International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.8012.1/Y.1308.1

(12/2012)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Packet over Transport aspects – Ethernet over Transport aspects

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Transport

Interfaces for the Ethernet transport network

Recommendation ITU-T G.8012.1/Y.1308.1

ITU-T

International Telecommunication Union

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
Quality and availability targets	G.8200–G.8299
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.8012.1/Y.1308.1

Interfaces for the Ethernet transport network

Summary

Recommendation ITU-T G.8012.1/Y.1308.1 defines the interfaces of the Ethernet transport network to be used within and between subnetworks of the Ethernet network, in terms of Ethernet transport hierarchy, formats for mapping and multiplexing client signals into Ethernet connections and formats for multiplexing Ethernet connection signals into Ethernet or non-Ethernet connection signals. These interfaces support the transport of Ethernet services, so-called Ethernet virtual connection (EVC) services, as defined in Recommendation ITU-T G.8011. The Ethernet connections support E-Line, E-Tree and E-LAN Ethernet services as defined in Recommendation ITU-T G.8011/Y.1307.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.8012.1/Y.1308.1	2012-12-22	15

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 not received notice of intellectual property, protected by patents, 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 TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Page

1 Scope ... 1
2 References ... 1
3 Definitions ... 3
 3.1 Terms defined elsewhere ... 3
 3.2 Terms defined in this Recommendation ... 3
4 Abbreviations and acronyms ... 4
5 Conventions ... 5
6 Ethernet transport network interface structure ... 5
 6.1 Basic signal structure ... 5
 6.2 Information structure for the Ethernet and Ethernet over Transport interfaces ... 8
7 Multiplexing/aggregation principles ... 11
8 Ethernet transport module ... 11
9 Physical media of the Ethernet and Ethernet over Transport NNI and UNI ... 11
 9.1 802.3 Ethernet LAN ... 11
 9.2 Synchronous Ethernet LAN ... 11
 9.3 OTN ... 11
10 Ethernet connection (EC) ... 11
 10.1 EC traffic unit structure ... 11
 10.2 EC types and identifiers ... 12
 10.3 EC tag formats ... 14
 10.4 EC reserved addresses ... 15
11 Ethernet switched path (ESP) ... 15
 11.1 ESP traffic unit structure ... 15
 11.2 ESP types and identifiers ... 15
 11.3 ESP header format ... 16
13 Ethernet OAM ... 16
14 Ethernet maintenance signals ... 18
15 Mapping of client signals ... 19
 15.1 EC on UNI to S-EC client/server ... 22
 15.2 EC on UNI to BS-EC client/server ... 29
16 Multiplexing/aggregation of Ethernet connection signals ... 33
 16.1 Ethernet virtual channel to virtual channel ... 33
 16.2 Ethernet virtual channel to virtual path ... 35
 16.3 Ethernet virtual channel to virtual section ... 40
 16.4 Ethernet virtual path to virtual section ... 42
 16.5 Ethernet switched path to virtual section ... 44

Page

16.6 Ethernet virtual section to physical medium ... 46

Annex A – EVC ↔ EC peering and EVC ⇔ EC client/server relationships ... 49

Appendix I – P2P, RMP, MP2MP, hairpin Ethernet connection identifiers ... 51

I.1 RMP Ethernet connection identifiers ... 52

I.2 MP2MP Ethernet connection identifiers ... 60

Appendix II – Relationship between ITU-T G.8012.1 Ethernet connection types and MEF Ethernet connection types... 65

II.1 Introduction ... 65

II.2 MEF EC and ITU-T G.8012.1 EC relationship examples... 65

Appendix III – Relationship between EVC packet format and traffic units on Ethernet UNI ... 79

III.1 Relationship between untagged C-EC traffic unit and EVC packet on Ethernet UNI ... 79

III.2 Relationship between (Priority) C-Tagged C-EC traffic unit and EVC packet on Ethernet UNI ... 79

III.3 Relationship between S-Tagged S-EC traffic unit and EVC packet on Ethernet UNI ... 80

III.4 Relationship between I-Tagged BS-EC traffic unit and EVC packet on Ethernet UNI ... 81

III.5 Relationship between Non-S-Tagged Link EC traffic unit and EVC packet on Ethernet UNI ... 82

III.6 Relationship between Priority-S-Tagged Link EC traffic unit and EVC packet on Ethernet UNI ... 83

III.7 Relationship between Link EC traffic unit and EVC packet on Ethernet UNI ... 84

Appendix IV – Ethernet connection (EC) over SDH VC-n... 86

IV.1 S-EC to SDH VC... 86

IV.2 B-EC to SDH VC ... 86

IV.3 L-EC to SDH VC... 87

IV.4 Ethernet OAM support in EC over SDH VC ... 88

Bibliography... 89

Recommendation ITU-T G.8012.1/Y.1308.1

Interfaces for the Ethernet transport network

1 Scope

This Recommendation defines the interfaces of the Ethernet transport network to be used within and between subnetworks of the Ethernet network, in terms of Ethernet transport hierarchy, formats for mapping and multiplexing client signals into Ethernet connections and formats for multiplexing Ethernet connection signals into Ethernet or non-Ethernet connection signals. These interfaces support the transport of Ethernet services, so-called Ethernet virtual connection (EVC) services, as defined in [ITU-T G.8011]. The Ethernet connections support e-Line, E-Tree and E-LAN Ethernet services as defined in [ITU-T G.8011].

This Recommendation specifies the interworking aspects between EVC service signals on an Ethernet user-to-network interface (UNI) and Ethernet connection signals on an Ethernet network-to-network interface (NNI).

This Recommendation does not specify the Ethernet component and/or equipment models to meet the Ethernet NNI. Those components and models are defined in [ITU-T G.8021] and [ITU-T G.8021.1].

The interfaces defined in this Recommendation can be applied at NNIs and UNIs of the Ethernet transport network. The Ethernet UNI is formed by an Ethernet interface and the Ethernet NNI by an Ethernet interface or an Ethernet over Transport interface. The Ethernet over Transport NNI uses various server layer networks like optical transport hierarchy (OTH) and SDH. [ITU-T G.8012] describes the mapping of ETH_CI into those server layers mainly for Ethernet private line applications. This Recommendation describes the mapping of S-EC, B-EC, BS-EC, L-EC and ESP signals into those server layers for an Ethernet transport network application which deploys a mix of ETY and OTH server layers. It is recognized, for Ethernet over Transport interfaces used within Ethernet subnetworks, that aspects of the interface are transport technology dependent. The transport technology dependent aspects are defined in the transport technology specific Recommendations, e.g., [ITU-T G.709] and [ITU-T G.707].

The operations, administration and maintenance (OAM) functionality necessary for operations and management of Ethernet subnetworks is described in [ITU-T G.8013]. The detailed requirements are specified in a number of ITU-T Recommendations, IEEE Standards and MEF Technical Specifications, which are referred to. This Recommendation provides a description of the applicability of Ethernet OAM to the different types of Ethernet connections. Note that [ITU-T G.8012] was developed prior to [ITU-T G.8013] and did not discuss Ethernet OAM.

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.707] Recommendation ITU-T G.707/Y.1322 (2007), *Network node interface for the synchronous digital hierarchy (SDH).*

[ITU-T G.709] Recommendation ITU-T G.709/Y.1331 (2012), *Interfaces for the Optical Transport Network (OTN).*

[ITU-T G.800] Recommendation ITU-T G.800 (2012), *Unified functional architecture of transport networks*.

[ITU-T G.841] Recommendation ITU-T G.841 (1998), *Types and characteristics of SDH network protection architectures*.

[ITU-T G.842] Recommendation ITU-T G.842 (1997), *Interworking of SDH network protection architectures*.

[ITU-T G.873.1] Recommendation ITU-T G.873.1 (2011), *Optical Transport Network (OTN): Linear protection*.

[ITU-T G.873.2] Recommendation ITU-T G.873.2 (2012), *ODUk Shared Ring Protection*.

[ITU-T G.7041] Recommendation ITU-T G.7041/Y.1303 (2011), *Generic framing procedure*.

[ITU-T G.8001] Recommendation ITU-T G.8001/Y.1354 (2012), *Terms and definitions for Ethernet frames over transport.*

[ITU-T G.8010] Recommendation ITU-T G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*.

[ITU-T G.8011] Recommendation ITU-T G.8011/Y.1307 (2012), *Ethernet service characteristics*.

[ITU-T G.8012] Recommendation ITU-T G.8012/Y.1308 (2004), *Ethernet UNI and Ethernet NNI*.

[ITU-T G.8013] Recommendation ITU-T G.8013/Y.1731 (2011), *OAM functions and mechanisms for Ethernet based networks*.

[ITU-T G.8021] Recommendation ITU-T G.8021/Y.1341 (2012), *Characteristics of Ethernet transport network equipment functional blocks*.

[ITU-T G.8021.1] Recommendation ITU-T G.8021.1/Y.1341.1 (2012), *Types and characteristics of Ethernet transport network equipment*.

[ITU-T G.8031] Recommendation ITU-T G.8031/Y.1342 (2011), *Ethernet Linear Protection Switching*.

[ITU-T G.8032] Recommendation ITU-T G.8032/Y.1344 (2012), *Ethernet ring protection switching*.

[ITU-T G.8262] Recommendation ITU-T G.8262/Y.1362 (2010), *Timing characteristics of a synchronous Ethernet equipment slave clock*.

[ITU-T G.8264] Recommendation ITU-T G.8264/Y.1364 (2008), *Distribution of timing information through packet networks*.

[IEEE 802.1AX] IEEE Std 802.1AX-2008 (November 2008), *IEEE Standard for Local and metropolitan area networks – Link Aggregation*.

[IEEE 802.1Q] IEEE Std 802.1Q-2011 (August 2011), *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges and Virtual Bridge Local Area Networks*.

[IEEE 802.3] IEEE Std 802.3-2012 (August 2012), *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements Part 3: Carrier sense multiple access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*.

[MEF 13] Technical Specification MEF 13 (November 2005), *User Network Interface (UNI) Type 1 Implementation Agreement*.

[MEF 26.1] Technical Specification MEF 26.1 (January 2012), *External Network Network Interface (ENNI) – Phase 2*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 virtual channel [ITU-T G.800]

3.1.2 virtual path [ITU-T G.800]

3.1.3 virtual section [ITU-T G.800]

3.1.4 Ethernet connection [ITU-T G.8001]

3.1.5 Ethernet virtual connection [ITU-T G.8011]

3.1.6 Ethernet link [ITU-T G.8010]

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 backbone Ethernet connection: An Ethernet connection of which the traffic units are encapsulated with a backbone VLAN tag (B-Tag) when they are transported through an Ethernet link. Outside an Ethernet link the traffic units are without a backbone VLAN tag; the information transported in the backbone VLAN tag is presented as a set of parameters: priority, drop eligible and EC identifier. The link end performs the mapping of those parameters into the backbone VLAN tag and the demapping of these parameters from the backbone VLAN tag.

3.2.2 backbone service Ethernet connection: An Ethernet connection of which the traffic units are encapsulated with the first 48-bits of a backbone service instance tag (I-Tag) when they are transported through an Ethernet link. Outside an Ethernet link, when the traffic units are without a backbone service instance tag; the information transported in the backbone service instance tag is presented as a set of parameters: priority, drop eligible and EC identifier. The link end performs the mapping of those parameters into the backbone service instance tag and the demapping of these parameters from the backbone service instance tag.

3.2.3 customer Ethernet connection: An Ethernet connection of which the traffic units are encapsulated with a customer VLAN tag (C-Tag) when they are transported through an Ethernet link. Outside an Ethernet link the traffic units are without a customer VLAN tag; the information transported in the customer VLAN tag is presented as a set of parameters: priority, drop eligible and EC identifier. The link end performs the mapping of those parameters into the customer VLAN tag and the demapping of these parameters from the customer VLAN tag.

3.2.4 leaf group: A leaf group represents two or more leaf ports within a rooted-multipoint (RMP) Ethernet connection (EC) which can transmit to, and receive from, other leaves in the leaf group. Leaf ports within a leaf group cannot transmit to, or receive from, leaves outside the group.

3.2.5 link Ethernet connection: An Ethernet connection of which the traffic units are either not encapsulated or encapsulated with a priority tag.

3.2.6 service Ethernet connection: An Ethernet Connection of which the traffic units are encapsulated with a service VLAN tag (S-Tag) when they are transported through an Ethernet link. Outside an Ethernet link[1] the traffic units are without service VLAN tag; the information

[1] The term 'Ethernet link' refers to the ETH link topological component defined in [ITU-T G.8010].

transported in the service VLAN tag is presented as a set of parameters: priority, drop eligible and EC identifier. The link end performs the mapping of those parameters into the service VLAN tag and the demapping of these parameters from the service VLAN tag.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AIS Alarm Indication Signal

B-EC Backbone EC

BS-EC Backbone Service EC

BSI Backbone Service Instance

B-VLAN Backbone VLAN

CC Continuity Check

CCM Continuity Check Message

C-EC Customer EC

CEN Carrier Ethernet Network

CSF Client Signal Fail

DEI Drop Eligible Indicator

EC Ethernet Connection

ENNI Ethernet External Network Node Interface

EoT Ethernet over Transport

ESP Ethernet Switched Path

EVC Ethernet Virtual Connection

FF Flow Forwarding

LAN Local Area Network

LCK Locked Indication

L-EC Link EC

MAC Media Access Control

MEG Maintenance Entity Group

MEP Maintenance entity group End Point

MSDU MAC Service Data Unit

NCM Network Connection Monitoring

NNI Network-to-Network Interface

OAM Operations, Administration and Maintenance

OTH Optical Transport Hierarchy

OTN Optical Transport Network

PBB Provider Backbone Bridge

PCP Priority Code Point

PDU Protocol Data Unit

RDI	Remote Defect Indication
RMP	Rooted-Multipoint
SDH	Synchronous Digital Hierarchy
S-EC	Service EC
SVL	Shared VLAN Learning
S-VLAN	Service VLAN
TCI	Tag Control Information
TCM	Tandem Connection Monitoring
TESI	Traffic Engineered Service Instance
TPID	Tag Protocol Identifier
UNI	User-to-Network Interface
VC	Virtual Channel
VID	VLAN Identifier
VLAN	Virtual LAN
VP	Virtual Path
VS	Virtual Section

5 Conventions

None.

6 Ethernet transport network interface structure

6.1 Basic signal structure

The basic structure is shown in Figure 6-1.

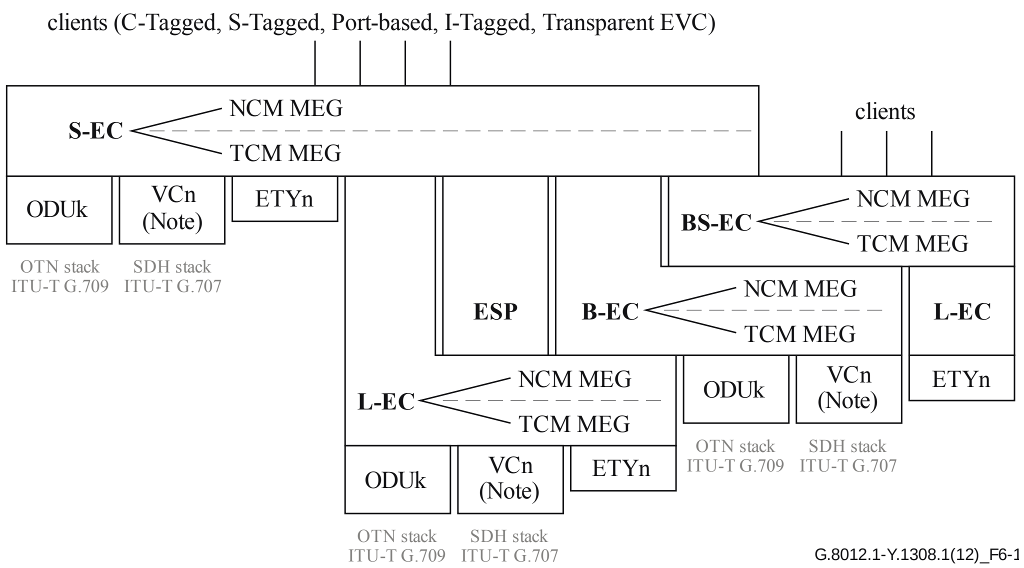


Figure 6-1 – Structure of the Ethernet network node interfaces

6.1.1 Ethernet substructure

The Ethernet layer as defined in [ITU-T G.8010] is further structured in (sub)layer networks in order to support the network management and supervision functionalities defined in [ITU-T G.8010] and [ITU-T G.8013]:

– The Ethernet connection (EC) which provides:
  - P2P, RMP and MP2MP network connections between aggregation points;
  - network connection monitoring (MEG level 7);
  - tandem connection monitoring (MEG levels 0 to 6);
  - adaptation of client signals via the Ethernet connection MAC service data unit (MSDU);
  - aggregation of Ethernet connection signals and Ethernet switched path signals via the MAC service data unit (MSDU).

– The Ethernet switched path (ESP), which provides: network connections between aggregation points.
  - P2P and P2MP network connections between aggregation points;
  - network connection monitoring (MEG level 7);
  - aggregation of Ethernet connection signals via the MAC service data unit (MSDU).

6.1.2 Ethernet NNI signal structure

The Ethernet NNI signal consists of the following layers:

- Ethernet physical layer (ETYn);
- Optionally an Ethernet virtual section (L-EC):
- Optionally, one or more Ethernet virtual paths (B-EC, ESP);
- Optionally, a second Ethernet virtual channel (BS-EC).
- Ethernet virtual channel (S-EC).

An Ethernet NNI may be protected by means of link aggregation between two nodes as specified in [IEEE 802.1AX].

NOTE 1 – Support for a distributed resilient version of link aggregation is under study in IEEE 802.1.

EC connections over an Ethernet NNI may be protected by means of Ethernet linear protection switching as specified in [ITU-T G.8031] or Ethernet ring protection as specified in [ITU-T G.8032]

NOTE 2 – Support for a distributed version of EC linear or ring protection between two pairs of two nodes is under study.

6.1.3 Ethernet over Transport NNI signal structure

The Ethernet over Transport signal consists of the following layers:

- Optical transport network (OTN) or synchronous digital hierarchy (SDH) stack with at the top an ODUk or VC-n;
- Optionally, an Ethernet virtual section (L-EC):
- Optionally, one or more Ethernet virtual paths (B-EC);
- Optionally, a second Ethernet virtual channel (BS-EC).
- Ethernet virtual channel (S-EC).

An Ethernet over Transport NNI may be protected by means of ODUk or VC-n linear protection switching as specified in [ITU-T G.873.1] and [ITU-T G.841] respectively, or ODUk or VC-n ring protection as specified in [ITU-T G.873.2] and [ITU-T G.841] respectively. Support for a distributed version of VC-n linear or ring protection between two pairs of two nodes is specified in [ITU-T G.842].

NOTE 1 – Support for a distributed version of ODUk linear or ring protection between two pairs of two nodes is under study.

EC connections over an Ethernet over Transport NNI may be protected by means of Ethernet linear protection switching as specified in [ITU-T G.8031] or Ethernet ting protection as specified in [ITU-T G.8032].

NOTE 2 – Support for a distributed version of EC linear or ring protection between two pairs of two nodes is under study.

6.1.4 Ethernet UNI signal structure

The Ethernet UNI signal consists of the following layers:

- ETYn;
- Optionally, an L-EC layer;
- Optionally, an S-EC or B-EC layer;
- A C-EC or BS-EC layer.

The structure of the Ethernet user-to-network interfaces (UNIs) is shown in Figure 6-2.

Each of those EC types may perform the role of the EVC. The EVC packet formats are described in Appendix III. The following EVC types are supported in this Recommendation:

- **C-EC type EVC**, consisting of an individual C-EC or bundle of C-ECs with or without L2CP_1;
- **S-EC type EVC**, consisting of an individual S-EC or bundle of S-ECs with or without L2CP_2;
- **L-EC type EVC**, consisting of an individual L-EC with or without L2CP_2 (port-based service) or L2CP_3 (transparent service);
- **BS-EC type EVC**, consisting of an individual BS-EC or bundle of BS-ECs;
- **B-EC type EVC**, consisting of an individual B-EC or bundle of B-ECs with or without L2CP_2.

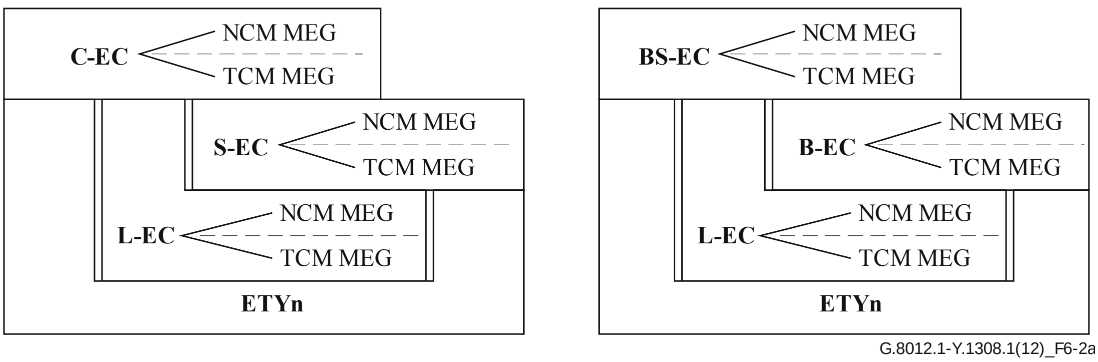
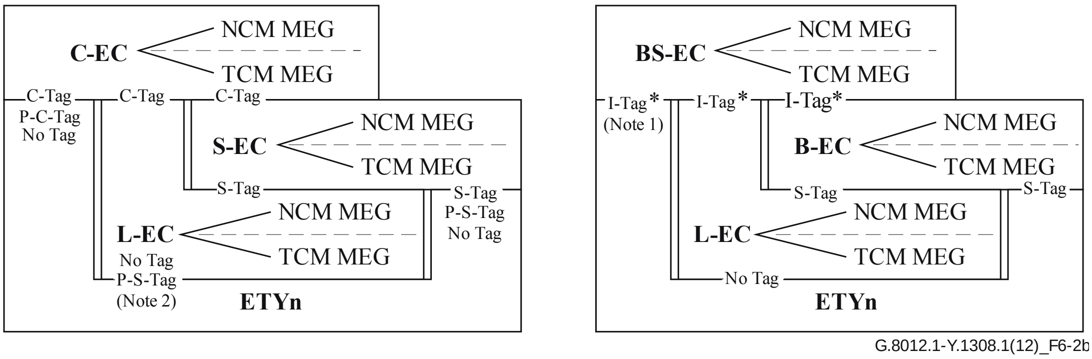


Figure 6-2a – Structure of the Ethernet user-to-network interfaces



NOTE 1 – The "I-TAG*" represents for modelling purposes either an 18-octet I-TAG, or the first 6-octets of the I-TAG for the case where the C-DA/C-SA fields are already present. The long or short 'I-TAG' form is determined by the value (89-10, ≠89-10) of the TYPE field of the client frame.

NOTE 2 – The "P-S-Tag" can only be inserted for the case of C-EC over L-EC over ETYn.

Figure 6-2b – Structure of the Ethernet user-to-network interfaces with additional tag insertion indications

An Ethernet UNI may be protected by means of link aggregation between two nodes as specified in [IEEE 802.1AX].

NOTE – Support for a distributed resilient version of link aggregation is under study in IEEE 802.1.

6.1.5 Ethernet external network node interface (ENNI) signal structure

The Ethernet ENNI signal consists of the following layers:

- Ethernet physical layer (ETYn);
- Optionally an Ethernet virtual section (L-EC):
- Ethernet virtual channel (S-EC).

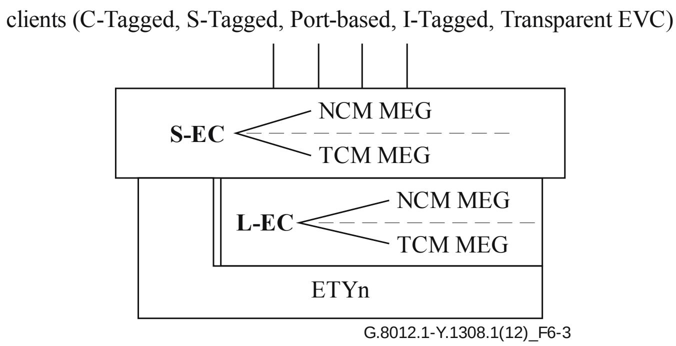


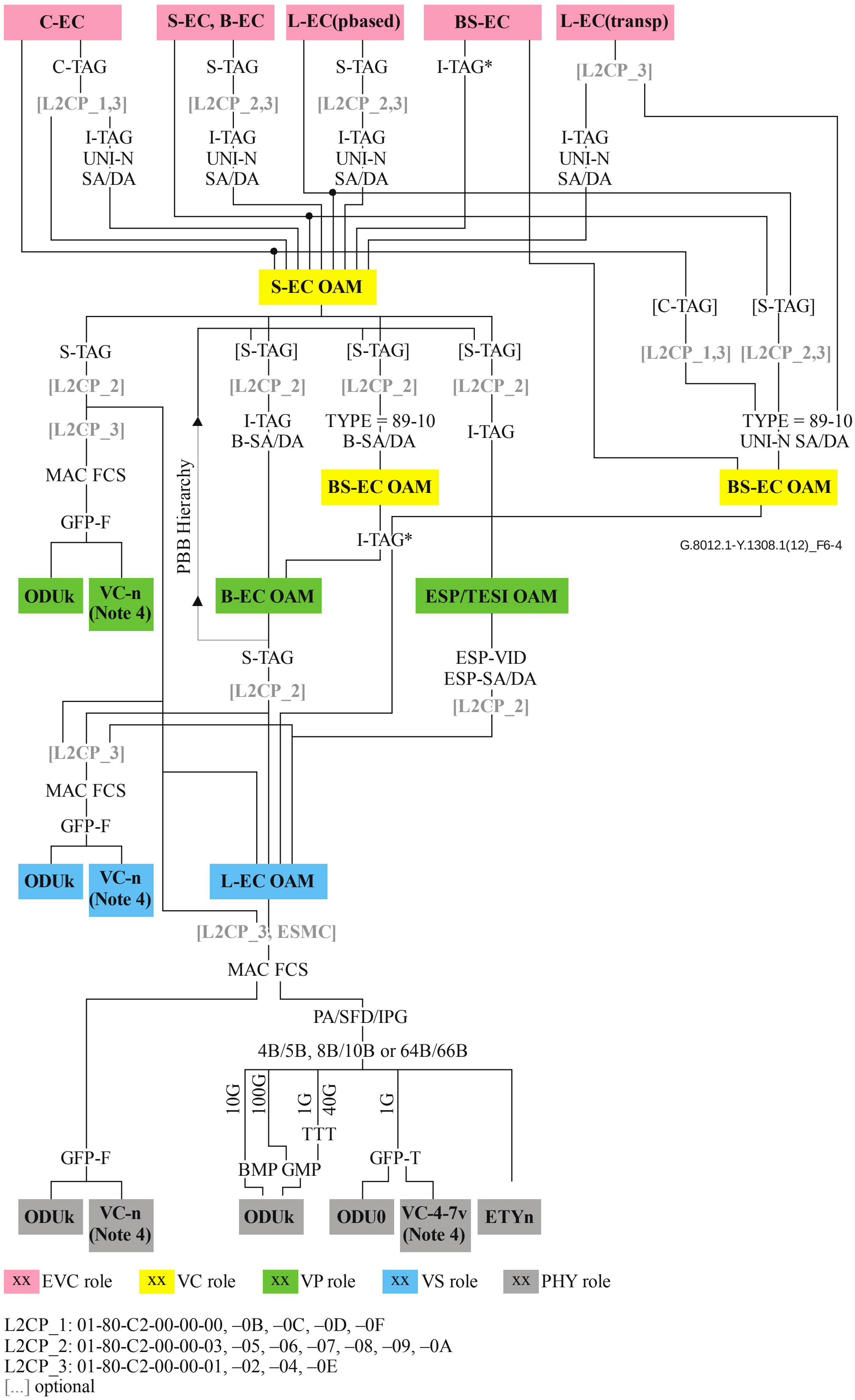
Figure 6-3 – Structure of the Ethernet external network node interfaces

An Ethernet ENNI may be protected by means of link aggregation between two nodes as specified in [IEEE 802.1AX].

NOTE – Support for a distributed resilient version of link aggregation is under study in IEEE 802.1.

6.2 Information structure for the Ethernet and Ethernet over Transport interfaces

The information structure for the Ethernet and Ethernet over Transport interfaces is represented by information containment relationships and flows. The principal information containment relationships are described in Figure 6-4.



NOTE 1 – The protocol identifiers (01-C2-80-00-00-0x) are specified in Tables 8-1, 8-2 and 8-3 of [IEEE 802.1Q].

NOTE 2 – The "I-TAG*" represents for modelling purposes either an 18-octet I-TAG, or the first 6-octets of the I-TAG for the case where the C-DA/C-SA fields are already present. The long or short 'I-TAG' form is determined by the value (89-10, ≠89-10) of the TYPE field of the client frame.

NOTE 3 – The figure above contains I-Tag insertion (including insertion of a new MAC header with source and destination addresses) at two locations and where the I-SID value may be fixed fill; the first location is in some of the EVC-to-S-EC mapping cases (at UNI-N ports), the second location is in the S-EC-to-B-EC, S-EC-to-ESP and BS-EC-to-B-EC mapping cases (at NNI ports) which may be recursive in hierarchal PBB networks.

NOTE 4 – SDH VC-n is listed to indicate interoperability with [ITU-T G.8012].

Figure 6-4 – Ethernet NNI information containment relationship

The Ethernet and Ethernet over Transport NNI information containment relationship described in Figure 6-4 illustrates how

– five types of EVC service interface signals can be mapped into two types of Ethernet Virtual Channel signals (S-EC, BS-EC),

– the S-EC signal can be mapped (and optionally multiplexed) into the BS-EC signal,

– the Ethernet VC signals can be mapped and multiplexed into Ethernet, OTN, SDH Virtual Path signals (B-EC, ESP/TESI, ODUk, VC-n),

– the Ethernet VP signals (B-EC, ESP/TESI) signals can be mapped and multiplexed into Ethernet, OTN, SDH virtual section signals (L-EC, ODUk, VC-n),

– the Ethernet VS signal (L-EC) can be mapped into Ethernet, OTN, SDH physical media signals (ETY, ODUk, VC-n).

Figure 6-4 illustrates at the top that four of the five EVC signals (C-EC, S-EC/B-EC, L-EC(pbased) and BS-EC signals) may peer with the Ethernet VC signals (S-EC, BS-EC) by not applying any encapsulation. The figure also illustrates that the five EVC signal types may have a client/server relationship with the virtual channel EC signals by encapsulating the EVC frames. Encapsulation may either deploy a Tag, a Type/SA/DA, a Tag and a Type/SA/DA, or a Tag and an I-Tag/SA/DA. C- and S-Tagged encapsulations may be complemented with Layer 2 Control Protocol (L2CP) messages when the service specification requires that the UNI-N port 'peers' with those L2 control protocols; otherwise (UNI-N port 'discards' those L2 control protocols) those L2CP messages are not present.

Figure 6-4 illustrates in the middle that the S-EC signal can be:

– S-Tagged and then mapped and multiplexed either into an L-EC signal, or via GFP-F into an ODUk or VC-n signal which perform the Ethernet VP role.

– S-Tagged (optional) and I-Tagged with the addition of B-SA/DA and then mapped and multiplexed into a B-EC signal. S-Tag is required for the case where the S-EC signal is identified by more than one S-VID value; e.g., for the case of an RMP EC with root(s), leaves and leaf groups.

– S-Tagged (optional) and Type encapsulated with the addition of B-SA/DA and then mapped and multiplexed into a BS-EC signal. An S-Tag is required for the case where the S-EC signal is identified by more than one S-VID value; e.g., for the case of RMP EC with root(s), leaves and leaf groups.

– S-Tagged (optional) and I-Tagged and then mapped and multiplexed into an Ethernet switched path/traffic engineered service instance ESP/TESI signal. The S-Tag is required for the case where the S-EC signal is identified by more than one S-VID value; e.g., for the case of RMP EC with root(s), leaves and leaf groups.

Figure 6-4 illustrates that the BS-EC signal can be I-Tagged and then mapped and multiplexed into either an Ethernet VP connection signal, or an Ethernet VS connection signal.

Figure 6-4 illustrates that the B-EC signal can be S-Tagged and then mapped and multiplexed into an L-EC signal, or via GFP-F into an ODUk or VC-n signal which perform the Ethernet VS role, or treated as an S-EC signal and mapped and multiplexed into either another B-EC, an BS-EC or an ESP/TESI creating a "PBB Hierarchy".

Figure 6-4 illustrates that the ESP/TESI signal can be ESP-Tagged with the addition of ESP-SA/DA and then mapped and multiplexed into an L-EC signal.

Figure 6-4 illustrates at the bottom that the L-EC signal can be mapped via GFP-F encapsulation into an ODUk or VC-n signal, via xB/yB encapsulation into an ETYn signal, or via xB/yB encapsulation and either BMP, GMP, TTT+GMP, or GFP-T into an ODUk or VC-n.

7 Multiplexing/aggregation principles

Multiplexing/aggregation of the client signals may occur at each interface between a client EC and server EC, between a client EC and server ESP, between a client ESP and server EC, and between a client EC and server ODUk or VCn.

8 Ethernet transport module

Definitions of Ethernet transport modules are for further study.

9 Physical media of the Ethernet and Ethernet over Transport NNI and UNI

9.1 802.3 Ethernet LAN

Refer to [IEEE 802.3]

9.2 Synchronous Ethernet LAN

Refer to [IEEE 802.3], [ITU-T G.8262] and [ITU-T G.8264].

9.3 OTN

Refer to [ITU-T G.709].

10 Ethernet connection (EC)

10.1 EC traffic unit structure

The EC traffic unit structure is shown in Figure 10-1. It contains the MAC frame as specified in clause 3 of [IEEE 802.3], without the PAD and Frame Check Sequence fields (EC D) accompanied by priority (EC P) and drop eligible (EC DE) information elements. The two main fields of the EC D part of the traffic unit are:

– MAC Destination Address and Source Address (DA/SA) fields in octets 1 to 12;

– MAC Service Data Unit (MSDU) field in octets 13 and beyond.

The MSDU field contains two fields:

– Type or TPID field in octet 13;

– MSDU Client Data field in octets 14 and beyond.

The MSDU Client Data field has a maximum length as specified in clause 3.2.7 of [IEEE 802.3].

The MSDU Client Data field can carry a tagged and/or encapsulated client EC frame, non-EC client information, an EC OAM PDU as specified in [ITU-T G.8013] or a control PDU as specified in [IEEE 802.1Q].

Each EC traffic unit is functionally associated with an access point or flow point which is implicitly associated with an EC Identifier (EC ID).

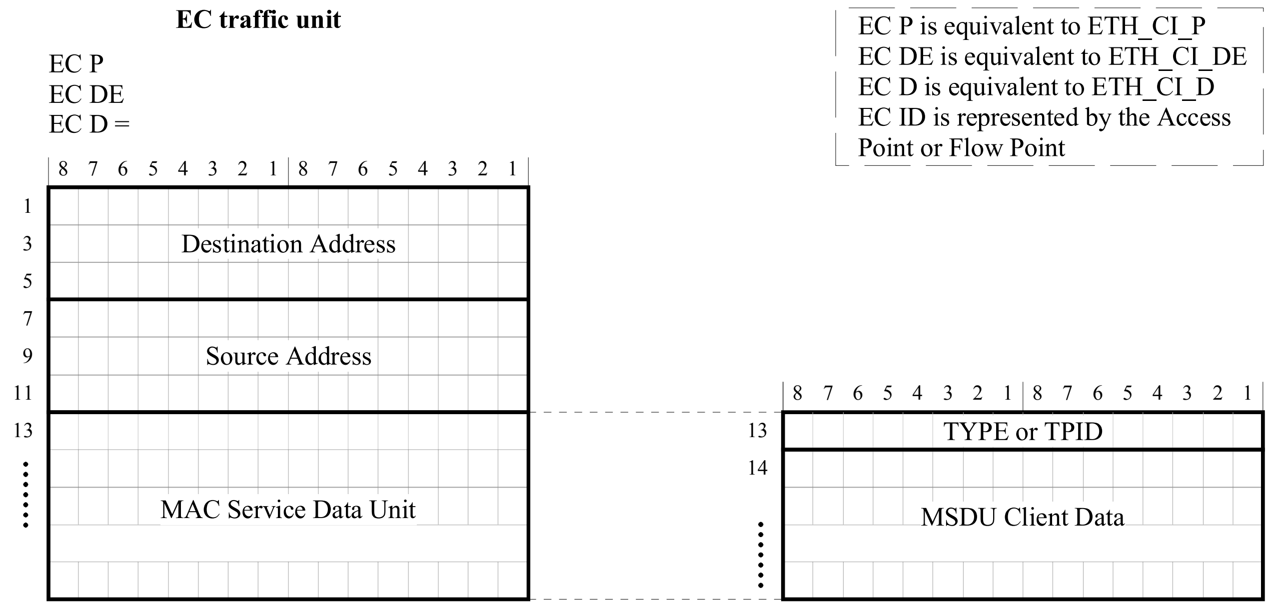


Figure 10-1 – EC traffic unit structure

10.2 EC types and identifiers

10.2.1 P2P EC

P2P Ethernet connections have two ports.

Connectivity between these ports is as follows:

– a port can transmit to, and receive from, the other port.

The connectivity pattern in P2P Ethernet connections is supported by means of deployment of a single EC-ID value and specific translations of this EC-ID value. When an explicit EC-ID is attached to EC traffic units in a P2P Ethernet connection transported over an Ethernet link, the EC-ID value will be the same in both directions of transport. Symmetric EC-ID translation is supported at UNI-N ports, ENNI ports and NNI ports at (e.g., access, metro, core, backbone) domain edges.

On a link, the EC-ID value is carried in the VID or I-SID fields of the tag. Within a network element the EC-ID value is represented by an internal identifier, referred to as "Relay VID" in [IEEE 802.1Q].

10.2.2 RMP EC

RMP Ethernet connections have three types of ports:

– one or more root ports (R1, R2, ...)
– one or more leaf ports (L1, L2, ...)
– optionally one or more leaf group port sets (LG11, LG12, ..., LG21, LG22, ...).

Connectivity between these ports is as follows:

– a root port can transmit to and receive from other root ports
– a root port can transmit to and receive from leaf ports
– a root port can transmit to and receive from leaf group ports
– a leaf port can transmit to and receive from root ports
– a leaf group port can transmit to and receive from root ports
– a leaf group port can transmit to and receive from other ports in its leaf group.

Note that there is no connectivity between leaf ports and there is no connectivity between ports in different leaf groups.

Four types of RMP Ethernet connections exist:

– single root RMP Ethernet connection
– multiple roots RMP Ethernet connection
– single root and one or more leaf groups, each containing a subset of leaf ports, RMP Ethernet connection
– multiple roots and one or more leaf groups, each containing a subset of leaf ports, RMP Ethernet connection.

The different connectivity patterns in RMP Ethernet connections are supported by means of deployment of multiple EC-ID values and specific translations of those EC-ID values. Examples of such EC-ID usage are presented in Appendix I. Those examples assume that interface ports support asymmetric EC-ID Translation, which is a capability referred to in [IEEE 802.1Q] and its amendments as "VID Translation" and "Egress VID Translation".

NOTE – Interworking with network elements not supporting VID Translation and/or Egress VID Translation is for further study.

On a link, the EC-ID value or values are carried in the VID or I-SID fields of the Tag. Within a network element the EC-ID value or values are represented by an internal identifier. VID values within a network element are referred to as "Relay VID" in [IEEE 802.1Q].

– A single-root RMP Ethernet connection has one EC-ID value per link and two EC-ID values internal in the network element. See clause I.2.1 for an example.
– A multiple-roots RMP Ethernet connection has two EC-ID values per link on links in the path between two root ports, one EC-ID value on links which are not in the path between two root ports and two EC-ID values internal in a network element. See clause I.2.2 for an example.
– A single-root and one or more leaf groups RMP Ethernet connections have one EC-ID value per link and two EC-ID values internal in the network element for the connectivity between the root and leaves. On the links which are in the path between the ports of a leaf group, an additional EC-ID value (per leaf group) is present, and within a network element one additional EC-ID value (per leaf group) is present. See clause I.2.3 for an example.
– A multiple-roots and one or more leaf groups RMP Ethernet connections have a two EC-ID values per link on links in the path between two root ports, one EC-ID value on links which are not in the path between two root ports and two EC-ID values internal in a network element for connectivity between root and leaf ports. On the links which are in the path between the ports of a leaf group, an additional EC-ID value (per leaf group) is present, and within a network element one additional EC-ID value (per leaf group) is present. See clause I.2.4 for an example.

10.2.3 MP2MP EC

Three types of MP2MP Ethernet connections exist:

– tree-structured MP2MP Ethernet connection
– full mesh MP2MP Ethernet connection
– hybrid MP2MP Ethernet connection.

10.2.3.1 Tree-structured

When an explicit EC-ID is attached to traffic units in a traditional tree-structured MP2MP Ethernet connection transported over an Ethernet link, the EC-ID value will be the same in both directions of transport. Symmetric EC-ID Translation is supported at UNI-N ports, ENNI ports and NNI ports at (e.g., access, metro, core, backbone) domain edges.

10.2.3.2 Full mesh

An MP2MP Ethernet connection (EC) may be supported by means of a full mesh of point-to-point Ethernet link connections between the network termination devices. This is commonly known as a VPLS configuration of such connection. The network termination devices support forwarding between two UNI-N ports, a UNI-N port and a NNI port, a NNI port and a UNI-N port, but not between two NNI ports, to prevent loops to occur in such MP2MP EC. This functionality is supported in Ethernet by means of associating the MP2MP EC with multiple EC-ID values.

On a link, the EC-ID value is carried in the VID or I-SID fields of the Tag. Within a network element the EC-ID value or values are represented by an internal identifier. VID values within a network element are referred to as "Relay VID" in [IEEE 802.1Q].

– A full mesh MP2MP Ethernet Connection has one EC-ID value per link and two EC-ID values internal in the network element. See clause I.3.2 for an example.

10.2.3.3 Hybrid

An MP2MP Ethernet connection (EC) may be supported by means of a hybrid configuration, which is partly tree-structured and partly full mesh. The full mesh parts are between, for example, metro or core domain edge devices which operate like the network termination devices in the full mesh case. This functionality is supported in those Ethernet domains by means of associating the MP2MP Ethernet sub network connection with multiple EC-ID values.

On a link, the EC-ID value is carried in the VID or I-SID fields of the Tag. Within a network element, the EC-ID value or values are represented by an internal identifier. VID values within a network element are referred to as "Relay VID" in [IEEE 802.1Q].

– A hybrid MP2MP Ethernet connection has one EC-ID value per link, one EC-ID value internal in a network element and one additional EC-ID value per full mesh Ethernet subnetwork connection end point. See clause I.3.3 for an example.

10.3 EC tag formats

EC traffic units may be VLAN-tagged and/or I-tagged when mapped into a server EC's MSDU Client Data field. [IEEE 802.1Q] specifies three Tag types, each consisting of a Tag Protocol Identifier (TPID) field and a Tag Control Information (TCI) field.

The TPID field contains an EtherType value that is used to identify the frame as a tagged frame and to identify the TCI field type.

The VLAN TCI field is a two octet field including priority code point (PCP), drop eligible indicator (DEI) and VLAN Identifier (VID) fields.

The I-Tag TCI field is a sixteen octet field including priority code point (PCP), drop eligible indicator (DEI), use customer address (UCA), Reserved 1 (Res1), Reserved 2 (Res2), backbone Service Instance Identifier (I-SID), Encapsulated Customer Destination Address and Encapsulated Customer Source Address fields.

Tagged EC frames are identified by the value in their VID or I-SID fields, referred to as EC-ID.

EC traffic units may be priority-tagged when mapped into a server layer signal, e.g., into an ETYn signal.

Refer to clauses 15 and 16 for specific EC tagging cases.

10.4 EC reserved addresses

To be added.

11 Ethernet switched path (ESP)

11.1 ESP traffic unit structure

The ESP traffic unit structure is shown in Figure 11-1. It contains the MAC frame as specified in clause 3 of [IEEE 802.3], without the Destination Address, Source Address, PAD and Frame Check Sequence fields (ESP D) accompanied by priority (ESP P) and drop eligible (ESP DE) information elements. The main field of the ESP traffic unit is:

– MAC Service Data Unit (MSDU) field in octets 13 and beyond.

NOTE – The Destination Address and Source Address fields of the MAC frame are a part of the ESP Identifier and as such not included in the ESP traffic unit definition.

The MSDU field contains two fields:

– Type or TPID field in octet 13;

– MSDU Client Data field in octets 14 and beyond.

The MSDU Client Data field has a maximum length as specified in clause 3.2.7 of [IEEE 802.3].

The MSDU Client Data field can carry a tagged and encapsulated client EC frame, an EC OAM PDU as specified in [ITU-T G.8013] or a control PDU as specified in [IEEE 802.1Q].

Each ESP traffic unit is functionally associated with an access point or flow point which is implicitly associated with an ESP Identifier (ESP ID).

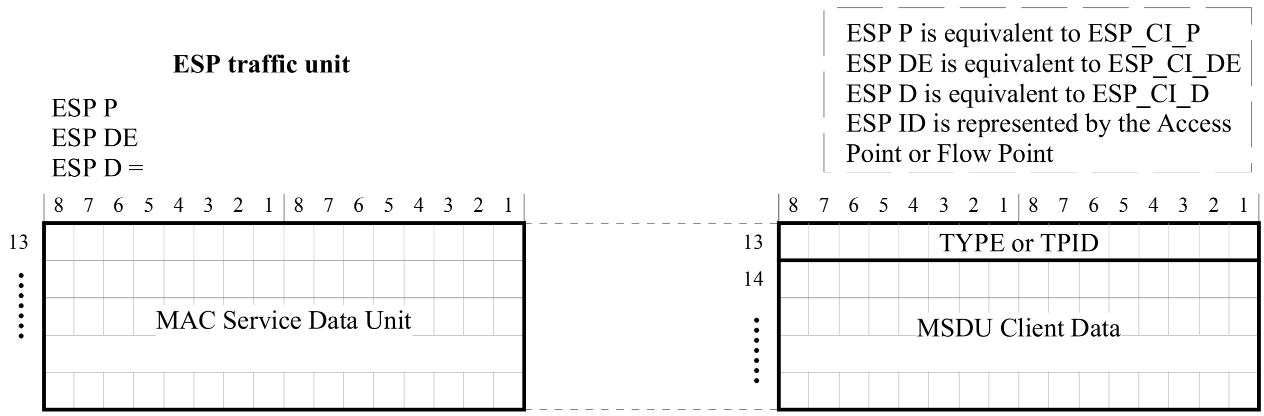


Figure 11-1 – ESP traffic unit structure

11.2 ESP types and identifiers

11.2.1 P2P ESP

P2P ESP Connections have two ports.

Connectivity between these ports is as follows:

– a port can transmit to and receive from the other port.

The connectivity pattern in P2P ESP Connections is supported by means of deployment of a two 3-tuple <ESP-DA, ESP-SA, ESP-VID> based ESP-ID values. When an explicit ESP-ID is attached to ESP traffic units in a P2P ESP Connection transported over an Ethernet link, the ESP-ID value will be different in both directions of transport; in direction X-to-Y the ESP-ID is <ESP-DA=Y, ESP-SA=X, ESP-VID=Vi> and in direction Y-to-X the ESP-ID is <ESP-DA=X, ESP-SA=Y, ESP-VID=Vj> in which Vi may be the same as Vj or Vi and Vj may be different. ESP-ID Translation is not supported. On a link, the ESP-ID value is carried in the DA and SA fields and the VID field of the VLAN Tag. Within a network element the ESP-ID value is represented by three internal identifiers, referred to as "destination_address", "source_address" and "Relay VID" in [IEEE 802.1Q].

11.2.2 P2MP ESP

P2MP ESP Connections have two types of ports:

– one root port (R),

– N-1 (N>1) leaf ports (L1, L2, ..).

Connectivity between these ports is as follows:

– a root port can transmit to and all leaf ports and receive from any leaf port,

– a leaf port can transmit to and receive from the root port.

Note that there is no connectivity between leaf ports.

The different connectivity patterns in P2MP ESP Connections are supported by means of deployment N 3-tuple <ESP-DA, ESP-SA, ESP-VID> based ESP-ID values. When an explicit ESP-ID is attached to ESP traffic units in a P2MP ESP Connection transported over an Ethernet link, the ESP-ID value will be different in both directions of transport and in each leaf to root direction of transport; in direction R-to-L1,L2,.. the ESP-ID is <ESP-DA=Group_Address (G), ESP-SA=R, ESP-VID=Vi> and in direction Li-to-R (i=1,2,3,..,N-1) the ESP-ID is <ESP-DA=R, ESP-SA=Li, ESP-VID=Vj> in which Vi may be the same as Vj or Vi and Vj may be different. ESP-ID Translation is not supported. On a link, the ESP-ID value is carried in the DA and SA fields and the VID field of the VLAN Tag. Within a network element the ESP-ID value is represented by three internal identifiers, referred to as "destination_address", "source_address" and "Relay VID" in [IEEE 802.1Q].

11.3 ESP header format

ESP traffic units are extended with ESP-DA and ESP-SA fields and a VLAN tag field – containing TPID and ESP-TCI fields – when mapped into an EC.

The TPID field contains the Backbone-VLAN Tag's EtherType value.

The ESP TCI field is a two octet field including ESP-PCP, ESP-DEI and ESP-VID fields.

The extended ESP traffic units are identified by the values in the ESP-DA, ESP-SA and ESP-VID fields.

Refer to clause 16 for specific ESP header format cases.

13 Ethernet OAM

Two types of Ethernet OAM exists; EC OAM and ESP OAM.

EC OAM information is added to the EC information payload to create an EC. It includes information for maintenance and operational functions to support Ethernet connections. The EC OAM consists of a portions dedicated to the end-to-end EC network connection MEG and up to seven levels of EC tandem connection (aka segment) MEGs. The EC network connection OAM is terminated where the EC is assembled and disassembled. The EC tandem connection OAM is added and terminated at the source and sink of the corresponding EC tandem connections (aka segments), respectively. The specific EC OAM PDU format and coding is defined in [ITU-T G.8013], [ITU-T G.8031], [ITU-T G.8032] and [IEEE 802.1Q] and is independent of the type of EC (C-EC, S-EC, BS-EC, B-EC, L-EC).

ESP OAM information is added to the ESP information payload to create an ESP. It includes information for maintenance and operational functions to support Ethernet switched path connections. The ESP OAM consists of portions dedicated to the end-to-end ESP network connection MEG and up to seven levels of ESP tandem connection (aka segment) MEGs. The ESP network connection OAM is terminated where the ESP is assembled and disassembled. The ESP tandem connection OAM is added and terminated at the source and sink of the corresponding ESP tandem connections (aka segments), respectively. The specific ESP OAM PDU format and coding is defined in [IEEE 802.1Q].

NOTE – [IEEE 802.1Q] specifies ESP tandem connection MEG end points to be located on Customer Backbone Ports only, directly adjacent to the ESP network connection MEG end points. ESP tandem connection MEG end points on intermediate Provider Network Ports are not supported because those ports are unable to recognize the ESP-ID <ESP-DA, ESP-SA, ESP-VID>, which identifies each individual ESP signal. MEG intermediate points are supported on Provider Network Ports.

A multiplicity of OAM functions as summarized in Table 13-1 may be supported in the Ethernet network's MEGs. These OAM functions can be classified along their main applications: pro-active connection monitoring, on-demand connection monitoring, protection switching communication and general purpose communication. The connection monitoring OAM can be further subdivided by the function type supported: status, performance, maintenance, fault localization and discovery.

Ethernet OAM is deployed in Ethernet transport networks either to offer a premium service, or to help maintain the network availability and to locate faults/degradations from the network operations centre preventing unnecessary visits to remote unmanned sites.

Table 13-1 – Ethernet OAM classes, types, functions and frames

Class	Type	Function	EC OAM frames	ESP OAM frames
Pro-active	Status	Continuity check and Connectivity verification	CCM.CC	CCM.CC (3)
	Performance	Interruption	CCM.CC, CCM.RDI	CCM.CC, CCM.RDI
		Frame loss	CCM.LM, LMM/R	(1)
		Synthetic frame loss	SLM/R, 1SL	(1)
		Frame delay	DMM/R, 1DM	(1)
		Frame delay variation	DMM/R, 1DM	(1)
	Maintenance	Alarm suppression	AIS	(1)
		Locked indication	LCK	(1)
		Remote defect indication	CCM.RDI	CCM.RDI
		Client signal fail	CSF	(1)

Table 13-1 – Ethernet OAM classes, types, functions and frames

Class	Type	Function	EC OAM frames	ESP OAM frames
On-demand	Status	Connectivity check	LBM/R	LBM/R
	Performance	Frame loss Synthetic frame loss Frame delay Frame delay variation Throughput	LMM/R SLM/R, 1SL DMM/R, 1DM DMM/R, 1DM TST, LBM/R	(1) (1) (1) (1) (1)
	Fault localization	Channel connectivity Flow connectivity	LBM/R LTM/R	LBM/R LTM/R
	Discovery	Flow connectivity	LTM/R	LTM/R
Protection	Communication channel	State machine synchronization	Linear APS, Ring APS	(1)(2)(3)
General purpose	Communication channel	Management communication channel	MCC	(1)
Experimental			EXM/R	(1)
Vendor specific			VSM/R	(1)

NOTE 1 – [ITU-T G.8013] does not specify ESP OAM, but most EC OAM PDUs can be used as ESP OAM PDUs. The exception is the LBM/LBR OAM PDU.

NOTE 2 – The protection communication channel for ESP is not defined although ESP supports linear protection (i.e., trail protection (referred to as TESI protection and specified in [IEEE 802.1Q]) and SNCG/T protection (referred to as Infrastructure Segment protection and specified in [IEEE 802.1Qbf]).

NOTE 3 – [IEEE 802.1Q] specifies an additional Traffic bit in the flag field of the ESP CCM OAM PDU, which is not specified in the EC CCM OAM PDU. This Traffic bit and the RDI bit are deployed as protection communication channel.

14 Ethernet maintenance signals

Ethernet maintenance signals for ECs are defined in [ITU-T G.8013] as:

- Alarm indication signal (AIS)
- Client signal fail (CSF)
- Locked indication (LCK)
- Remote defect indication (RDI).

The specific traffic unit for Ethernet maintenance signals is specified in [ITU-T G.8013] and it is independent of the type of EC.

Maintenance signal related processing is specified in [ITU-T G.8021].

Ethernet maintenance signals for ESPs are defined in [IEEE 802.1Q] as:

- Remote defect indication (RDI).

The specific traffic unit for ESP maintenance signals is specified in [IEEE 802.1Q].

Maintenance signal related processing is specified in [IEEE 802.1Q].

15 Mapping of client signals

This clause specifies the mapping of

– (UnTagged, Priority-C-Tagged, C-Tagged) Customer EC (C-EC)
– (Priority-S-Tagged, S-Tagged) Service EC (S-EC)
– (I-Tagged) Backbone Service EC (BS-EC) and
– Link EC (L-EC) Services

into Service Ethernet Connection (S-EC) signals and of

– (UnTagged, Priority-C-Tagged, C-Tagged) C-EC
– (Priority-S-Tagged, S-Tagged) S-EC
– (I-Tagged, non-S-Tagged) L-EC and
– L-EC Services

into Backbone Service Ethernet Connection (BS-EC) signals.

These EC services are supported via five Ethernet Service Interface types, which are specified in [IEEE 802.1Q] as:

– C-Tagged Service Interface
– S-Tagged Service Interface
– I-Tagged Service Interface
– Port-based Service Interface
– Transparent Service Interface.

Each service interface supports one or more EC services as illustrated in Table 15-1A with a transparency for Layer 2 Control Protocols (L2CP) as illustrated in Table 15-2A. For the case where the transparency for the L2CPs is 'pass', the frames are an element of the EC signal. For the case where the transparency for the L2CPs is 'peer', the frames represent EC control protocol PDUs and are processed by the higher layers in the service interface and these higher layers may generate new L2CP messages which have to be transported via the EC. For the case where the transparency for the L2CPs is 'discard', the frames are discarded as those frames are not part of the EC or its control protocols.

In an MEF context, only a subset of the above EC services is supported by an MEF UNI, as illustrated in Table 15-1B, and only a subset of EC types is supported by an MEF ENNI, as illustrated in Table 15-1C. The MEF transparency for L2CPs is shown in Table 15-2B.

Table 15-1A – [IEEE 802.1Q] Service interface support of EC services

	[IEEE 802.1Q]				
	C-Tagged Service Interface	**S-Tagged Service Interface**	**I-Tagged Service Interface**	**Port-based Service Interface**	**Transparent Service Interface**
UnTagged C-EC	√	–	–	√	√
Priority-C-Tagged C-EC	√	–	–	√	√
C-Tagged C-EC	√	–	–	–	(1)
Bundled C-Tagged C-EC	√	–	–	–	(1)
Priority-S-Tagged S-EC	–	–	–	√	√
S-Tagged S-EC	–	√	–	–	(1)

Table 15-1A – [IEEE 802.1Q] Service interface support of EC services

	[IEEE 802.1Q]				
	C-Tagged Service Interface	**S-Tagged Service Interface**	**I-Tagged Service Interface**	**Port-based Service Interface**	**Transparent Service Interface**
Bundled S-Tagged S-EC	–	√	–	–	(1)
I-Tagged BS-EC	–	–	√	–	(1)
Bundled I-Tagged BS-EC	–	–	√	–	(1)
Non-S-Tagged Link EC	–	–	–	√	√
Priority S-Tagged Link EC	–	–	–	√	√
Link EC	–	–	–	–	√
NOTE – Tagged EC and Bundled EC service types represent a subset of the EC signals on the UNI interface. A transparent service interface is non-selective.					

Table 15-1B – MEF UNI support of EC services

	[MEF 13]
	UNI
UnTagged C-EC	√
Priority-C-Tagged C-EC	√
C-Tagged C-EC	√
Bundled C-Tagged C-EC	√ (bundling) (all-to-one bundling)
Priority-S-Tagged S-EC	–
S-Tagged S-EC	–
Bundled S-Tagged S-EC	–
I-Tagged BS-EC	–
Bundled I-Tagged BS-EC	–
Non-S-Tagged Link EC	–
Priority S-Tagged Link EC	–
Link EC	–

Table 15-1C – NNI support of EC types

	[MEF 26.1]	ITU-T G.8012.1
	ENNI	INNI
S+C-Tagged C-EC	√	
S-Tagged S-EC	√	√
I+S-Tagged S-EC	–	√
B+I+S-Tagged S-EC	–	√
I-Tagged BS-EC	–	√
B+I-Tagged BS-EC	–	√
B-Tagged B-EC	–	√
Link EC	–	√
GFP-F+S-Tagged S-EC	–	√
GFP-F+B+I+S-Tagged S-EC	–	√

Table 15-2A – [IEEE 802.1Q] Service interface transparency for Layer 2 Control Protocols (L2CP)

Layer 2 Control Protocol address	C-Tagged Service Interface	S-Tagged Service Interface	I-Tagged Service Interface	Port-based Service Interface	Transparent Service Interface
Nearest Bridge group address set 01-80-C2-00-00-0x, x=1,2,4,E	Peer or discard	Peer or discard	Peer or discard	Peer or discard	Peer or discard
Nearest non-TPMR Bridge group address set 01-80-C2-00-00-0x, x=3,5,6,7,8,9,A	Peer or discard	Peer or discard	Peer or discard	Peer or discard	Pass
Nearest Customer Bridge group address set 01-80-C2-00-00-0x, x=0,B,C,D,F	Peer or discard	Pass	Peer or Discard	Pass	Pass
All Bridges (Deprecated) 01-80-C2-00-00-10	Should not be used. If however received, node may discard or pass like any other group address.				
MRP application addresses 01-80-C2-00-00-2x, x=0..F	Peer or pass as specified in clause 10.5, item b of [IEEE 802.1Q]				
MIRP Default Backbone Destination	Pass	Pass	Pass	Pass	Pass
Continuity Check Message Group Destination MAC Addresses 01-80-C2-00-00-3y, y=0..7	Determined by service type and service level agreement				
Linktrace Message Group Destination MAC Addresses 01-80-C2-00-00-3y, y=8..F	Determined by service type and service level agreement				

Table 15-2B – MEF transparency for Layer 2 Control Protocols (L2CP)

Layer 2 Control Protocol address	Refer to [ITU-T G.8011] series

These EC services on the UNI are supported via a peering or a client/server relationship between the EC on the UNI and the EC in the network. Refer to Annex A.

For the case of a peering relationship, the EC signal format on the UNI is the same as the EC signal format on the NNI; i.e., there is no encapsulation performed.

For the case of a client/server relationship, the EC signal on the UNI is encapsulated into the virtual channel EC (S-EC, BS-EC) signal in the network; the encapsulation is either a tag based encapsulation, a MAC header based encapsulation, or a combination of both types of encapsulation.

The following clauses specify the client/server mapping of EC signals on a UNI into virtual channel EC (S-EC, BS-EC) signals in the network. The figures show on the left the format of the specific EC traffic unit on the UNI without its UNI based tagging and encapsulation, and on the right the S-EC or BS-EC traffic unit in the network.

15.1 EC on UNI to S-EC client/server

All EC signals on a UNI may be supported via an EC to S-EC client/server relationship. The S-EC signal carries the UNI EC traffic units with a tag plus the S-EC's ETH OAM and optionally some UNI EC related L2CPs. The EC tag on the UNI may be a C-Tag, I-Tag, S-Tag plus I-Tag, or C-Tag plus I-Tag.

15.1.1 C-EC mapping into S-EC

The C-EC traffic unit is mapped into a Service EC traffic unit (Figures 15-1 and 15-2, right). There are two mapping formats, without MAC address encapsulation and with MAC address encapsulation.

The Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the Customer EC Priority and Drop Eligible values as input.

The mapping without MAC address encapsulation (Figure 15-1, right) adds a C-Tag in which the TPID value is 81-00, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the C-EC traffic unit (and may be the same as the PCP and DEI values in the Tagged C-EC frame) and the VLAN ID value is either configured or the same as the value of the VLAN ID in the Tagged C-EC frame.

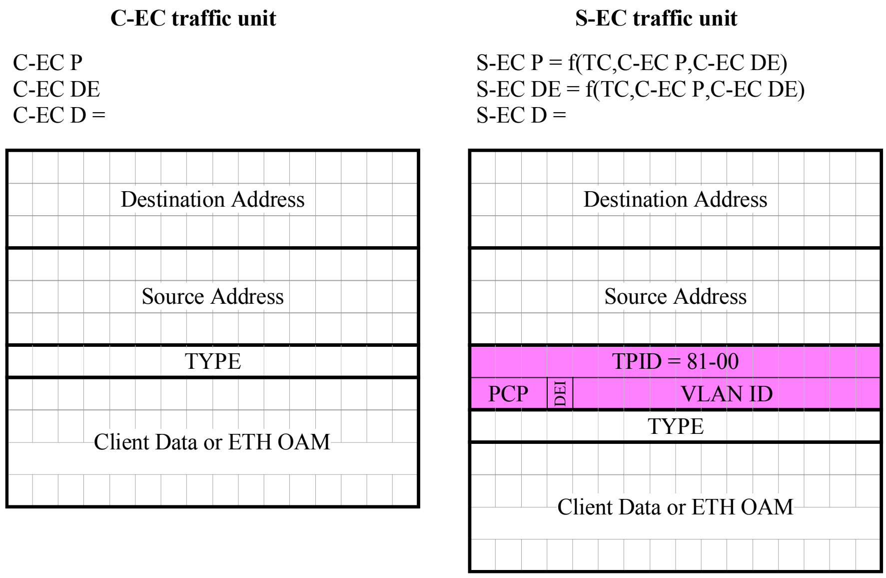


Figure 15-1 – C-EC traffic unit to S-EC traffic unit encapsulation for individual and bundled C-EC services

The mapping with MAC address encapsulation (Figure 15-2) adds UNI-N destination and UNI-N source address fields, the first 48 bits of an I-Tag (TPID to I-SID fields) and optionally a C-Tag. For the case where the C-Tag is added (Figure 15-2, middle), it contains a TPID field with value 81-00, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the C-EC traffic unit (and may be the same as the PCP and DEI values in the Tagged C-EC frame) and a VLAN ID field of which the value is either configured or the same as the VLAN ID value in the Tagged C-EC frame. The added I-Tag fields contain the TPID field with value 88-e7, PCP and DEI fields with values derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the C-EC traffic unit, a UCA field with fixed value zero, RES1 and RES2 fields with fixed all-0 values and the I-SID field with a configured value. The UNI-N source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a network MAC address value and the type of S-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured network MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the S-EC is a point-to-point Ethernet connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received S-EC traffic unit. If the Default Backbone Destination is supported, then the UNI-N destination address value is the value of the Default Backbone Destination, otherwise the UNI-N destination address value is the Backbone Service Instance Group Address.

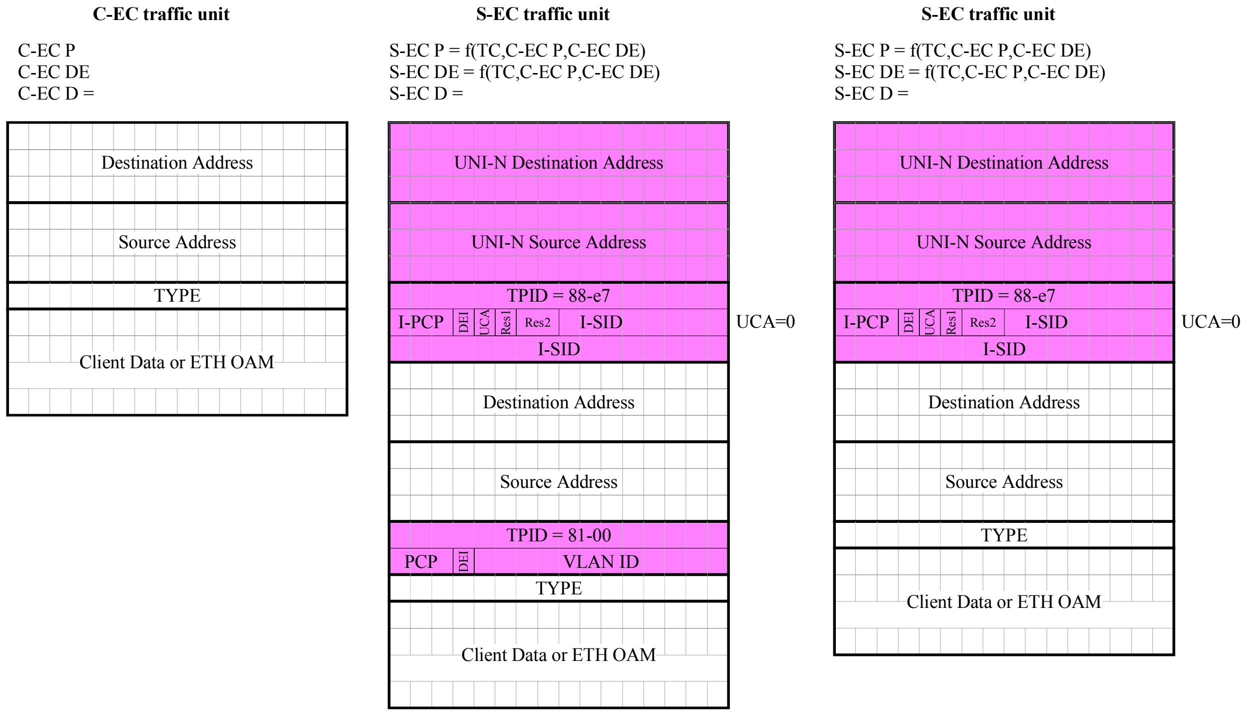


Figure 15-2 – MAC encapsulated C-EC traffic unit to S-EC traffic unit encapsulation for individual and bundled C-EC service

15.1.2 S-EC mapping into S-EC

The S-EC traffic unit is mapped into a Service EC traffic unit (Figure 15-3). There is one mapping format, with MAC address encapsulation.

NOTE – Mappings without MAC address encapsulation are outside the scope of this Recommendation.

The Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the received Service EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-3, right) adds UNI-N destination and UNI-N source address fields, the first 48 bits of an I-Tag (TPID to I-SID fields) and optionally an S-Tag. For the case where the S-Tag is added (Figure 15-3, middle), it contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and may be the same as the PCP and DEI values in the Tagged S-EC frame, and a VLAN ID field of which the value is either configured or the same as the VLAN ID value in the Tagged S-EC frame. The added I-Tag fields contain the TPID field with value 88-e7, PCP and DEI fields with values derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit, a UCA field with fixed value zero, RES1 and RES2 fields with fixed all-0 values and the I-SID field with a configured value. The network source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a UNI-N MAC address value and the type of S-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured UNI-N MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the S-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received S-EC traffic unit, else if the Default Backbone Destination is supported, then the UNI-N destination address value is the value of the Default Backbone Destination, else the network destination address value is the Backbone Service Instance Group Address.

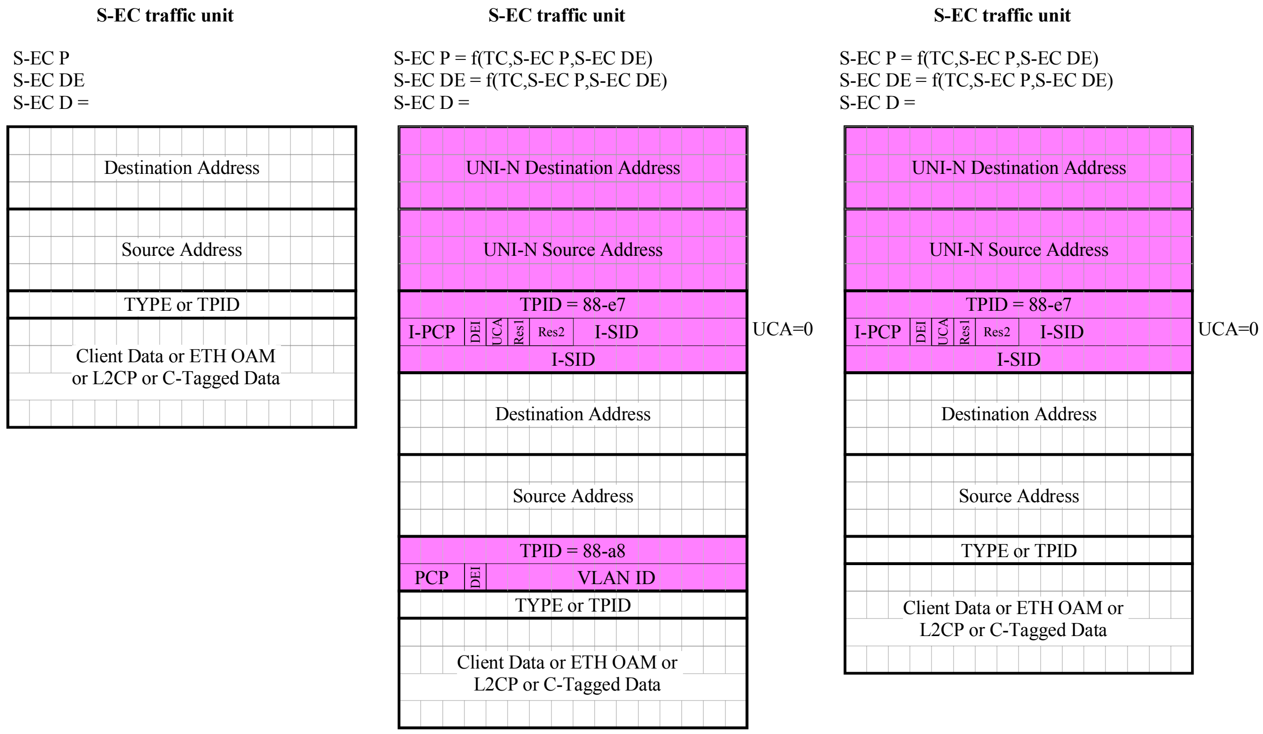


Figure 15-3 – MAC encapsulated S-EC traffic unit to S-EC traffic unit encapsulation for individual and bundled S-EC service

15.1.3 BS-EC mapping into S-EC

The BS-EC traffic unit is mapped into a Service EC traffic unit (Figures 15-4 and 15-5, right). There is one mapping format, without MAC address encapsulation.

NOTE – Mappings with MAC address encapsulation are for further study.

The Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the received Backbone Service EC Priority and Drop Eligible values as input.

The mapping without MAC address encapsulation (Figures 15-4 and 15-5) performs an MSDU dependent encapsulation. There are two types of MSDU: an MSDU containing a MAC frame identified by a TYPE field with value 89-10, and an MSDU with another payload (e.g., ETH OAM, L2CP) identified by a TYPE field with a value not equal to 89-10.

For the case where the BS-EC traffic unit contains an MSDU with value 89-10 in the TYPE field (Figure 15-4), the mapping replaces the TYPE field by the first 48 bits of an I-Tag in which the TPID value is 88-e7, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the BS-EC traffic unit and may be the same as the PCP value in the Tagged BS-EC frame, the UCA value is 0, the RES1 and RES2 values are all-0's and the I-SID value is either configured or the same as the value of the I-SID in the Tagged BS-EC frame. The mapping may also replace the value in the backbone destination address field. For the case where the value in the backbone destination address field of the BS-EC traffic unit is the Backbone Service Instance Group Address and the Default Backbone Destination Address is provided, then the value of the backbone destination address field in the S-EC traffic unit is the Default Backbone Destination Address. The demapping may also replace the value in the backbone destination address field. For the case where the value in the backbone destination address field of the S-EC traffic unit is the Local MAC Address or a Group Address, then the value of the backbone destination address field in the BS-EC traffic unit is the Backbone Service Instance Group Address.

For the case where the BS-EC traffic unit contains an MSDU with value not equal to 89-10 in the TYPE field (Figure 15-5), the mapping adds a new backbone destination address and backbone source address fields and the first 48 bits of an I-Tag in which the TPID value is 88-e7, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the BS-EC traffic, the UCA value is one, the RES1 and RES2 values are all-0's and the I-SID value is configured or the same as the value of the I-SID in the Tagged BS-EC frame. The value of the backbone source address field is the value of the backbone source address field in the BS-EC traffic unit. The value of the backbone destination address field is either the value of the backbone destination address field in the BS-EC traffic unit, or the Backbone Service Instance Group Address, or the Default Backbone Destination Address. For the case where the value in the backbone destination address field of the BS-EC traffic unit is an Individual Address, then the value in the new backbone destination address field of the S-EC traffic unit is the value of the backbone destination address in the BS-EC traffic unit. For the case where the value in the backbone destination address field of the BS-EC traffic unit is a Group Address and the Default Backbone Destination Address is not provided, then the value in the new backbone destination address field of the S-EC traffic unit is the Backbone Service Instance Group Address. For the case where the value in the backbone destination address field of the BS-EC traffic unit is a Group Address and the Default Backbone Destination Address is provided, then the value in the new backbone destination address field of the S-EC traffic unit is the Default Backbone Destination Address.

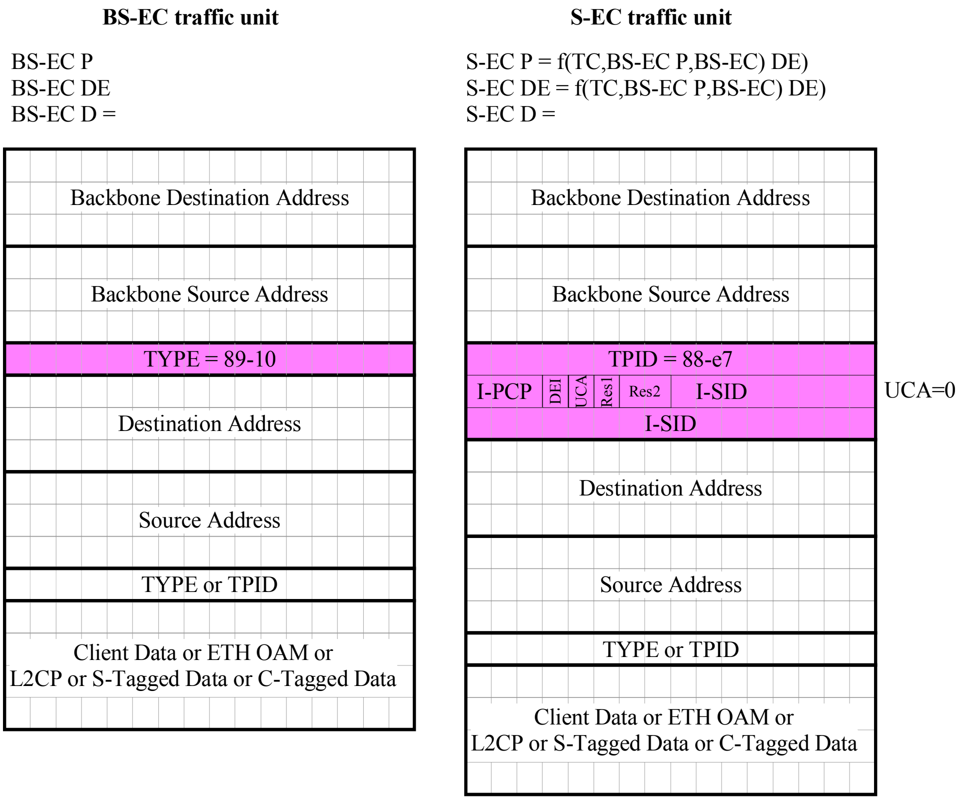


Figure 15-4 – BS-EC traffic unit to S-EC traffic unit encapsulation for individual and bundled BS-EC service (UCA=0, TYPE = 89-10)

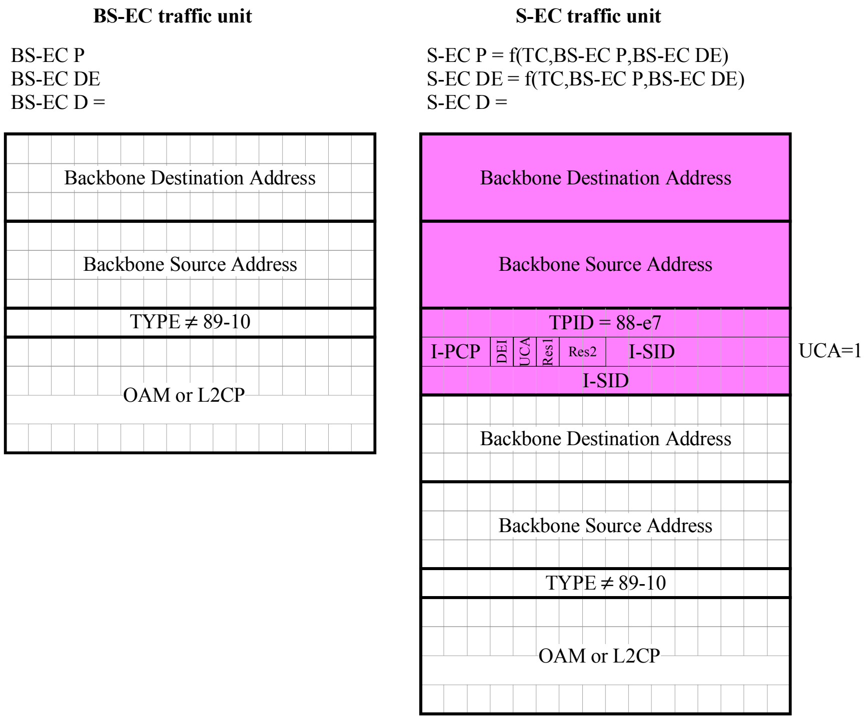


Figure 15-5 – BS-EC traffic unit to S-EC traffic unit encapsulation for individual and bundled BS-EC service (UCA=1, TYPE ≠ 89-10)

15.1.4 Non-S-Tagged and Priority-S-Tagged L-EC (port-based) mapping into S-EC

The L-EC traffic unit is mapped into a Service EC traffic unit (Figure 15-6). There is one mapping format, with MAC address encapsulation.

NOTE – Mappings without MAC address encapsulation are outside the scope of this Recommendation.

The Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the received Link EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-6) adds UNI-N destination and UNI-N source address fields and the first 48 bits of an I-Tag (TPID to I-SID fields). The added I-Tag fields contain the TPID field with value 88-e7, PCP and DEI fields with values derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the L-EC traffic unit, a UCA field with fixed value zero, RES1 and RES2 fields with fixed all-0 values and the I-SID field with a configured value. The UNI-N source address value is the local EUI-48 value. The network destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a network MAC address value and the type of S-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured network MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the S-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received S-EC traffic unit, else if the Default Backbone Destination is supported, then the UNI-N destination address value is the value of the Default Backbone Destination, else the UNI-N destination address value is the Backbone Service Instance Group Address.

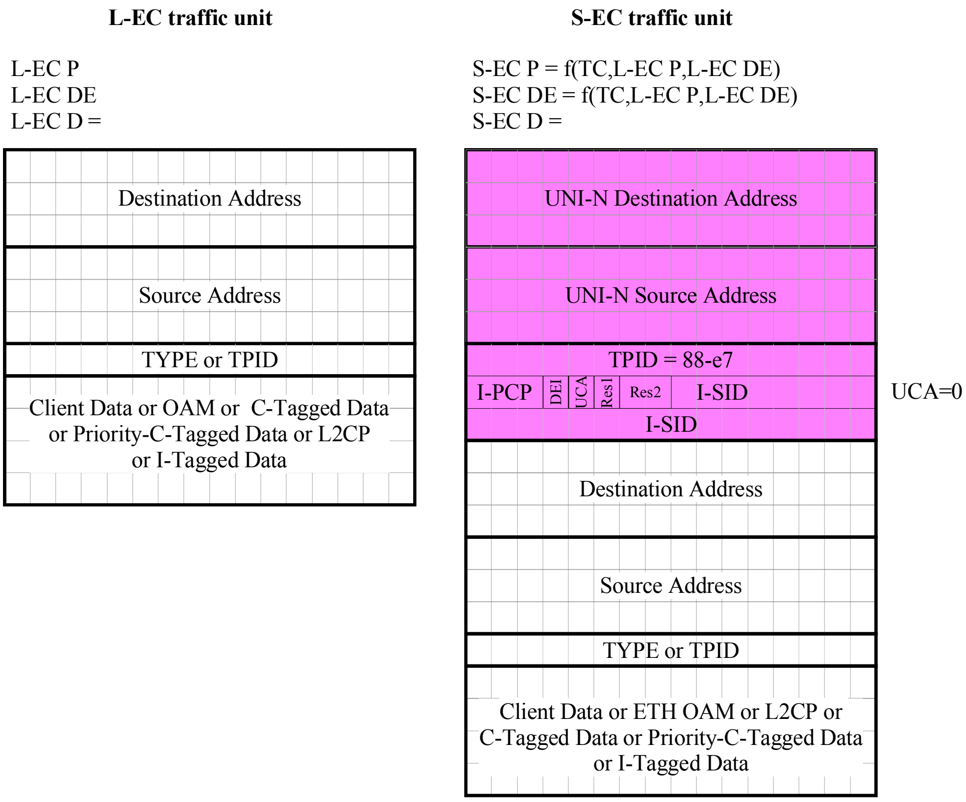


Figure 15-6 – MAC encapsulated L-EC traffic unit to S-EC traffic unit encapsulation for non-S-Tagged or priority-S-Tagged L-EC (port-based) service

15.1.5 L-EC (transparent) mapping into S-EC

The L-EC traffic unit is mapped into a Service EC traffic unit (Figure 15-7). There is one mapping format, with MAC address encapsulation.

NOTE – Mappings without MAC address encapsulation are outside the scope of this Recommendation.

The Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the received Link EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-7) adds UNI-N destination and UNI-N source address fields and the first 48 bits of an I-Tag (TPID to I-SID fields). The added I-Tag fields contain the TPID field with value 88-e7, PCP and DEI fields with values derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the L-EC traffic unit, a UCA field with fixed value zero, RES1 and RES2 fields with fixed all-0 values and the I-SID field with a configured value. The UNI-N source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a UNI-N MAC address value and the type of S-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured UNI-N MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the S-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received S-EC traffic unit, else if the Default Backbone Destination is supported, then the UNI-N destination address value is the value of the Default Backbone Destination, else the UNI-N destination address value is the Backbone Service Instance Group Address.

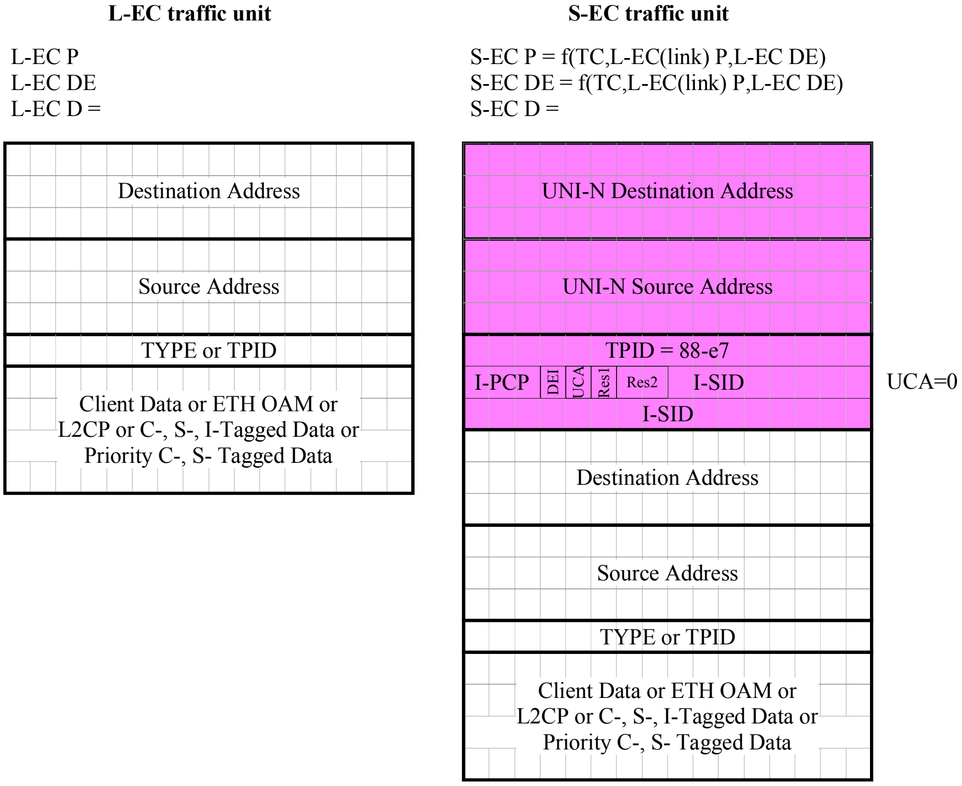


Figure 15-7 – MAC encapsulated L-EC traffic unit to S-EC traffic unit encapsulation for L-EC (transparent) service

15.2 EC on UNI to BS-EC client/server

EC signals on a UNI may be supported via an EC to BS-EC client/server relationship. The BS-EC signal carries the UNI EC traffic units with a tag plus the BS-EC's ETH OAM and optionally some UNI EC related L2CPs. The EC tag on the UNI may be a C-Tag or S-Tag.

15.2.1 C-EC mapping into BS-EC

The C-EC traffic unit is mapped into a Backbone Service EC traffic unit (Figure 15-8). There is one mapping format, with MAC address encapsulation.

The Backbone Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the Customer EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-8) adds UNI-N destination and UNI-N source address fields, a TYPE field with value 89-10 and optionally a C-Tag. For the case where the C-Tag is added (Figure 15-8, middle), it contains a TPID field with value 81-00, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the C-EC traffic unit and may be the same as the PCP and DEI values in the Tagged C-EC frame and a VLAN ID field of which the value is either configured or the same as the VLAN ID value in the Tagged C-EC frame. The UNI-N source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a UNI-N MAC address value and the type of BS-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured UNI-N MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the BS-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received BS-EC traffic unit, else the UNI-N destination address value is the Backbone Service Instance Group Address.

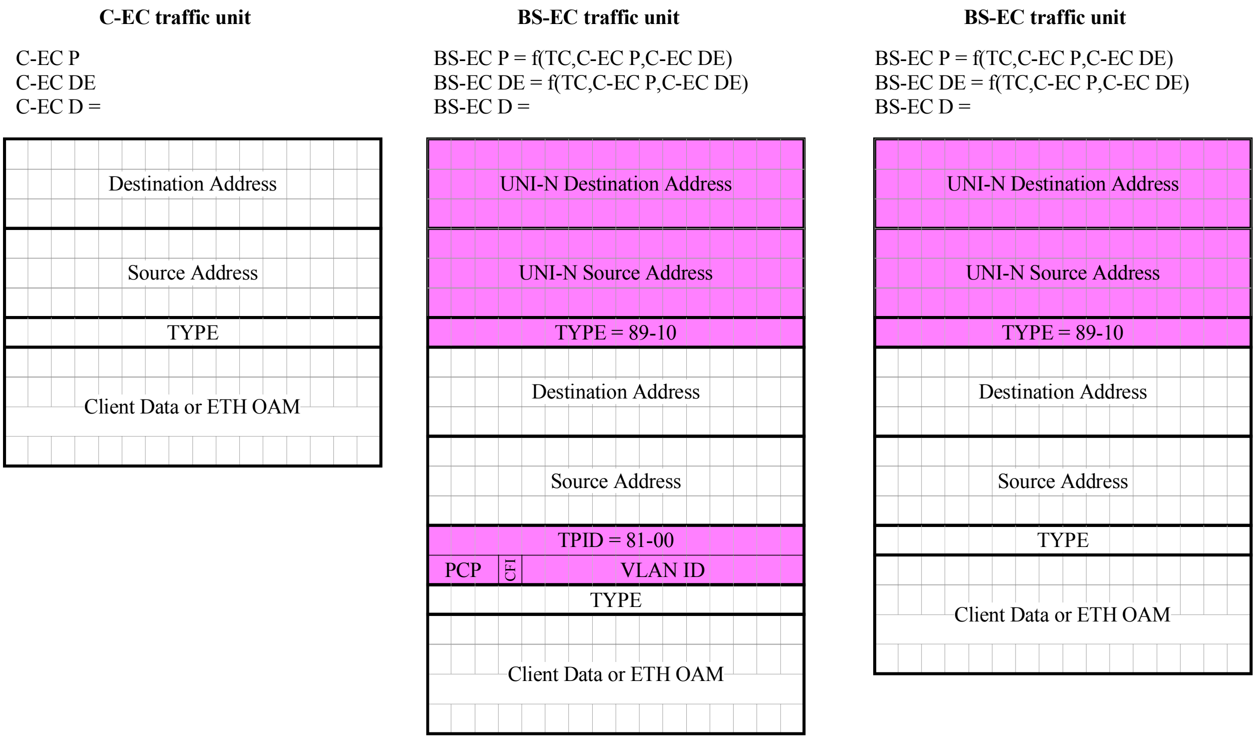


Figure 15-8 – MAC encapsulated C-EC traffic unit to BS-EC traffic unit encapsulation for individual and bundled C-EC service

15.2.2 S-EC mapping into BS-EC

The S-EC traffic unit is mapped into a Backbone Service EC traffic unit (Figure 15-9). There is one mapping format, with MAC address encapsulation.

The Backbone Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the Service EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-9) adds UNI-N destination and UNI-N source address fields, a TYPE field with value 89-10 and optionally an S-Tag. For the case where the S-Tag is added (Figure 15-9, middle), it contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the EVC traffic unit and may be the same as the PCP and DEI values in the Tagged S-EC frame, and a VLAN ID field of which the value is either configured or the same as the VLAN ID value in the Tagged S-EC frame. The UNI-N source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a backbone MAC address value and the type of BS-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured UNI-N MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the BS-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the backbone source address field in the last received BS-EC traffic unit, else the UNI-N destination address value is the Backbone Service Instance Group Address.

NOTE – The S-Tag is optional for an individual S-EC of which the traffic units are identified by a single S-VID value and for which S-VID or S-PCP/DEI preservation is not required.

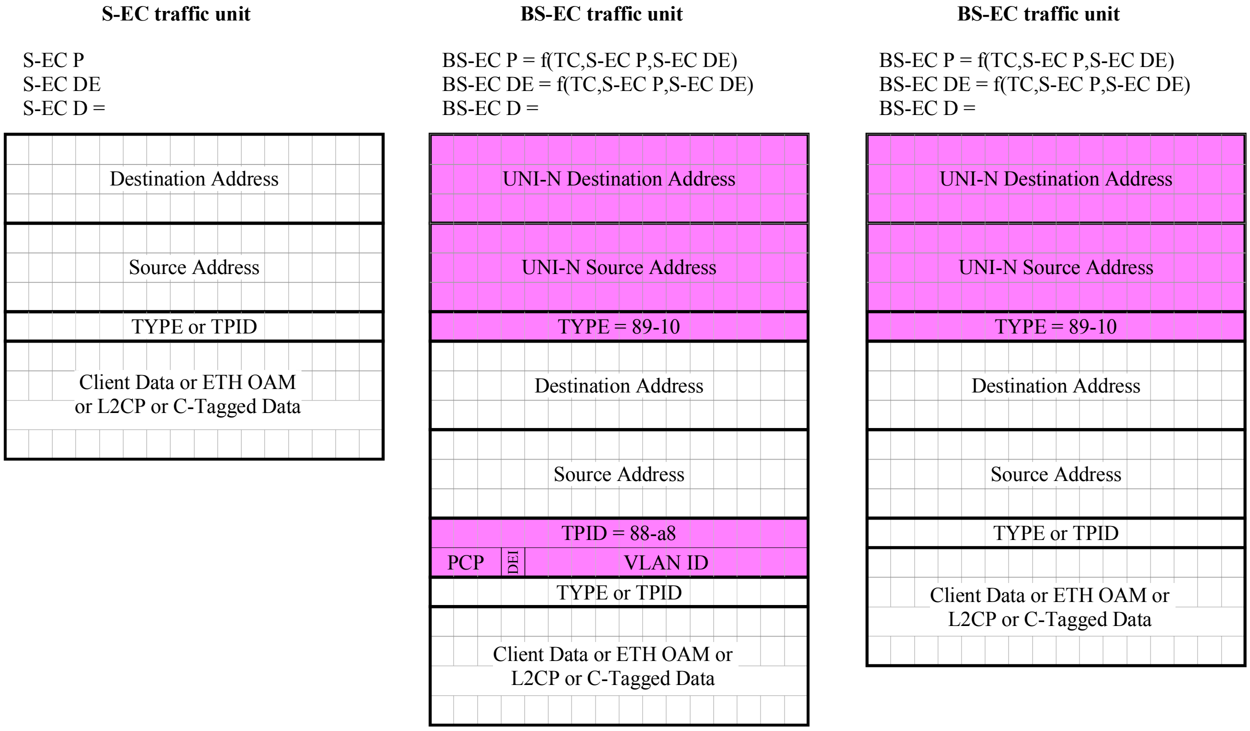


Figure 15-9 – MAC encapsulated S-EC traffic unit to BS-EC traffic unit encapsulation for individual and bundled S-EC service

15.2.3 Non-S-Tagged or Priority-S-Tagged L-EC (port-based) mapping into BS-EC

The L-EC traffic unit is mapped into a Backbone Service EC traffic unit (Figure 15-10). There is one mapping format, with MAC address encapsulation.

The Backbone Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the Link EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-10) adds UNI-N destination and UNI-N source address fields and a TYPE field with value 89-10. The UNI-N source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a UNI-N MAC address value and the type of BS-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured UNI-N MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the BS-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received BS-EC traffic unit, else the UNI-N destination address value is the Backbone Service Instance Group Address.

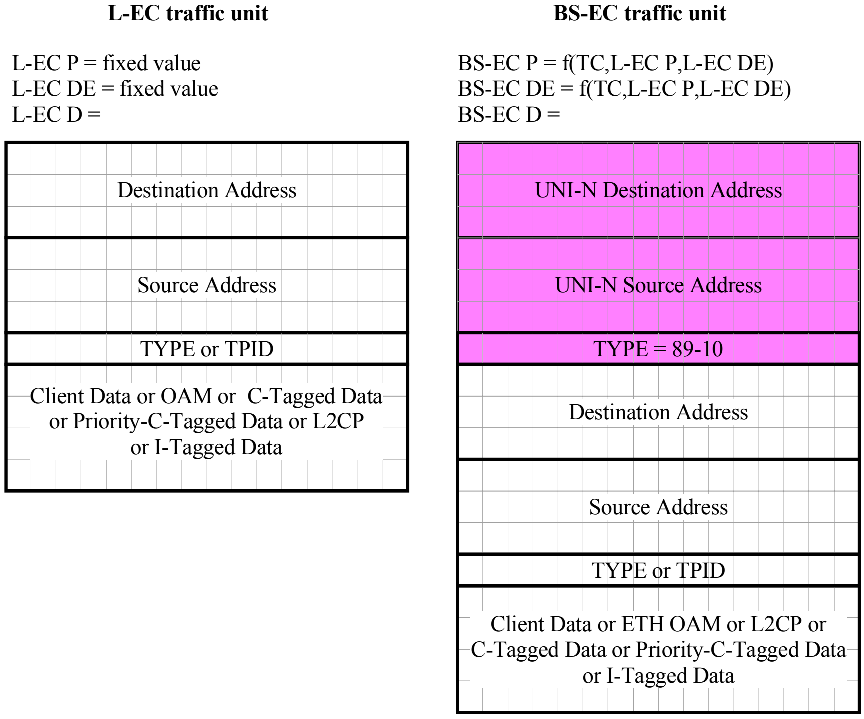


Figure 15-10 – MAC encapsulated EVC traffic unit to BS-EC traffic unit encapsulation for non-S-Tagged and Priority S-Tagged L-EC (port-based) service

15.2.4 L-EC (transparent) mapping into BS-EC

The L-EC traffic unit is mapped into a Backbone Service EC traffic unit (Figure 15-11). There is one mapping format, with MAC address encapsulation.

The Backbone Service EC Priority and Drop Eligible elements contain priority and drop eligible values which are determined by a traffic conditioning function using the Link EC Priority and Drop Eligible values as input.

The mapping with MAC address encapsulation (Figure 15-11) adds UNI-N destination and source address fields and a TYPE field with value 89-10. The UNI-N source address value is the local EUI-48 value. The UNI-N destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a UNI-N MAC address value and the type of BS-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured UNI-N MAC address value, then the UNI-N destination address value is the associated UNI-N MAC address value. Otherwise, if the BS-EC is a point-to-point Ethernet Connection, then the UNI-N destination address value is the value of the UNI-N source address field in the last received BS-EC traffic unit, else the UNI-N destination address value is the Backbone Service Instance Group Address.

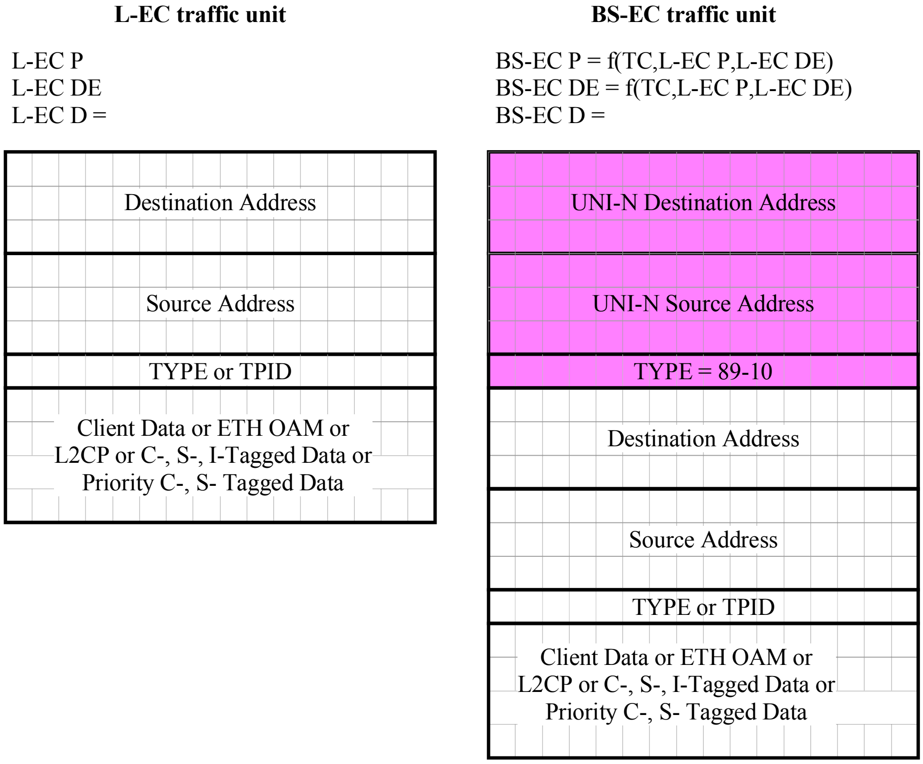


Figure 15-11 – MAC address encapsulated client/server L-EC traffic unit to BS-EC traffic unit encapsulation for L-EC (transparent) service

16 Multiplexing/aggregation of Ethernet connection signals

This clause specifies the mapping and multiplexing/aggregation of Ethernet connection signals into server layer Ethernet connection signals, or PBB-TE Ethernet switched path connection signals or non-Ethernet server layer signals (OTN ODUk, SDH VC-n) for the following cases:

– S-EC into BS-EC
– S-EC and BS-EC into B-EC
– S-EC into ESP/TESI and ODUk
– S-EC and BS-EC into L-EC
– B-EC and ESP into L-EC
– B-EC into ODUk and VC-n
– ESP into ODUk
– L-EC into ETY and ODUk.

16.1 Ethernet virtual channel to virtual channel

An Ethernet virtual channel connection layer signal (S-EC) may be transported within a second virtual channel layer signal (BS-EC) to pass through a series of Ethernet virtual path trails (B-EC) and I-Tagged LAN trails (L-EC). Typically a single S-EC signal is transported in a BS-EC signal.

16.1.1 S-EC to BS-EC

The mapping of an S-EC traffic unit (Figure 16-1 left) into a BS-EC traffic unit (Figure 16-1, middle and right) adds backbone destination and backbone source address fields, a TYPE field with value 89-10 and optionally an S-Tag (Figure 16-1, middle). For the case where the S-Tag is added (e.g., for an S-EC identified by more than one VID value), it contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and a Service VLAN ID field of which the value is configured. The backbone source address value is the local EUI-48 value. The backbone destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a backbone MAC address value and the type of BS-EC (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured backbone MAC address value, then the backbone destination address value is the associated backbone MAC address value. Otherwise, if the BS-EC is a point-to-point Ethernet Connection, then the backbone destination address value is the value of the backbone source address field in the last received BS-EC traffic unit, else the backbone destination address value is the Backbone Service Instance Group Address.

The BS-EC priority and drop_eligible values are copied from the S-EC priority and drop_eligible values.

The demultiplexing and demapping of an S-EC traffic unit from a BS-EC traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the S-EC traffic unit from the PCP and DEI fields in the I-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

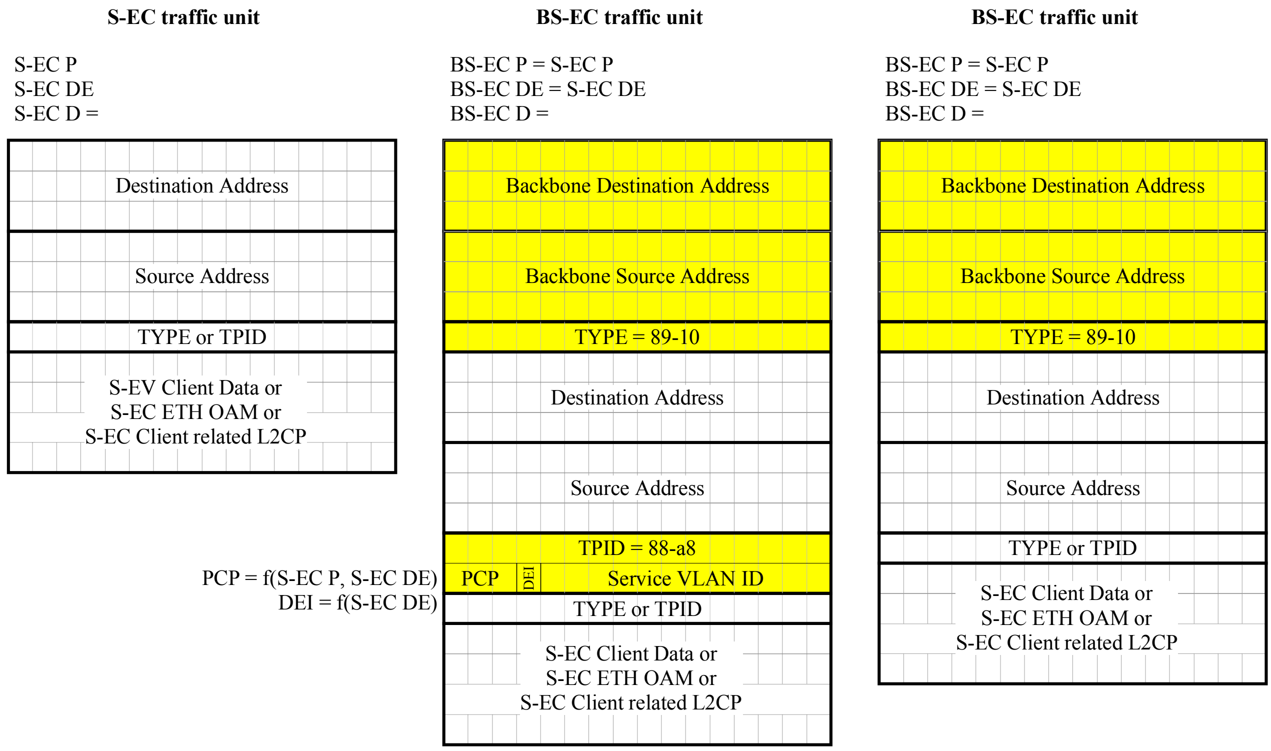


Figure 16-1 – Encapsulation of S-EC traffic unit into a BS-EC traffic unit, with and without S-Tag insertion

16.2 Ethernet virtual channel to virtual path

16.2.1 Ethernet virtual channel to B-EC

16.2.1.1 S-EC to B-EC

The mapping and multiplexing of an S-EC traffic unit (Figure 16-2, left) into a B-EC traffic unit (Figure 16-2, middle and right) adds backbone destination and backbone source address fields, the first 48 bits of an I-Tag and optionally an S-Tag (Figure 16-2, middle). For the case where the S-Tag is added (e.g., for an S-EC identified by more than one VID value), it contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and a Service VLAN ID field of which the value is configured. The added I-Tag fields contain the TPID field with value 88-e7, PCP and DEI fields with values derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit, a UCA field with fixed value zero, RES1 and RES2 fields with fixed all-0 values and the I-SID field with a configured value. The backbone source address value is the local EUI-48 value. The backbone destination address value is derived from the MAC address value in the destination address field, the presence of a learned or configured relationship between this MAC address value and a backbone MAC address value and the type of S-EC link connection (point-to-point or multipoint). If the MAC address value in the destination address field is associated with a learned or configured backbone MAC address value, then the backbone destination address value is the associated backbone MAC address value. Otherwise, if the S-EC link connection is a point-to-point Ethernet Connection, then the backbone destination address value is the value of the backbone source address field in the last received encapsulated S-EC traffic unit. If the Default Backbone Destination is supported, then the backbone destination address value is the value of the Default Backbone Destination, or else the backbone destination address value is the Backbone Service Instance Group Address.

The B-EC priority and drop_eligible values are derived from the values in the I-Tag's PCP and DEI fields as per clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

The demultiplexing and demapping of an S-EC traffic unit from a B-EC traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the S-EC traffic unit from the PCP and DEI fields in the I-Tag or the PCP and DEI fields in the S-Tag (if present) as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

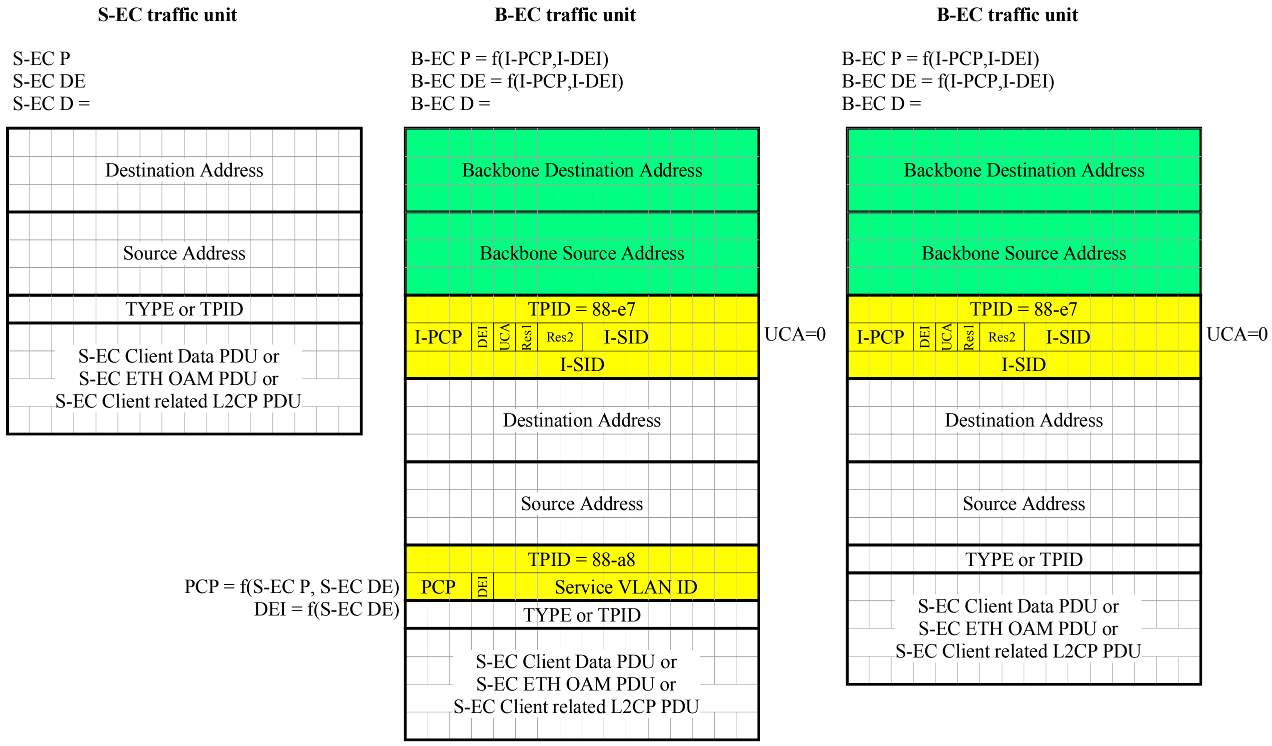


Figure 16-2 – Encapsulation of S-EC traffic unit into a B-EC traffic unit, with and without S-Tag insertion

16.2.1.2 BS-EC to B-EC

The mapping and multiplexing of a BS-EC traffic unit (Figure 16-3, left) into a B-EC traffic unit (Figure 16-3, right) performs a MAC service data unit (MSDU)-dependent encapsulation. There are two types of MSDU: an MSDU containing a MAC frame identified by a TYPE field with value 89-10, and an MSDU with another payload (e.g., ETH OAM, L2CP) identified by a TYPE field with a value not equal to 89-10.

For the case where the BS-EC traffic unit contains an MSDU with value 89-10 in the TYPE field (Figure 16-3, top), the mapping replaces the TYPE field by the first 48 bits of an I-Tag in which the TPID value is 88-e7, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the BS-EC traffic unit, the UCA value is 0, the RES1 and RES2 values are all-0's and the I-SID value is configured. The mapping may also replace the value in the backbone destination address field. For the case where the value in the backbone destination address field of the BS-EC traffic unit is the Backbone Service Instance Group Address and the Default Backbone Destination Address is provided, then the value of the backbone destination address field in the B-EC traffic unit is the Default Backbone Destination Address. The demapping may also replace the value in the backbone destination address field. For the case where the value in the backbone destination address field of the B-EC traffic unit is the Local MAC Address or a Group Address, then the value of the backbone destination address field in the BS-EC traffic unit is the Backbone Service Instance Group Address.

For the case where the BS-EC traffic unit contains an MSDU with value not equal to 89-10 in the TYPE field (Figure 16-3, bottom), the mapping adds new backbone destination address and backbone source address fields and the first 48 bits of an I-Tag in which the TPID value is 88-e7, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the BS-EC traffic, the UCA value is 1, the RES1 and RES2 values are all-0's and the I-SID value is configured. The value of the new backbone source address field is the value of the backbone source address field in the BS-EC traffic unit. The value of the new backbone destination address field is either the value of the backbone destination address field in the BS-EC traffic unit, or the Backbone Service Instance Group Address, or the Default Backbone Destination Address. For the case where the value in the backbone destination address field of the BS-EC traffic unit is an Individual Address, then the value in the new backbone destination address field of the B-EC traffic unit is the value of the backbone destination address in the B-EC traffic unit. For the case where the value in the backbone destination address field of the BS-EC traffic unit is a Group Address and the Default Backbone Destination Address is not provided, then the value in the new backbone destination address field of the B-EC traffic unit is the Backbone Service Instance Group Address. For the case where the value in the backbone destination address field of the BS-EC traffic unit is an Group Address and the Default Backbone Destination Address is provided, then the value in the new backbone destination address field of the B-EC traffic unit is the Default Backbone Destination Address.

The B-EC priority and drop_eligible values are derived from the values in the I-Tag's PCP and DEI fields as per clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

The demultiplexing and demapping of an BS-EC traffic unit from a B-EC traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the BS-EC traffic unit from the PCP and DEI fields in the I-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

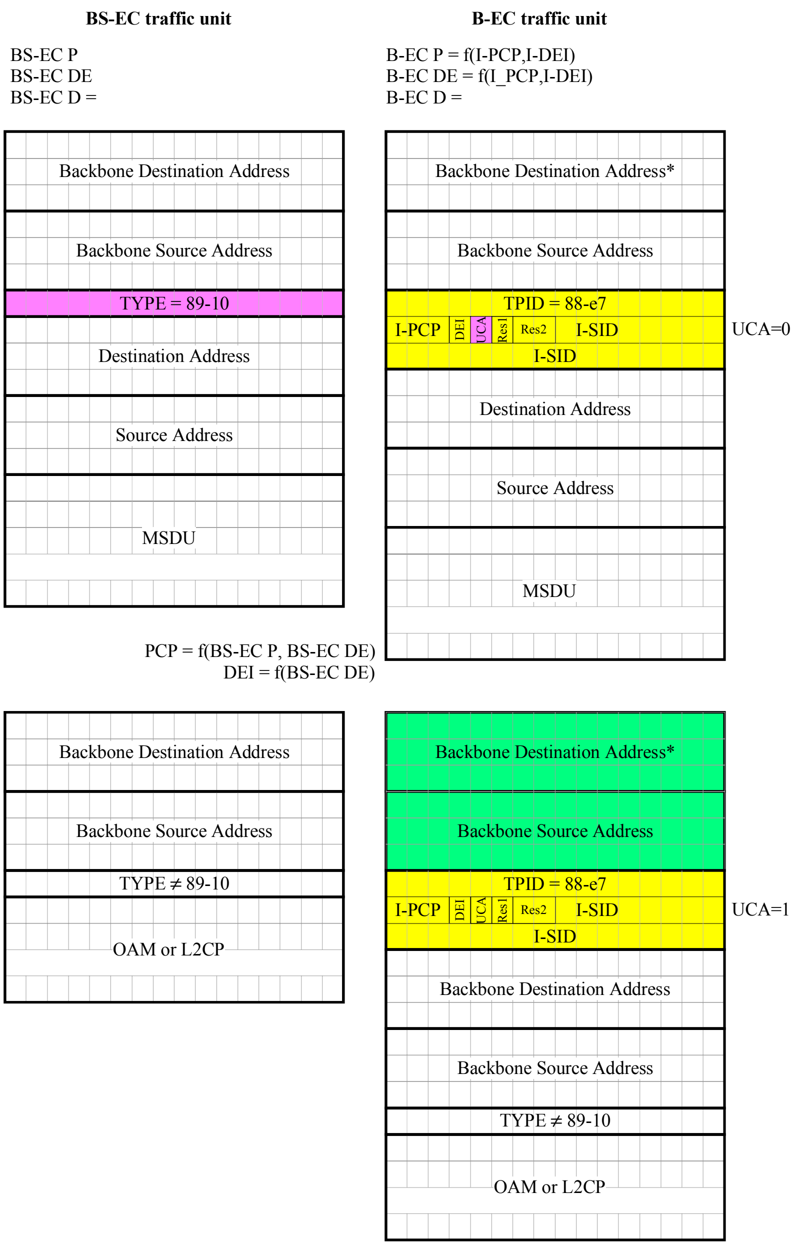


Figure 16-3 – Encapsulation of BS-EC traffic unit into a B-EC traffic unit

16.2.2 S-EC to ESP

The mapping and multiplexing of an S-EC traffic unit (Figure 16-4, left) into an Ethernet switched path (ESP) traffic unit (Figure 16-4, middle and right) adds the first 48 bits of an I-Tag and optionally an S-Tag (Figure 16-4, middle). For the case where the S-Tag is added (e.g., for an S-EC identified by more than one VID value), it contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and a Service VLAN ID field of which the value is configured. The added I-Tag fields contain the TPID field with value 88-e7, PCP and DEI fields with values derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the S-EC traffic unit, a UCA field with fixed value zero, RES1 and RES2 fields with fixed all-0 values and the I-SID field with a configured value.

The ESP priority and drop_eligible values are derived from the values in the I-Tag's PCP and DEI fields as per clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

NOTE – The 3-tuple <ESP-DA, ESP-SA, ESP-VID> represent the ESP Identifier. The ESP-DA, ESP-SA and ESP-VID fields are therefore considered to be added to the traffic unit when the ESP signal is mapped and multiplexed into its server layer signal. See clause 16.5.

The demultiplexing and demapping of an S-EC traffic unit from an ESP traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the S-EC traffic unit from the PCP and DEI fields in the I-Tag and the PCP and DEI fields in the S-Tag (if present) as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

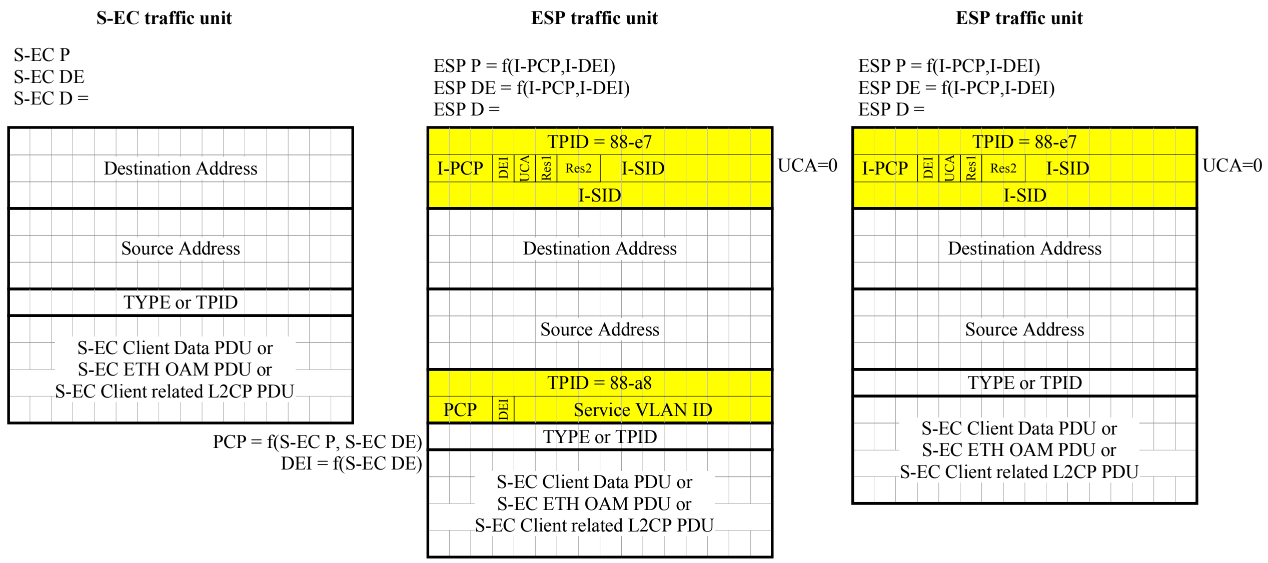


Figure 16-4 – Encapsulation of S-EC traffic unit into an ESP traffic unit, with and without S-Tag insertion

16.2.3 Ethernet virtual channel to OTN virtual path

16.2.3.1 S-EC to OTN ODUk

For the mapping and multiplexing of an S-EC traffic unit (Figure 16-5, left) into an OTN OPUk Payload area the S-EC traffic unit is extended with an S-Tag, a MAC FCS field and GFP-F Payload and Core Headers (Figure 16-5, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the OPUk Payload area (Figure 16-5, top) as specified in [ITU-T G.709].

The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and a Service VLAN ID field of which the value is configured.

The demultiplexing and demapping of an S-EC traffic unit from the OPUk Payload area removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the S-EC traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

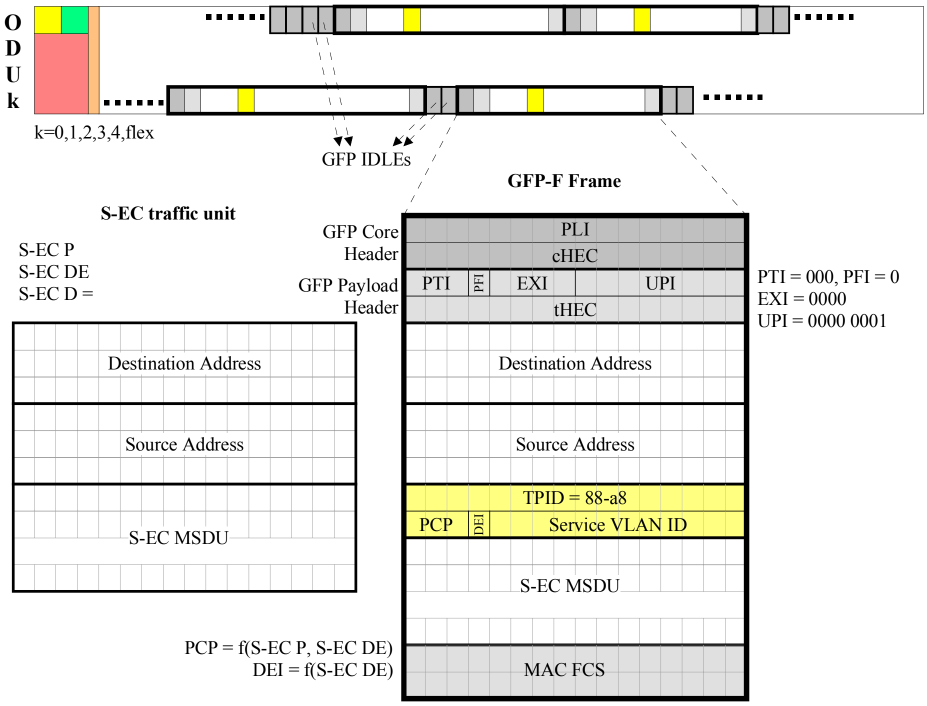


Figure 16-5 – Encapsulation of S-EC traffic unit into GFP-F frame and mapping of GFP-F frame into OTN ODUk

16.3 Ethernet virtual channel to virtual section

16.3.1 Ethernet virtual channel to Ethernet virtual section

16.3.1.1 S-EC to L-EC

The mapping and multiplexing of an S-EC traffic unit (Figure 16-6, left) into an L-EC traffic unit (Figure 16-6, right) adds an S-Tag. The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and a Service VLAN ID field of which the value is configured.

The L-EC priority and drop_eligible values are copied from the S-EC priority and drop_eligible values.

The demultiplexing and demapping of an S-EC traffic unit from an L-EC traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the S-EC traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

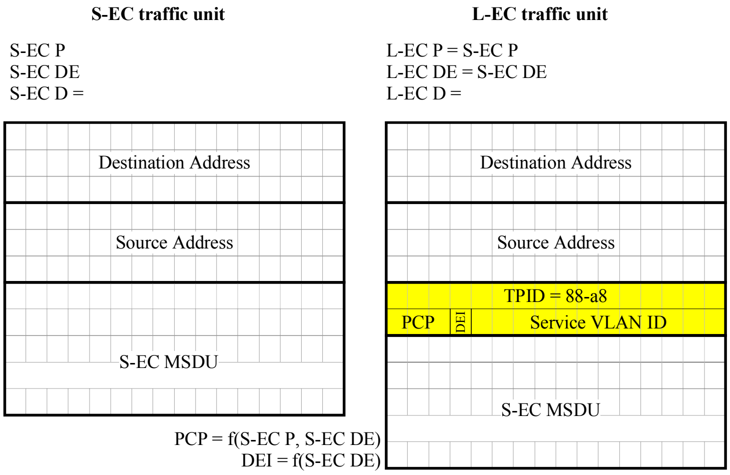


Figure 16-6 – Encapsulation of S-EC traffic unit into an L-EC traffic unit

16.3.1.2 BS-EC to L-EC

The mapping and multiplexing of a BS-EC traffic unit (Figure 16-7, left) into an L-EC traffic unit (Figure 16-7, right) performs an MSDU-dependent encapsulation. There are two types of MSDU: an MSDU containing a MAC frame identified by a TYPE field with value 89-10, and an MSDU with another payload (e.g., ETH OAM, L2CP) identified by a TYPE field with a value not equal to 89-10.

For the case where the BS-EC traffic unit contains an MSDU with value 89-10 in the TYPE field (Figure 16-7, top), the mapping replaces the TYPE field by the first 48 bits of an I-Tag in which the TPID value is 88-e7, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the BS-EC traffic unit, the UCA value is 0, the RES1 and RES2 values are all-0's and the I-SID value is configured.

For the case where the BS-EC traffic unit contains an MSDU with value not equal to 89-10 in the TYPE field (Figure 16-7, bottom), the mapping adds new backbone destination address and backbone source address fields and the first 48 bits of an I-Tag in which the TPID value is 88-e7, the PCP and DEI values are derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the BS-EC traffic unit, the UCA value is 1, the RES1 and RES2 values are all-0's and the I-SID value is configured. The value of the new backbone source address field is the value of the backbone source address field in the BS-EC traffic unit. The value of the new backbone destination address field is either the value of the backbone destination address field in the BS-EC traffic unit, or the Backbone Service Instance Group Address, or the Default Backbone Destination Address. For the case where the value in the backbone destination address field of the BS-EC traffic unit is an Individual Address, then the value in the new backbone destination address field of the L-EC traffic unit is the value of the backbone destination address in the BS-EC traffic unit. For the case where the value in the backbone destination address field of the BS-EC traffic unit is an Group Address and the Default Backbone Destination Address is not provided, then the value in the new backbone destination address field of the L-EC traffic unit is the Backbone Service Instance Group Address. For the case where the value in the backbone destination address field of the BS-EC traffic unit is a Group Address and the Default Backbone Destination Address is provided, then the value in the new backbone destination address field of the L-EC traffic unit is the Default Backbone Destination Address.

The L-EC traffic unit priority and drop_eligible values are copied from the BS-EC priority and drop_eligible values.

The demultiplexing and demapping of an BS-EC traffic unit from an L-EC traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the BS-EC traffic unit from the PCP and DEI fields in the I-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

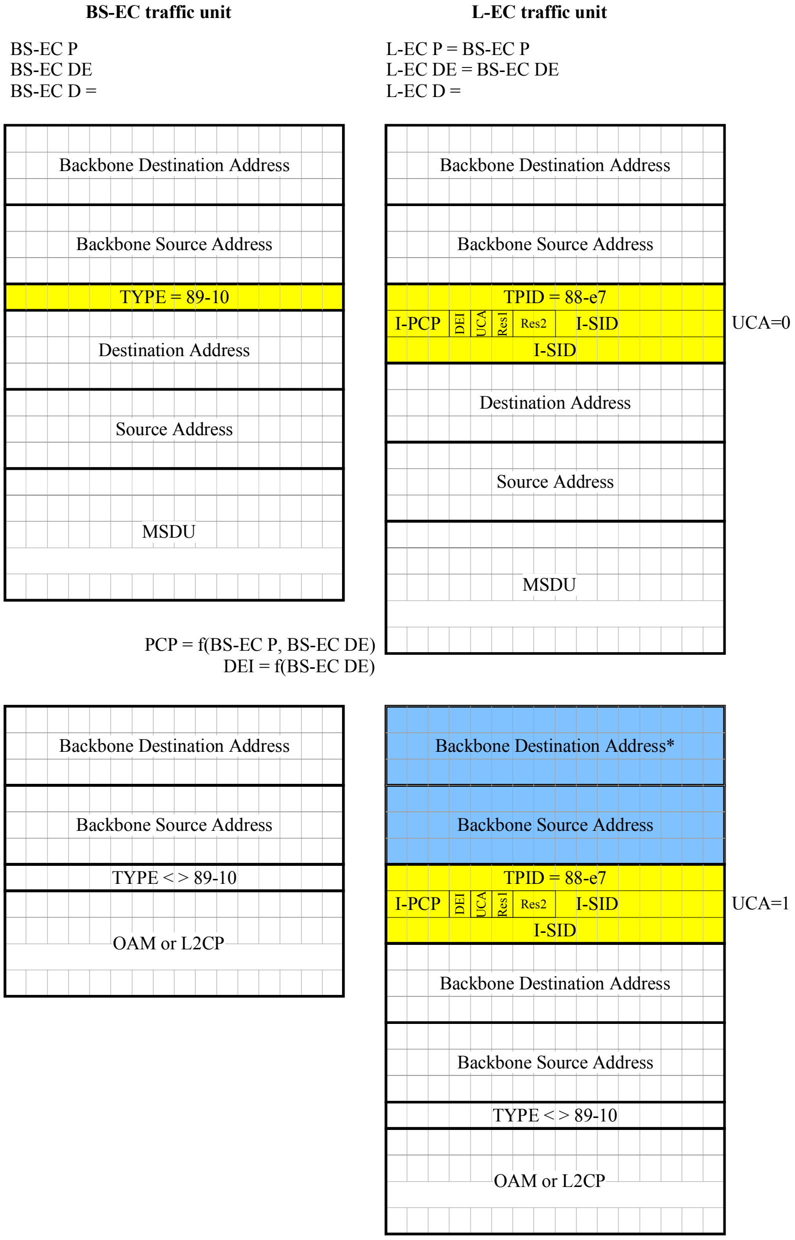


Figure 16-7 – Encapsulation of BS-EC traffic unit into an L-EC traffic unit

16.3.2 Ethernet virtual channel to OTN virtual section

This mapping and multiplexing is the same as for an Ethernet virtual channel to OTN virtual path. Refer to clause 16.2.3.

16.4 Ethernet virtual path to virtual section

16.4.1 B-EC to L-EC

The mapping and multiplexing of a B-EC traffic unit (Figure 16-8, left) into an L-EC traffic unit (Figure 16-8, right) adds a B-Tag (which is identical to an S-Tag). The B-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of

[IEEE 802.1Q]) from the priority and drop_eligible information of the B-EC traffic unit and a Backbone VLAN ID field of which the value is configured.

The L-EC traffic unit priority and drop_eligible values are copied from the B-EC priority and drop_eligible values.

The demultiplexing and demapping of an B-EC traffic unit from an L-EC traffic unit removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the B-EC traffic unit from the PCP and DEI fields in the B-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

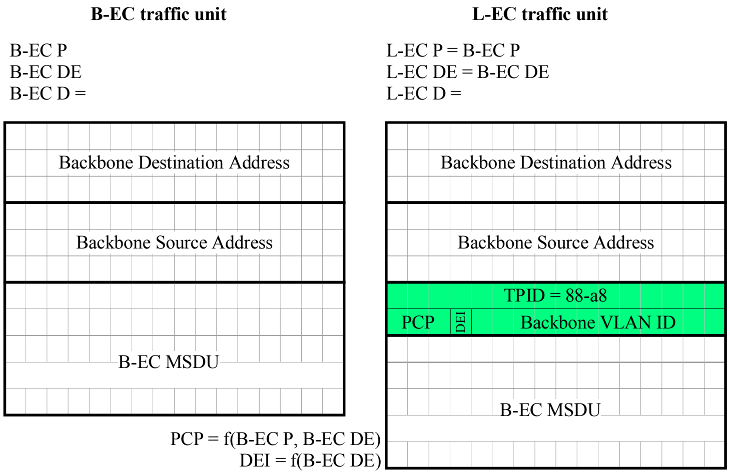


Figure 16-8 – Encapsulation of B-EC traffic unit into an L-EC traffic unit

16.4.2 B-EC to OTN ODUk

For the mapping and multiplexing of an B-EC traffic unit (Figure 16-9, left) into an OTN OPUk Payload area the B-EC traffic unit is extended with an S-Tag, a MAC FCS field and GFP-F Payload and Core Headers (Figure 16-10, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the OPUk Payload area (Figure 16-9, top) as specified in [ITU-T G.709].

The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the B-EC traffic unit and a Backbone VLAN ID field of which the value is configured.

The demultiplexing and demapping of an B-EC traffic unit from the OTN OPUk Payload area removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the B-EC traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

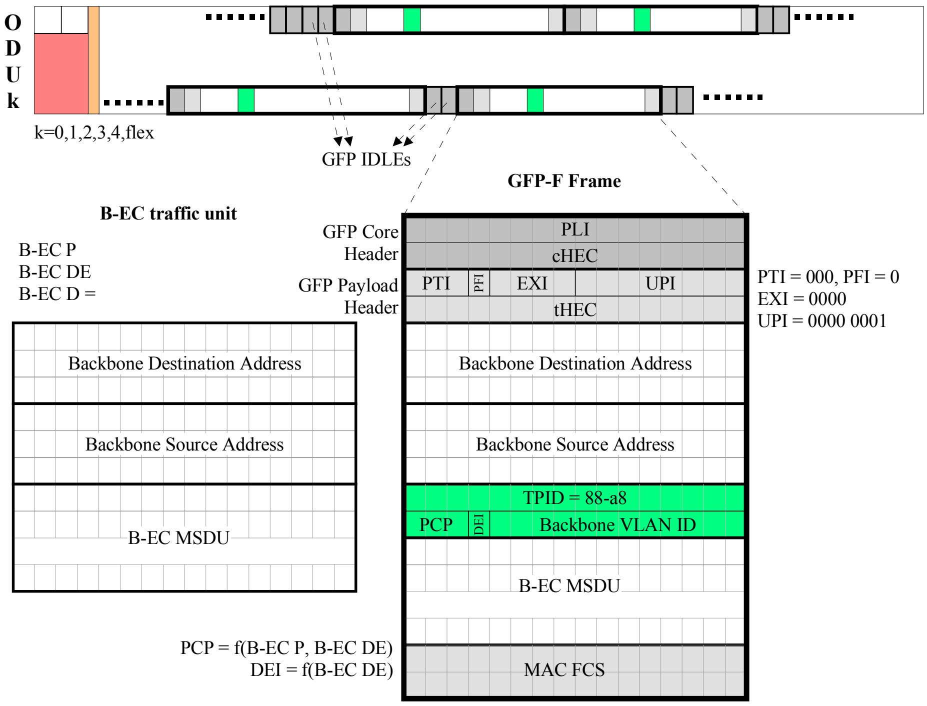


Figure 16-9 – Encapsulation of B-EC traffic unit into GFP-F frame and mapping of GFP-F frame into OTN ODUk

16.5 Ethernet switched path to virtual section

16.5.1 ESP to L-EC

The mapping and multiplexing of an ESP traffic unit (Figure 16-10, left) into an L-EC traffic unit (Figure 16-10, right) adds ESP Destination Address, ESP Source Address and an S-Tag. The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the ESP traffic unit and an ESP VID field of which the value is configured.

NOTE – The 3-tuple <ESP-DA, ESP-SA, ESP-VID> represent the ESP Identifier. The ESP-DA, ESP-SA and ESP-VID fields are therefore considered to be added to the traffic unit when the ESP signal is mapped and multiplexed into its server layer signal.

The L-EC traffic unit priority and drop_eligible values are copied from the ESP priority and drop_eligible values.

The demultiplexing and demapping of an ESP traffic unit from an L-EC traffic unit removes the fields added during mapping and multiplexing and derives the priority and drop_eligible information values of the ESP traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

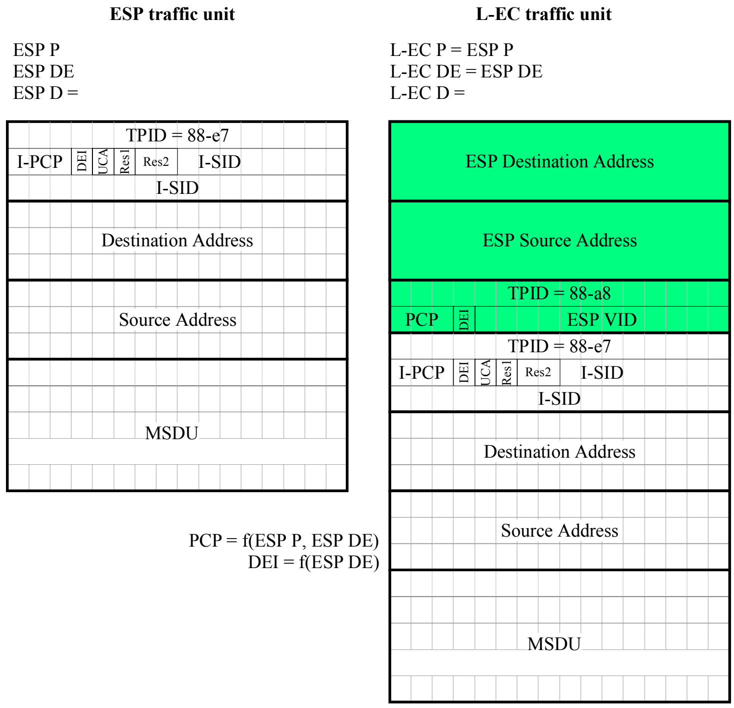


Figure 16-10 – Encapsulation of ESP traffic unit into an L-EC traffic unit

16.5.2 Ethernet switched path to OTN virtual section

The mapping and multiplexing of an ESP traffic unit (Figure 16-11, left) into an OTN OPUk Payload area adds ESP Destination Address, ESP Source Address, an S-Tag, a MAC FCS field and GFP-F Payload and Core Headers (Figure 16-11, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the OPUk Payload area (Figure 16-11, top) as specified in [ITU-T G.709].

The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the ESP traffic unit and an ESP VID field of which the value is configured.

NOTE – The 3-tuple <ESP-DA, ESP-SA, ESP-VID> represent the ESP Identifier. The ESP-DA, ESP-SA and ESP-VID fields are therefore considered to be added to the traffic unit when the ESP signal is mapped and multiplexed into its server layer signal.

The demultiplexing and demapping of an ESP traffic unit from an OTN OPUk Payload area removes the fields added during mapping and multiplexing and derives the priority and drop_eligible information values of the ESP traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

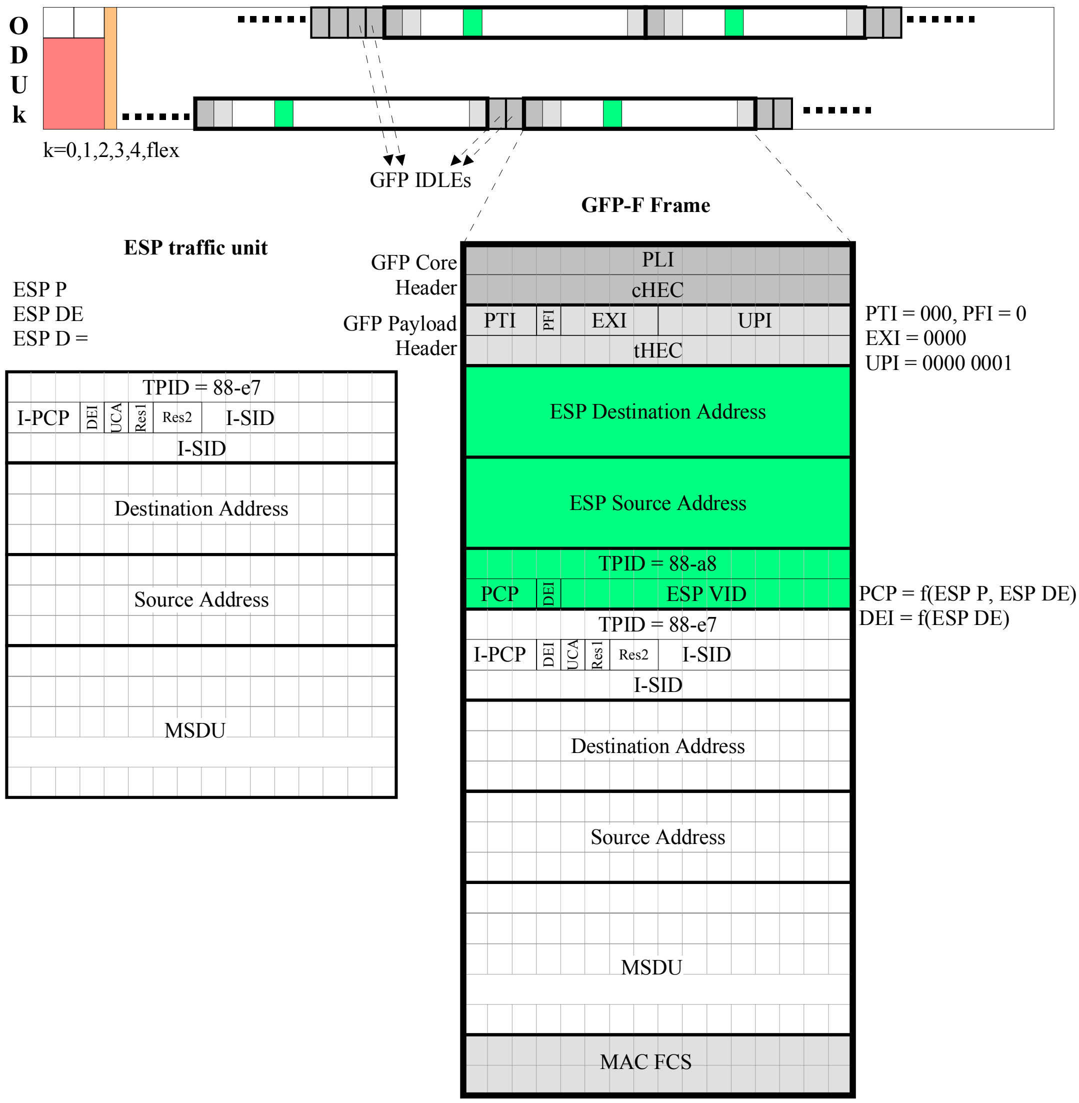


Figure 16-11 – Encapsulation of ESP traffic unit into GFP-F frame and mapping of GFP-F frame into OTN ODUk

16.6 Ethernet virtual section to physical medium

16.6.1 L-EC to Ethernet LAN physical medium

The mapping of an L-EC traffic unit (Figure 16-12, left) into an ETY frame (Figure 16-12, right) adds a Preamble field, a Start Frame Delimiter (SFD) field, a Frame Check Sequence (FCS) field and optionally a PAD field as specified in [IEEE 802.3].

The demapping of an L-EC traffic unit from an ETY frame removes the fields added during the mapping sets the priority information value of the L-EC traffic unit to the value of the Default User Priority parameter for the Port through which the L-EC traffic unit was received as specified in clause 6.7 of [IEEE 802.1Q] and sets the drop_eligible information value of the L-EC traffic unit to the value non-drop_eligible.

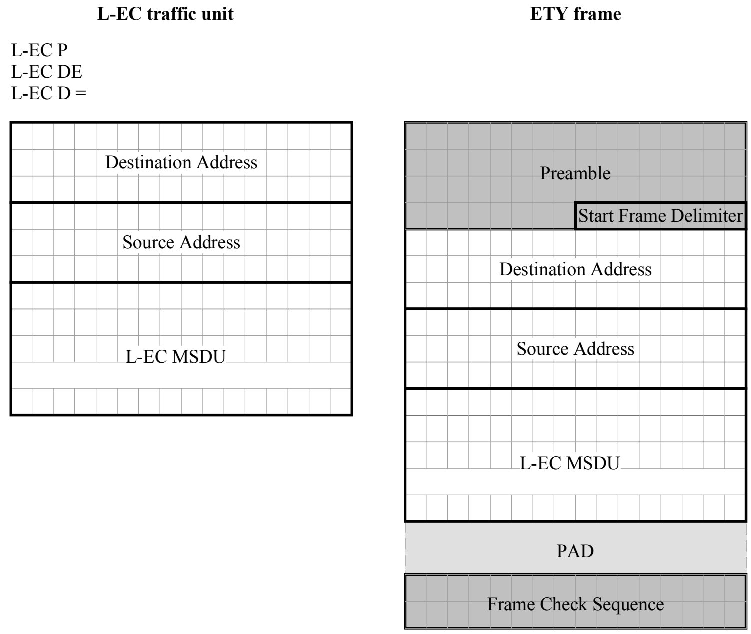


Figure 16-12 – Encapsulation of L-EC traffic unit into an ETY frame

16.6.2 L-EC to OTN ODUk

For the mapping of an L-EC traffic unit (Figure 16-13, left) into an OTN OPUk Payload area the L-EC traffic unit is extended with a MAC FCS field and GFP-F Payload and Core Headers (Figure 16-13, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the OPUk Payload area (Figure 16-13, top) as specified in [ITU-T G.709].

The demapping of an L-EC traffic unit from an OTN OPUk Payload area removes the fields added during the mapping sets the priority information value of the L-EC traffic unit to the value of the Default User Priority parameter for the Port through which the L-EC traffic unit was received as specified in clause 6.7 of [IEEE 802.1Q] and sets the drop_eligible information value of the L-EC traffic unit to the value non-drop_eligible.

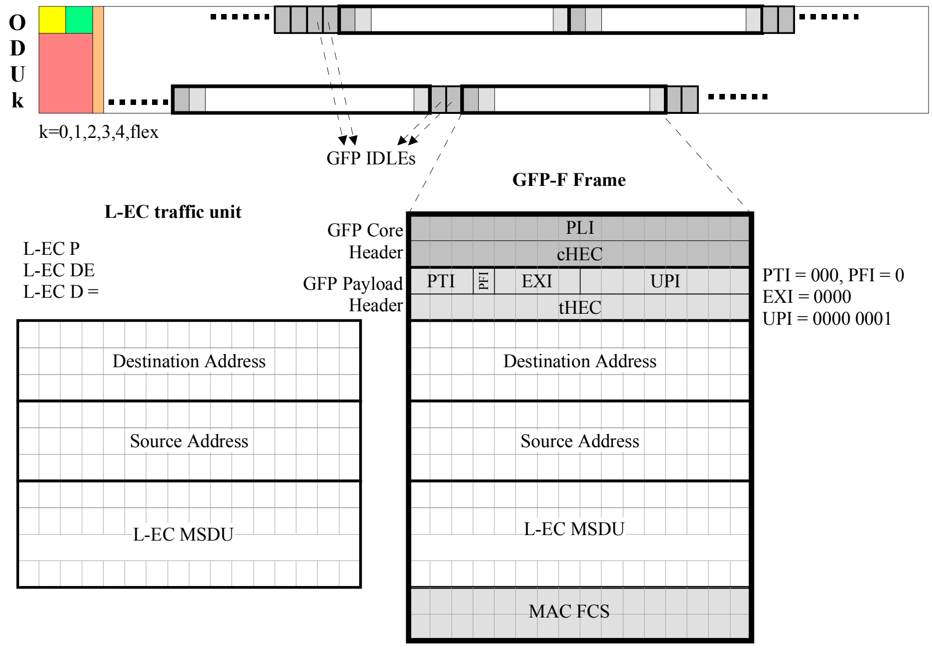


Figure 16-13 – Encapsulation of L-EC traffic unit into GFP-F frame and mapping of GFP-F frame into OTN ODUk

Annex A

EVC ↔ EC peering and EVC ⇔ EC client/server relationships

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

The relationship between an EVC on an Ethernet UNI and the EC in the ETH virtual channel layer in the network can be either a peering, or a client/server relationship.

In the client/server relationship illustrated in Figure A.1, the EVC is a client of the EC. The EC has its end points on the UNI-N interface ports in the transport network where NCM MEP functions perform the UNI-N to UNI-N monitoring of the EC. The EVC may represent a single subscriber Ethernet connection, or multiple subscriber Ethernet connections. The subscriber Ethernet connection(s) represented by the EVC and the EC each have their own set of eight Ethernet OAM levels.

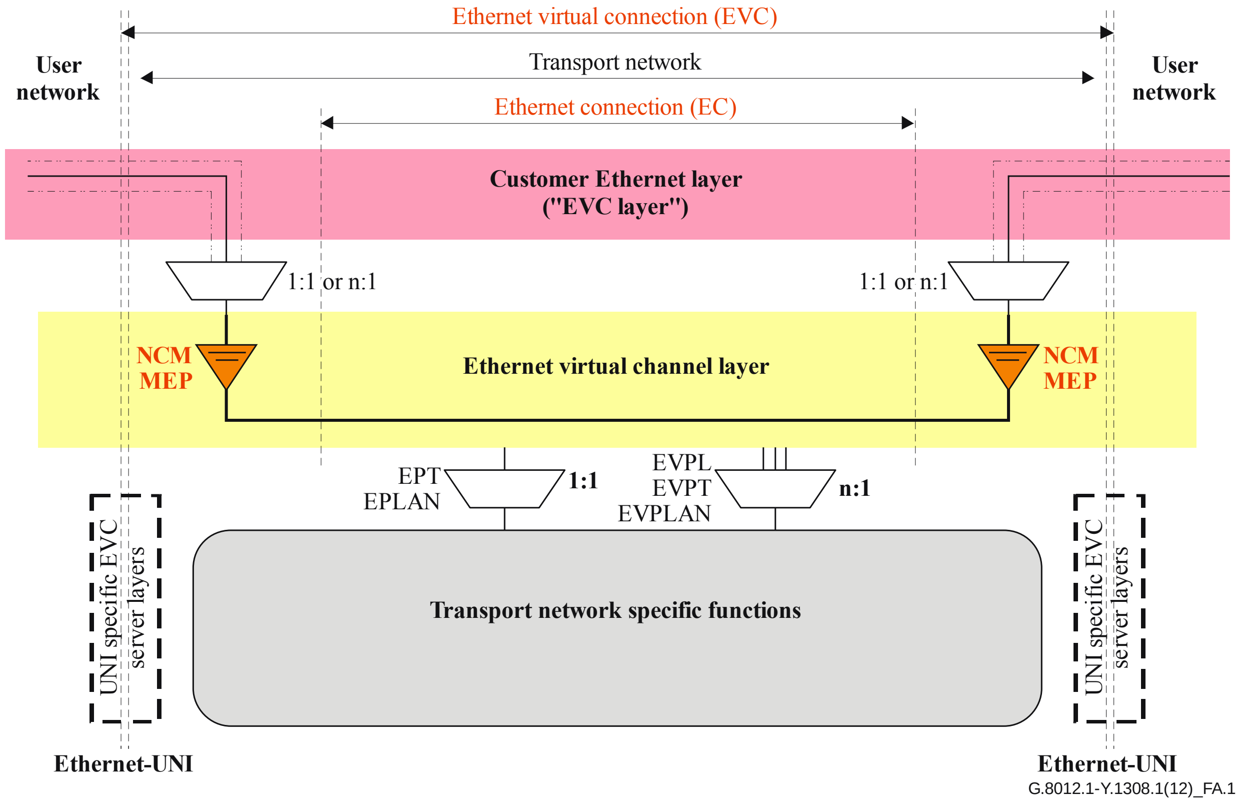


Figure A.1 – EVC⇔EC client/server illustration

In the peering relationship illustrated in Figure A.2, the EVC and EC form a single Ethernet connection of which the end points are located in the user network. The EC is a tandem connection of the EVC. The EC has its tandem connection endpoints on the UNI-N interface ports in the transport network where TCM MEP functions perform the UNI-N to UNI-N monitoring of the EC. The EVC represents a single subscriber Ethernet connection. The subscriber Ethernet connection represented by the EVC and the EC share the same eight Ethernet OAM levels.

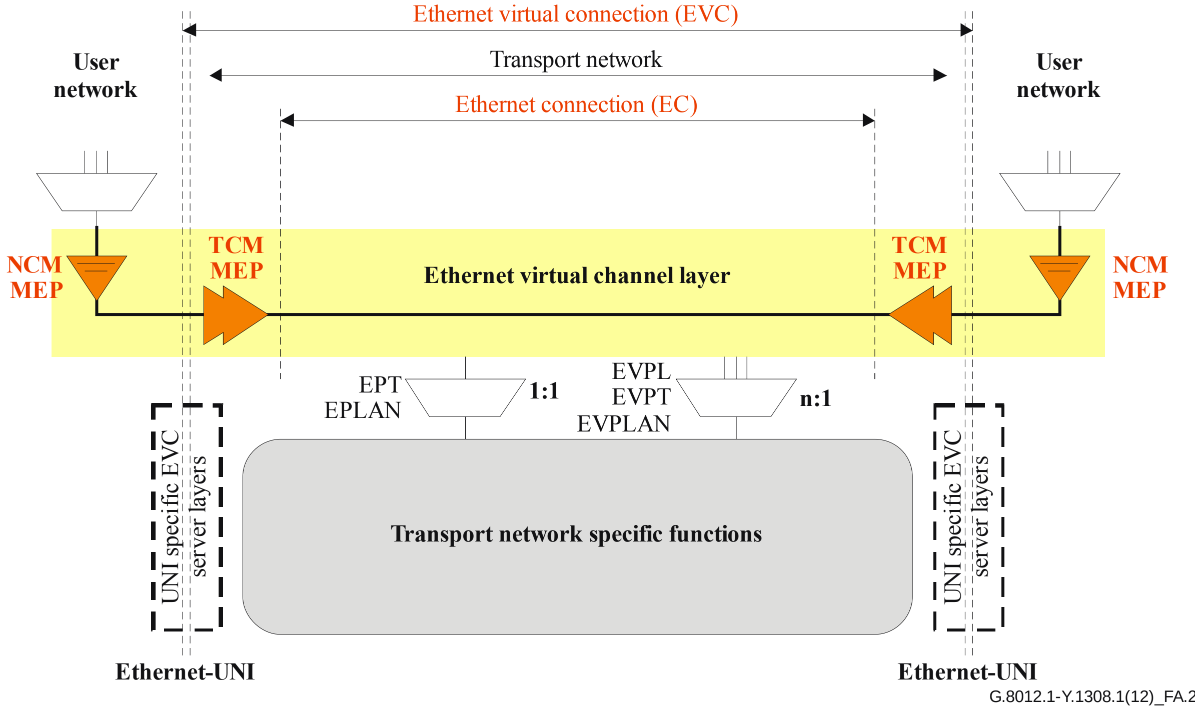


Figure A.2 – EVC↔EC peering illustration

Appendix I

P2P, RMP, MP2MP, hairpin Ethernet connection identifiers

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

An Ethernet link is supported by an Ethernet or non-Ethernet server layer trail. An Ethernet link is capable of supporting either a single Ethernet connection or multiple Ethernet connections. If a link is capable of supporting multiple Ethernet connections, it is required to attach an explicit Ethernet connection identifier (EC-ID) to every Ethernet connection traffic unit transported over the Ethernet link so that an egress link end point is capable of delivering each traffic unit to the appropriate Ethernet connection. If a link is capable of supporting a single Ethernet connection only, it is in most cases (but not all) not required to attach and explicit an EC-ID to every traffic unit of the single Ethernet connection. EC-IDs typically have the same value in the two directions of transmission, but some exceptions exist. This annex describes the EC-ID structures for a P2P EC, a single root RMP EC, a multi-root RMP EC, a RMP EC with leaf groups, a tree-structured MP2MP EC, an MP2MP EC with full mesh of link connections and a hairpin EC.

An EC-ID represents one of the following externally observable [IEEE 802.1Q] identifiers: C-VLAN ID (CVID), S-VLAN ID (SVID) and B-VLAN ID (BVID).

[IEEE 802.1Q] specifies an additional EC-ID type, the Relay VID (RVID). The RVID is an equipment internal EC-ID. In ITU-T's Ethernet functional model, an RVID value is represented by an ETH flow point.

[IEEE 802.1Q] specifies that the external EC-ID and the internal EC-ID of an Ethernet connection may have the same value, or that they may have different values. The latter is referred to as ID translation. EC-ID Translation may be symmetric or asymmetric, as specified in Table I.1.

Table I.1 – EC-ID translation alternatives

EC-ID translation	External EC-ID e.g., SVID	direction	Internal EC-ID RVID	ETH FP
None	X X	→ ←	X X	One bidirectional FP
Symmetric	X X	→ ←	Y Y	One bidirectional FP
Asymmetric I	X X	→ ←	Y1 Y2	Two unidirectional FPs
Asymmetric II	X1 X2	→ ←	Y1 Y2	Two unidirectional FPs
Asymmetric III	X X X	→ ← ←	Y1 Y1 Y2	One bidirectional FP and one unidirectional FP

If an Ethernet connection is associated with one RVID/ETH FP, the learning process for the Ethernet connection will be based on independent VLAN learning (IVL).

If an Ethernet connection is associated with two or more RVIDs/ETH FPs, the learning process for the Ethernet connection will be based on shared VLAN learning (SVL).

In all the figures below, the UNI-N ports are located in the Leaf (L), Leaf Group (LG) and Root (R) nodes.

I.1 RMP Ethernet connection identifiers

I.1.1 Single root

Figure I.1 illustrates an RMP Ethernet connection (EC) consisting of one root R1 and five leaves L1 to L5. This RMP EC is supported via five Ethernet bridge nodes (B1 to B5) which are interconnected via point-to-point Ethernet links. Those Ethernet links may be supported by any type of server layer trail, e.g., Ethernet, PBB-TE, SDH, OTN, etc. Each of those Ethernet links provides an EC-ID to support the RMP EC. The EC-ID values associated with the RMP EC are indicated on the lines between the nodes in Figure I.1 (e.g., "A", "B", etc.). Each port (e.g., P10, P11, etc.) on a node provides EC-ID translation between the external EC-ID value and the internal EC-ID values. For example, port P10 translates external EC-ID value "A" into internal EC-ID value "I" and translates internal EC-ID value "R" into external EC-ID value "A", and port P13 translates external EC-ID value "Q" into internal EC-ID value "I" and translates internal EC-ID value "R" into external EC-ID value "Q".

It is noted that the RMP EC is supported by a single external EC-ID value on each Ethernet link, e.g., "P" on the Ethernet link between nodes B1 and B2.

It is also noted that each node operates with two internal EC-ID values; i.e., "I" and "R". Those two EC-ID values are associated with two ETH flow forwarding processes (FF(I), FF(R)) as illustrated in Figure I.2. Those two ETH FF processes are operated in Shared VLAN Learning (SVL) mode to support the connectivity of this RMP EC. These two ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.2. The adaptation function associated with port P20 receives ETH traffic units from the Ethernet link with an EC-ID value "B" and forwards those traffic units to the ETH FF(I) process. Vice versa, this adaptation function receives traffic units from the ETH FF(R) process and forwards those traffic units to the Ethernet link with an EC-ID value of "B". ETH TCM MEP and MIP functions operate with those internal EC-ID values I and R.

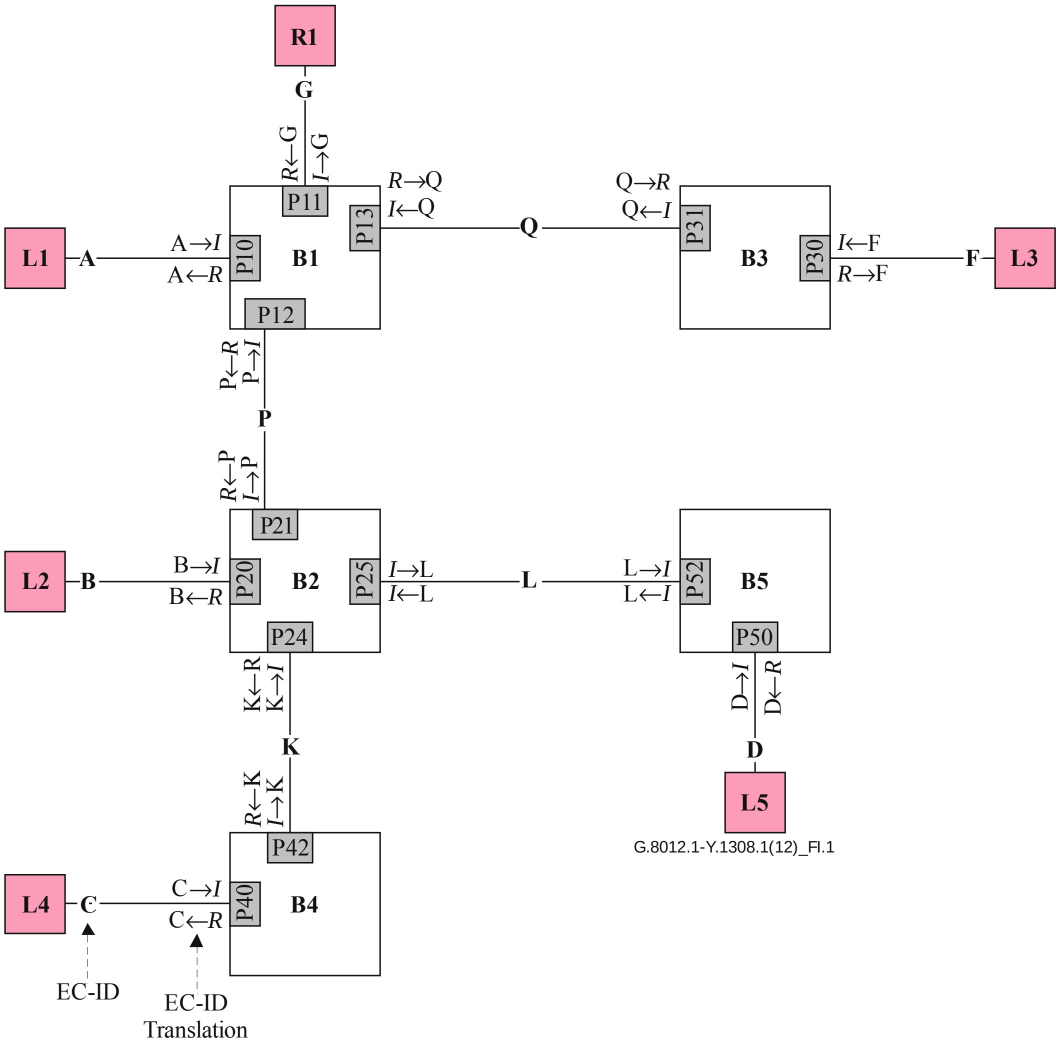


Figure I.1 – RMP Ethernet connection example with one root port and five leaf ports

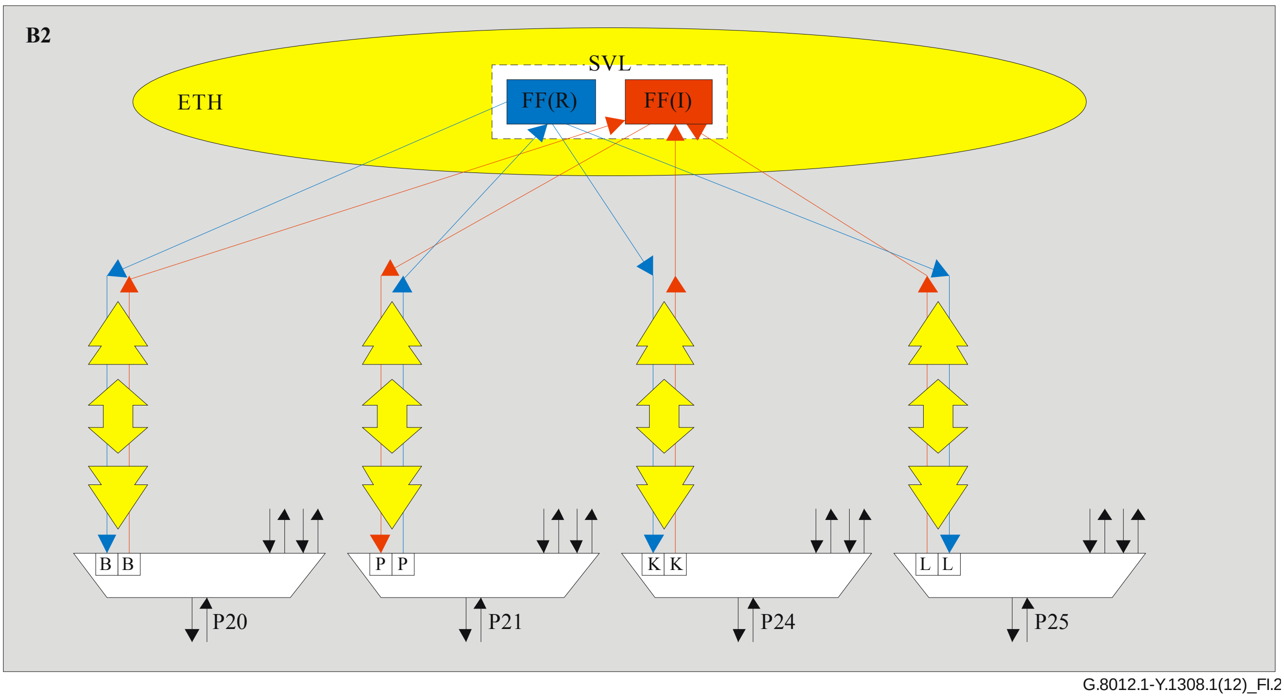


Figure I.2 – RMP Ethernet connection configuration details in Bridge 2 of Figure I.1

I.1.2 Multiple roots

Figure I.3 illustrates an RMP Ethernet connection (EC) consisting of two roots R1 and R2 and five leaves L1 to L5. This RMP EC is supported via five Ethernet bridge nodes (B1 to B5) which are interconnected via point-to-point Ethernet links. Those Ethernet links may be supported by any type of server layer trail, e.g., Ethernet, PBB-TE, SDH, OTN, etc. Each of those Ethernet links provides one or two EC-ID to support the RMP EC. The EC-ID values associated with the RMP EC are indicated on the lines between the nodes in Figure I.3 (e.g., "A", "B", etc.). Each port (e.g., P10, P11, etc.) on a node provides EC-ID translation between the external EC-ID value or values and the internal EC-ID values. For example, port P10 translates external EC-ID value "A" into internal EC-ID value "I" and translates internal EC-ID value "R" into external EC-ID value "A", port P11 translates external EC-ID value "G" into internal EC-ID value "R" and translates internal EC-ID values "I" and "R" into external EC-ID value "G", and port P13 translates external EC-ID value "Q" into internal EC-ID value "I" and translates internal EC-ID value "R" into external EC-ID value "Q".

It is noted that the RMP EC is supported by one or two external EC-ID values on each Ethernet link, e.g., "P" and "R" on the Ethernet link between nodes B1 and B2. On the Ethernet link between nodes B2 and B4 the RMP EC is identified by one EC-ID value "K". In general on the links between the roots two EC-ID values are deployed, on other links one EC-ID value.

It is also noted that each node operates with two internal EC-ID values; i.e., "I" and "R". Those two EC-ID values are associated with two ETH Flow Forwarding processes (FF(I), FF(R)) as illustrated in Figure I.4. Those two ETH FF processes are operated in shared VLAN learning (SVL) mode to support the connectivity of this RMP EC. These two ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.4. The adaptation function associated with port P20 receives ETH traffic units from the Ethernet link with an EC-ID value "B" and forwards those traffic units to the ETH FF(I) process. Vice versa, this adaptation function receives traffic units from the ETH FF(R) process and forwards those traffic units to the Ethernet link with an EC-ID value of "B". ETH TCM MEP and MIP functions operate with those internal EC-ID values I and R.

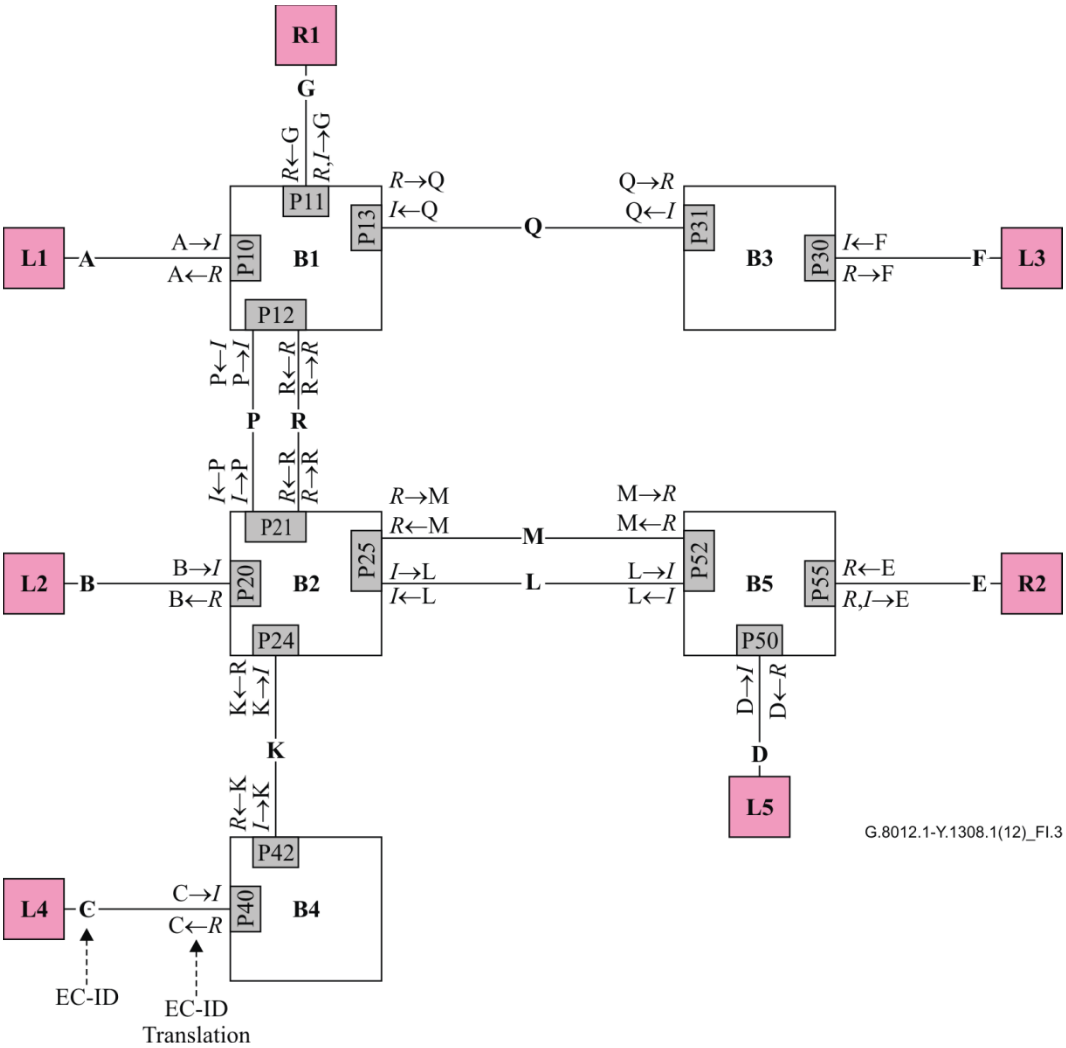


Figure I.3 – RMP Ethernet connection example with two root ports and five leaf ports

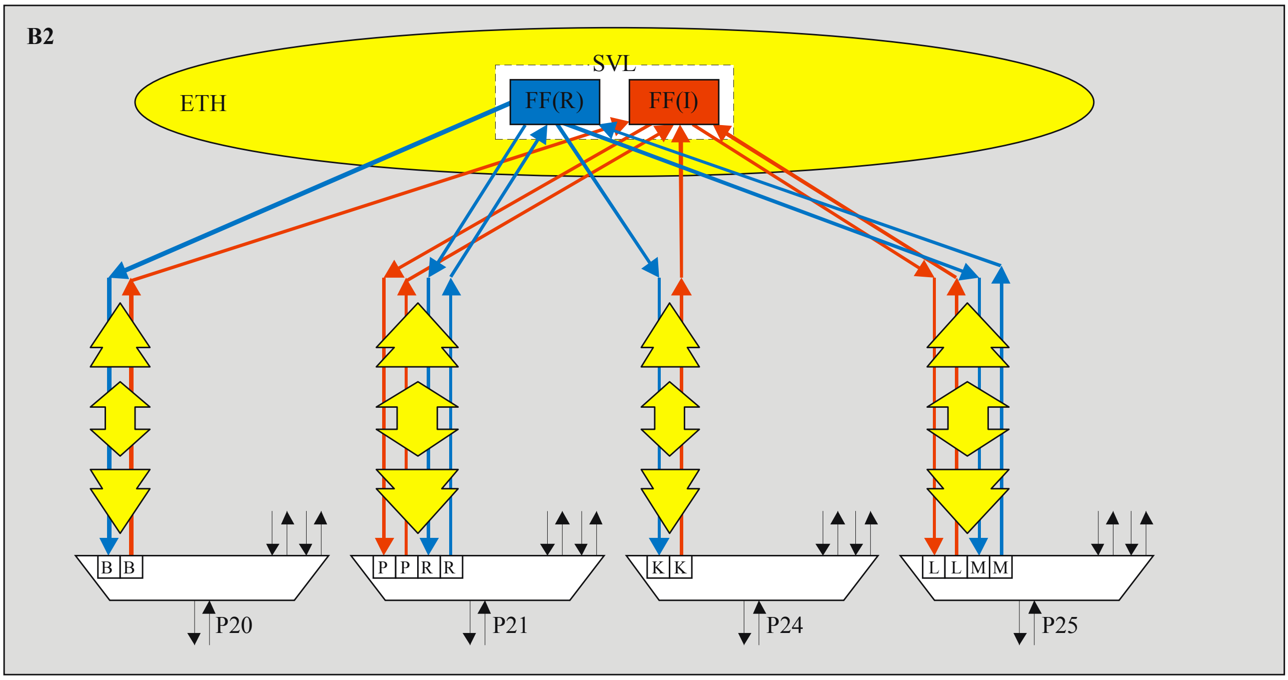


Figure I.4 – RMP Ethernet connection configuration details in Bridge 2 of Figure I.3

I.1.3 Single root, one or more leaf groups

Figure I.5 illustrates an RMP Ethernet connection (EC) consisting of one root R1, five leaves L1 to L5 and one leaf group (LG1) with two leaves (LG11, LG12). This RMP EC is supported via five Ethernet bridge nodes (B1 to B5) which are interconnected via point-to-point Ethernet links. Those Ethernet links may be supported by any type of server layer trail, e.g., Ethernet, PBB-TE, SDH, OTN, etc. Each of those Ethernet links provides one or two EC-ID values to support the RMP EC. The EC-ID value associated with the RMP EC are indicated on the lines between the nodes in Figure I.5 (e.g., "A", "B", etc.). Each port (e.g., P10, P11, ..) on a node provides EC-ID Translation between the external EC-ID value or values and the internal EC-ID values. For example, port P10 translates external EC-ID value "A" into internal EC-ID value "I" and translates internal EC-ID value "R" into external EC-ID value "A", port P11 translates external EC-ID value "G" into internal EC-ID value "R" and translates internal EC-ID values "I" and "V_{G1}" into external EC-ID value "G", and port P13 translates external EC-ID value "Q" into internal EC-ID value "I", translates internal EC-ID value "R" into external EC-ID value "Q", translates external EC-ID value "T" into internal EC-ID value "V_{G1}" and translates internal EC-ID value "V_{G1}" into external EC-ID value "T".

It is noted that the RMP EC is supported by one or two external EC-ID values on each Ethernet link, e.g., "P" on the Ethernet link between nodes B1 and B2. On the Ethernet link between nodes B1 and B2 the RMP EC is supported by two external EC-ID values "P" and "S".

It is also noted that one node (B5) operates with two internal EC-ID values (i.e., "I" and "R") and that the other four nodes operator with three internal EC-ID values (i.e., "I", "R" and "V_{G1}"). Those three EC-ID values are associated with three ETH Flow Forwarding processes (FF(I), FF(R) and FF(V_{G1})) as illustrated in Figure I.6. Those three ETH FF processes are operated in Shared VLAN Learning (SVL) mode to support the connectivity of this RMP EC. These three ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.6. The adaptation function associated with port P24 receives ETH traffic units from the Ethernet link with EC-ID values "K" and "N" and forwards those traffic units to the ETH FF(I) and FF(V_{G1}) processes. Vice versa, this adaptation function receives traffic units from the ETH FF(R) and FF(V_{G1}) processes and forwards those traffic units to the Ethernet link with an EC-ID value of "K" or "N". ETH TCM MEP and MIP functions operate with those internal EC-ID values I, R and V_{G1}.

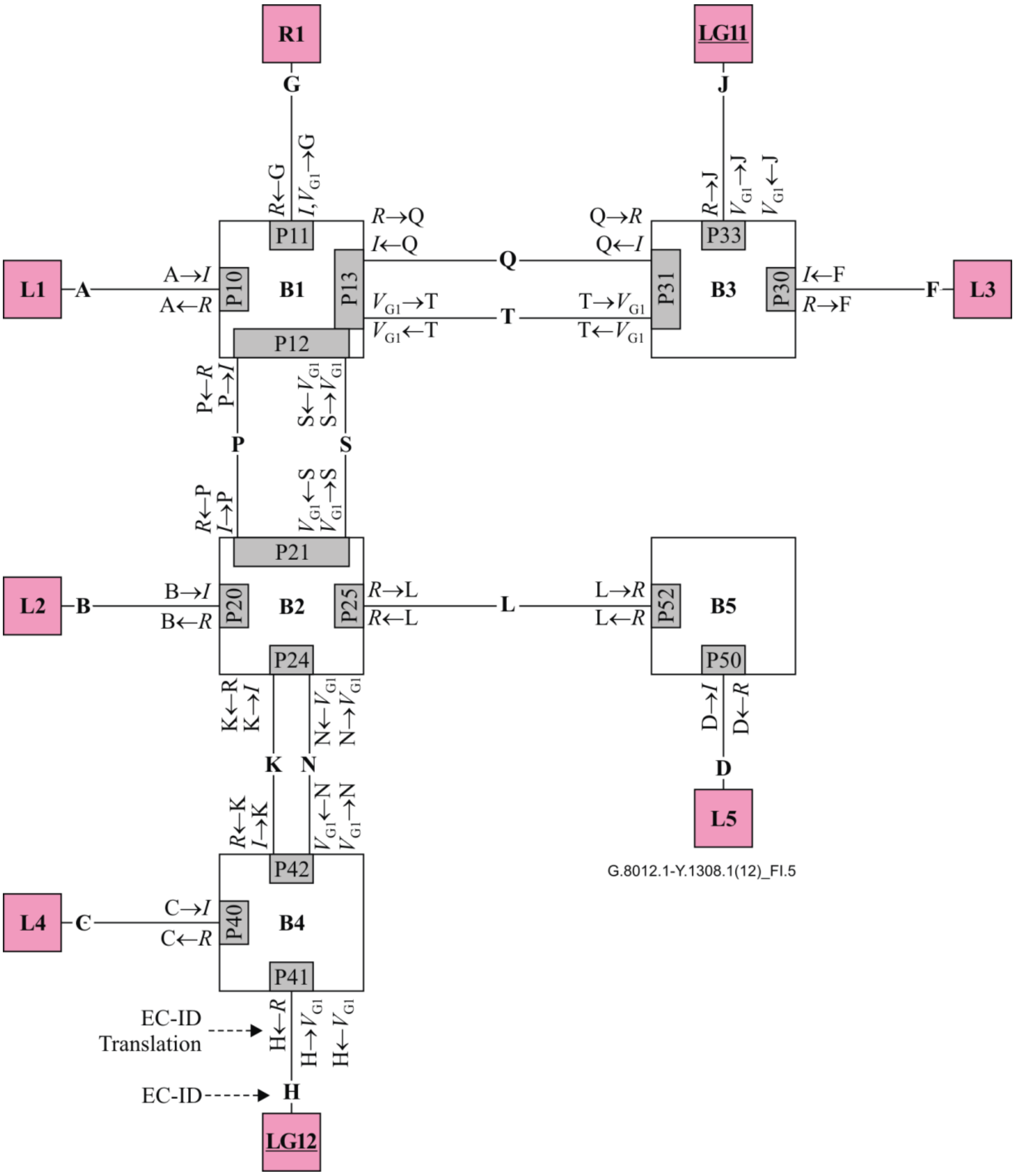


Figure I.5 – RMP Ethernet connection example with one root port, five leaf ports and one leaf group with two leaf group ports

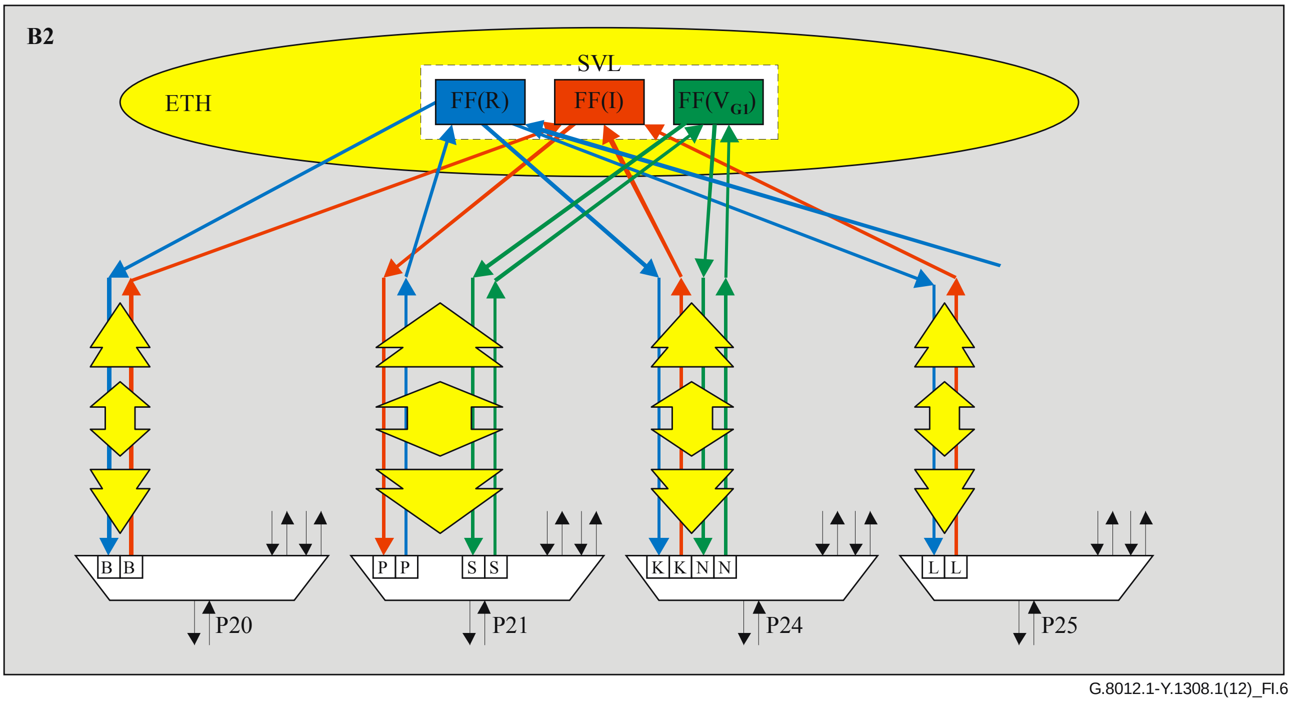


Figure I.6 – RMP Ethernet connection configuration details in Bridge 2 of Figure I.5

I.1.4 Multiple roots, one or more leaf groups

Figure I.7 illustrates an RMP Ethernet connection (EC) consisting of two roots R1 and R2, five leaves L1 to L5 and one leaf group (LG1) with two leaves (LG11, LG12). This RMP EC is supported via five Ethernet Bridge nodes (B1 to B5) which are interconnected via point-to-point Ethernet links. Those Ethernet links may be supported by any type of server layer trail, e.g., Ethernet, PBB-TE, SDH, OTN, etc. Each of those Ethernet links provides one, two or three EC_ID values to support the RMP EC. The EC-ID values associated with the RMP EC are indicated on the lines between the nodes in Figure I.7 (e.g., "A", "B", etc.). Each port (e.g., P10, P11, ..) on a node provides EC-ID Translation between the external EC-ID value or values and the internal EC-ID values. E.g., port P10 translates external EC-ID value "A" into internal EC-ID value "I" and translates internal EC-ID value "R" into external EC-ID value "A", port P11 translates external EC-ID value "G" into internal EC-ID value "R" and translates internal EC-ID values "I", "R" and "V_{G1}" into external EC-ID value "G", and port P13 translates external EC-ID value "Q" into internal EC-ID value "I", translates internal EC-ID value "R" into external EC-ID value "Q", translates external EC-ID value "T" into internal EC-ID value "V_{G1}" and translates internal EC-ID value "V_{G1}" into external EC-ID value "T".

It is noted that the RMP EC is supported by one, two or three external EC-ID values on each Ethernet link, e.g., "P", "R" and "S" on the Ethernet link between nodes B1 and B2. On the Ethernet link between nodes B2 and B4 the RMP EC is identified by two EC-ID values "K" and "N", and on the Ethernet link between node B4 and LG12 the RMP EC is identified by a single EC-ID value "H".

It is also noted that all nodes operate with three internal EC-ID values (i.e., "I", "R" and "V_{G1}"). Those three EC-ID values are associated with three ETH Flow Forwarding processes (FF(I), FF(R) and FF(V_{G1})) as illustrated in Figure I.8. Those three ETH FF processes are operated in Shared VLAN Learning (SVL) mode to support the connectivity of this RMP EC. These three ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.8. The adaptation function associated with e.g., port P21 receives ETH traffic units from the Ethernet link with EC-ID values "P", "R" and "S" and forwards those traffic units to the ETH FF(I), FF(R) and FF(V_{G1}) processes. Vice versa, this adaptation function receives traffic units from the ETH FF(I), FF(R) and FF(V_{G1}) processes and forwards those traffic units to the Ethernet link with an EC-ID value of "P", "R" or "S". ETH TCM MEP and MIP functions operate with those internal EC-ID values I, R and V_{G1}.

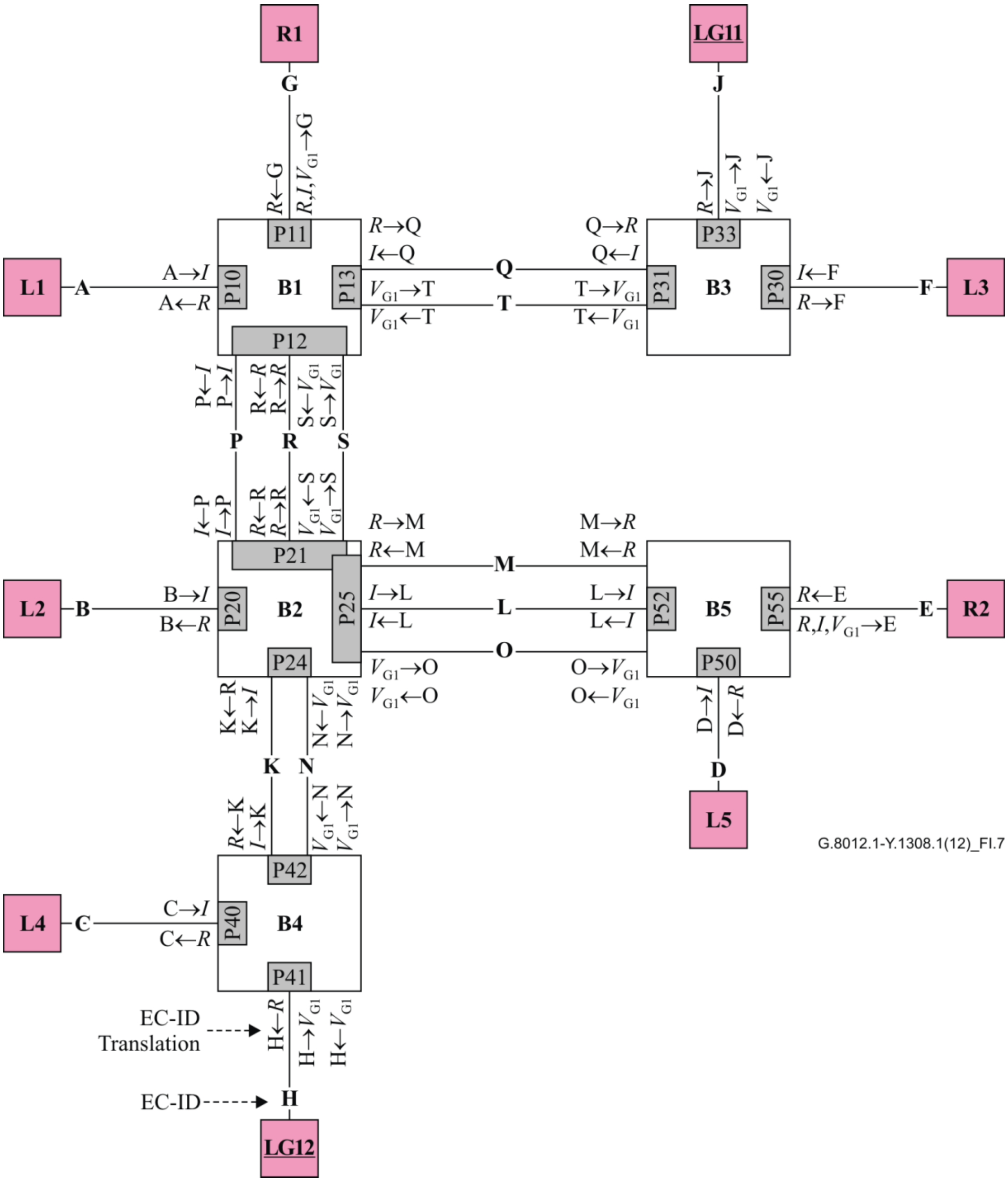


Figure I.7 – RMP Ethernet connection example with two root ports, five leaf ports and one leaf group with two leaf group ports

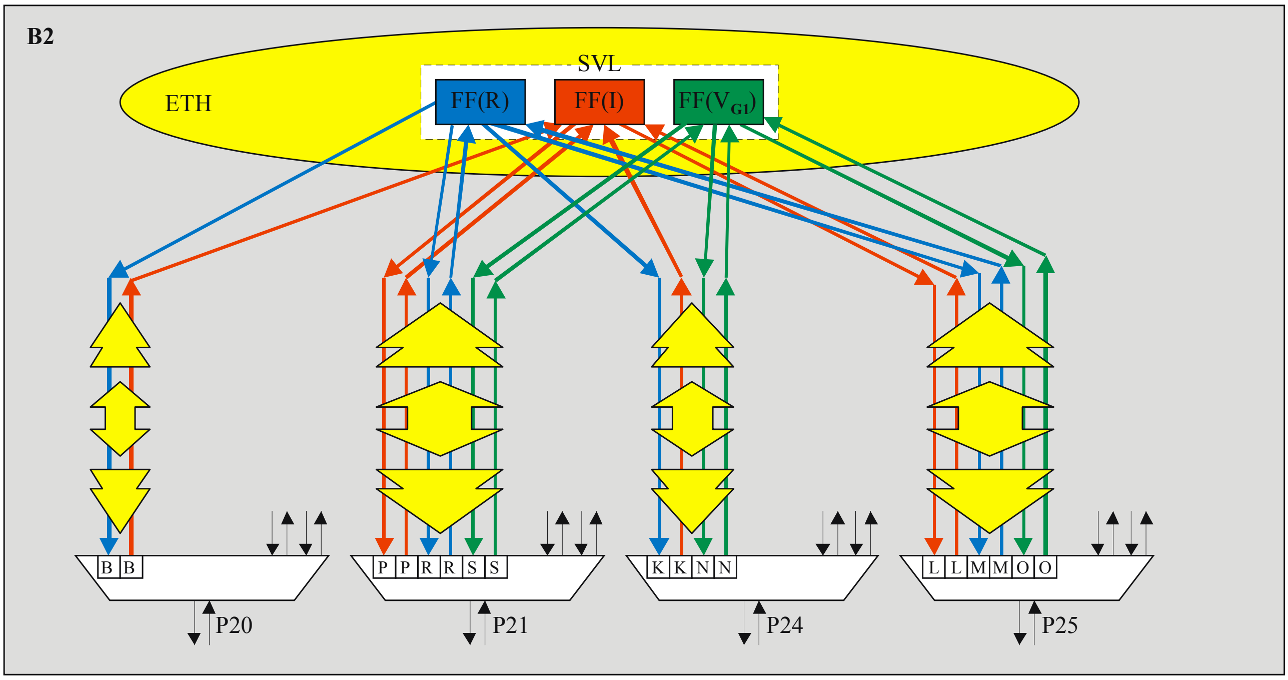


Figure I.8 – RMP Ethernet connection configuration details in Bridge 2 of Figure I.7

I.2 MP2MP Ethernet connection identifiers

I.2.2 Full mesh

Figure I.9 illustrates a full mesh MP2MP Ethernet connection (EC) consisting of six end points C1 to C6. This MP2MP EC is supported via four Ethernet bridge nodes (B1 to B4) which are interconnected via point-to-point Ethernet links. Those Ethernet links may be supported by any type of server layer trail, e.g., Ethernet, PBB-TE, SDH, OTN, etc. Each of those Ethernet links provides one external EC-ID value to support the MP2MP EC. The EC-ID values associated with the MP2MP EC are indicated on the lines between the nodes in Figure I.9 (e.g., "P", "Q", etc.). Each port (e.g., P10, P11, ..) on a node provides EC-ID Translation between the external EC-ID value and the internal EC-ID values. For example, port P10 translates external EC-ID value "A" into internal EC-ID value "V" and translates internal EC-ID values "I" and "V" into external EC-ID value "A" and port P13 translates external EC-ID value "Q" into internal EC-ID value "I", translates internal EC-ID value "V" into external EC-ID value "Q".

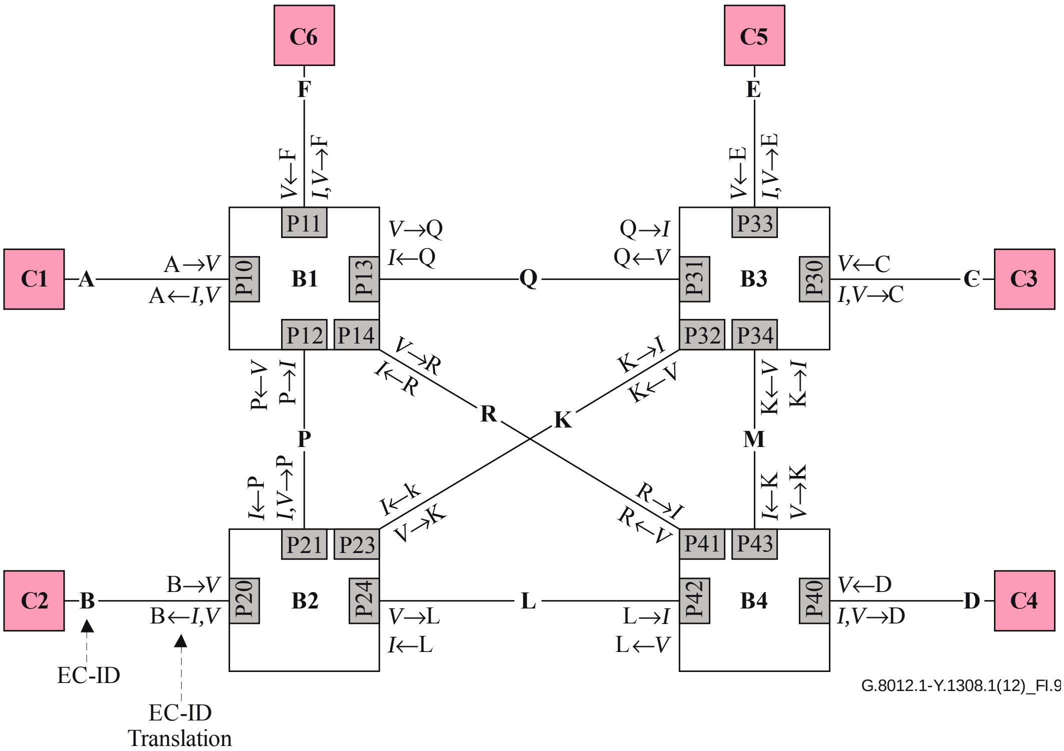


Figure I.9 – VPLS style MP2MP Ethernet connection example

It is noted that the MP2MP EC is supported by a single external EC-ID value on each Ethernet link, e.g., "P" on the Ethernet link between nodes B1 and B2.

It is also noted that each node operates with two internal EC-ID values; i.e., "I" and "V". Those two EC-ID values are associated with two ETH Flow Forwarding processes (FF(I), FF(V)) as illustrated in Figure I.10. Those two ETH FF processes are operated in Shared VLAN Learning (SVL) mode to support the connectivity of this full mesh MP2MP EC. These two ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.10. The adaptation function associated with port P10 receives ETH traffic units from the Ethernet link with an EC-ID value "A" and forwards those traffic units to the ETH FF(V) process. Vice versa, this adaptation function receives traffic units from the ETH FF(V) and FF(I) processes and forwards those traffic units to the Ethernet link with an EC-ID value of "A". The adaptation function associated with port P12 receives ETH traffic units from the Ethernet link with an EC-ID value "P" and forwards those traffic units to the ETH FF(I) process. Vice versa, this adaptation function receives traffic units from the ETH FF(V) process and forwards those traffic units to the Ethernet link with an EC-ID value of "P". ETH TCM MEP and MIP functions operate with those internal EC-ID values I and V.

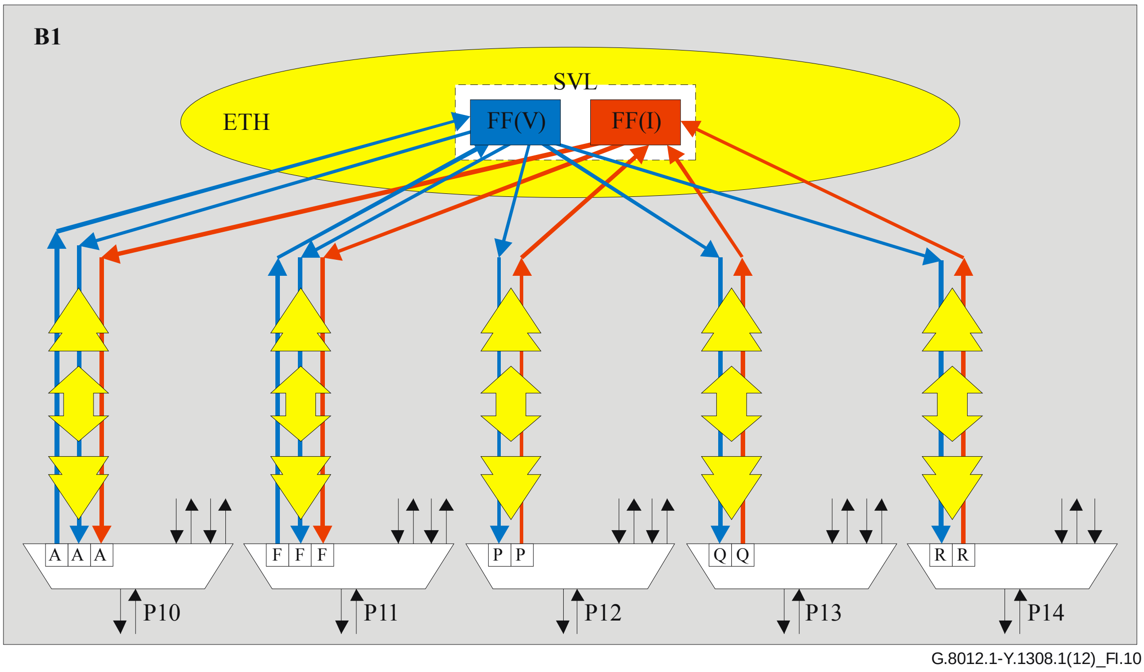


Figure I.10 – Full mesh MP2MP Ethernet connection configuration details in Bridge 1 of Figure I.9

I.2.3 Hybrid

Figure I.11 illustrates a hybrid MP2MP Ethernet connection (EC) consisting of eight end points C1 to C8. This MP2MP EC is supported via six Ethernet bridge nodes (B1 to B6) which are interconnected via point-to-point Ethernet links. Those Ethernet links may be supported by any type of server layer trail, e.g., Ethernet, PBB-TE, SDH, OTN, etc. Each of those Ethernet links provides one external EC-ID value to support the MP2MP EC. The EC-ID values associated with the MP2MP EC are indicated on the lines between the nodes in Figure I.11 (e.g., "P", "Q", etc.). Each port (e.g., P20, P21, ..) on a node provides EC-ID Translation between the external EC-ID value and the internal EC-ID values. E.g., port P20 translates external EC-ID value "B" into internal EC-ID value "*V*" and translates internal EC-ID values "I_A", "I_B" and "*V*" into external EC-ID value "B", port P21 translates external EC-ID value "P" into internal EC-ID value "I_A" and translates internal EC-ID values "I_B" and "V" into external EC-ID value "P" and port P26 translates external EC-ID value "Z" into internal EC-ID value "*V*" and translates internal EC-ID values "I_A" , "I_B" and "*V*" into external EC-ID value "Z".

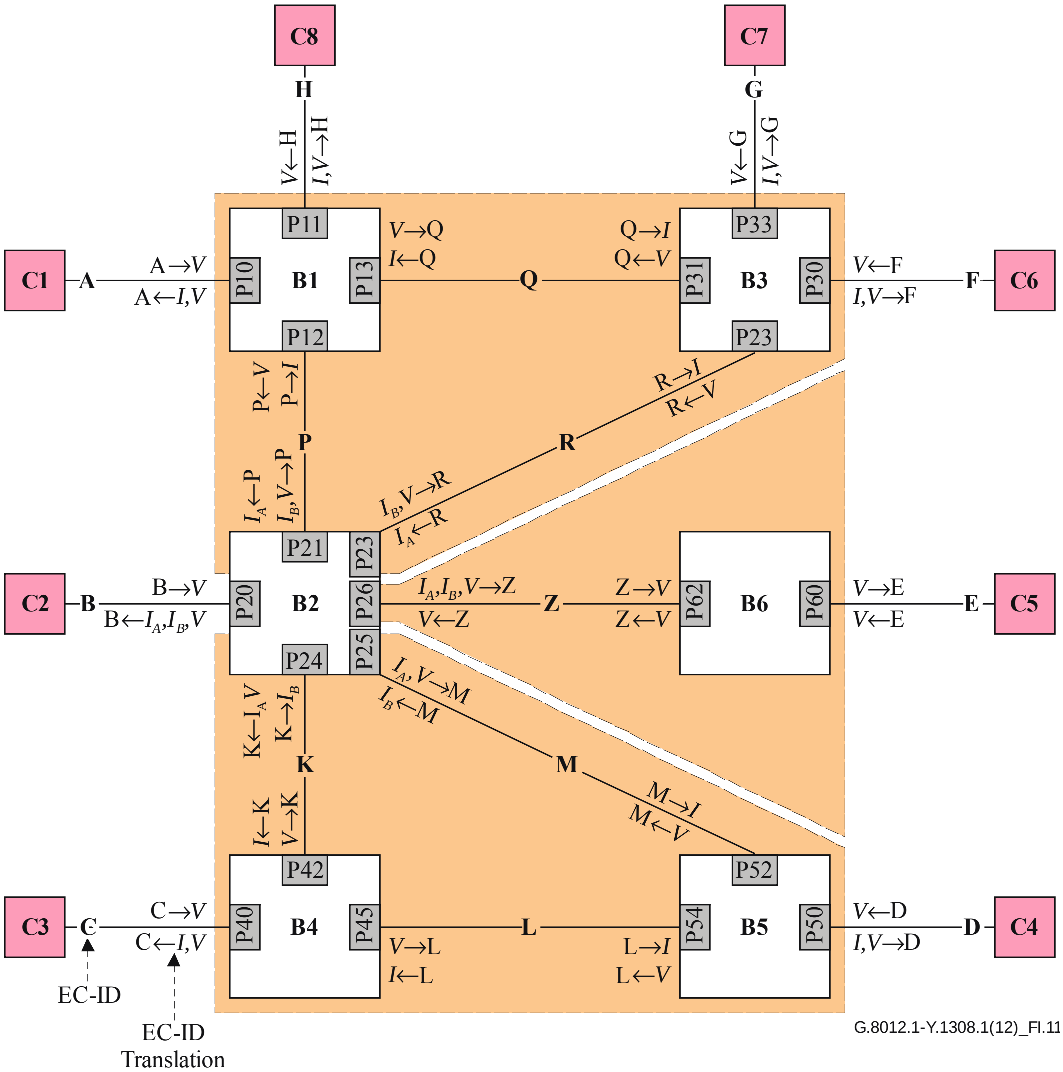


Figure I.11 – Example of a hybrid MP2MP Ethernet connection

It is noted that the hybrid MP2MP EC is supported by a single external EC-ID value on each Ethernet link, e.g., "P" on the Ethernet link between nodes B1 and B2.

It is also noted that each node in this example operates with one, two or three internal EC-ID values to support this hybrid MP2MP EC; i.e., "*V*" in node B6, "*I*" and "*V*" in nodes B1, B3, B4 and B5 and "I_A", "I_B" and "*V*" in node B2. In general, a node in an MP2MP EC will deploy N+1 internal EC-IDs to support an MP2MP EC, with N representing the number of VPLS-style Ethernet SubNetwork Connections ending in the node (B6: N=0, B1,B3,B4,B5: N=1, B2: N=2).

A node supporting the MP2MP EC with a single internal EC-ID value deploys one ETH Flow Forwarding process (FF(V)) operating in Independent VLAN Learning (IVL) mode.

A node supporting the MP2MP EC with two internal EC-ID values deploys two ETH Flow Forwarding processes (FF(I), FF(V)) as illustrated in Figure I.10. Those two ETH FF processes are operated in Shared VLAN Learning (SVL) mode to support the connectivity of this MP2MP EC. These two ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.10. The adaptation function associated with port P10 receives ETH traffic units from the Ethernet link with an EC-ID value "A" and forwards those traffic units to the ETH FF(V) process. Vice versa, this adaptation function receives traffic units from the ETH FF(V) and FF(I) processes and forwards those traffic units to the Ethernet link with an EC-ID value of "A". The adaptation function associated with port P12 receives ETH traffic units from the Ethernet link with an EC-ID value "P" and forwards those traffic units to the ETH FF(I) process. Vice versa, this adaptation function receives traffic units from the ETH FF(V) process and forwards those traffic units to the Ethernet link with an EC-ID value of "P". ETH TCM MEP and MIP functions operate with those internal EC-ID values I and V.

A node supporting the MP2MP EC with three internal EC-ID values deploys three ETH Flow Forwarding processes (FF(I_A), FF(I_B), FF(V)) as illustrated in Figure I.12. Those three ETH FF processes are operated in Shared VLAN Learning (SVL) mode to support the connectivity of this MP2MP EC. These three ETH FF processes are connected with the ETH adaptation function as illustrated in Figure I.12.

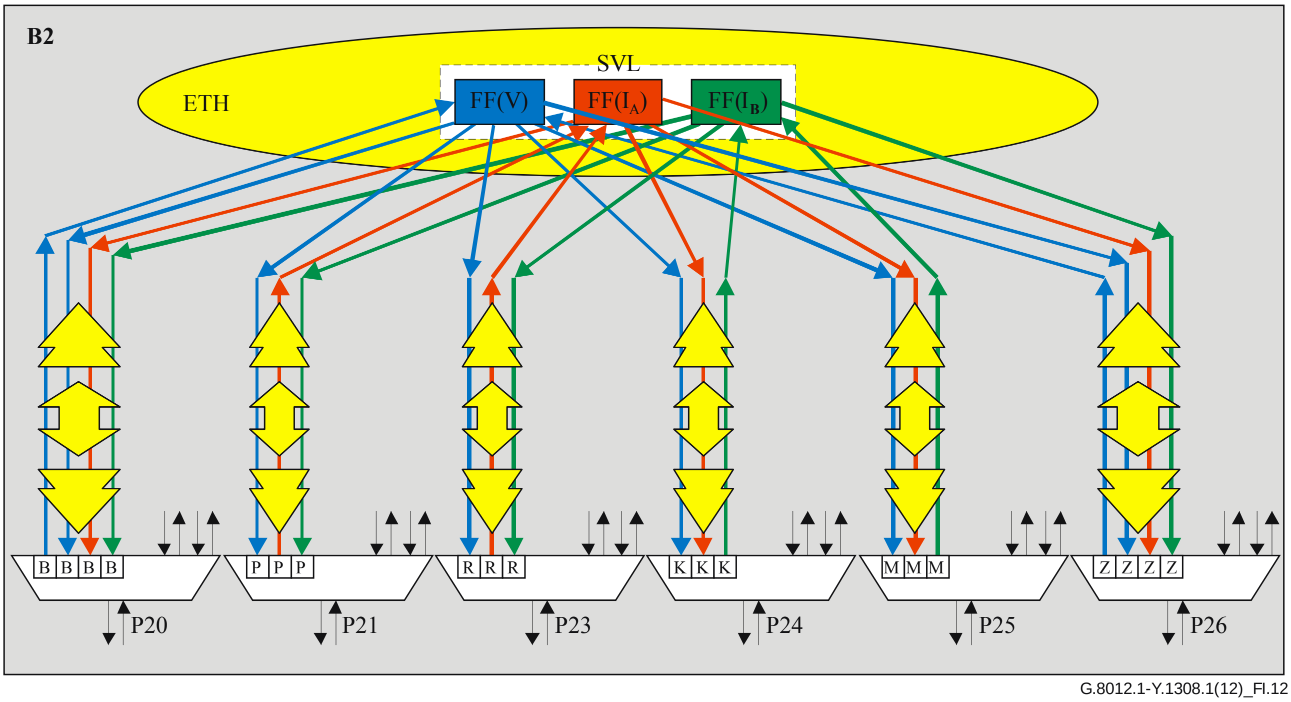


Figure I.12 – Details of hybrid MP2MP Ethernet connection configuration in Bridge 2 of Figure I.11

Appendix II

Relationship between ITU-T G.8012.1 Ethernet connection types and MEF Ethernet connection types

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

II.1 Introduction

EC, ECS

Regarding the EC roles in the carrier Ethernet network (CEN), three kinds of ECs are defined in [b-MEF 12.1]:

– Subscriber EC (S-EC); Operator EC (O-EC); Service provider EC (SP-EC).

EVC. OVC

The relationship between an EVC, its associated subscriber EC(s), operator EC(s), service provider EC, and any underlying OVC(s), is illustrated in Figure 10 of [b-MEF 12.1].

MEF defines the following EC types in [b-MEF 12.1]:

– Point-to-point ECs, multipoint ECs, rooted multipoint ECs
– Hairpin ECs
– Tunnel ECs, Tunnel-1 service, Tunnel-2 service

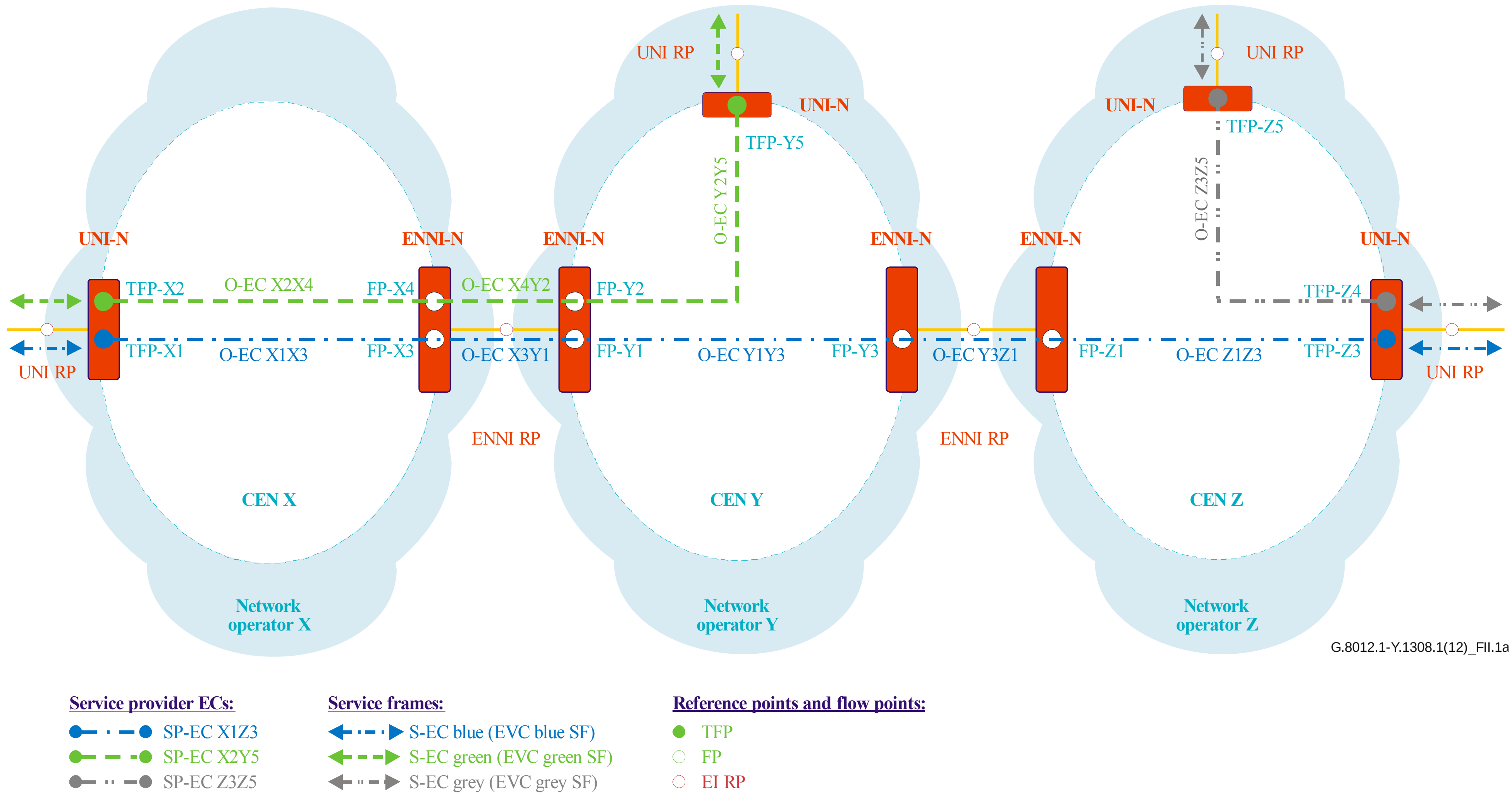
In [b-MEF 12.1.1], the following EC constructs that may be used by network operators and service providers to instantiate operator and service provider ECs over CENs are defined:

– UNI tunnel access (UTA) SP-EC, H-NID service (HNS) SP-EC
– Remote management interface (RMI) EC, NID management (MGT) EC

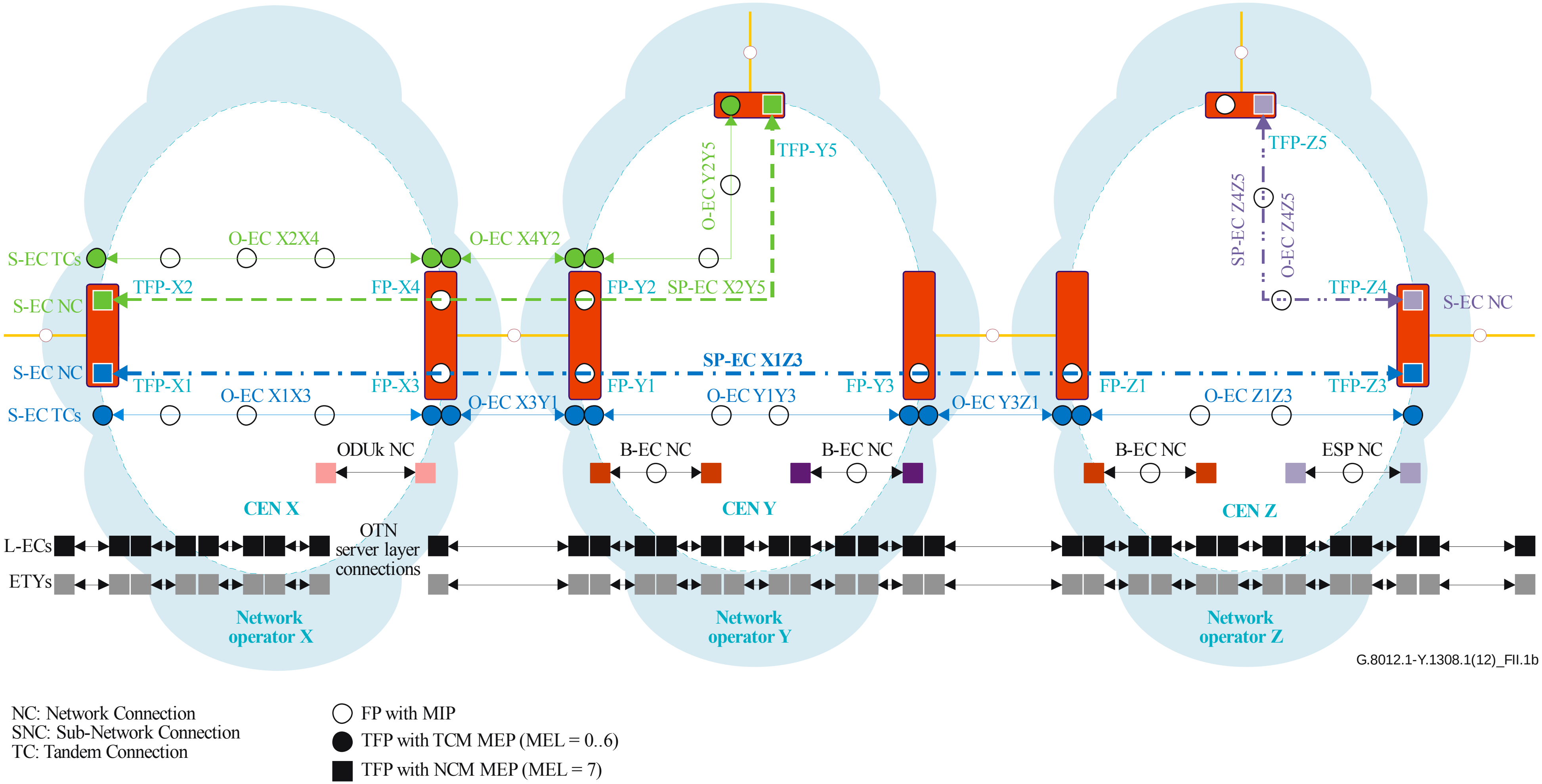
II.2 MEF EC and ITU-T G.8012.1 EC relationship examples

Figure II.1 illustrates for the case of point-to-point ECs in Figure 11 of [b-MEF 12.1] the relationship between the SP-EC, O-EC, TFP and FP terms used by MEF (Figure II.1 A) and the C-EC, S-EC, B-EC, L-EC, ESP, … TFP with NCM MEP, TFP with TCM MEP and FP terms used by ITU-T G.8012.1 (Figure II.1 B).

The SP-EC X1Z3 is supported in this example by a point-to-point S-EC network connection which has its two S-EC NCM MEP functions (operating at MEG level 7) located on the UNI-N ports X1 and Z3. To monitor each O-EC (X1X3, X3Y1, Y1Y3, Y3Z1 and Z1Z3), it is possible to establish S-EC TCM MEGs and activate their S-EC TCM MEP functions (at, for example, MEG level 4) on the UNI-N ports X1, Z3 and E-NNI ports X3, Y1, Y3, Z1. CEN X contains a PB subnetwork (left) and an OTN subnetwork (right), in which L-EC/ETY and ODUk network connections respectively carry the S-ECs signals. CEN Y contains two PBB subnetworks, in which B-EC network connections carry the S-EC signals. CEN Z contains a PBB subnetwork (left) and a PBB-TE subnetwork (right), in which B-EC and ESP network connections respectively carry the S-EC signals. B-EC and ESP signals are carried by L-EC/ETY network connections. On the E-NNIs, S-EC signals are carried by L-EC/ETY network connections.


UNI RP
UNI-N
TFP-Y5
O-EC Y2Y5
UNI RP
UNI-N
TFP-Z5
O-EC Z3Z5
UNI-N
ENNI-N
ENNI-N
ENNI-N
ENNI-N
UNI-N
TFP-X2
O-EC X2X4
FP-X4
O-EC X4Y2
FP-Y2
TFP-Z4
TFP-X1
O-EC X1X3
FP-X3
O-EC X3Y1
FP-Y1
O-EC Y1Y3
FP-Y3
O-EC Y3Z1
FP-Z1
O-EC Z1Z3
TFP-Z3
UNI RP
UNI RP
ENNI RP
ENNI RP
CEN X
CEN Y
CEN Z
Network operator X
Network operator Y
Network operator Z
G.8012.1-Y.1308.1(12)_FII.1a
Service provider ECs:
SP-EC X1Z3
SP-EC X2Y5
SP-EC Z3Z5
Service frames:
S-EC blue (EVC blue SF)
S-EC green (EVC green SF)
S-EC grey (EVC grey SF)
Reference points and flow points:
TFP
FP
EI RP

(A)

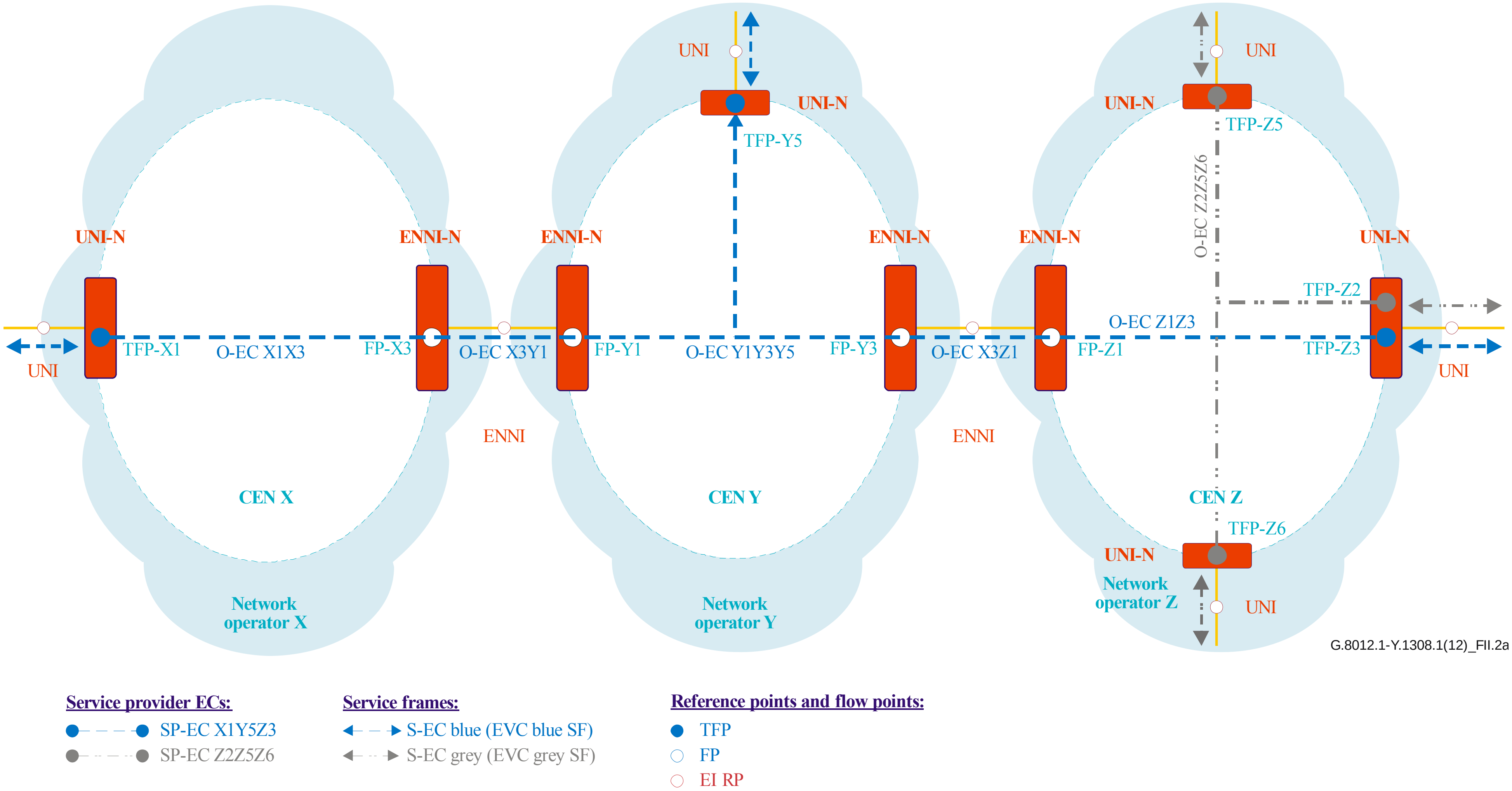


(B)

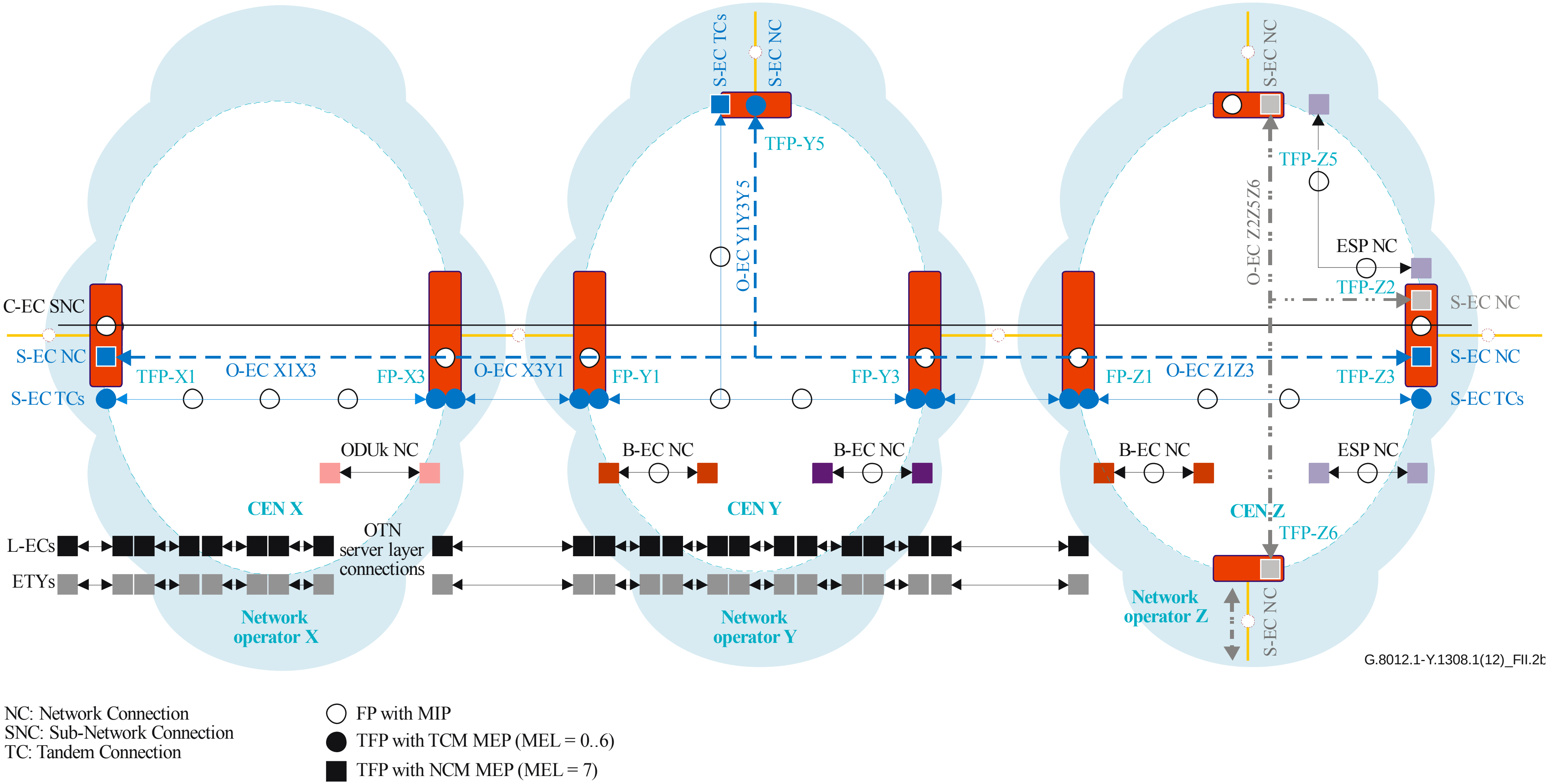
Figure II.1 – Point-to-point ECs
(A) Figure 11 of [b-MEF 12.1], (B) ITU-T G.8012.1-based connection example assuming a C-VLAN tagged service

For the case of multi-point ECs in Figure 12 of [b-MEF 12.1], Figure II.2 illustrates the relationship between the SP-EC, O-EC, TFP and FP terms used by MEF (Figure II.2 A) and the C-EC, S-EC, B-EC, L-EC, ESP, … TFP with NCM MEP, TFP with TCM MEP and FP terms used by ITU-T G.8012.1 (Figure II.2 B).

The SP-EC X1Y5Z3 is supported, as in the previous figure, by a multipoint S-EC network connection which has its three S-EC NCM MEP functions (operating at MEG level 7) located on the UNI-N ports X1, Y5 and Z3. To monitor each O-EC (X1X3, X3Y1, Y1Y3Y5, Y3Z1 and Z1Z3), it is possible to establish S-EC TCM MEGs and activate their S-EC TCM MEP functions (at e.g., MEG level 4) on the UNI-N ports X1, Y5, Z3 and E-NNI ports X3, Y1, Y3, Z1.


UNI
UNI-N
TFP-Y5
UNI
UNI-N
TFP-Z5
O-EC Z2Z5Z6
UNI-N
ENNI-N
ENNI-N
ENNI-N
ENNI-N
UNI-N
TFP-Z2
O-EC Z1Z3
TFP-X1
O-EC X1X3
FP-X3
O-EC X3Y1
FP-Y1
O-EC Y1Y3Y5
FP-Y3
O-EC X3Z1
FP-Z1
TFP-Z3
UNI
UNI
ENNI
ENNI
CEN X
CEN Y
CEN Z
TFP-Z6
UNI-N
Network operator X
Network operator Y
Network operator Z
UNI
G.8012.1-Y.1308.1(12)_FII.2a
Service provider ECs:
SP-EC X1Y5Z3
SP-EC Z2Z5Z6
Service frames:
S-EC blue (EVC blue SF)
S-EC grey (EVC grey SF)
Reference points and flow points:
TFP
FP
EI RP

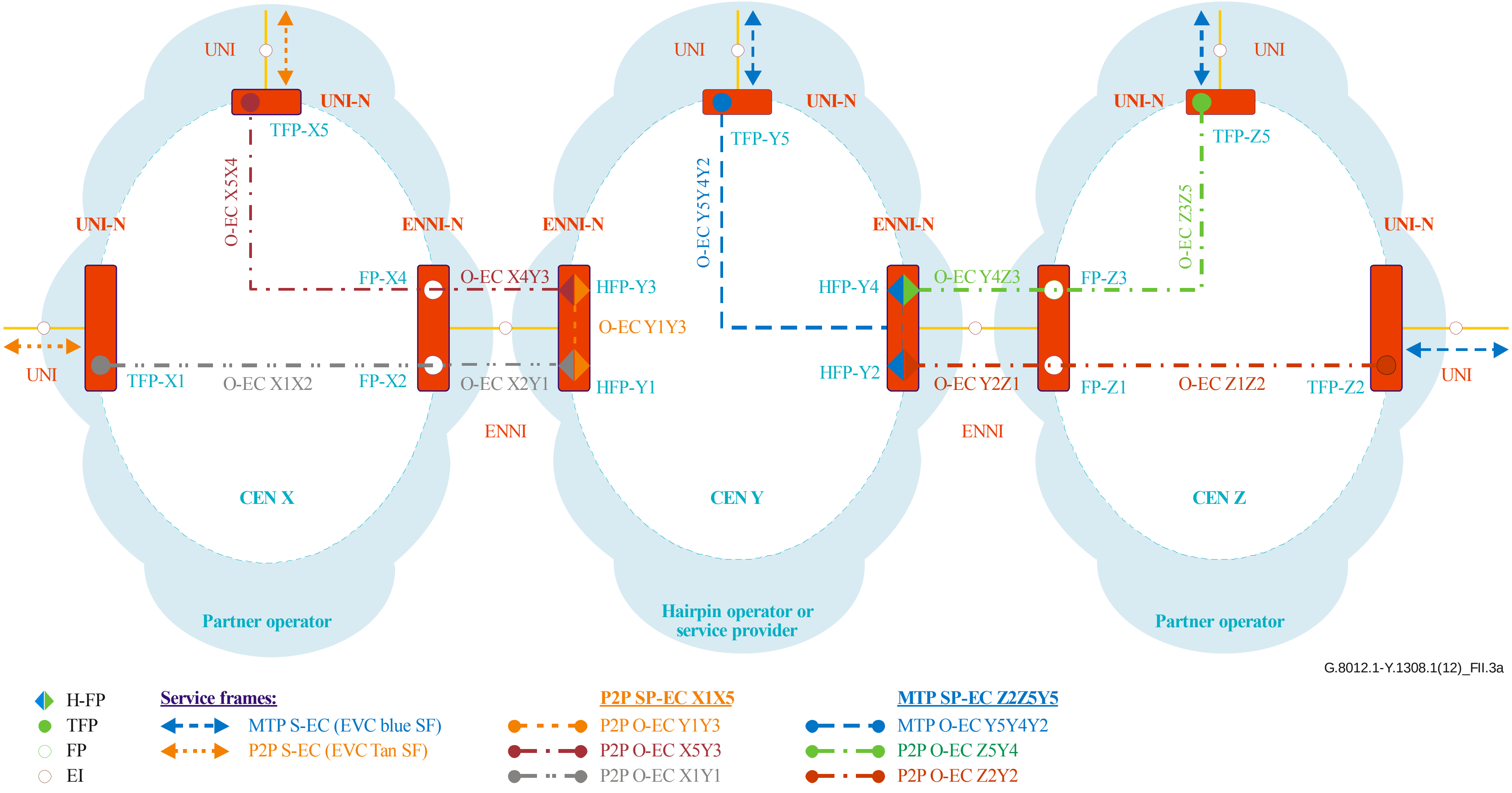
(A)



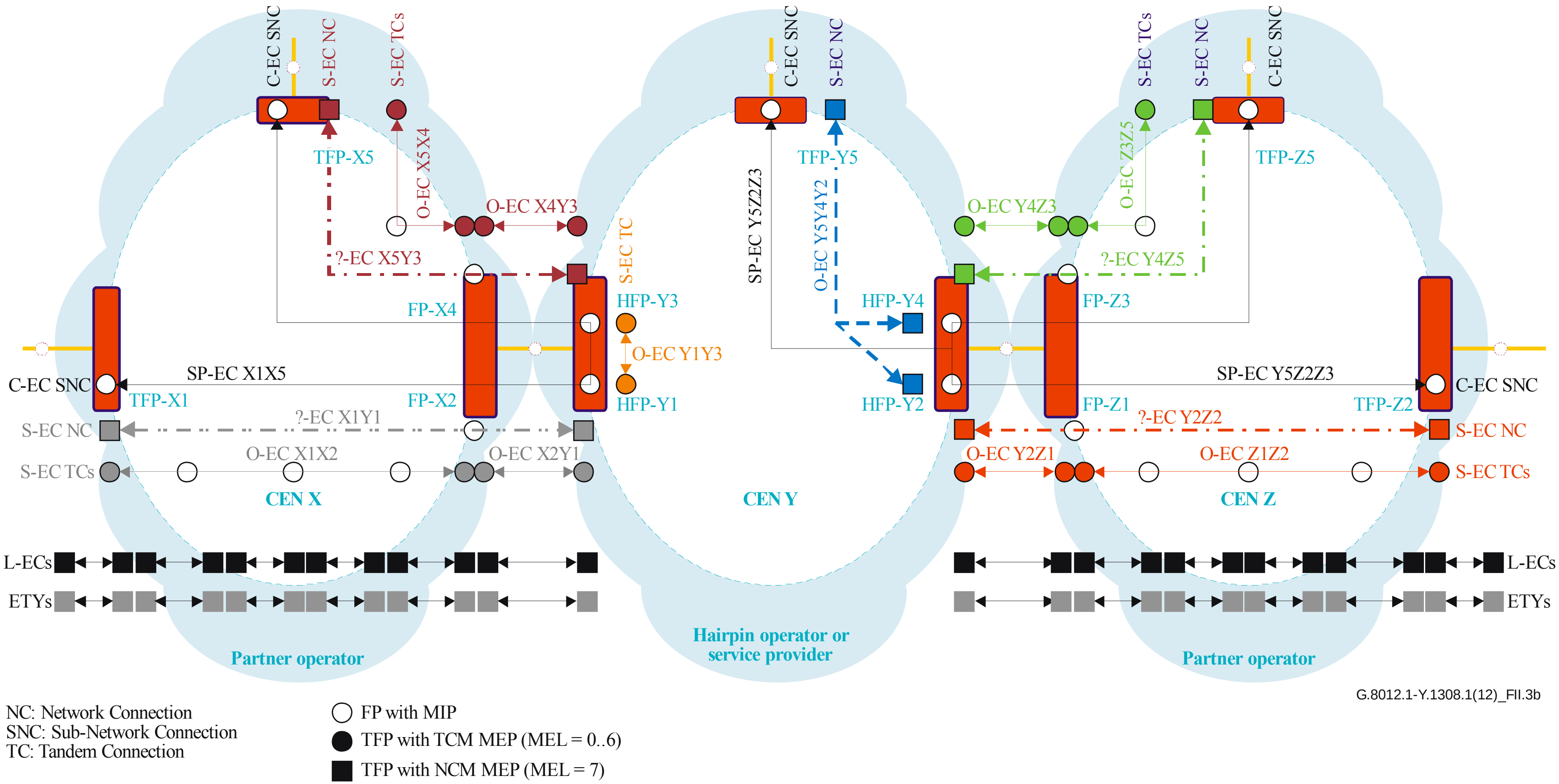
(B)

Figure II.2 – Multi-point ECs
(A) Figure 12 of [b-MEF 12.1], (B) ITU-T G.8012.1-based connection example assuming a C-VLAN tagged service

For the case of hairpin ECs (supporting C-VLAN service(s)) in Figure 15 of [b-MEF 12.1], Figure II.3 illustrates the relationship between the SP-EC, O-EC, TFP, FP and H-FP terms used by MEF (Figure II.3 A) and the C-EC, S-EC, B-EC, L-EC, ESP, … TFP with NCM MEP, TFP with TCM MEP and FP terms used by ITU-T G.8012.1 (Figure II.3 B). Figure II.4 illustrates this relationship also for the case of hairpin ECs supporting a port-based service.



(A)



(B)

Figure II.3 – Multi-point hairpin ECs
(A) Figure 15 of [b-MEF 12.1], (B) ITU-T G.8012.1-based connection example using C-VLAN tagged service

The SP-EC X1X5 in Figure II.3 B is supported by three point-to-point S-EC network connections X1Y1, Y1Y3 and Y3X5. Note that those connections have not been explicitly named in Figure II.3 A, and are therefore represented by ?-EC X1Y1, etc., in Figure II.3B. S-EC X1Y1 has its two S-EC NCM MEP functions (operating at MEG level 7) located on the UNI-N port X1 and E-NNI port Y1. To monitor each O-EC (X1X2, X2Y1) it is possible to establish S-EC TCM MEGs and activate their S-EC TCM MEP functions (at, for example, MEG level 4) on the UNI-N port X1 and E-NNI ports X2, Y1. S-EC Y1Y3 has its two S-EC NCM MEP functions (operating at MEG level 7) located on the E-NNI ports Y1 and Y3 located in the same node. S-EC Y3X5 has its two S-EC NCM MEP functions (operating at MEG level 7) located on the UNI-N port X5 and E-NNI port Y3. To monitor each O-EC (X4Y3, X5X4) it is possible to establish S-EC TCM MEGs and activate their S-EC TCM MEP functions (at e.g., MEG level 4) on the UNI-N port X5 and E-NNI ports X4, Y3. The UNI to UNI service is a C-VLAN service, of which the C-EC has FPs on the UNI-N ports X1, X5 and on the E-NNI ports Y1 and Y3.

The SP-EC X1X5 in Figure II.4 is supported by three point-to-point S-EC tandem connections X1Y1, Y1Y3 and Y3X5. Note that those connections have not been explicitly named in Figure II.3A, and are therefore represented by ?-EC X1Y1, etc., in Figure II.4. S-EC X1Y1 has its two S-EC TCM MEP functions (operating at e.g., MEG level 4) located on the UNI-N port X1 and E-NNI port Y1. To monitor each O-EC (X1X2, X2Y1) it is possible to establish S-EC TCM MEGs and activate their S-EC TCM MEP functions (at e.g., MEG level 3) on the UNI-N port X1 and E-NNI ports X2, Y1. S-EC Y1Y3 has its two S-EC TCM MEP functions (operating at e.g., MEG level 4) located on the E-NNI ports Y1 and Y3 located in the same node. S-EC Y3X5 has its two S-EC TCM MEP functions (operating at e.g., MEG level 4) located on the UNI-N port X5 and E-NNI port Y3. To monitor each O-EC (X4Y3, X5X4) it is possible to establish S-EC TCM MEGs and activate their S-EC TCM MEP functions (at e.g., MEG level 3) on the UNI-N port X5 and E-NNI ports X4, Y3. The UNI to UNI service is a port-based service appearing as an S-EC subnetwork connection. This S-EC has FPs on the UNI-N ports X1, X5 and on the E-NNI ports Y1 and Y3.

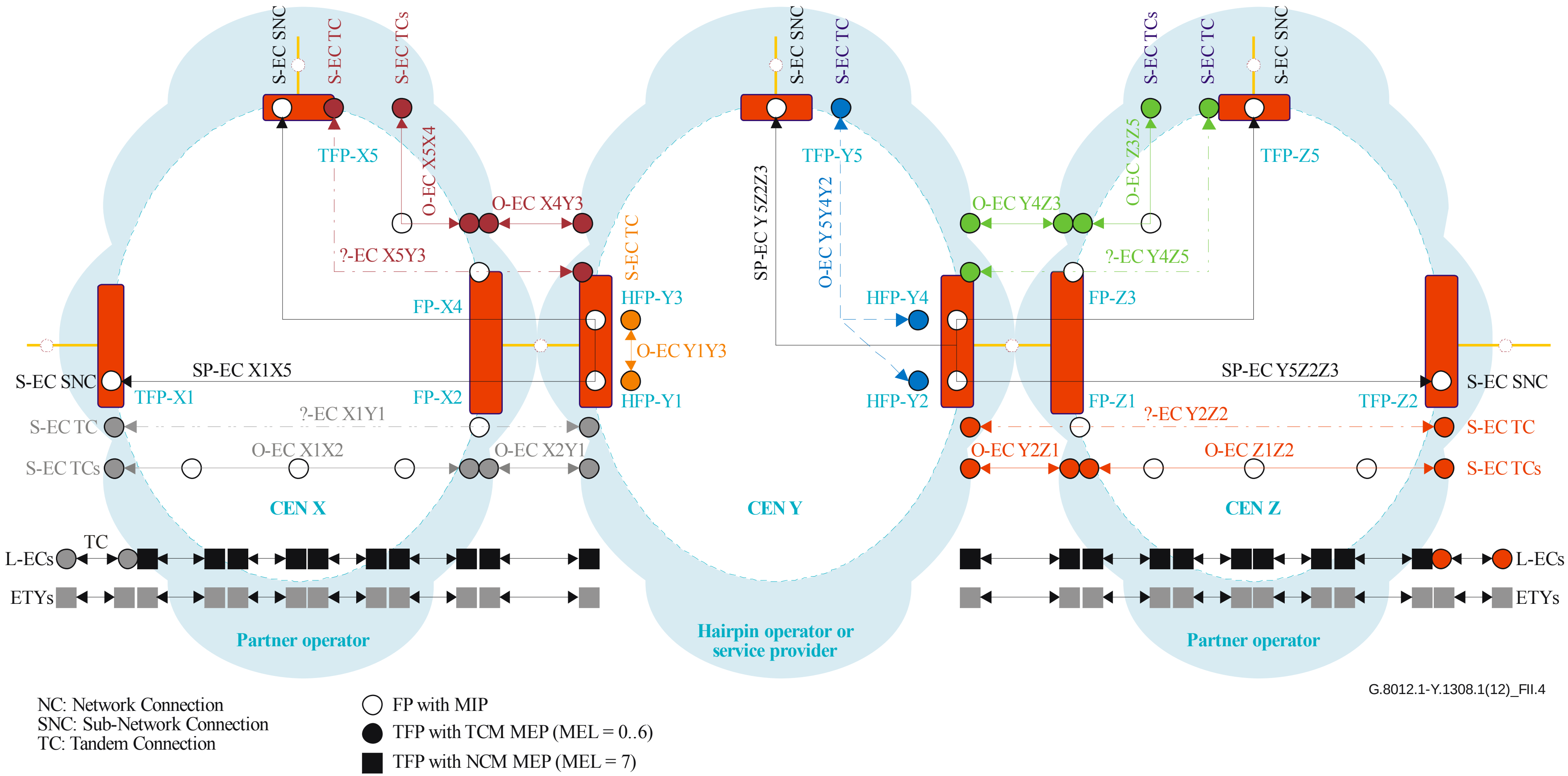
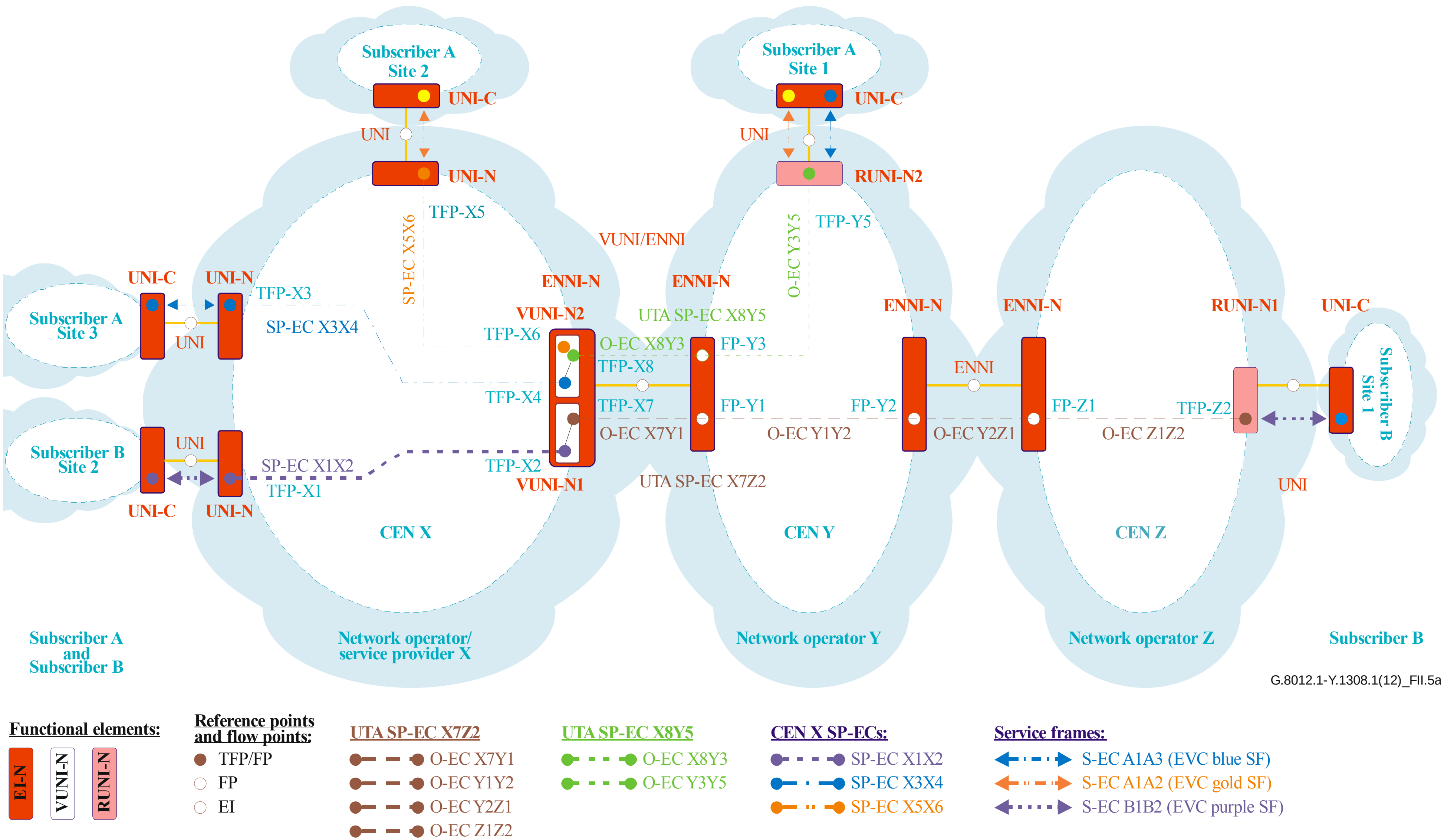


Figure II.4 – Multi-point hairpin ECs
ITU-T G.8012.1-based connection example using port-based service

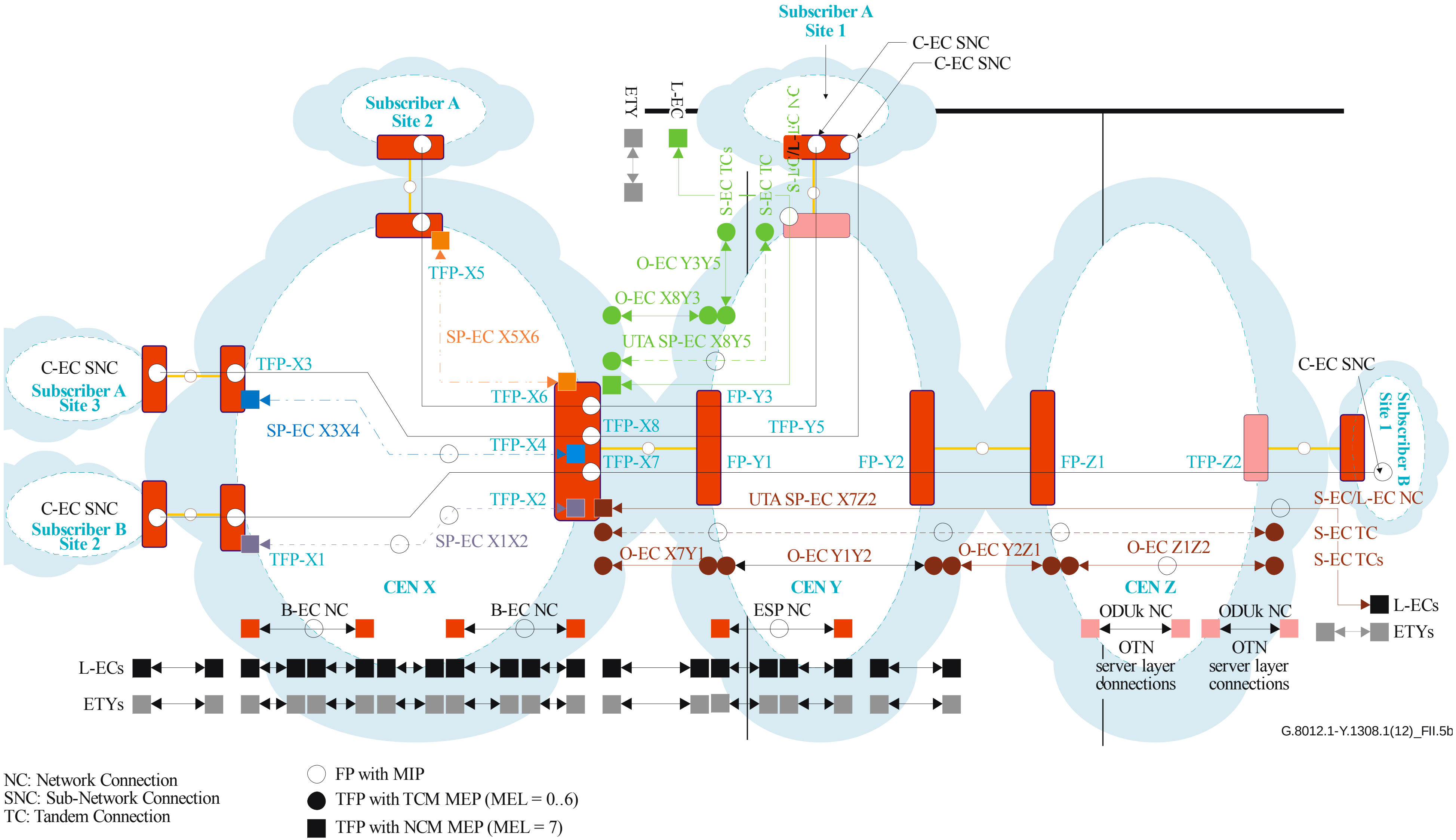
For the case of UTA ECs (supporting C-VLAN services) Figure II.5 illustrates in Figure 20 of [b-MEF 12.1.1] the relationship between the UTA SP-EC, SP-EC, O-EC, TFP and FP terms used by MEF (Figure II.5 A) and the C-EC, S-EC, B-EC, L-EC, ESP, … TFP with NCM MEP, TFP with TCM MEP and FP terms used by ITU-T G.8012.1 (Figure II.5 B).

The three SP-ECs X1X2, X3X4 and X5X6 in CEN X in Figure II.5 B are supported by three point-to-point S-EC network connections X1X2, X3X4 and X5X6 respectively. These three S-ECs have two S-EC NCM MEP functions (operating at MEG level 7) located on their UNI-N ports X1, X3 and X5 and their V-UNI-N ports X2, X4 and X6. In this example, CEN X contains two provider backbone bridge (PBB) networks, which are interconnected via S-Tagged LAN interfaces. S-EC X1X2 is passing through both PBB networks and their interconnecting link. In each PBBN, S-EC X1X2 is transported within a B-EC and those B-ECs are transported via L-ECs and ETYs. In the interconnecting link, S-EC X1X2 is transported within an L-EC. The S-ECs carry one (or more) C-EC signal(s).



NOTE – The blue service frame legend "S-EC B1A3 (EVC Blue SF)" should read "S-EC A1A3"

(A)



(B)

Figure II.5 – UTA SP-ECs via VUNI-Ns and RUNI-Ns
(A) Figure 20 of [b-MEF 12.1.1], (B) ITU-T G.8012.1-based connection example assuming a C-VLAN tagged service

The C-EC signal(s) which are transported over S-EC X1X2 (SP-EC X1X2) in CEN X are carried through CEN Y and CEN Z by a hybrid L-EC/S-EC network connection (which does not have an MEF EC name) with L/S-EC NCM MEPs at level 7 on the UNI-C port at subscriber B site 1 and at the V-UNI-N port X7. The hybrid L/S-EC signal is transported over the UNI via an ETY and via an S-EC X7Z2 tandem connection (at, for example, MEG level 6) between the RUNI-N1 and VUNI-N1. This latter S-EC X7Z2 tandem connection is the UTA SP-EC X7Z2. This S-EC X7Z2 tandem connection is supported by four operator level S-EC tandem connections (at for example, MEG level 4); O-EC Z1Z2 represents the S-EC Z1Z2 TC within CEN Z, O-EC Y2Z1 represents the S-EC Y2Z1 TC on the E-NNI between CEN Y and CEN Z, O-EC Y1Y2 represents the S-EC Y1Y2 TC within CEN Y and O-EC X7Y1 represents the S-EC X7Y1 TC on the E-NNI between CEN X and CEN Y.

The C-EC signals which are transported over S-EC X3X4 (SP-EC X3X4) and S-EC X5X6 (SP-EC X5X6) in CEN X are carried through CEN Y by a hybrid L-EC/S-EC network connection (which does not have an MEF EC name) with L/S-EC NCM MEPs at level 7 on the UNI-C port at subscriber A site 1 and at the V-UNI-N port X8. The hybrid L/S-EC signal is transported over the UNI via an ETY and via an S-EC X8Y5 tandem connection (at, for example, MEG level 6) between the RUNI-N2 and VUNI-N2. This latter S-EC X8Y5 tandem connection is the UTA SP-EC X8Y5. This S-EC X8Y5 tandem connection is supported by two operator level S-EC tandem connections (at, for example, MEG level 4); O-EC Y3Y5 represents the S-EC Y3Y5 TC within CEN Y, O-EC X8Y3 represents the S-EC X8Y3 TC on the E-NNI between CEN X and CEN Y.

Appendix III

Relationship between EVC packet format and traffic units on Ethernet UNI

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

Clause 6.1.4 specifies the Ethernet UNI signal structure and describes how each of the EC types in this structure may perform the role of the EVC. This appendix describes the relationship between the EVC packet formats and the EC traffic units on the Ethernet UNI.

III.1 Relationship between untagged C-EC traffic unit and EVC packet on Ethernet UNI

An untagged EVC on an Ethernet UNI consists of a stream of untagged EVC packets (Figure III.1, left). Each packet carries an EVC traffic unit, containing customer EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figure III.1, right). The EVC priority and drop_eligible information has fixed values and the EVC data contains client data or ETH OAM.

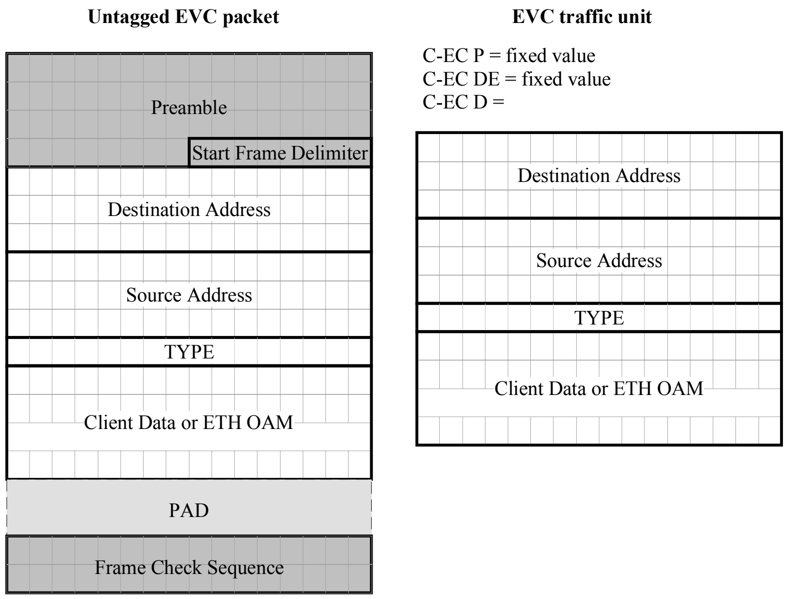


Figure III.1 – Untagged EVC packet and traffic unit formats

III.2 Relationship between (Priority) C-Tagged C-EC traffic unit and EVC packet on Ethernet UNI

A (Priority) C-Tagged EVC on an Ethernet UNI consists of a stream of (Priority) C-Tagged EVC packets (Figure III.2, left). Each packet carries an EVC traffic unit, containing Customer EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figure III.2, right). The EVC priority and drop_eligible information is decoded from the PCP and DEI fields of the (Priority) C-Tag and the EVC data contains client data or ETH OAM.

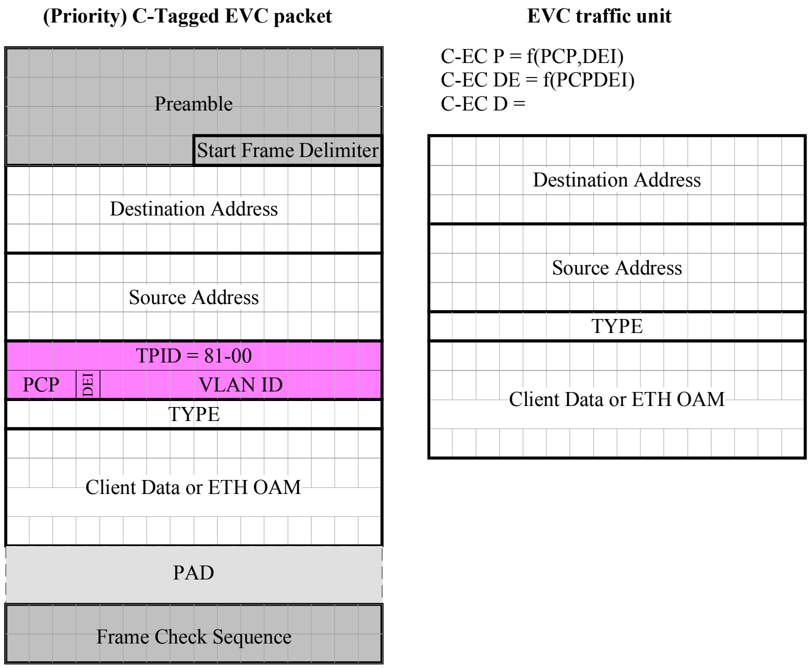


Figure III.2 – C-Tagged EVC packet and traffic unit formats

III.3 Relationship between S-Tagged S-EC traffic unit and EVC packet on Ethernet UNI

An S-Tagged EVC on an Ethernet UNI consists of a stream of S-Tagged EVC frames (Figure III.3, left). Each frame carries an EVC traffic unit, containing Service EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figure III.3, right). The EVC priority and drop_eligible information is decoded from the PCP and DEI fields of the S-Tag and the EVC data contains C-Tagged data (e.g., client, ETH OAM), L2CP, or ETH OAM.

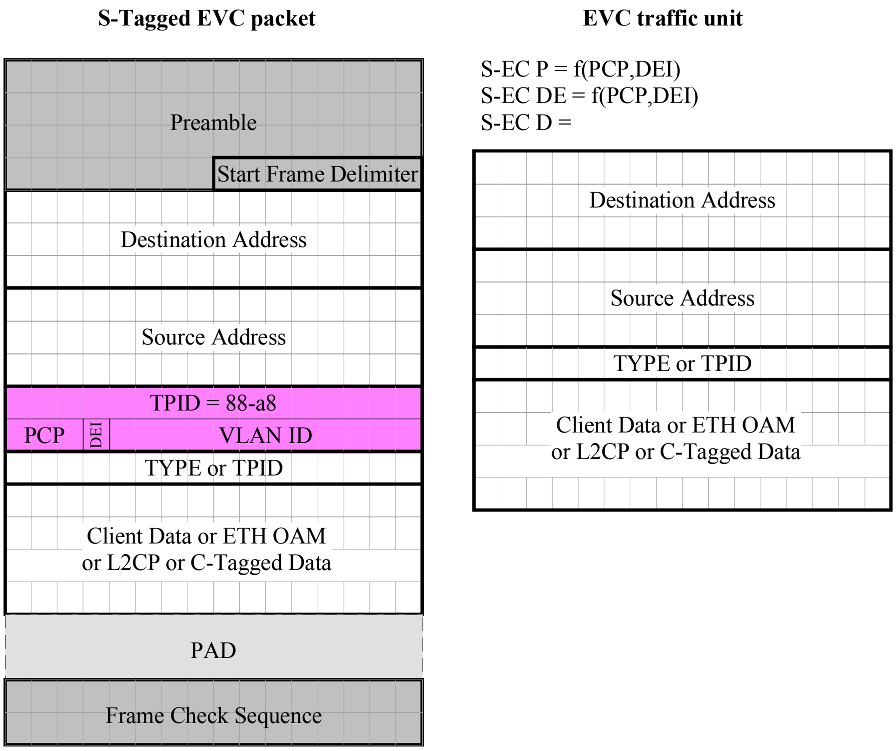


Figure III.3 – S-Tagged EVC packet and traffic unit formats

III.4 Relationship between I-Tagged BS-EC traffic unit and EVC packet on Ethernet UNI

An I-Tagged EVC on an Ethernet UNI consists of a stream of I-Tagged EVC packets (Figures III.4 and III.5, left). Each packet carries an EVC traffic unit, containing backbone service EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figures III.4 and III.5, right). The EVC priority and drop_eligible information is decoded from the PCP and DEI fields of the I-Tag and the EVC data contains a MAC frame or ETH OAM.

The relationship between the tagged EVC packet and the EVC traffic unit depends on the value of the UCA field in the I-Tag.

– UCA = 0 (Figure III.4): The EVC traffic unit Backbone Service EC data contains DA, SA and MSDU fields, of which the MSDU field contains a TYPE field with value 89-10 and a MAC frame with DA, SA and MSDU fields.

– UCA = 1 (Figure III.5): the EVC traffic unit Backbone Service EC data contains a DA, SA and MSDU field, of which the MSDU field contains a TYPE field with an value not equal to 89-10 followed by a field which does not contain a DA; e.g., an OAM PDU or an L2CP PDU.

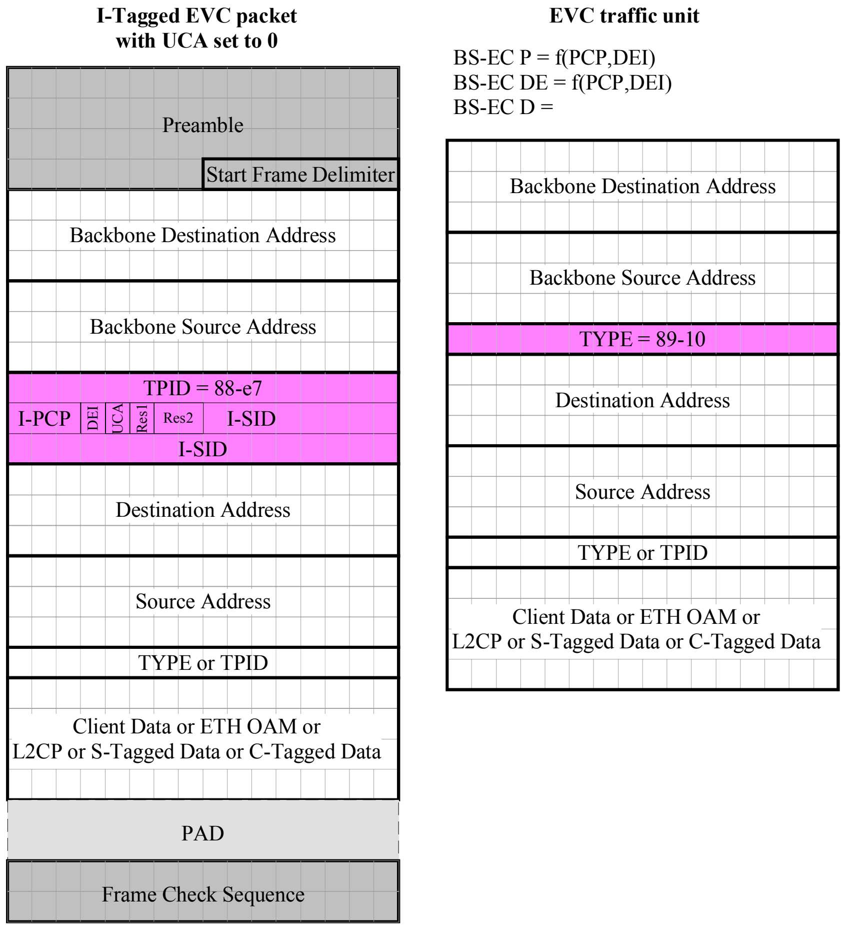


Figure III.4 – I-Tagged EVC (UCA=0, TYPE = 89-10) packet and traffic unit formats

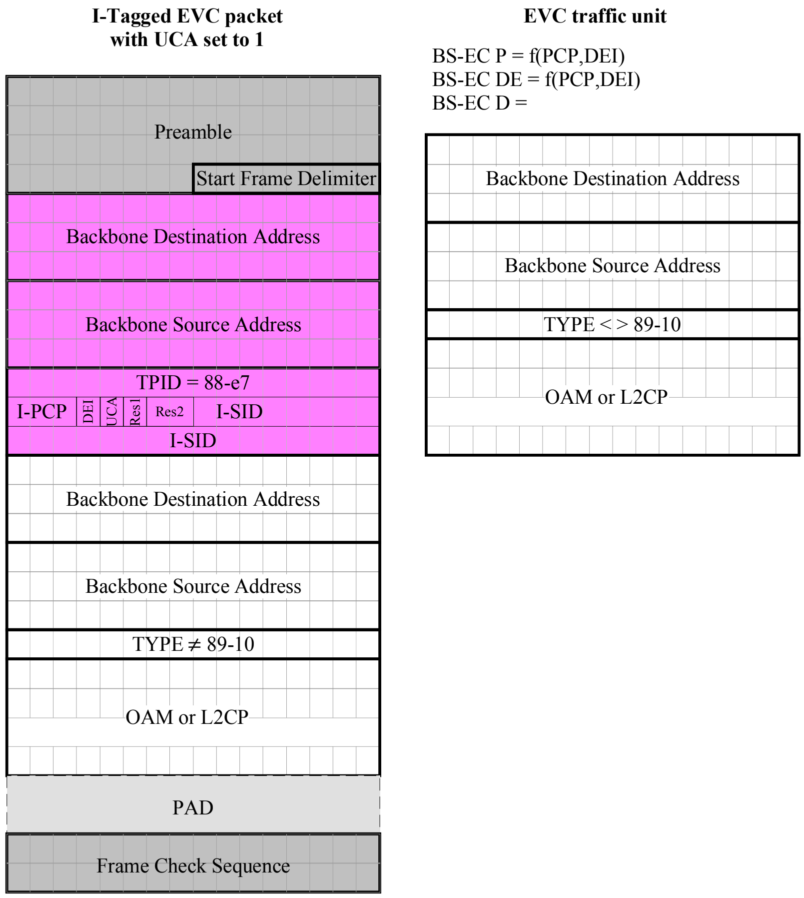


Figure III.5 – I-Tagged EVC (UCA=1, TYPE ≠ 89-10) packet and traffic unit formats

III.5 Relationship between Non-S-Tagged Link EC traffic unit and EVC packet on Ethernet UNI

A Non-S-Tagged Link EVC on an Ethernet UNI consists of a stream of "untagged" EVC packets (Figure III.6, left). Each packet carries an EVC traffic unit, containing Link EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figure III.6, right). The EVC priority and drop_eligible information has fixed values and the EVC data contains client data, (Priority) C- or I-Tagged data (e.g., client, ETH OAM), L2CP or ETH OAM.

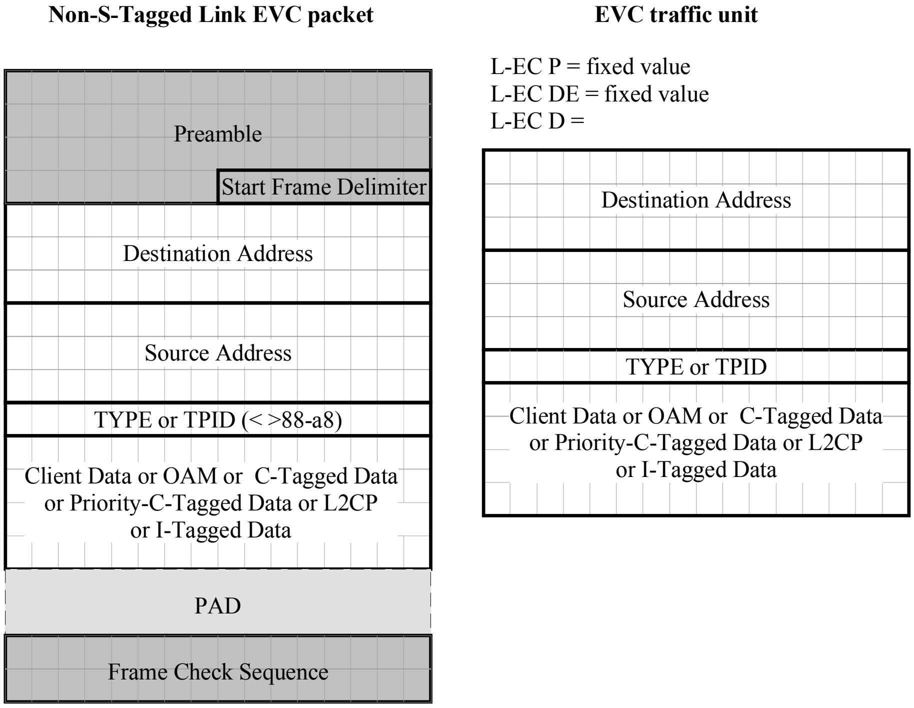


Figure III.6 – Non-S-Tagged Link EVC packet and traffic unit formats

III.6 Relationship between Priority-S-Tagged Link EC traffic unit and EVC packet on Ethernet UNI

A Priority-S-Tagged Link EVC on an Ethernet UNI consists of a stream of Priority-S-Tagged EVC packets (Figure III.7, left). Each frame carries an EVC traffic unit, containing Link EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figure III.7, right). The EVC priority and drop_eligible information is decoded from the PCP and DEI fields of the Priority-S-Tag and the EVC data contains client data, C-Tagged data (e.g., client, ETH OAM), L2CP or ETH OAM.

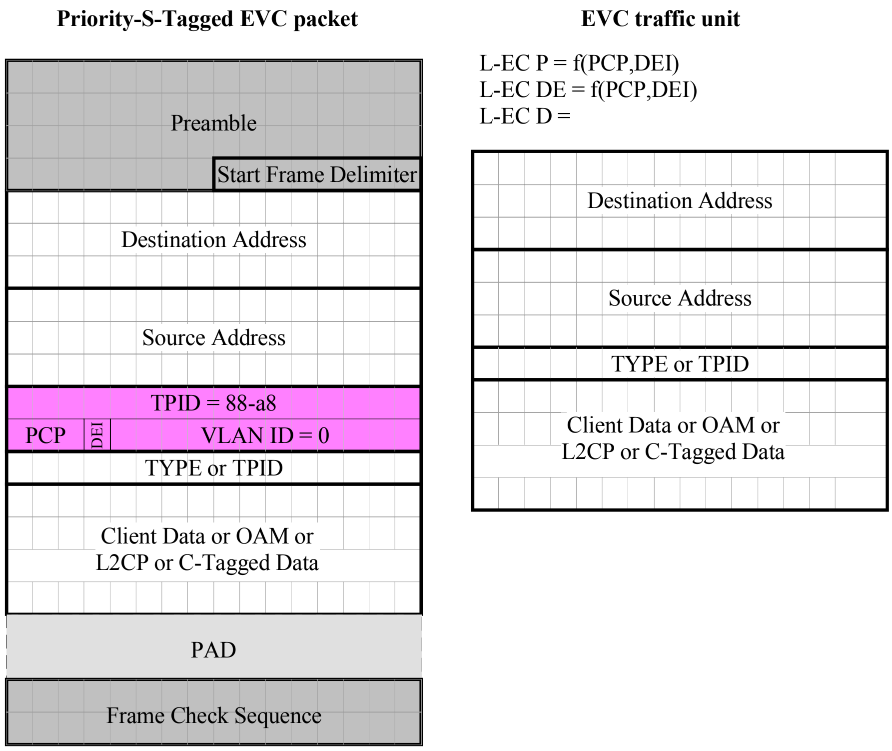


Figure III.7 – Priority-S-Tagged Link EVC packet and traffic unit formats

III.7 Relationship between Link EC traffic unit and EVC packet on Ethernet UNI

A Link EVC on an Ethernet UNI consists of a stream of "untagged" Link EVC packets (Figure III.8, left). Each packet carries an EVC traffic unit, containing Link EC Data (D), Priority (P) and Drop Eligible (DE) elements (Figure III.8, right). The EVC priority and drop_eligible information has either fixed values, or is decoded from the PCP and DEI fields of the C- or S-Tag (if present) and the EVC data contains client data, C-, S- or I-Tagged data (e.g., client, ETH OAM), L2CP or ETH OAM.

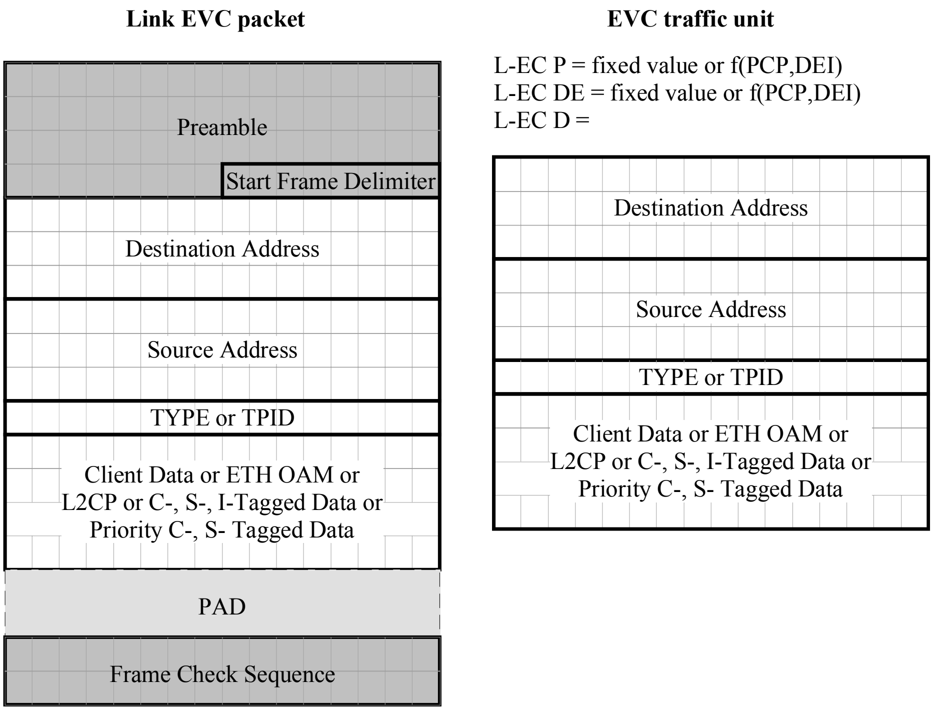


Figure III.8 – Link EVC packet and traffic unit formats

Appendix IV

Ethernet connection (EC) over SDH VC-n

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

IV.1 S-EC to SDH VC

For the mapping and multiplexing of an S-EC traffic unit (Figure IV.1, left) into an SDH virtual container, the S-EC traffic unit is extended with an S-Tag, a MAC FCS field and GFP-F Payload and Core Headers (Figure IV.1, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the SDH virtual container (Figure IV.1, top) as specified in [ITU-T G.707].

The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the S-EC traffic unit and a Service VLAN ID field of which the value is configured.

The demultiplexing and demapping of an S-EC traffic unit from the SDH virtual container removes the fields added during mapping and multiplexing and decodes the priority and drop_eligible information values of the S-EC traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

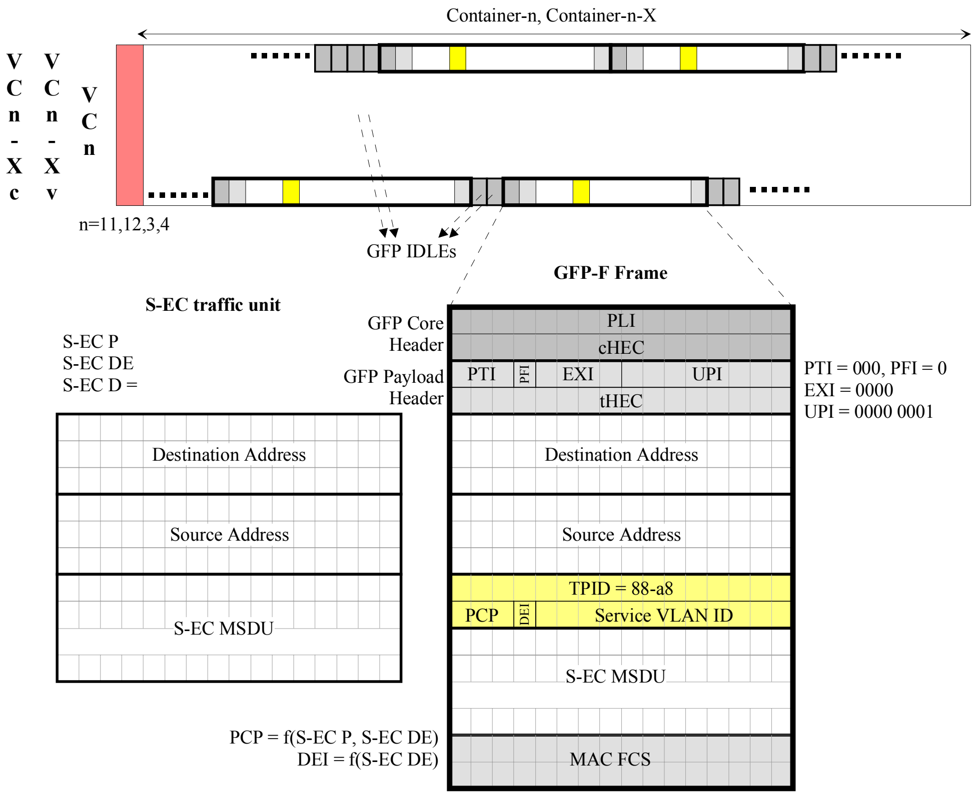


Figure IV.1 – Encapsulation of S-EC traffic unit into GFP-F frame and mapping of GFP-F frame into SDH virtual container

IV.2 B-EC to SDH VC

For the mapping and multiplexing of a B-EC traffic unit (Figure IV.2, left) into an SDH virtual container, the B-EC traffic unit is extended with an S-Tag, a MAC FCS field and GFP-F Payload and Core Headers (Figure IV.2, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the SDH virtual container (Figure IV.2, top) as specified in [ITU-T G.707].

The S-Tag contains a TPID field with value 88-a8, PCP and DEI fields of which the value is derived (as specified in clause 6.9.3 of [IEEE 802.1Q]) from the priority and drop_eligible information of the B-EC traffic unit and a backbone VLAN ID field of which the value is configured.

The demultiplexing and demapping of an B-EC traffic unit from the SDH virtual container removes the fields added during mapping and multiplexing and derives the priority and drop_eligible information values of the B-EC traffic unit from the PCP and DEI fields in the S-Tag as specified in clauses 6.9.3 and 6.9.4 of [IEEE 802.1Q].

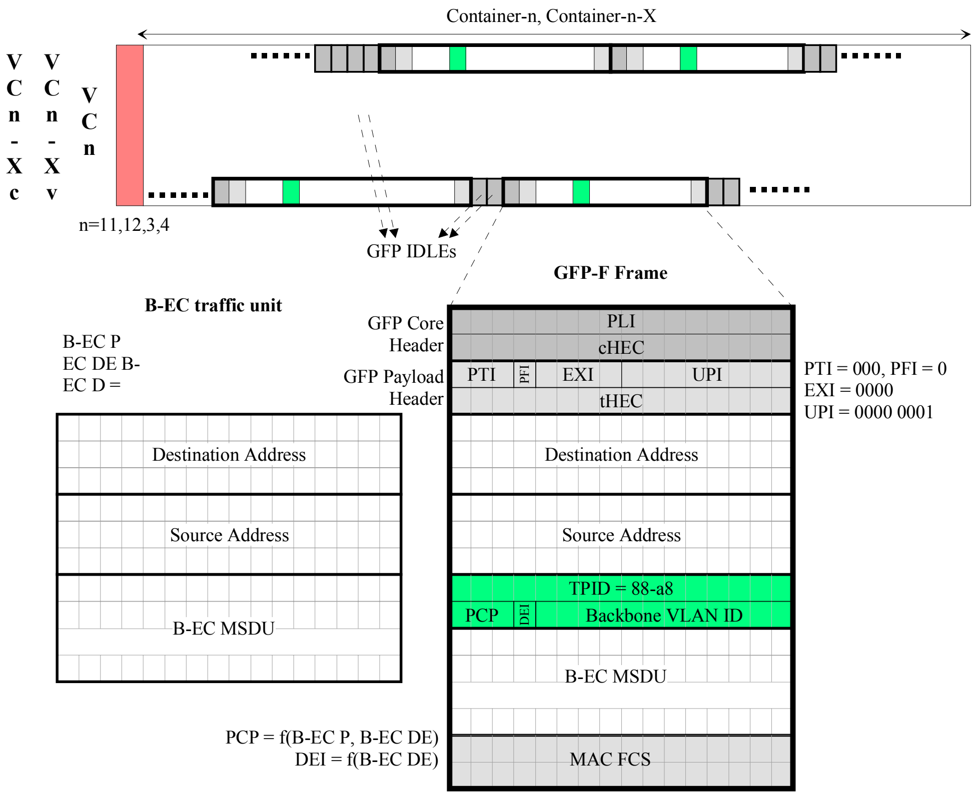


Figure IV.2 – Encapsulation of B-EC traffic unit into GFP-F frame and mapping of GFP-F frame into SDH virtual container (VC)

IV.3 L-EC to SDH VC

For the mapping of an L-EC traffic unit (Figure IV.3, left) into an SDH virtual container (VC), the L-EC traffic unit is extended with a MAC FCS field and GFP-F Payload and Core Headers (Figure IV.3, right) as specified in [ITU-T G.7041]. The GFP-F frames are then mapped into the SDH virtual container (Figure IV.3, top) as specified in [ITU-T G.707].

The demapping of an L-EC traffic unit from an SDH VC removes the fields added during the mapping sets the priority information value of the L-EC traffic unit to the value of the Default User Priority parameter for the Port through which the L-EC traffic unit was received as specified in clause 6.7 of [IEEE 802.1Q] and sets the drop_eligible information value of the L-EC traffic unit to the value non-drop_eligible.

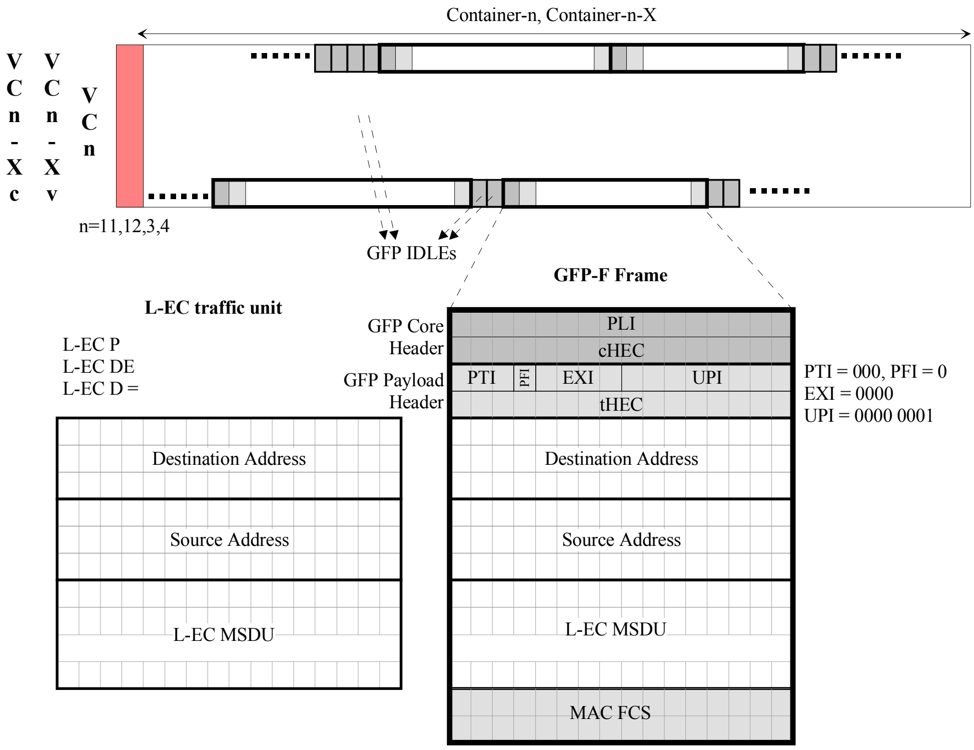


Figure IV.3 – Encapsulation of L-EC traffic unit into GFP-F frame and mapping of GFP-F frame into SDH VC

IV.4 Ethernet OAM support in EC over SDH VC

The EC over SDH VC implementations were developed on the basis of [ITU-T G.8012] which does not specify the use of Ethernet OAM. EC over SDH VC implementations may, as such, support only a subset of the Ethernet OAM specified in [ITU-T G.8013].

Bibliography

[b-MEF 12.1] Technical Specification MEF 12.1 (April 2010), *Carrier Ethernet Network Architecture Framework Part 2: Ethernet Services Layer – Base Elements*.

[b-MEF 12.1.1] Technical Specification MEF 12.1.1 (October 2011), *Carrier Ethernet Network Architecture Framework Part 2: Ethernet Services Layer – External Interface Extensions*.

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	**Y.1300–Y.1399**
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Numbering, naming and addressing	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3999

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

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
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	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	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
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 and next-generation networks**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2013