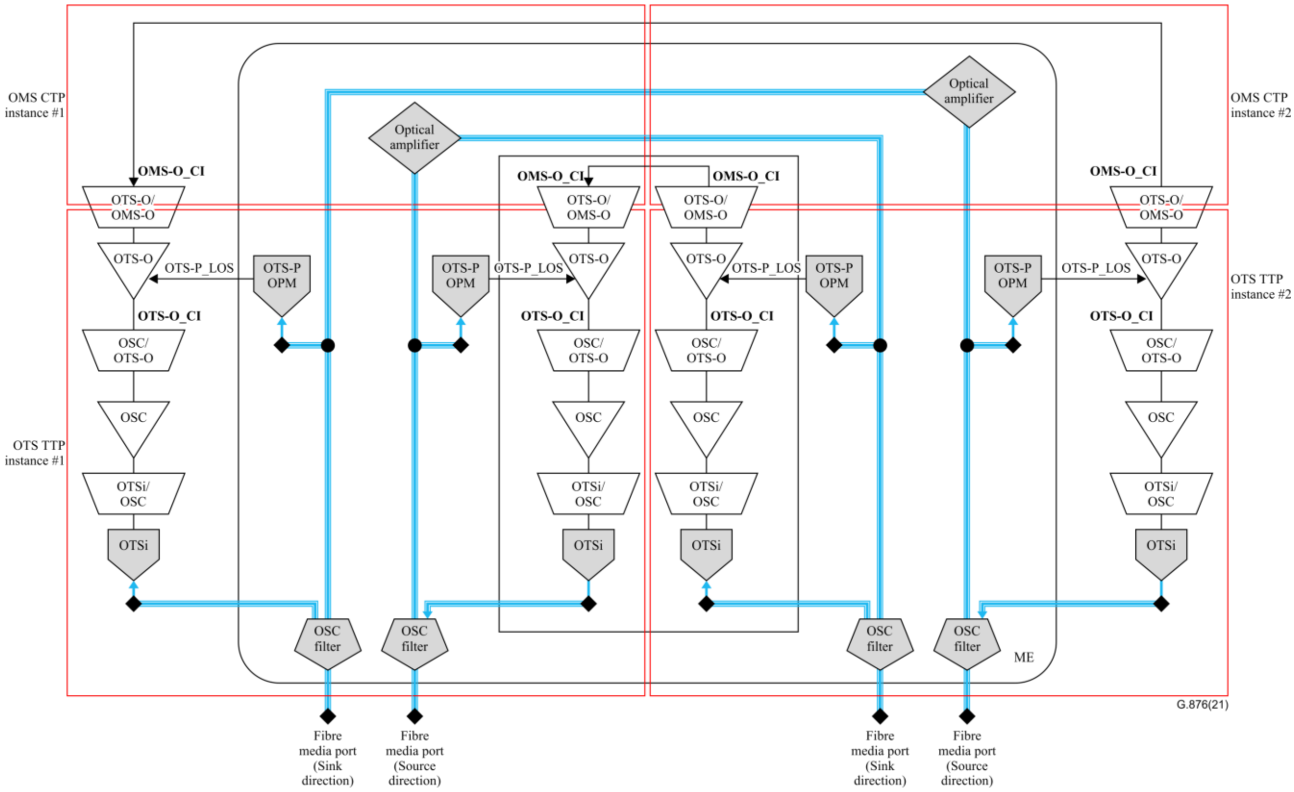

Figure III.2 – iLA ports (bidirectional view)

III.2 Use cases 2 – Reconfigurable optical add/drop multiplexer (ROADMs)

III.2.1 Use case 2a – Transit ROADM

Figure III.3 describes the functional model of a transit ROADM and its mapping to G.876 object classes:

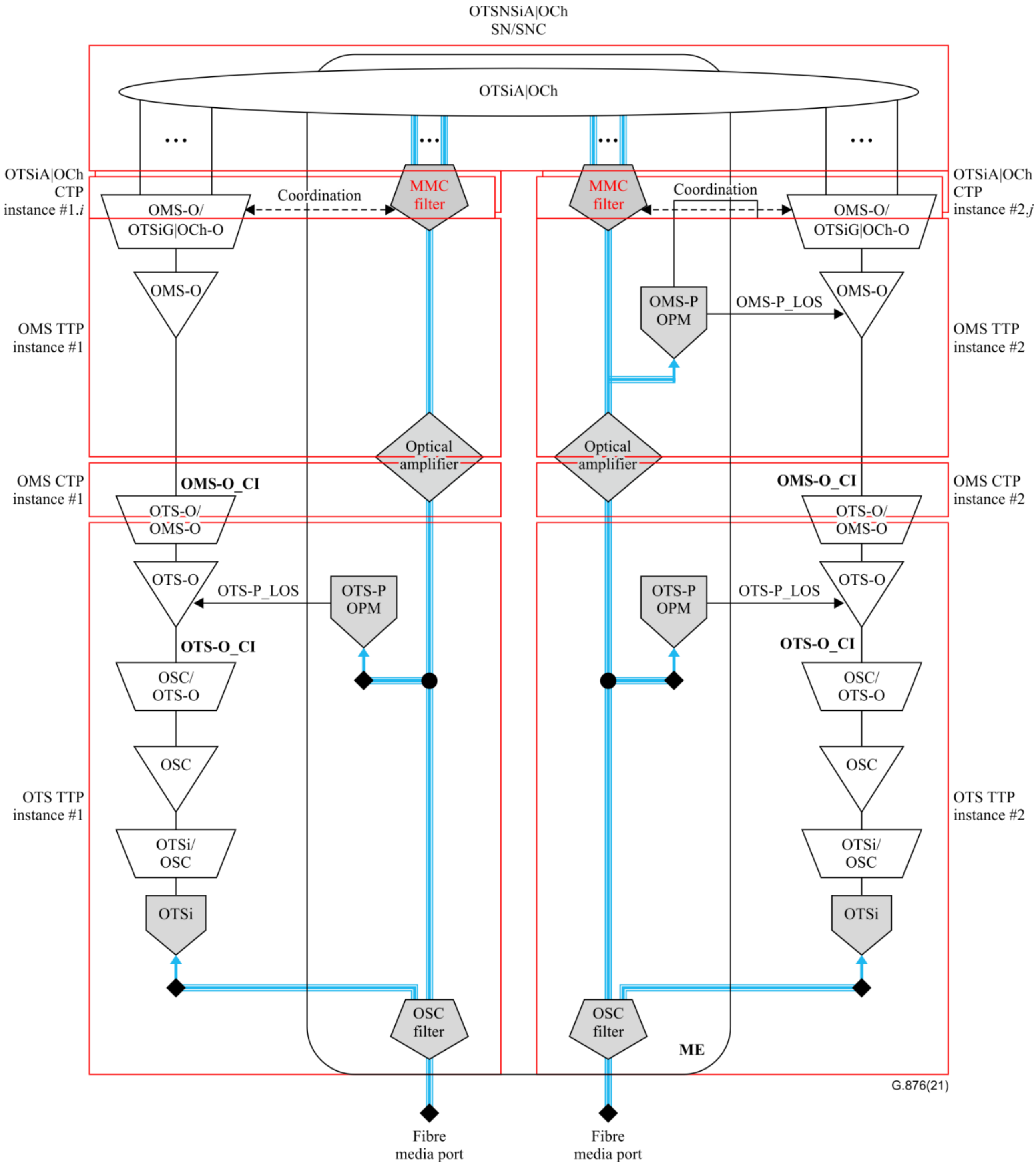

Figure III.3 – Functional model of a transit ROADM

A transit ROADM has two or more interfaces with flexible OTSiA connectivity.

Therefore, the ROADM ports are modelled using two or more instances of OTS TTP, OMS CTP, and OMS TTP object classes (one for each interface), where each OMS CTP instance has fixed connectivity with an OMS TTP instance (and vice-versa).

Since OAs are unidirectional media constructs, within a ROADM port, there are two OAs instances (one for each direction), usually referred to as a booster amplifier (in the source direction) and pre-amplifier (in the sink direction), as shown in Figure III.4 below:

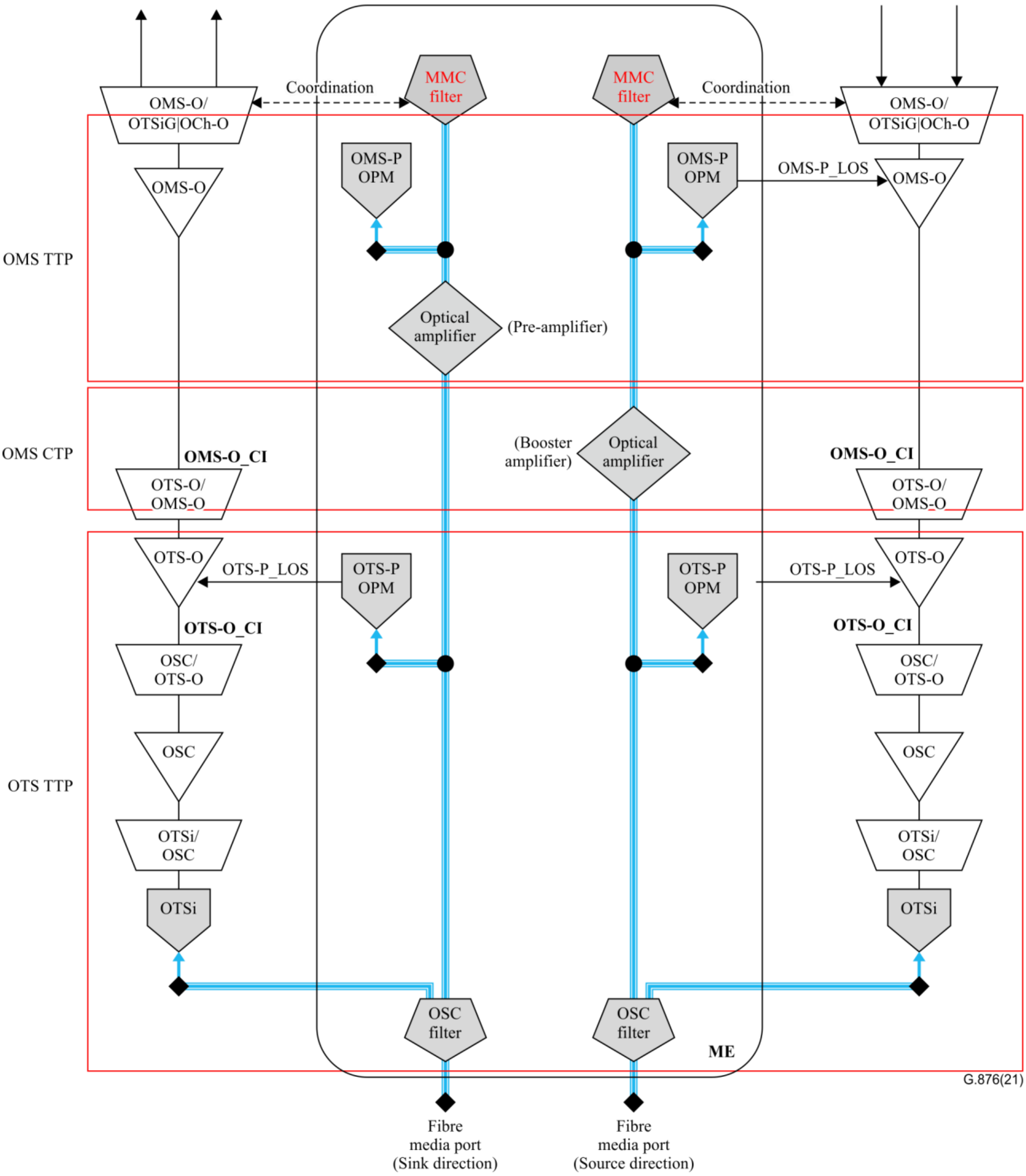

Figure III.4 – ROADM port (bidirectional view)

The pre-amplifier is modelled as an instance of the OA "auxiliary" object class of the OMS TTP (sink), which amplifies the signals being received by the OMS TTP, and the booster amplifier is modelled as an instance of the OA "auxiliary" object class instance of the OMS CTP (source), which amplifies the signals being transmitted to the underlying OTS TTP.

Each OMS TTP instance can support zero or more OTSiA CTP LTPs instances and each OTSiA CTP instance belongs to only one OTSiA connection.

The OTSiA SNC instance models the OTSiA connection being setup between the OTSiA CTP instances that belong to the same OTSiA connection.

It is worth noting that the OTSiA SNC models the matrix media channel group (MMCG) between the two OTSiA CTP instances, independently of the number of OTSi's being carried by each MMC.

Each MMC filter is therefore configured with the set of frequency slots allocated to the MMCs of each OTSiA CTP instance.

III.2.2 Use case 2b – Edge ROADM

Figure III.5 describes the functional model of an edge ROADM and its mapping to G.876 object classes:

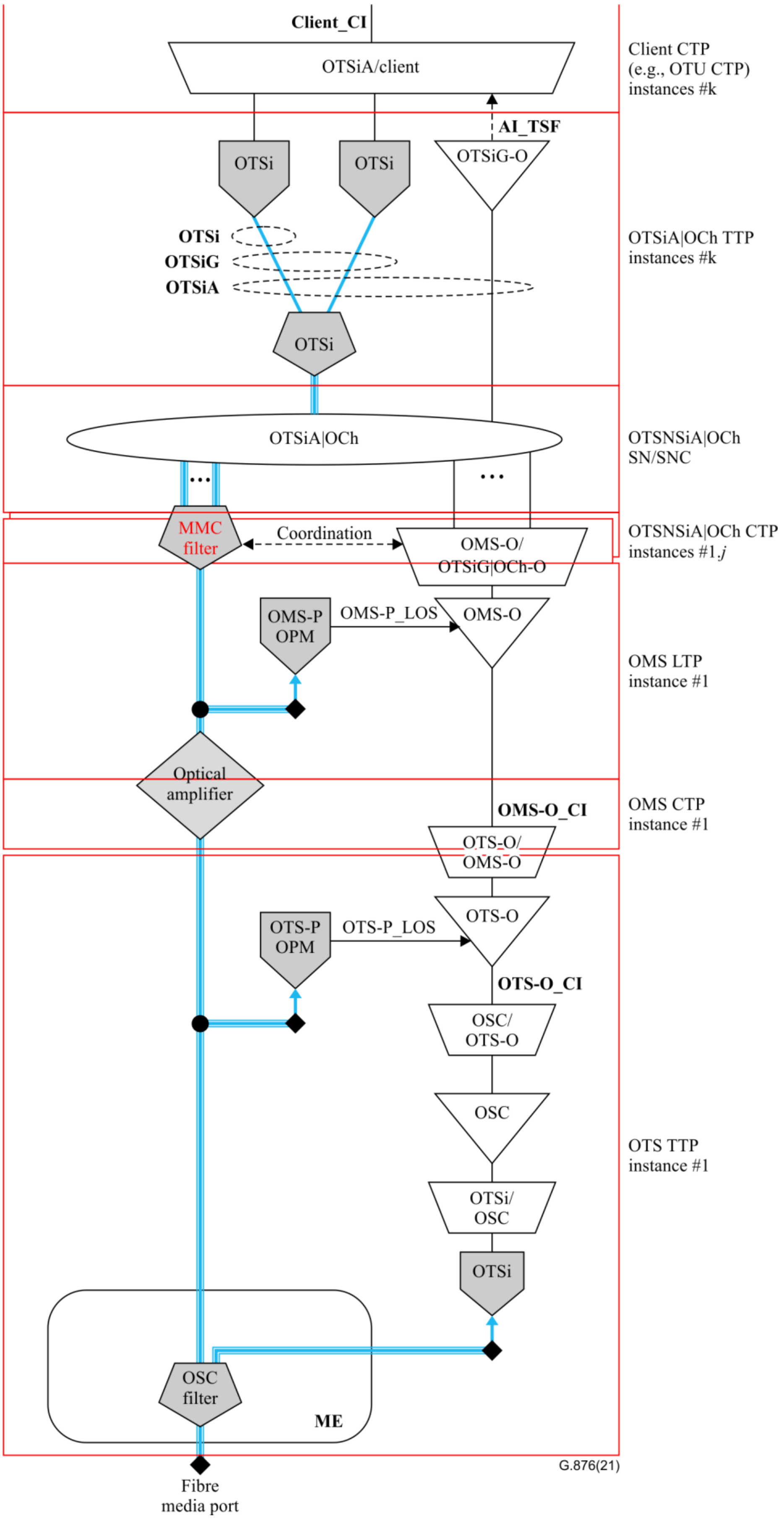

Figure III.5 – Functional model of an edge ROADM

An edge ROADM has two or more interfaces, with flexible OTSiA connectivity, and one or more client interfaces.

The ROADM ports are modelled same as in the above use case 2a (Transit ROADM).

The client interfaces are modelled by one or more OTSiA TTP and client CTP object class instances, where each OTSiA TTP instance belongs to only one OTSiA connection.

The OTSiA SNC instance, models the OTSiA connection, being setup between an OTSiA CTP instance and an OTSiA TTP instance that belong to the same OTSiA connection.

The OTSiA SNC models the matrix media channel group (MMCG) between the OTSiA CTP and OTSiA TTP instances, independently on the number of OTSis being carried by each MMC.

It is worth noting that the same ROADM can behave as a transit ROADM for some OTSiA connections and as an edge ROADM for other OTSiA connections: this flexibility is managed by proper configuration of each OTSiA SNC instances.

The management of the OTSis is only within the scope of the OTSiA TTP object class.

The media constructs within the ME portion managed by the OTSiA TTP instance can optionally contain an OTSi filter: this filter is not present if the MMC carries only one OTSi or the OTSi demodulator is not a coherent demodulator. The configuration of the OTSi filter, if present, can be done by the EMF based on the MMC configuration (derived from the configuration of the associated OTSiA SNC and OTSiA CTP instances) and of the OTSis configuration of the OSTiA TTP instance.

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[b-Eclipse-Papyrus] Eclipse Papyrus™ modeling environment. <https://www.eclipse.org/papyrus/>

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