

Recommendation

ITU-T G.8310 (2020) Amd. 1 (03/2024)

SERIES G: Transmission systems and media, digital systems and networks

Packet over Transport aspects – Mobile network transport aspects

Architecture of the metro transport network
Amendment 1



ITU-T G-SERIES RECOMMENDATIONS

Transmission systems and media, digital systems and networks

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100-G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200-G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300-G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400-G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450-G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600-G.699
DIGITAL TERMINAL EQUIPMENTS	G.700-G.799
DIGITAL NETWORKS	G.800-G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900-G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000-G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000-G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000-G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000-G.8999
Ethernet over Transport aspects	G.8000-G.8099
MPLS over Transport aspects	G.8100-G.8199
Synchronization, quality and availability targets	G.8200-G.8299
Mobile network transport aspects	G.8300-G.8399
Service Management	G.8600-G.8699
ACCESS NETWORKS	G.9000-G.9999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T G.8310

Architecture of the metro transport network

Amendment 1

Summary

Recommendation ITU-T G.8310 describes the functional architecture of the metro transport network (MTN) using the modelling methodology described in Recommendations ITU-T G.800 and ITU-T G.805. MTN is primarily intended to support transport of distributed radio access network (D-RAN) and cloud radio access network (C-RAN) traffic. The MTN functionality is described from a network level viewpoint, taking into account the client characteristic information, client/server layer associations, networking topology, and layer network functionality that provide multiplexing, routing and supervision of the digital clients.

MTN consists of two non-recursive layers, the MTN path layer, and the MTN section layer. The MTN path layer uses the MTN section layer as its server layer. The MTN path layer provides configurable connection-oriented connectivity. The server layer for the MTN section layer is provided by 50GBASE-R, 100GBASE-R, 200GBASE-R, and 400GBASE-R Ethernet interfaces.

Amendment 1 adds the architecture of fine grain MTN layer which uses the MTN path as its server layer. It also incorporates Corrigendum 1.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T G.8310	2020-12-22	15	11.1002/1000/14516
1.1	ITU-T G.8310 (2020) Cor. 1	2022-02-13	15	11.1002/1000/14907
1.2	ITU-T G.8310 (2020) Amd. 1	2024-03-08	15	11.1002/1000/15839

Keywords

Ethernet, FlexE, metro transport network, MTN.

* To access the Recommendation, type the URL <https://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2024

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Table of Contents

	Page
1 Scope.....	1
2 References.....	1
3 Definitions	2
3.1 Terms defined elsewhere.....	2
3.2 Terms defined in this Recommendation	2
4 Abbreviations and acronyms	2
5 Conventions	3
6 Functional architecture of the MTN	4
7 MTN digital layer networks.....	5
7.1 MTNP layer network.....	5
7.2 MTNS layer	8
7.3 Client/server associations	9
8 Architecture of the media network supporting the MTN	10
8.1 Media constructs.....	10
8.2 Optical tributary signal group (OTSiG).....	10
8.3 Client/server associations	12
9 Management capabilities.....	13
9.1 Capabilities	13
9.2 Connection supervision techniques	15
9.3 Connection supervision applications	15
10 Survivability techniques	15
Annex A Relationship of MTN to other technologies	16
Annex B Architecture of the fgMTNP layer network	17
B.1 Fine grain MTN path layer network.....	17
B.2 Client/server associations	19
B.3 Management capabilities	20
Bibliography.....	21

Recommendation ITU-T G.8310

Architecture of the metro transport network

Amendment 1

Editorial note: This is a complete-text publication. Modifications introduced by this Amendment are shown in revision marks relative to Recommendation ITU-T G.8310 (2020) plus its Corrigendum 1 (2022).

1 Scope

This Recommendation describes the functional architecture of the metro transport network (MTN) using the modelling methodology described in [ITU-T G.800], [ITU-T G.805] for the digital layer networks and [ITU-T G.807] for the optical media network.

The MTN functionality is described from a network-level viewpoint. This takes into account the characteristic information (CI) of the client (Ethernet MAC frames), the client/server layer associations, network topology, the network structure, and the layer network functionalities that provide multiplexing, routing, supervision, performance assessment and network survivability for the client. The digital layers of the MTN use the frame formats defined in [ITU-T G.8312]. The media portion of the network is defined in [IEEE 802.3] and is described, in this Recommendation, in terms of media constructs described in [ITU-T G.807].

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.800] Recommendation ITU-T G.800 (2016), *Unified functional architecture of transport networks*.
- [ITU-T G.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks*.
- [ITU-T G.807] Recommendation ITU-T G.807 (2020), *Generic functional architecture of the optical media network*.
- [ITU-T G.808.1] Recommendation ITU-T G.808.1 (2014), *Generic protection switching - Linear trail and subnetwork protection*.
- [ITU-T G.959.1] Recommendation ITU-T G.959.1 (2024~~18~~), *Optical transport network physical layer interfaces*.
- [ITU-T G.7712] Recommendation ITU-T G.7712/Y.1703 (2019), *Architecture and specification of data communication network*.
- [ITU-T G.8312] Recommendation ITU-T G.8312 (~~2021~~2020), *Interfaces for the metro transport network*.
- [\[ITU-T G.8312.20\]](#) Recommendation ITU-T G.8312.20 (2024), *Overview of fine-grain MTN*.
- [IEEE 802.3] IEEE Std 802.3-~~(2018)~~2022, *IEEE Standard for Ethernet*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

- 3.1.1 **access point (AP)**: See [ITU-T G.805]
- 3.1.2 **adaptation**: See [ITU-T G.805]
- 3.1.3 **adapted information (AI)**: See [ITU-T G.805]
- 3.1.4 **characteristic information (CI)**: See [ITU-T G.805]
- 3.1.5 **connection supervision**: See [ITU-T G.805]
- 3.1.6 **connection**: See [ITU-T G.805]
- 3.1.7 **connection point**: See [ITU-T G.805]
- 3.1.8 **forwarding point**: See [ITU-T G.800]
- 3.1.9 **forwarding end point**: See [ITU-T G.800]
- 3.1.10 **layer network**: See [ITU-T G.805]
- 3.1.11 **link**: See [ITU-T G.805]
- 3.1.12 **optical tributary signal (OTSi)**: See [ITU-T G.959.1]
- 3.1.13 **optical tributary signal group (OTSiG)**: See [ITU-T G.807]
- 3.1.14 **subnetwork**: See [ITU-T G.805]
- 3.1.15 **topological component**: See [ITU-T G.805]
- 3.1.16 **transport entity**: See [ITU-T G.800]
- 3.1.17 **transport processing function**: See [ITU-T G.805]

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI	Adapted Information
AIS	Alarm Indication Signal
AP	Access Point
CI	Characteristic Information
CP	Connection Point
C-RAN	Cloud Radio Access Network
D-RAN	Distributed Radio Access Network
ETH	Ethernet MAC layer
FEC	Forward Error Correction

<u>fgCS</u>	<u>fine grain Calendar Slot</u>
<u>fgMTN</u>	<u>fine grain MTN</u>
<u>fgMTNP</u>	<u>fine grain MTN Path</u>
<u>fgMU</u>	<u>fine grain Multiplex Unit</u>
FlexE	Flex Ethernet
FP	Forwarding Point
FwEP	Forwarding End Point
IPG	Inter-packet Gap
M-AI	Modulator Adapted Information
<u>MAC</u>	<u>Media Access Control</u>
MTN	Metro Transport Network
MTNP	MTN Path
MTNS	MTN Section
NMC	Network Media Channel
NMCG	NMC Group
OCI	Open Connection Indication
OSME	Optical Signal Maintenance Entity
OTSi	Optical Tributary Signal
OTSiG	OTSi Group
PCS	Physical Coding Sublayer
PMA	Physical Medium Attachment
PMD	Physical Medium Dependent
PTP	Precision Time Protocol
SSF	Server Signal Fail
TTI	Trail Trace Identifier

5 Conventions

This Recommendation uses the diagrammatic conventions defined in [ITU-T G.800], [ITU-T G.805] and [ITU-T G.807].

The forwarding point (FP), defined in [ITU-T G.800], is used in this Recommendation and is equivalent to the connection point (CP), defined in [ITU-T G.805].

This Recommendation uses the following textual conventions to identify information elements:

Block: A 66-bit information element. The first two bits are a sync header which identifies the type of block; the remaining 64 bits carry data or control information. The 64B/66B block coding format is described in clause 82 of [IEEE 802.3].

Sequence: A series of information elements for which sequential arrangement must be maintained during transmission, but the time interval between information elements need not be maintained.

Stream: A sequence where the time interval between information elements is maintained.

6 Functional architecture of the MTN

The metro transport network (MTN) consists of two non-recursive digital layer networks; the MTN path (MTNP) layer and the MTN section (MTNS) layer. The rates and formats used in the MTN are defined in [ITU-T G.8312].

The MTNS is supported by an MTN optical media layer. The MTN media layer provides fixed point-to-point connections between Ethernet interfaces. The layer structure of the MTN is shown in Figure 6-1.

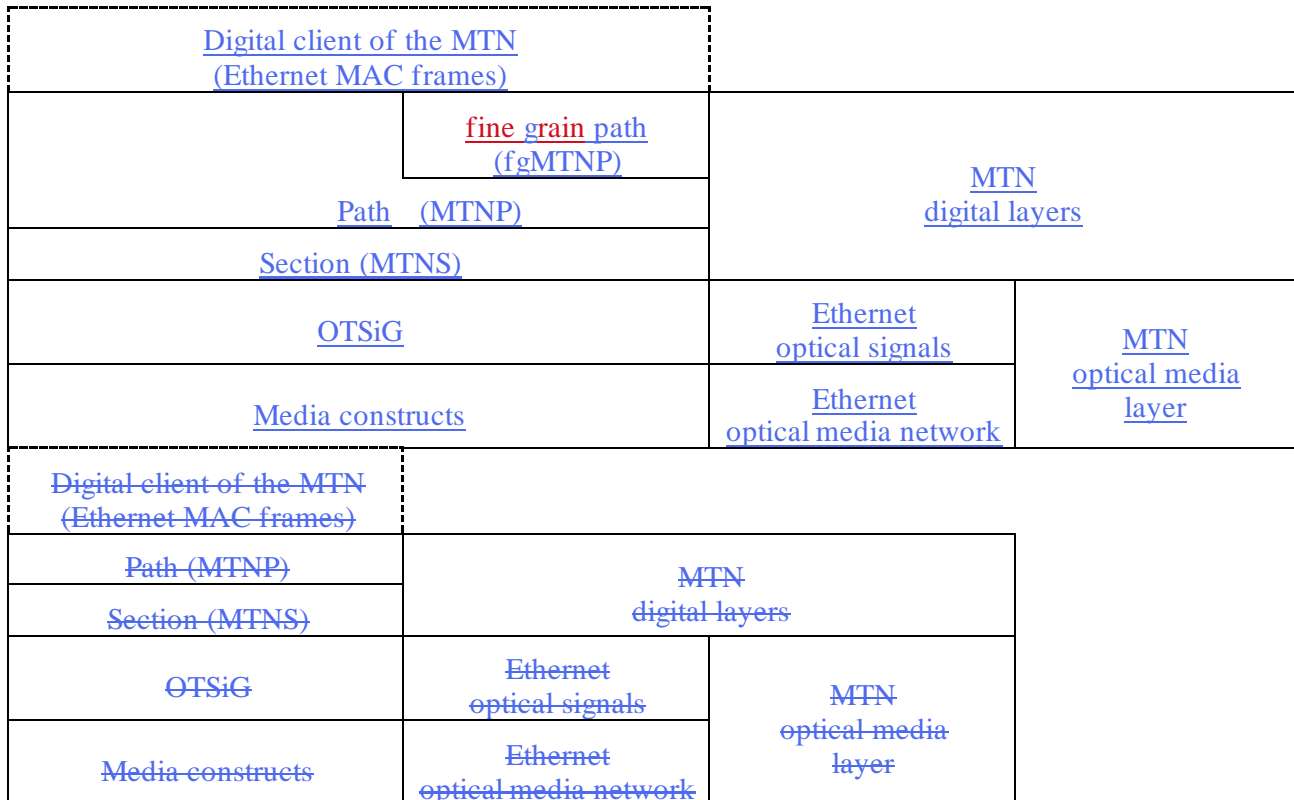


Figure 6-1 – MTN layer structure

The only eClients defined for the MTN is-are Ethernet media access control (MAC) frames and fgMTN path frames (fgMTNP) which are encoded into 64B/66B blocks as defined in clause 82 of [IEEE 802.3] for transport across the MTN.

The MTNP layer provides channel forwarding, as described in clause 6.3.1 of [ITU-T G.800], for Ethernet MAC frames and fgMTN path frames.

The MTNP layer does not transfer client Ethernet MAC frame timing information. Any link status indication blocks (e.g., LF, RF, LPI) present on the UNI links are terminated by the UNI interface and are not transferred across the MTN layer networks.

The only server layer defined for the MTNP is the MTNS. An instance of a MTNP layer network cannot be a client or server for another instance of a MTNP layer network.

The only client defined for the MTNS layer is the MTNP layer. The MTNS layer provides fixed point to point connectivity for its MTNP layer clients at bitrates in multiples of ~5 Gb/s. The MTNS is based on Flex Ethernet (FlexE) as defined in [OIF FLEXE IA].

The server layer for the MTNS layer is provided by any of the Ethernet physical layers that use the encoding defined in clause 82 of [IEEE 802.3]. The Ethernet interfaces defined at the time this

Recommendation was published are: 50GBASE-R, 100GBASE-R, 200GBASE-R and 400GBASE-R [IEEE 802.3].

The MTNS characteristic information (CI) is adapted to a modulator input by the lower functions of the physical coding sublayer (PCS) defined in clause 82 of [IEEE 802.3], the physical medium attachment (PMA) defined in clause 83 of [IEEE 802.3] and corresponding physical medium dependent (PMDs) of [IEEE 802.3]. The processing includes; scrambling, lane distribution, insertion of alignment markers, forward error correction (FEC) (except for some 100GBASE-R interfaces) and mapping to one or more digital lanes for modulation.

The MTN digital layers are described in clause 7, the MTN optical media network is described in clause 8.

Annex A provides a description of the relationship between the MTN layer networks and Ethernet [IEEE 802.3] and FlexE [OIF FLEXE IA].

[Annex B describes the fgMTNP layer network.](#)

~~The MTN digital layers are described in clause 7, the MTN optical media network is described in clause 8.~~

7 MTN digital layer networks

The client/server associations of the MTN digital layers are shown in Figure 7-1.

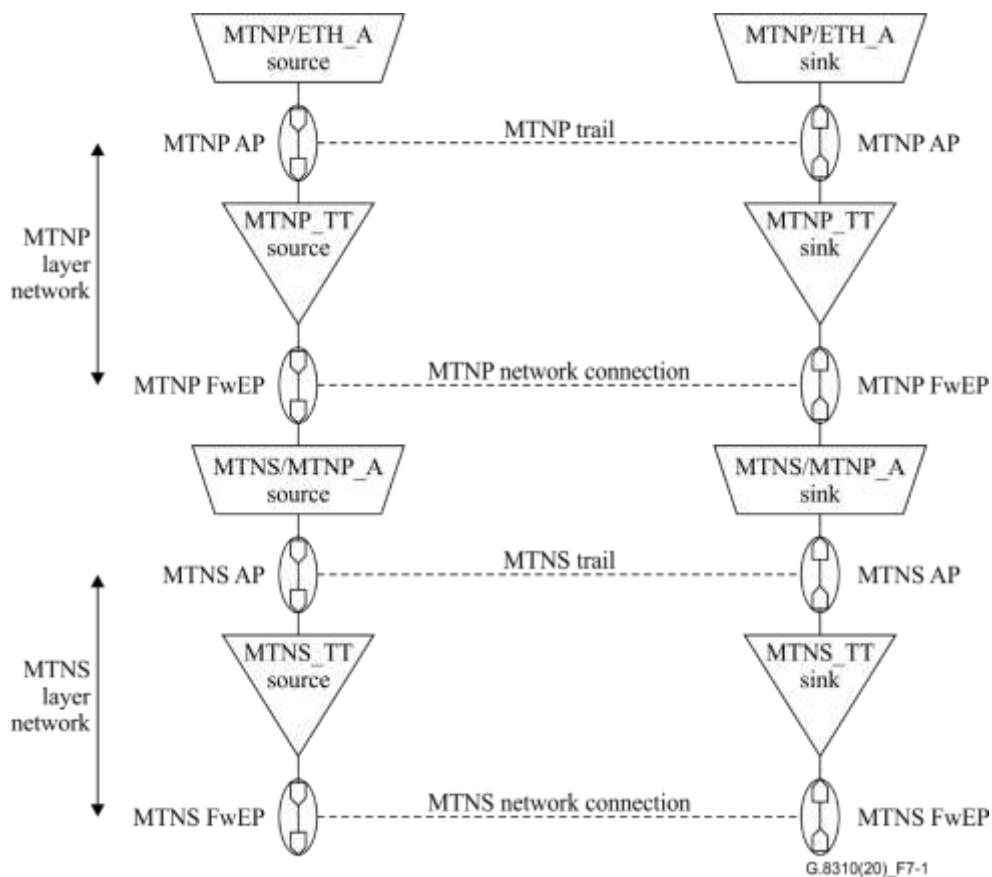


Figure 7-1 – Client/server layer associations of the MTN digital layer networks

7.1 MTNP layer network

The MTNP layer network provides a MTNP trail transport entity to support the transport of [Ethernet MACclient](#) frames across the MTN. The MTNP trail is supported by zero or more MTNS trail(s) as shown in Figures 7-2 and 7-3. The MTNS trail is described in clause 7.2. The MTNP trail transport

entity supports only bidirectional, symmetrical, point to point connectivity. The description of the supported MTNP client layer network is ~~outside the scope of this Recommendation in Annex B.~~

The MTNP trail transport entity provides channel forwarding, as described in clause 6.3.1 of [ITU-T G.800], for the client Ethernet MAC frames.

The MTNP layer network provides configurable connectivity between path forwarding end points (FwEPs), or between a path FwEP and a path FP or between path FPs.

The MTNP layer network is non-recursive i.e., a MTNP layer cannot be a client of another MTNP layer network. The only server layer for the MTNP layer is the MTNS layer described in clause 7.2.

The CI of a MTNP layer network is a sequence of 64B/66B blocks encoded as defined in clause 82 of [IEEE 802.3] and is composed of:

- A contiguous sequence of 64B/66B blocks that carry ~~a MAC frame~~ client information, including (called a packet)s with a minimum gap between packets (called the inter-packet gap (IPG)).
- MTNP overhead encoded into 64B/66B blocks.

The duration of the IPG can be modified to provide rate adaptation between ~~the~~ client MAC frames and the MTNP. Therefore, the MTNP layer network does not transfer client timing information. Also, any link status indications blocks (e.g., LF, RF, LPI) present on the UNI links are terminated by the UNI interface and are not transferred across the MTN layer networks.

Details of the format of the MTNP CI are provided in [ITU-T G.8312].

To provide end-to-end networking, the following capabilities are included in the MTNP layer network:

- MTNP connection rearrangement for flexible network routing;
- MTNP overhead processes to verify the integrity of the client adapted information (AI);
- MTNP operations, administration and maintenance functions, including network survivability.

The MTNP layer network, shown in Figure 7-2, contains the transport processing functions, transport entities, and topological components described in clauses 7.1.1, 7.1.2 and 7.1.3 respectively. The interlayer adaptation functions are described in clause 7.3.1.

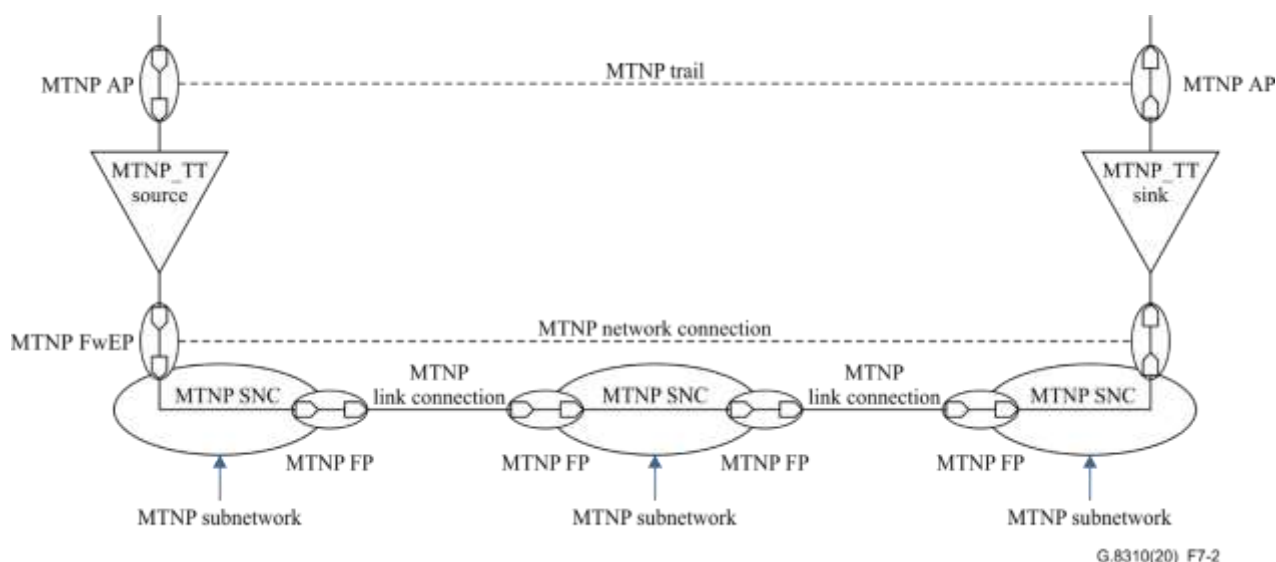


Figure 7-2 – MTNP layer network

As described in [ITU-T G.800], the MTNP subnetwork may represent the aggregation of contained subnetworks and links or, it may represent the limit of subnetwork recursion which is a matrix.

A MTNP subnetwork may provide a subnetwork connection directly between MTNP FwEPs without adaptation to an MTN section layer. This is illustrated in Figure 7-3.

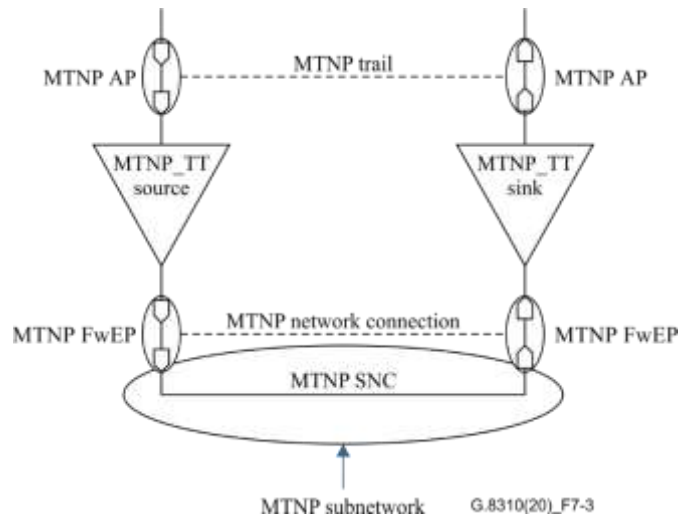


Figure 7-3 – MTNP subnetwork example

7.1.1 MTNP trail termination

The following generic processes are assigned to the MTNP trail termination:

- validation of connectivity integrity;
- assessment of transmission quality;
- transmission defect detection and indication.

The requirements for these processes are outlined in clause 9.

There are three types of MTNP trail termination:

- MTNP bidirectional trail termination: consists of a pair of collocated MTNP trail termination source and sink functions;
- MTNP trail termination source: accepts AI from a client layer network at its input, generates and inserts the MTNP trail overhead as a separate and distinct logical data stream and presents the CI of the MTNP layer network at its output;
- MTNP trail termination sink: accepts the CI of the MTNP layer network at its input, extracts and processes the separate and distinct logical data stream containing the MTNP trail overhead and presents the AI at its output.

7.1.2 MTNP transport entities

Network connections, subnetwork connections, link connections and trails are as described in [ITU-T G.800]. Tandem connections are not supported.

7.1.3 MTNP topological components

Layer network, subnetworks, links and access groups are as described in [ITU-T G.800].

The MTNP subnetwork provides configurable subnetwork connections between an input forwarding point (FP) or forwarding end point (FwEP) and an output FP or FwEP.

7.2 MTNS layer

The MTNS layer network provides a fixed point-to-point MTNS trail transport entity, that is bidirectional and symmetrical to support the transport of the MTNP client. The MTNS trail is supported by an optical signal tributary group (OTSiG). The OTSiG is implemented by one or more Ethernet optical interfaces as described in clause 8.2.

The MTNS layer network is non-recursive and the only client for the MTNS layer network is the MTNP layer network.

The CI of an MTNS layer network is a stream of 64B/66B blocks encoded as defined in clause 82 of [IEEE 802.3] and is composed of:

- Client MTNP CI; and
- MTNS overhead encoded into 64B/66B blocks.

The format of the MTNS is based on FlexE that is defined in [OIF FLEXE IA], details of the format are provided in [ITU-T G.8312]. The MTNS is structured as a set of calendar slots each with a capacity of ~5Gbit/s. The number of calendar slots supported by the MTNS is dependent on the OTSiG that supports the MTNS. A MTNP client is allocated one or more calendar slots.

The duration of the IPG (in the MTNP CI) can be modified by adding or removing 64B/66B blocks (in the IPG) to provide rate adaptation between the MTNP CI and the calendar slots allocated to it in the MTNS.

The capabilities of the MTNS layer network include:

- MTNS overhead processes to confirm the integrity of the client AI and conditioning for its transport over an OTSiG;
- MTNS operations, administration and maintenance functions.

The MTNS layer network, shown in Figure 7-4 contains the transport processing functions, transport entities, and topological components described in clauses 7.2.1, 7.2.2 and 7.2.3 respectively. The interlayer adaptation functions are described in clause 7.3.2.

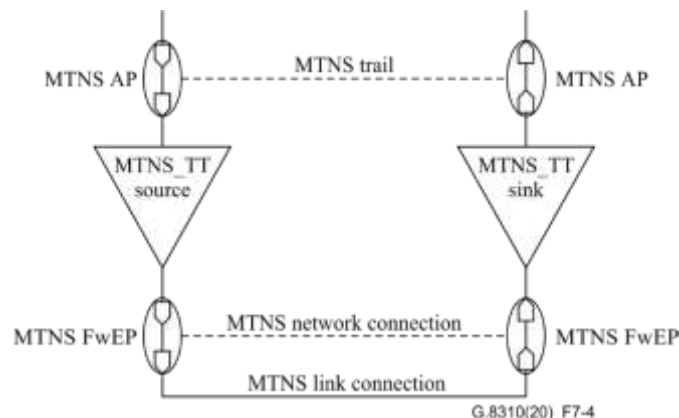


Figure 7-4 – MTNS layer network

The MTNS network connection is supported by an OTSiG as described in clause 8.2.

7.2.1 MTNS trail termination

The following generic processes are assigned to the MTNS trail termination:

- Validation of connectivity integrity.

The requirements for these processes are outlined in clause 9.

There are three types of MTNS trail termination:

- MTNS bidirectional trail termination: consists of a pair of collocated MTNS trail termination source and sink functions;
- MTNS trail termination source: accepts AI from the MTNP client layer network at its input, generates and inserts the MTNS trail overhead as a separate and distinct logical data stream and presents the CI of the MTNS layer network at its output. If bonding is supported (see clause 8.2.2) it inverse multiplexes the client AI onto a group of homogenous Ethernet interfaces;
- MTNS trail termination sink: accepts the CI of the MTNS layer network at its input, extracts and processes the separate and distinct logical data stream containing the MTNS trail overhead and presents the MTNP AI at its output. If bonding is supported (see clause 8.2.2) it accepts the input from a group Ethernet interfaces, aligns the members of the group and reconstructs the payload at the aggregate line rate.

7.2.2 MTNS transport entities

Network connections, link connections and trails are as described in [ITU-T G.800]. Subnetwork connections and tandem connections are not supported.

7.2.3 MTNS topological components

Layer network and access groups are as described in [ITU-T G.800]. Subnetworks are not supported.

7.3 Client/server associations

7.3.1 MTNP/Ethernet MAC frame (ETH) adaptation

The bidirectional MTNP/ETH adaptation function is performed by a collocated pair of source and sink MTNP/ETH adaptation functions.

The MTNP/ETH adaptation source performs the following processes between its input and its output:

- all the processing required to encode the client MAC frame into a contiguous sequence of 64B/66B blocks as defined in clauses 81 and 82 of [IEEE 802.3];
- generation of management/maintenance signals as described in clause 9.

The MTNP/ETH adaptation sink performs the following processes between its input and its output:

- recovery of the client MAC frames from the contiguous sequence of 64B/66B blocks as defined in clauses 81 and 82 of [IEEE 802.3];
- termination of management/maintenance signals as described in clause 9.

7.3.2 MTNS/MTNP adaptation

The bidirectional MTNS/MTNP adaptation function is performed by a collocated pair of source and sink MTNS/MTNP adaptation functions.

The MTNS/MTNP adaptation source performs the following processes between its input and its output:

- all the processing required to map 664B/66B blocks of the MTNP CI into a defined number of calendar slots;
- generation and termination of relevant management/maintenance signals as described in clause 9.

The MTNS/MTNP adaptation sink performs the following processes between its input and its output:

- recovery of the MTNP CI from the assigned calendar slots;
- generation and termination of management/maintenance signals as described in clause 9.

7.3.3 MTNP/fgMTNP adaptation

See Annex B.

8 Architecture of the media network supporting the MTN

The architecture of the media network, defined in [IEEE 802.3], is described using the media constructs listed in clause 8.1 to represent the different functions that are present in the media network. Media constructs operate on the signal envelope (e.g., constrain or direct the media channel, etc.) and are not aware of the information being carried. Media constructs do not modulate or demodulate the signal and therefore do not process the digital information that is carried by the signal.

A full description of the generic functional architecture of the media network is provided in [ITU-T G.807].

The media network that support the MTNS only provides fixed point to point media associations and does not support the optical signal maintenance entity (OSME) described in [ITU-T G.807].

8.1 Media constructs

The following media constructs used to describe the architecture of the media network are described in [ITU-T G.807]:

- media port;
- media channel;
- media channel group;
- fibre.

8.2 Optical tributary signal group (OTSiG)

The MTNS is supported by an OTSiG. The OTSiG is a management/control abstraction that represents a group of one or more optical tributary signals (OTSi), see [ITU-T G.807]. The OTSiG consists of one or more Ethernet physical layer interfaces defined in [IEEE 802.3]. Each unidirectional optical tributary signal (OTSi) is carried in an independent network media channel (NMC). The NMC is described in clause 7.1.2.1 of [ITU-T G.807]. The digital information stream from the MTNS present at the FwEP is mapped and encoded by an adaptation source function.

NOTE – The encoding process in the M-AI/MTNS adaptation may include the computation and insertion of a forward error correction (FEC) code.

The resultant modulator adapted information (M-AI) is used by a modulator source to create an OTSi. The OTSi is converted back to M-AI by a demodulator sink according to a specific modulation/demodulation mechanism. The adaptation sink function processes the M-AI to recreate the MTNS digital information stream. As illustrated in Figure 8-2, the MTNS client may be carried by more than one OTSi (depending on the particular Ethernet interface that is used). The functional models for these interfaces are provided in Figures 8-1 and 8-2. Note that in most Ethernet interfaces the modulators and filters are not configurable.

At the time of publication of this Recommendation the Ethernet interfaces, defined in [IEEE 802.3], that can be used in the MTN media network are: 50GBASE-R, 100GBASE-R, 200GBASE-R and 400GBASE-R.

8.2.1 MTNS carried over a single Ethernet interface

The case where the MTNS is carried by one Ethernet interface that uses a single OTSi is shown in Figure 8-1. The OTSi is carried from the media port on the modulator source to the media port on the demodulator sink by a network media channel (NMC).

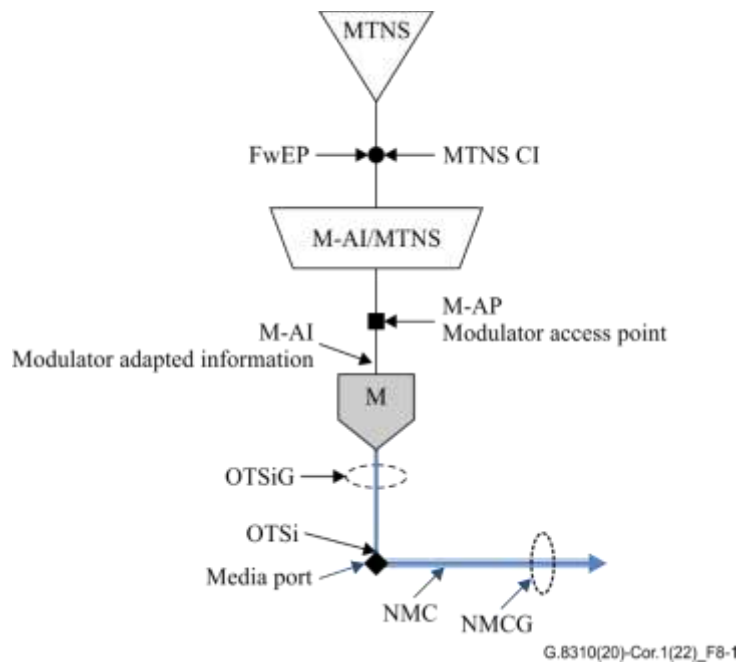


Figure 8-1 – Mapping an MTNS to an OTSiG that contains one OTSi

The case where an MTNS is carried by one Ethernet interface that uses more than one OTSi is illustrated in Figure 8-2.

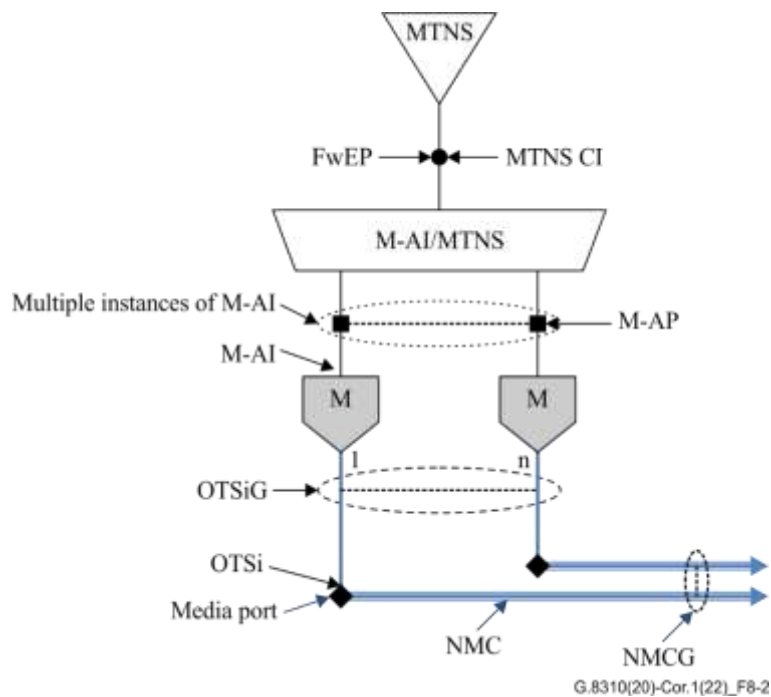


Figure 8-2 – Mapping an MTNS to an OTSiG that contains more than one OTSi

The differential delay between members of the OTSiG must be controlled, this is represented by placing all of the NMCs in a single NMC group (NMCG). Normally these functions are supported by an Ethernet interface and all members of the OTSiG are carried over the same fibre.

8.2.2 MTNS carried over more than one Ethernet interface

The MTNS may be carried by a group of two or more Ethernet interfaces. In the description of FlexE in [OIF FLEXE IA] this is referred to as bonding. This is modelled by expanding the MTNS trail

termination to provide an inverse multiplexing sub-layer as described in clause 5.3.3.1.2 of [ITU-T G.805]. This is shown in Figure 8-3, in this example each Ethernet interface is supported by a single OTSi. Each of the Ethernet interfaces may be supported by more than one OTSi as shown in Figure 8-2.

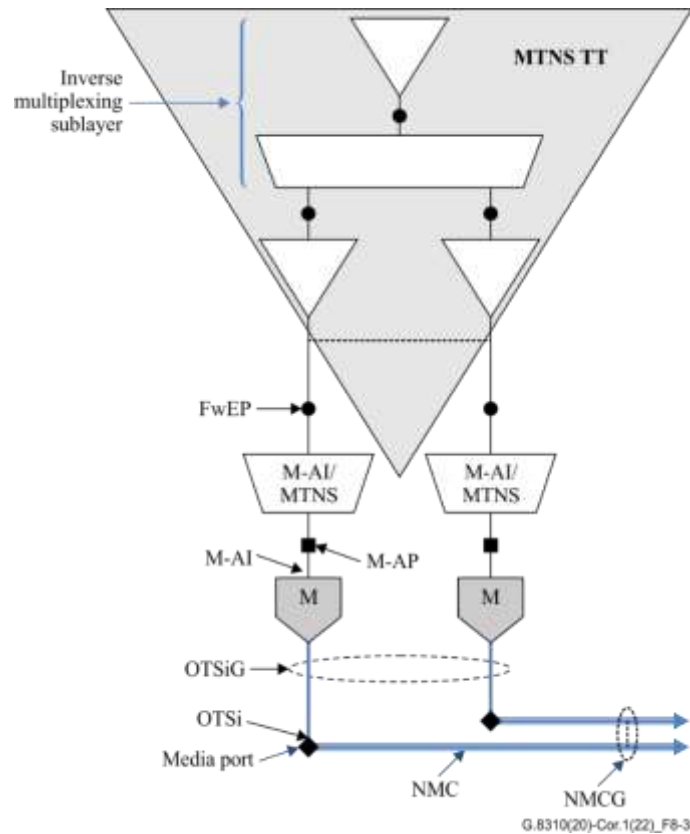


Figure 8-3 – Mapping an MTNS to a set of bonded Ethernet interfaces

In this case the OTSi that supports each of the Ethernet interfaces is in the same OTSiG and the differential delay of the members of the OTSiG must be constrained.

8.3 Client/server associations

8.3.1 M-AI/MTNS adaptation

The bidirectional M-AI/MTNS adaptation function is performed by a collocated pair of source and sink M-AI/MTNS adaptation functions.

The M-AI/MTNS adaptation source performs the following processes between its input and its output:

- all the processing required to encode and map the MTNS client into one or more instances of M-AI. These processes include scrambling, lane distribution, insertion of alignment markers, forward error correction (FEC), PMA and physical medium dependent (PMD) sublayers. FEC is required on all Ethernet interfaces except for some legacy 100GBASE-R Ethernet interfaces. These processes are described in [IEEE 802.3].

The M-AI/MTNS adaptation sink performs the following processes between its input and its output:

- All the processes necessary to recover the MTNS client from one or more instances of M-AI. These processes are described in [IEEE 803.3].
- If the Ethernet interface uses FEC:
 - ensure that all blocks in an uncorrectable FEC codeword are error marked;

- replace all 64B/66B blocks with an invalid sync header with a /E/ block.

9 Management capabilities

This clause provides an overview of the fault, performance and configuration management capabilities provided by the MTN. The capabilities are described in [ITU-T G.8312].

NOTE – Further details will be provided in the MTN equipment Recommendation.

The MTN digital layers (MTNP, MTNS) use digital overhead to provide OAM, which can report on the status of the layer and may be used to infer the status of the server layer.

The media network that is deployed as a part of an MTN network uses point-to-point Ethernet links and is not expected to support fault, performance and configuration management.

9.1 Capabilities

9.1.1 Fault, configuration and performance management

The MTNP layer network provides the capabilities to:

- configure the interconnection of reference points e.g., FPs, FwEPs;
- detect faults and initiate recovery actions where applicable;
- support single-ended maintenance;
- detect and report misconnections;
- detect performance degradation and verify quality of service.

The MTNS layer network provides the capabilities to:

- interconnect the FwEP reference points;
- detect faults;
- support single-ended maintenance;
- detect and report misconnections.

9.1.2 Client/server interaction

The server detects and indicates to the client layer when a digital stream or optical signal is not present.

To avoid unnecessary, inefficient or conflicting survivability actions, escalation strategies (e.g., introduction of hold-off times and alarm suppression methods) may be required:

- within a layer;
- between a server and client layer.

9.1.3 Adaptation management

Adaptation management refers to the set of processes for managing the adaptation of a client layer network to/from the server layer network.

9.1.4 Connection supervision

9.1.4.1 Continuity supervision

Continuity supervision refers to the set of processes for monitoring the continuity of a transport entity (e.g., trail).

In general, a continuity fault in a server is indicated to a client through server signal fail (SSF) indication.

9.1.4.2 Connectivity supervision

Connectivity supervision refers to the set of processes for monitoring the integrity of the routing of a connection between the source and sink trail terminations.

Connectivity supervision is necessary to confirm proper routing of a connection between trail termination source and sink during the connection set-up process. Furthermore, connectivity supervision is needed to ensure that connectivity is maintained while the connection is active.

Trail trace identifier (TTI) is necessary to ensure that the signal received by a trail termination sink originates from the intended trail termination source:

- TTI is provided by the trail transport entity for the MTNS layer to ensure proper MTNS layer connections.
- TTI is provided by the trail transport entity for the MTNP layer to ensure proper MTNP layer connections.

9.1.4.3 Maintenance information

Maintenance information refers to the set of processes for indicating defects in a connection, which is part of a trail. The defect indications are given in the downstream and upstream directions of a bidirectional trail.

The capabilities are described in [ITU-T G.8312].

NOTE – Further details will be provided in the MTN equipment Recommendation.

Two maintenance information processes are identified for the digital layers:

- alarm indication signal (AIS);
- open connection indication (OCI).

These processes enable defect localization and single-ended maintenance.

9.1.5 Connection quality supervision

Connection quality supervision refers to the set of processes for monitoring the performance of a connection. Generic processes include parameter measurement, collection, filtering and processing. Connection quality supervision is supported for the MTNP layer network. Delay measurement is also supported by the MTNP layer.

9.1.6 Management communications

Management communications are transported via an embedded communication channel as specified in [ITU-T G.7712]. The MTNS provides a management communications channel (MCC), the MTNP does not support management communications.

9.1.7 Frequency and time synchronization

The communication of time and frequency information using either precision time protocol (PTP) as defined in [b-ITU-T G.8265.1] or in [b-ITU-T G.8275.1] or synchronization status message (SSM) as defined in [b-ITU-T G.8264] may be supported by the MTNS (using the FlexE synchronization messaging channel).

9.2 Connection supervision techniques

Connection supervision is the process of monitoring the integrity of a given connection in the digital layers of the MTN. The integrity may be verified by means of detecting and reporting connectivity and transmission performance defects for a given connection. Only inherent monitoring defined in [ITU-T G.805] is supported.

9.3 Connection supervision applications

9.3.1 Unused connections

In order to detect the inadvertent opening of a MTNP subnetwork connection a distinct replacement signal (open connection indication (OCI)) is used.

9.3.2 Connection monitoring

Only the MTNP and MTNS trail transport entities are monitored.

10 Survivability techniques

It is expected that survivability techniques will only be used in the MTN for the trail transport entity in the MTNP layer network. It is only envisioned that 1+1 linear path protection as described in [ITU-T G.808.1] will be used. The MTNP overhead is used to detect faults or performance degradations (see clause 9) and these events may be used to trigger the replacement of the failed transport entity with a protection transport entity. Details of the mechanism are out of the scope of this Recommendation.

Annex A

Relationship of MTN to other technologies

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

Figure A.1 shows the relationship between the MTN layer networks, Ethernet as defined in [IEEE 802.3] and FlexE as defined in [OIF FLEXE IA].

The MTN path to Ethernet client adaptation is defined by reference to [IEEE 802.3]. The AI at the MTNP_AP consists of a sequence of [IEEE 802.3] clause 82-compliant 64B/66B blocks. The adaptation of the MTN section to media is described by [IEEE 802.3]. The CI at the MTNS FwEP consists of a stream of [IEEE 802.3] clause 82-compliant 64B/66B blocks. The use of [IEEE 802.3] clause 82-compliant 64B/66B blocks allows the MTN section layer to be carried over Ethernet PHYs that use [IEEE 802.3] clause 82 PCS. Figure A.1 shows the relationship of MTN to [IEEE 802.3] and [OIF FLEXE IA] for the case where the Ethernet signal is carried by a single OTSi (see Figure 8-1) and bonding (described in clause 8.2.2) is not used.

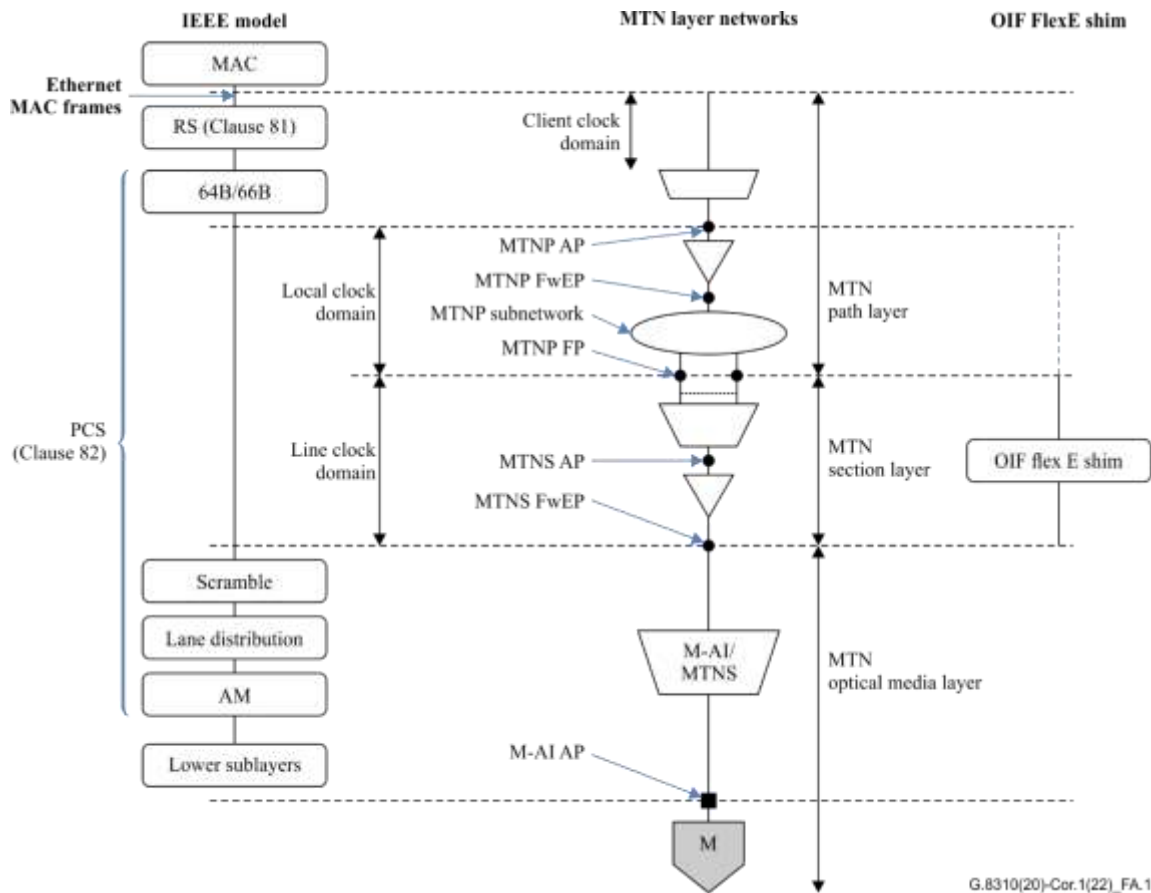


Figure A.1 – Relationship of MTN to [IEEE 802.3] Ethernet and [OIF FLEXE IA] FlexE

Annex B

Architecture of the fgMTNP layer network

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

B.1 Fine grain MTN path layer network

Fine grain MTN (fgMTN) is a non-recursive digital layer network whose rates and formats are defined in [ITU-T G.8312]. The fine grain MTN path layer network provides the capability to multiplex and maintain digital clients of MTN. The only server layer defined for the fgMTNP is the entire 5 Gbit/s MTNP. When the MTNP carries fgMTN path clients, the entire 5 Gbit/s MTNP is dedicated to fgMTN.

The client/server associations of the fgMTNP digital layer are shown in Figure B.1.

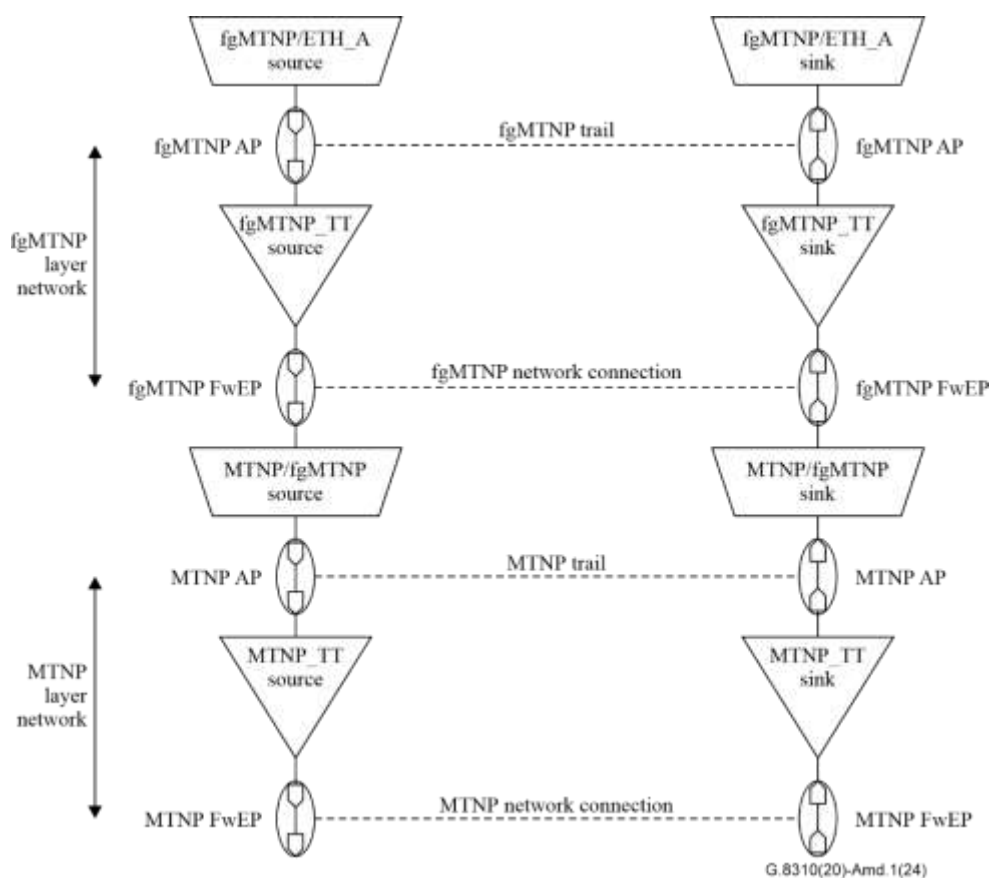


Figure B.1 – Client/server layer associations of the fgMTNP digital layer network

The fgMTNP layer network provides an fgMTNP trail transport entity to support the transport of Ethernet MAC frames across the fgMTNP. The fgMTNP trail could be supported by one MTNP trail as shown in Figure B.1. The MTNP trail is described in clause 7.1. The fgMTNP trail transport entity supports only bidirectional, symmetrical, point to point connectivity. The description of the supported clients is outside the scope of this Recommendation.

The fgMTNP trail transport entity provides channel forwarding, as described in clause 6.3.1 of [ITU-T G.800], for the client Ethernet MAC frames.

The fgMTNP layer network provides configurable connectivity between path forwarding end points (FwEPs), or between a path FwEP and a path FP or between path FPs.

The fgMTNP layer network is non-recursive i.e., an fgMTNP layer cannot be a client of another fgMTNP layer network. The only server layer for the fgMTNP layer is the MTNP layer described in clause 7.1. Ethernet MAC frames are a defined fgMTN client but are first encoded or transcoded into sequences of 64B/66B blocks compliant with clause 82 of [IEEE 802.3].

The CI of an fgMTNP layer network is a sequence of 64B/66B blocks encoded as defined in Annex A of [ITU-T G.8312] and is composed of:

- fgMTNP payload.
- fgMTNP overhead.

Details of the format of the fgMTNP CI are provided in [ITU-T G.8312].

To provide end-to-end networking, the following capabilities are included in the fgMTNP layer network:

- fgMTNP connection rearrangement for flexible network routing;
- fgMTNP overhead processes to verify the integrity of the client adapted information (AI);
- fgMTNP operations, administration and maintenance functions, including network survivability.

The fgMTNP layer network, shown in Figure B.2, contains the transport processing functions, transport entities, and topological components described in clauses B.1.1, B.1.2 and B.1.3 respectively. The interlayer adaptation functions are described in clause B.2.

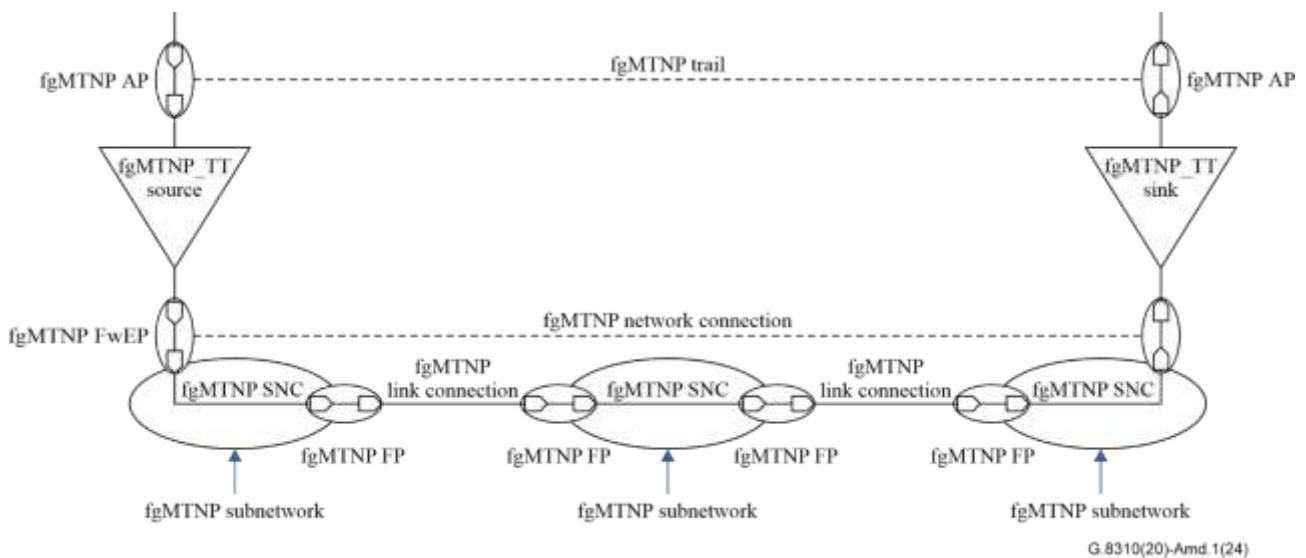


Figure B.2 – fgMTNP layer network

As described in [ITU-T G.800], the fgMTNP subnetwork may represent the aggregation of contained subnetworks and links or, it may represent the limit of subnetwork recursion which is a matrix.

An fgMTNP subnetwork may provide a subnetwork connection directly between fgMTNP FwEPs without adaptation to an MTNP layer. This is illustrated in Figure B.3.

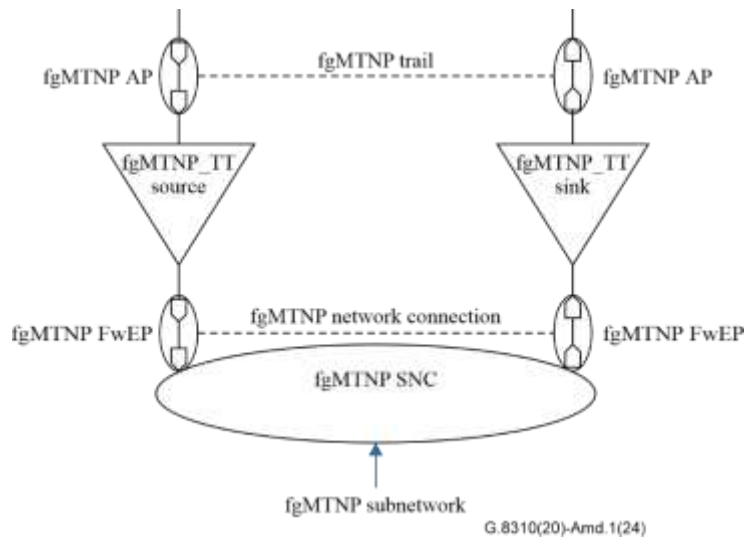


Figure B.3 – fgMTNP subnetwork example

B.1.1 fgMTNP trail termination

The following generic processes are assigned to the fgMTNP trail termination:

- validation of connectivity integrity;
- assessment of transmission quality;
- transmission defect detection and indication.

The requirements for these processes are outlined in clause B.3.

There are three types of fgMTNP trail termination:

- fgMTNP bidirectional trail termination: consists of a pair of collocated fgMTNP trail termination source and sink functions;
- fgMTNP trail termination source: accepts AI from a client layer network at its input, generates and inserts the fgMTNP trail overhead as a separate and distinct logical data stream and presents the CI of the fgMTNP layer network at its output;
- fgMTNP trail termination sink: accepts the CI of the fgMTNP layer network at its input, extracts and processes the separate and distinct logical data stream containing the fgMTNP trail overhead and presents the AI at its output.

B.1.2 fgMTNP transport entities

Network connections, subnetwork connections, link connections and trails are as described in [ITU-T G.800]. Tandem connections are not supported.

B.1.3 fgMTNP topology components

Layer network, subnetworks, links and access groups are as described in [ITU-T G.800].

The fgMTNP subnetwork provides configurable subnetwork connections between an input forwarding point (FP) or forwarding end point (FwEP) and an output FP or FwEP.

B.2 Client/server associations

B.2.1 fgMTNP/Ethernet MAC frame (ETH) adaptation

The bidirectional fgMTNP/ETH adaptation function is performed by a collocated pair of source and sink fgMTNP/ETH adaptation functions.

The fgMTNP/ETH adaptation source performs the following processes between its input and its output:

- all the processing required to encode the client MAC frame into a contiguous sequence of 64B/66B blocks as defined in clauses 81 and 82 of [IEEE 802.3];
- generation of management/maintenance signals as described in clause B.3.

The fgMTNP/ETH adaptation sink performs the following processes between its input and its output:

- recovery of the client MAC frames from the contiguous sequence of 64B/66B blocks as defined in clauses 81 and 82 of [IEEE 802.3];
- termination of management/maintenance signals as described in clause B.3.

B.2.2 MTNP/fgMTNP adaptation

The bidirectional MTNP/fgMTNP adaptation function is performed by a collocated pair of source and sink MTNP/fgMTNP adaptation functions.

The MTNP/fgMTNP adaptation source performs the following processes between its input and its output:

- all the processing required to map the fgMTNP CI into fine grain calendar slots (fgCSs) of the fine grain multiplex unit (fgMU); The fgMU is a 992 64B/66B block that conforms to the IEEE 802.3 clause 82 encoding rules.
- generation of management/maintenance signals as described in clause B.3.

The MTNP/fgMTNP adaptation sink performs the following processes between its input and its output:

- recovery of the fgMTNP CI from the fgCS of the fgMU;
- termination of management/maintenance signals as described in clause B.3.

B.3 Management capabilities

The fgMTNP layer network follows the MTNP layer network management capabilities defined in clause 9.

Bibliography

- [b-ITU-T G.8264] Recommendation ITU-T G.8264/Y.1364 (2017), *Distribution of timing information through packet networks*.
- [b-ITU-T G.8265.1] Recommendation ITU-T G.8265.1/Y.1365.1 (~~2014~~[2022](#)), *Precision time protocol telecom profile for frequency synchronization*.
- [b-ITU-T G.8275.1] Recommendation ITU-T G.8275.1/Y.1369.1 (~~2020~~[2022](#)), *Precision time protocol telecom profile for phase/time synchronization with full timing support from the network*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems