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

Digital networks – General aspects

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

Internet protocol aspects – Transport

Architecture of Ethernet layer networks

ITU-T Recommendation G.8010/Y.1306

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
TESTING EQUIPMENTS	G.500–G.599
TRANSMISSION MEDIA 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
QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DIGITAL TERMINAL EQUIPMENTS	G.7000–G.7999
DIGITAL NETWORKS	G.8000–G.8999
General aspects	**G.8000–G.8099**
Design objectives for digital networks	G.8100–G.8199
Quality and availability targets	G.8200–G.8299
Network capabilities and functions	G.8300–G.8399
SDH network characteristics	G.8400–G.8499
Management of transport network	G.8500–G.8599
SDH radio and satellite systems integration	G.8600–G.8699
Optical transport networks	G.8700–G.8799

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

ITU-T Recommendation G.8010/Y.1306

Architecture of Ethernet layer networks

Summary

This Recommendation describes the functional architecture of Ethernet networks using the modelling methodology described in ITU-T Recs G.805 and G.809. The Ethernet network functionality is described from a network level viewpoint, taking into account an Ethernet network layered structure, client characteristic information, client/server layer associations, networking topology, and layer network functionality providing Ethernet signal transmission, multiplexing, routing, supervision, performance assessment, and network survivability. The functional architecture of the server layer networks used by the Ethernet network is not within the scope of this Recommendation. Such architectures are described in other ITU-T Recommendations or IETF RFCs.

This Recommendation is based on the Ethernet specifications in IEEE Standards 802.1D-2003, 802.1Q-2003 and 802.3-2002, and developments of provider bridged networks. Furthermore, the architectural aspects of provider bridges currently being defined in IEEE P802.1ad task force are taken into account.

This Recommendation defines the Ethernet maintenance entities, but the specific impact on the transport functions of connection monitoring in a connectionless layer network is not addressed. Ethernet network survivability is intended for inclusion in a future version.

This Recommendation is the first of a series of Ethernet and Ethernet over Transport-related Recommendations. Other Recommendations in this series will address e.g., equipment, OAM, service, performance aspects.

Source

ITU-T Recommendation G.8010/Y.1306 was approved on 22 February 2004 by ITU-T Study Group 15 (2001-2004) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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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.

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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.

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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, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation G.8010/Y.1306

Architecture of Ethernet layer networks

1 Scope

This Recommendation describes the functional architecture of Ethernet networks using the modelling methodology described in ITU-T Recs G.805 and G.809. The Ethernet network functionality is described from a network level viewpoint, taking into account an Ethernet network layered structure, client characteristic information, client/server layer associations, networking topology, and layer network functionality providing Ethernet signal transmission, multiplexing, routing, supervision, performance assessment, and network survivability. The functional architecture of the server layer networks used by the Ethernet network is not within the scope of this Recommendation. Such architectures are described in other ITU-T Recommendations or IETF RFCs.

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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 Recommendation G.707/Y.1322 (2003), *Network node interface for the synchronous digital hierarchy (SDH)*.

– ITU-T Recommendation G.709/Y.1331 (2003), *Interfaces for the Optical Transport Network (OTN)*.

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

– ITU-T Recommendation G.809 (2003), *Functional architecture of connectionless layer networks*.

– ITU-T Recommendation G.7041/Y.1303 (2003), *Generic framing procedure (GFP)*.

– ITU-T Recommendation Y.1730 (2004), *Requirements for OAM functions in Ethernet-based networks and Ethernet services*.

– IEEE Standard 802-2001, *IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture*.

– IEEE Standard 802.1D-2004, *IEEE Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges*.

– IEEE Standard 802.1Q-2003, *IEEE Standards For Local And Metropolitan Area Networks: Virtual Bridged Local Area Network*s.

– IEEE Standard 802.2-1998, *Information Technology – Telecommunications and Information Exchange Between Systems – Local and metropolitan area networks – Specific Requirements – Part 2: Logical Link Control*.

– IEEE Standard 802.3-2002, *Information Technology – Telecommunication and Information Exchange Between Systems – LAN/MAN – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*.

– IEEE Standard 802.3AE-2002, *IEEE Standard for Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Media Access Control (MAC) Parameters, Physical Layer and Management Parameters for 10 Gb/s Operation*.

– IETF RFC 2684 (1999), *Multiprotocol Encapsulation over ATM Adaptation Layer 5*.

– IETF RFC 3031 (2001), *Multiprotocol Label Switching Architecture*.

3 Terms and definitions

3.1 This Recommendation uses the following terms defined in ITU-T Rec. G.805:

a) access point;

b) bidirectional reference point;

c) component link;

d) compound link;

e) connection point;

f) link;

g) link connection;

h) network connection;

i) network operator;

j) serial-compound link;

k) service provider;

l) termination connection point;

m) trail;

n) trail termination.

3.2 This Recommendation uses the following terms defined in ITU-T Rec. G.809:

a) access point;

b) adaptation;

c) adapted information;

d) characteristic information;

e) client/server relationship;

f) connectionless trail;

g) flow;

h) flow domain;

i) flow domain flow;

j) flow point;

k) flow point pool;

l) flow point pool link;

m) flow termination;

n) flow termination sink;

o) flow termination source;

p) layer network;

q) link flow;

r) matrix;

s) network;

t) network flow;

u) port;

v) reference point;

w) traffic unit;

x) transport;

y) transport entity;

z) transport processing function;

aa) termination flow point;

bb) termination flow point pool.

3.3 This Recommendation defines the following term:

3.3.1 traffic conditioning function: A "transport processing function" which accepts the characteristic information of the layer network at its input, classifies the traffic units according to configured rules, meters each traffic unit within its class to determine its eligibility, polices non-conformant traffic units and presents the remaining traffic units at its output as characteristic information of the layer network.

4 Acronyms and abbreviations

This Recommendation uses the following abbreviations:

AI	Adapted Information
AP	Access Point
ARP	Address Resolution Protocol
ATM	Asynchronous Transfer Mode
BP	Bridge Protocol
CI	Characteristic Information
cLink	component Link
CLPS	Connectionless Packet Switched
CO-CS	Connection-Oriented Circuit Switched
CO-PS	Connection-Oriented Packet Switched
CoS	Class of Service
CP	Connection Point
DP	Dropping Precedence

ETC	Ethernet Coding sublayer of ETY
ETCn	Ethernet Coding sublayer of order n
ETH	Ethernet MAC layer network
ETHS	ETH Segment
ETY	Ethernet PHY layer network
ETYn	Ethernet PHY layer network of order n
FCS	Frame Check Sequence
FD	Flow Domain
FDF	Flow Domain Flow
FDFr	Flow Domain Fragment
FP	Flow Point
FPP	Flow Point Pool
FT	Flow Termination
GARP	Generic Attribute Registration Protocol
GFP	Generic Framing Procedure
GFP-F	Frame-mapped GFP
GFP-T	Transparent GFP
IP	Internet Protocol
LAN	Local Area Network
LCAS	Link Capacity Adjustment Scheme
LF	Link Flow
M_SDU	MAC Service Data Unit
MAC	Media Access Control
ME	Maintenance Entity
MFD	Matrix Flow Domain
MFDFr	Matrix Flow Domain Fragment
MPLS	Multi-Protocol Label Switching
NF	Network Flow
NNI	Network Node Interface
OAM	Operations, Administration and Maintenance
ODU	Optical Channel Data Unit
ODUk	Optical Channel Data Unit-k
ODUk-Xv	X virtually concatenated ODUks
OTH	Optical Transport Hierarchy
OTN	Optical Transport Network
PCS	Physical Coding Sub-layer of PHY
PHY	Ethernet Physical Layer entity consisting of the PCS, the PMA, and, if present, the PMD sub-layers
PMA	Physical Medium Attachment sub-layer of PHY
PMD	Physical Medium Dependent sub-layer of PHY
SDH	Synchronous Digital Hierarchy

SDU	Service Data Unit
SLA	Service Level Agreement
TC	Traffic Conditioning
TCP	Termination Connection Point
TFP	Termination Flow Point
TFPP	Termination Flow Point Pool
TP	Transmission Path
TT	Trail Termination
UNI	User Network Interface
UNI-C	Customer side of UNI
UNI-N	Network side of UNI
VC	Virtual Channel
VC-n	Virtual Container-n
VC-n-Xc	X contiguously concatenated VC-ns
VC-n-Xv	X virtually concatenated VC-ns
VID	VLAN Identifier
VLAN	Virtual LAN
VPN	Virtual Private Network

5 Conventions

The diagrammatic convention for connection-oriented layer networks described in this Recommendation is that of ITU-T Rec. G.805.

The diagrammatic convention for connectionless layer networks described in this Recommendation is that of ITU-T Rec. G.809 with the exception of the colouring of atomic function and port symbols.

For the purpose of this Recommendation, the following additional diagrammatic convention (see Figure 1) is defined as a shorthand notation for two co-located Flow Points in opposite directions:

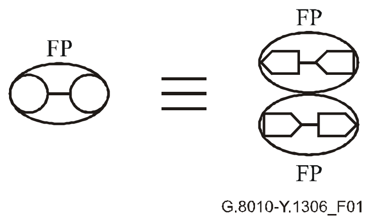

Figure 1/G.8010/Y.1306 – Diagrammatic convention for two co-located Flow Points in opposite directions

For the purpose of this Recommendation, the following (see Figure 2) symbol is defined to represent an ETH flow point pool (FPP) link or component link:

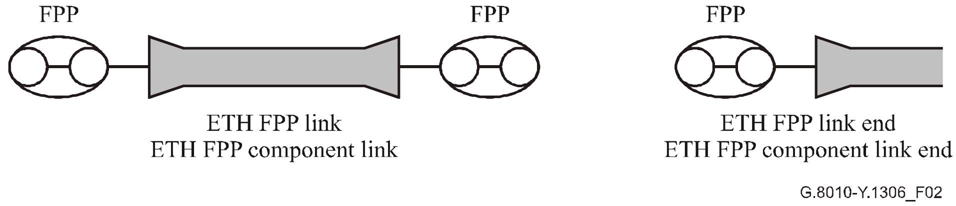

Figure 2/G.8010/Y.1306 – Diagrammatic convention for ETH FPP (component) link (end)

The diagrammatic convention for a unidirectional traffic conditioning function is shown in Figure 3.

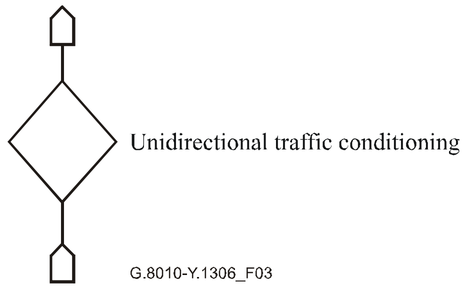

Figure 3/G.8010/Y.1306 – Diagrammatic convention for unidirectional traffic conditioning function

This Recommendation describes the topology using both the FPPs and FPs. The FPP (as defined in ITU-T Rec. G.809) is "a group of co-located flow points that have a common routing". The FPP is used to describe the architecture of the Ethernet layer networks when aggregate flows are of more interest than individual flows. The FP is used when individual flows are of interest.

6 Functional architecture of Ethernet transport networks

6.1 General

The functional architecture of Ethernet transport networks is described using the generic rules defined in ITU-T Recs G.805 and G.809. The specific aspects regarding the characteristic information, client/server associations, the topology, the connection supervision, multipoint capabilities and partitioning of Ethernet transport networks are provided in this Recommendation. This Recommendation uses the terminology and functional architecture and diagrammatic conventions defined in ITU-T Recs G.805 and G.809.

6.2 Ethernet network layered structure

Two layer networks are defined in the Ethernet transport network architecture:

- Ethernet MAC (ETH) layer network;
- Ethernet PHY (ETY) layer network.

The ETH layer network is a path layer network. The ETY layer network is a section layer network. The ETH layer network characteristic information can be transported through ETH links supported by trails in the server layer networks (e.g., ETY, SDH VC-n, OTN ODUk, MPLS, ATM).

6.3 Ethernet MAC (ETH) layer network

The ETH layer network provides the transport of adapted information through an ETH connectionless trail between ETH access points. The adapted information is a (non-)continuous flow of MAC Service Data Units (IEEE 802.3).

An example of the ETH layer network containing the following transport processing functions, transport entities, topological components and reference points is shown in Figure 4:

- ETH connectionless trail;
- ETH flow termination source (ETH_FT_So);
- ETH flow termination sink (ETH_FT_Sk);
- ETH network flow (NF);
- ETH link flow (LF);
- ETH flow domain flow (FDF);
- ETH flow domain (FD);
- ETH access point (AP);
- ETH flow point (FP);
- ETH termination flow point (TFP).

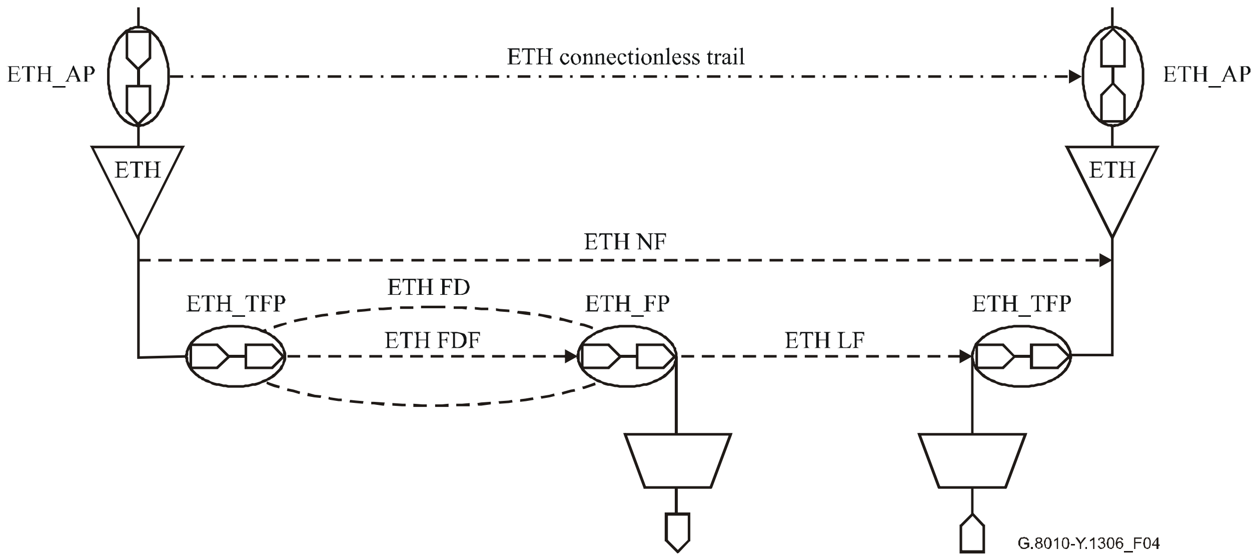

Figure 4/G.8010/Y.1306 – ETH layer network example (unicast flow)

6.3.1 ETH characteristic information

The ETH layer network Characteristic Information (ETH_CI) is a (non-)continuous flow of ETH_CI traffic units.

The ETH_CI traffic unit consists of the following set of signals: Destination Address (DA), Source Address (SA), MAC Service Data Unit (M_SDU) with optional Priority (P).

The ETH_CI traffic unit is transported over an ETH FPP Link within a link specific frame or packet, of which the generic format is depicted in Figure 5. The Priority signal may be transported implicitly or explicitly.

NOTE 1 – The Preamble (PA), Start-of-Frame Delimiter (SFD) and Frame Check Sequence (FCS) are considered part of the MAC frame (IEEE 802.3 clause 3). In the layer network model, this PA/SFD/FCS is associated with the ETH FPP link, not with the ETH characteristic information. This modelling does not change the requirement, in IEEE 802.1D and IEEE 802.1Q, regarding introducing undetected frame errors.

NOTE 2 – Refer to Appendix III for VLAN ID considerations.

	link frame/packet specific header
ETH_CI traffic unit format	DESTINATION ADDRESS
	SOURCE ADDRESS
	MAC SERVICE DATA UNIT
	link frame/packet specific trailer

Figure 5/G.8010/Y.1306 – ETH characteristic information (ETH_CI) traffic unit format when mapped into a link specific frame or packet

The ETH_CI traffic unit may be a *unicast*, *multicast* or *broadcast* frame as identified by the MAC Destination Address (IEEE 802).

6.3.2 ETH topological components

The ETH topological components are:

– ETH layer network;

– ETH flow domain;

– ETH flow point pool link;

– ETH access group.

The ETH layer network can be partitioned into one or more ETH flow domains interconnected by ETH FPP links.

6.3.2.1 ETH layer network

The ETH layer network is defined by the complete set of ETH access groups that may be associated for the purpose of transferring information. The information transferred is characteristic of the ETH layer network and is termed ETH characteristic information. The associations of the ETH flow terminations (that form a connectionless trail) in the ETH layer network are defined on a per traffic unit basis, which is the ETH_CI traffic unit (see 6.3.1). The topology of the ETH layer network is described by ETH access groups, ETH flow domains and the ETH flow point pool links between them. The structures within the ETH layer network and its server and client layer networks are described by the components below.

6.3.2.2 ETH flow domain

An ETH flow domain is defined by the set of ETH (termination) flow points that are available for the purpose of transferring information. ETH_CI traffic unit transfers, across the ETH flow domain that corresponds to a particular association between ingress and egress ETH (termination) flow points, need not be present at all times. In general, ETH flow domains may be partitioned into smaller flow domains interconnected by ETH flow point pool links. The matrix (e.g., bridge) is a special case of an ETH flow domain.

An ETH flow domain provides broadcast connectivity between the connected ETH (termination) flow points. An ETH_CI traffic unit received via an input port (e.g., A in Figure 6) of the ETH flow domain is forwarded to all output ports on the ETH flow domain (B, C, D), with the exception of the output port (A) that is in the same bidirectional ETH (termination) flow point as the input port.

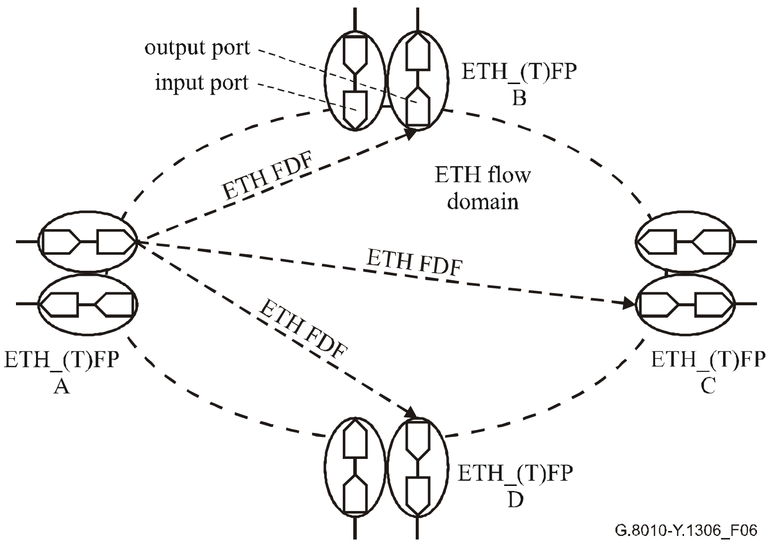

Figure 6/G.8010/Y.1306 – Broadcast connectivity in ETH Flow Domain

By means of ETH network management, ETH control plane actions and/or MAC learning, connectivity in an ETH flow domain can be restricted.

6.3.2.3 ETH flow point pool link

An ETH flow point pool link (FPP link) consists of a subset of the ETH flow points at the edge of one ETH flow domain or ETH access group that are associated with a corresponding subset of ETH flow points at the edge of another ETH flow domain or ETH access group for the purpose of transferring ETH characteristic information.

The ETH FPP link represents the topological relationship and available capacity between a pair of ETH flow domains, or an ETH flow domain and an ETH access group, or a pair of ETH access groups.

Multiple ETH FPP links may exist between any given ETH flow domain and ETH access group or pair of ETH flow domains or ETH access groups.

6.3.2.4 ETH access group

An ETH access group is a group of co-located ETH flow termination functions that are connected to the same ETH flow domain or ETH FPP link.

6.3.2.5 Partitioning ETH topological components

Subsets of ETH topological components can be allocated to specific users, creating ETH VPNs. Traffic within an ETH VPN is bound to that ETH VPN and will not cross over to another ETH VPN.

NOTE – ETH VPNs may be deployed for other purposes as well, e.g., to segregate two or more applications.

6.3.2.5.1 Fragmenting an ETH layer network

The ETH layer network can be fragmented in ETH VPNs such that either:

– two ETH VPNs do not have any components (flow domains, FPP links, access groups) in common (spatial separation) (see Figure 7); or

– flow domains and links are shared by multiple ETH VPNs and ETH VPN separation is obtained via the allocation of flow domain fragments, component links and/or links to each ETH VPN (logical separation) (see Figure 7).

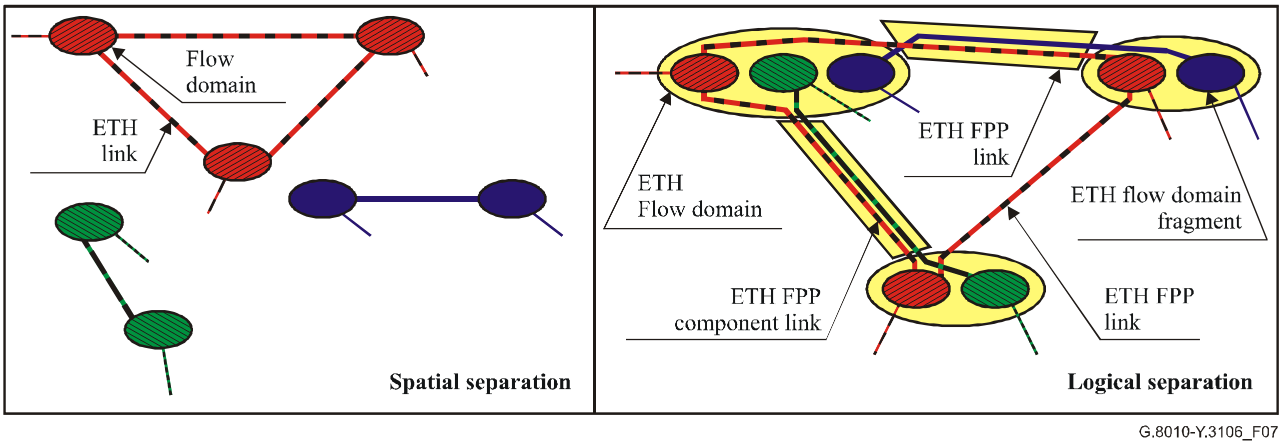

Figure 7/G.8010/Y.1306 – Spatially and logically separated ETH VPNs

6.3.2.5.2 Fragmenting an ETH flow domain

An ETH flow domain can be fragmented into ETH flow domain fragments (FDFr) (see Figure 8). Refer to Annex A. An ETH FDFr provides connectivity between the (termination) flow points in the fragment.

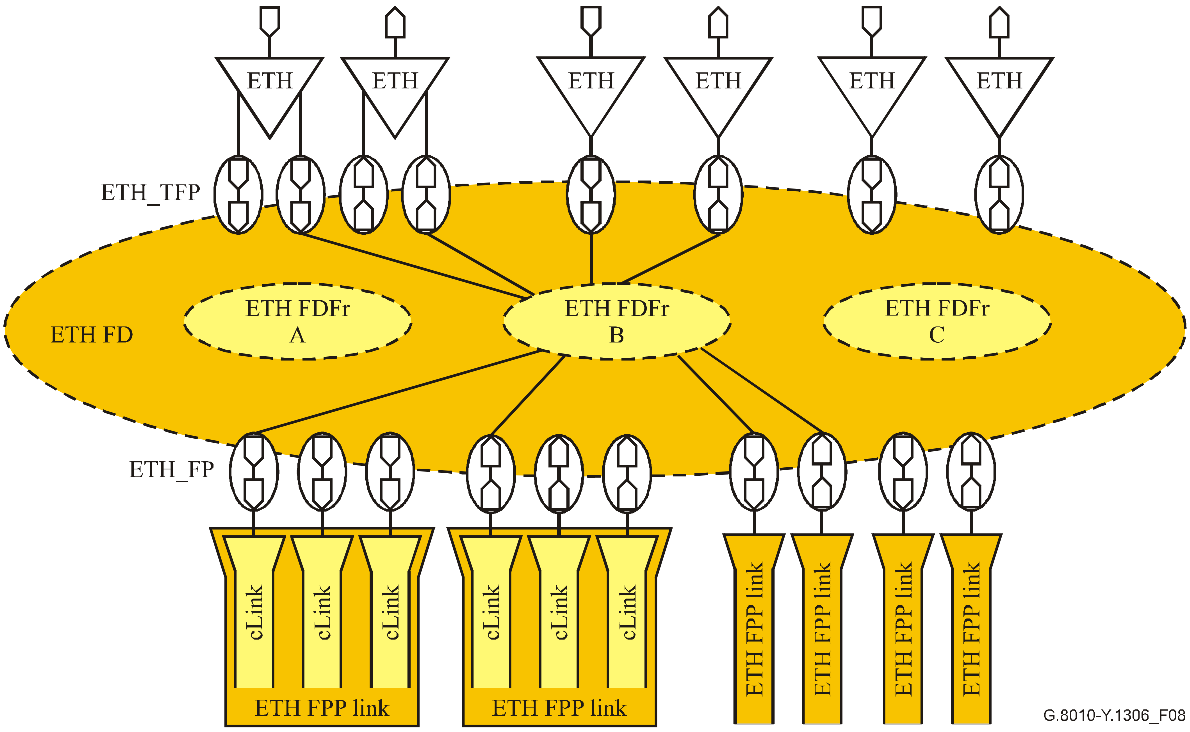

Figure 8/G.8010/Y.1306 – ETH flow domain fragments

NOTE – There is in general no theoretical limit to the number of fragments in an ETH flow domain. IEEE 802.1Q implementations however, have a limit of 4094 fragments due to the use of the VLAN IDs for the identification of flow domain fragments.

6.3.2.5.3 Partitioning an ETH flow point pool link

An ETH flow point pool link can be partitioned into ETH flow point pool component links (cLink) (see Figures 8 and 9). The input and output ports of an ETH FPP cLink can be bound to output and input ports of ETH Flow Domains and/or ETH Flow Termination functions. ETH FPP cLinks provide the same connectivity as an ETH FPP link.

NOTE – The ETH layer network technology supporting component links within the ETH FPP link is the VLAN technology. MAC frames are extended with an additional VLAN tag (see IEEE 802.3 clause 3.5, IEEE 802.1Q clause 9) including a VLAN ID to identify the ETH VPN these frames belong to. There is a maximum number of ETH FPP cLinks within an ETH FPP link that can be supported with the VLAN technology.

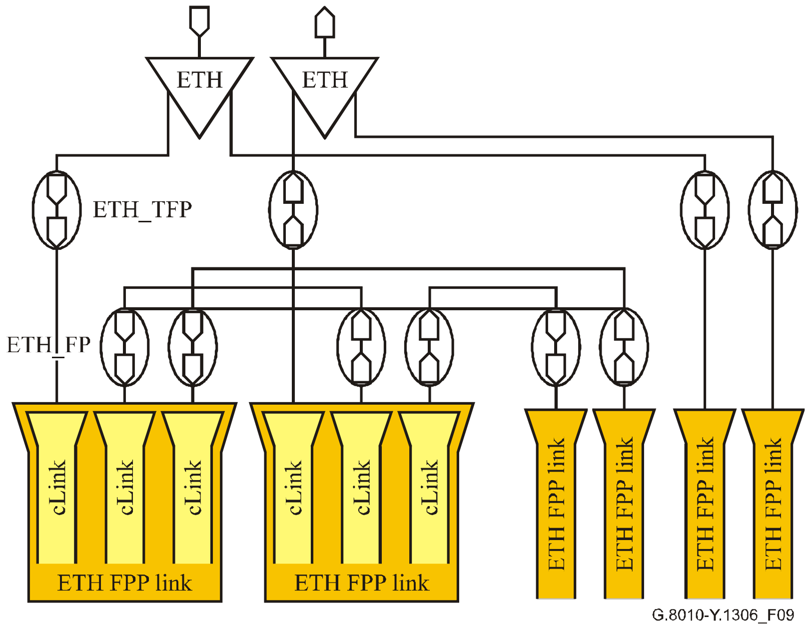

Figure 9/G.8010/Y.1306 – ETH FPP component links

6.3.3 ETH transport entities

The ETH transport entities are:

– ETH link flow;

– ETH flow domain flow;

– ETH network flow;

– ETH connectionless trail.

6.3.4 ETH transport processing functions

The ETH transport processing functions are:

– ETH flow termination function;

– ETH to client layer network adaptation functions;

– ETH traffic conditioning function.

6.3.4.1 ETH flow termination function

The bidirectional ETH Flow Termination (ETH_FT) function is performed by a co-located pair of ETH flow termination source (ETH_FT_So) and sink (ETH_FT_Sk) functions.

The ETH_FT_So function inserts the Destination Address, Source Address and Priority in the ETH_CI traffic unit. The Destination Address and Priority may be received from a client layer.

NOTE 1 – ETH OAM processing in the ETH_FT_So function is for further study; the requirements are defined in ITU-T Rec. Y.1730.

The ETH_CI traffic unit is output via the ETH_TFP or via one of the ETH_TFPs.

NOTE 2 – In the source direction, the client layer network may pass the MAC destination address to the ETH_FT function. The method to determine the MAC destination address (e.g., ARP) is not part of the ETH_FT function; it is client-dependent.

The ETH_FT_Sk accepts ETH_CI traffic units where the Destination Address matches the ETH_FT's MAC address. It furthermore accepts ETH_CI traffic units where Destination Addresses match a configured set of MAC addresses. Other ETH_CI traffic units are discarded. It terminates the accepted ETH_CI traffic units and forwards the M_SDU to the ETH_AP.

NOTE 3 – ETH OAM processing in the ETH_FT_Sk function is for further study; the requirements are defined in ITU-T Rec. Y.1730.

6.3.4.2 ETH traffic conditioning function

The ETH Traffic Conditioning (ETH_TC) function performs the following processes:

– *Classification*: This process classifies each ETH_CI traffic unit.

– *Metering*: This process meters every ETH_CI traffic unit within its class in order to determine the eligibility of the ETH_CI traffic unit and set the drop precedence if applicable.

– *Policing*: This process disposes the ETH_CI traffic unit according to the result from the metering process. There are only two dispositions for an ETH_CI traffic unit, passing to the ETH_FP or discarding.

The ETH traffic conditioning function is assigned on a per ETH_FP basis, as shown in Figure 27.

The ETH traffic conditioning function may also be assigned to a group of ETH_FPs. This configuration allows the possibility of traffic conditioning based on the ETH_CI traffic units of multiple ETH_FPs. This is for further study.

6.3.5 ETH reference points

The ETH reference points (see Figures 4, 12 and 13) are:

• ETH access point (AP);

• ETH termination flow point (TFP);

• ETH flow point (FP);

• ETH flow point pool (FPP);

• ETH termination flow point pool (TFPP);

6.3.5.1 ETH access point

An ETH access point (ETH_AP) represents the binding between an ETH flow termination function and one or more ETH/Client adaptation functions.

6.3.5.2 ETH termination flow point

An ETH Termination Flow Point (ETH_TFP) represents the binding between an ETH flow termination function and either an ETH flow domain, or an ETH flow point pool link (see Figure 10).

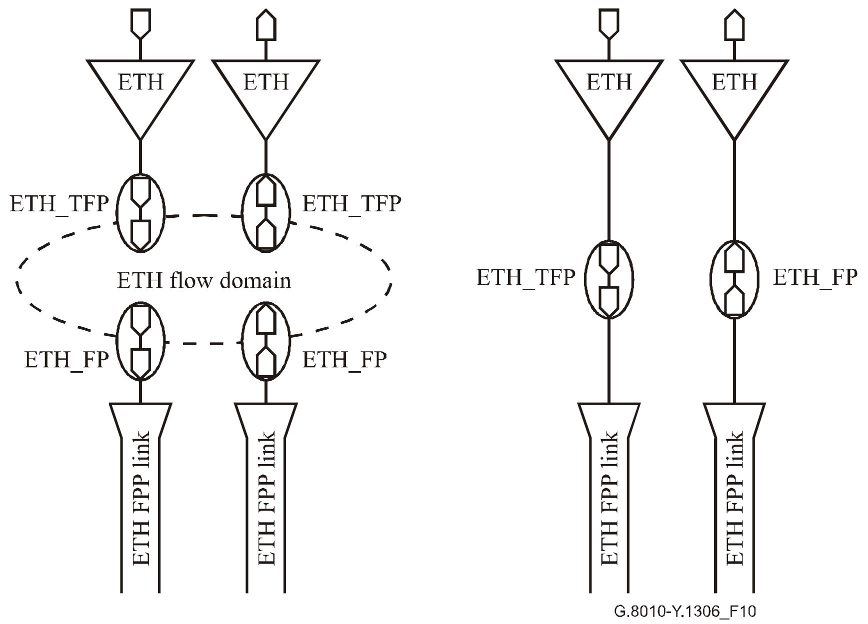

Figure 10/G.8010/Y.1306 – ETH termination flow points between ETH_FT function and ETH flow domain or ETH FPP link

6.3.5.3 ETH flow point

An ETH flow point represents the binding of an ETH FPP link with an ETH flow domain or another ETH FPP link (see Figure 11). This flow point is provided through the Server/ETH adaptation function.

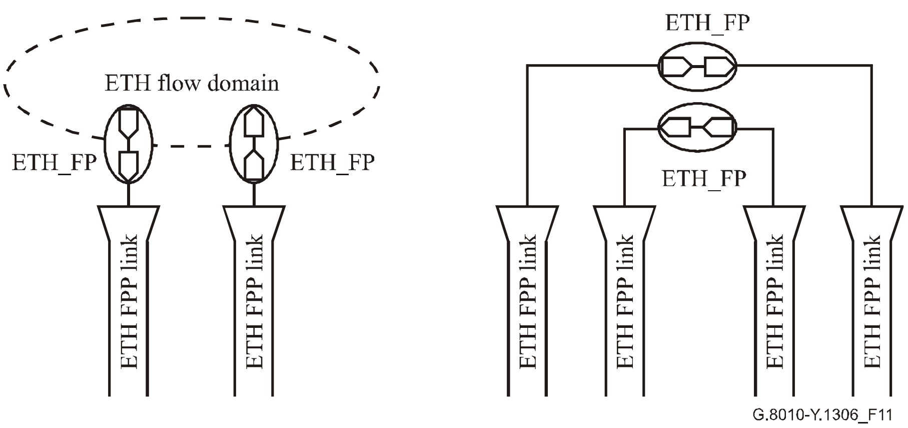

Figure 11/G.8010/Y.1306 – ETH flow points between ETH FPP links and ETH flow domain

An ETH flow point, from the network viewpoint, is transparent to both the source address and destination address of any ETH_CI traffic unit that traverses it.

6.3.5.4 ETH flow point pools

A group of co-located ETH flow points that have a common routing is referred to as an ETH flow point pool (FPP). An FPP has the same properties as its member flow points.

6.3.5.5 ETH termination flow point pools

A group of co-located ETH termination flow points is referred to as an ETH termination flow point pool (TFPP). A TFPP has the same properties as its termination flow points.

6.3.5.6 Partitioning ETH reference points

6.3.5.6.1 Partitioning an ETH flow point

An ETH flow point can be partitioned to generate new ETH flow points (see Figure 12).

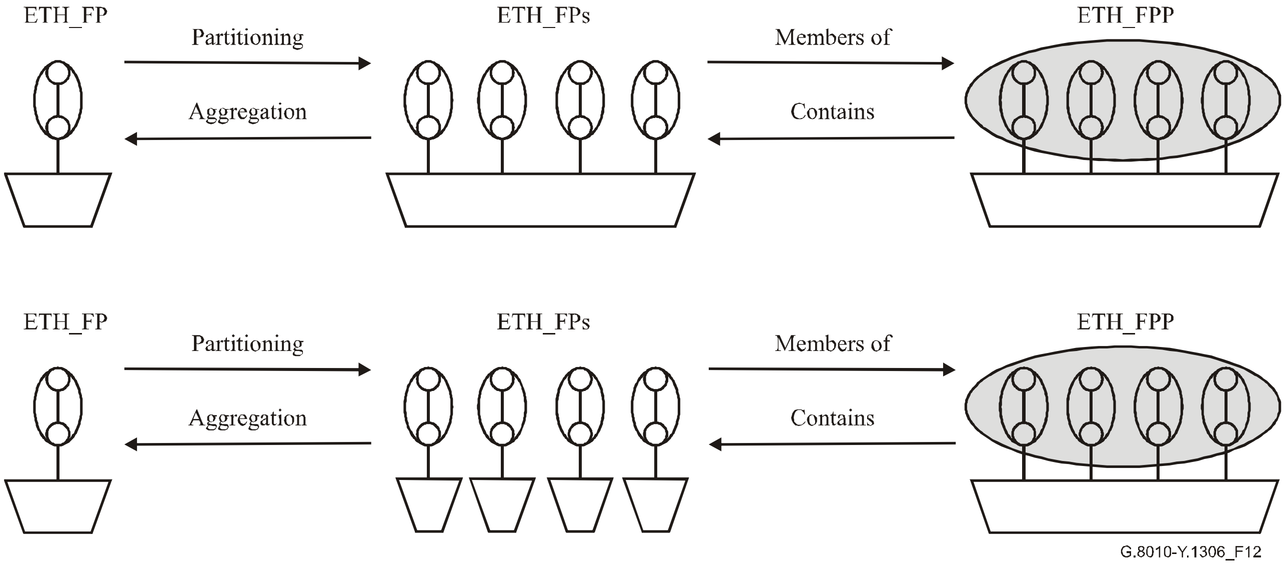

Figure 12/G.8010/Y.1306 – ETH flow point partitioning

This mechanism is used, for example, to generate additional flow points in the ETH layer network as a result of creating logically separated VPNs (see 6.3.2.5.1). This results from the fragmenting of an ETH flow domain, resulting in one ETH flow point for each of the fragments attached to the ETH FPP link containing the ETH flow points. The set of ETH flow points that results from this partitioning is contained within an ETH flow point pool. The new ETH flow points have the same properties as the original ETH flow point.

The additional ETH flow points may represent the ETH FPP component link ends (see Figure 12 top) or the ETH FPP link ends (see Figure 12 bottom). In the former case the additional flow points are supported by the Ethernet VLAN technology; in the latter case the additional flow points are supported by a CO-CS (e.g., ETY, SDH VC-n), CO-PS (e.g., MPLS, ATM VC), or CLPS (e.g., IP tunnel) layer technology.

For the ETH layer network, the property of flow point partitioning results in two Server/ETH adaptation functions as described in 6.5.2.

6.3.5.6.2 Partitioning an ETH termination flow point

An ETH termination flow point can be partitioned to generate new ETH termination flow points (see Figure 13).

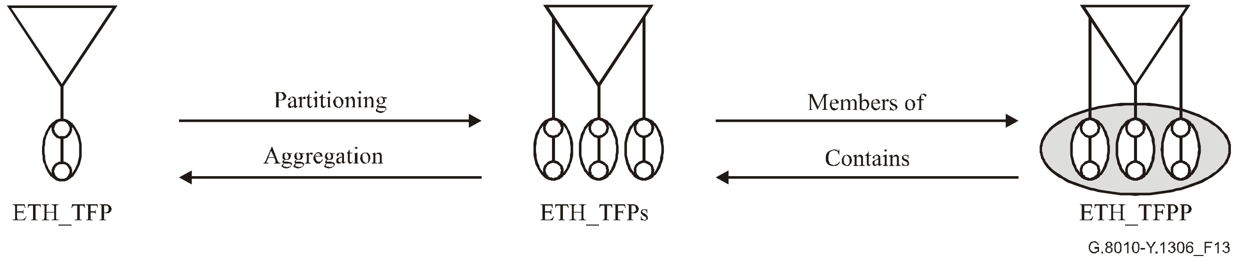

Figure 13/G.8010/Y.1306 – ETH termination flow point partitioning

6.4 Ethernet PHY (ETY) layer network

The ETYn layer network provides the transport of adapted ETH characteristic information through an ETYn trail between ETYn access points. The adapted information is a continuous bit stream with appropriate line encoding as specified in IEEE 802.3 and IEEE 802.3ae. The ETYn characteristic information is the physical section signal that will be transported over the medium (e.g., fibre, copper).

The ETYn layer network contains the following transport processing functions, transport entities and topological components (see Figure 14):

- ETYn trail;
- ETYn trail termination source (ETYn_TT_So);
- ETYn trail termination sink (ETYn_TT_Sk);
- ETYn network connection (NC);
- ETYn link connection (LC);
- ETYn link (not shown specifically in Figure 14).

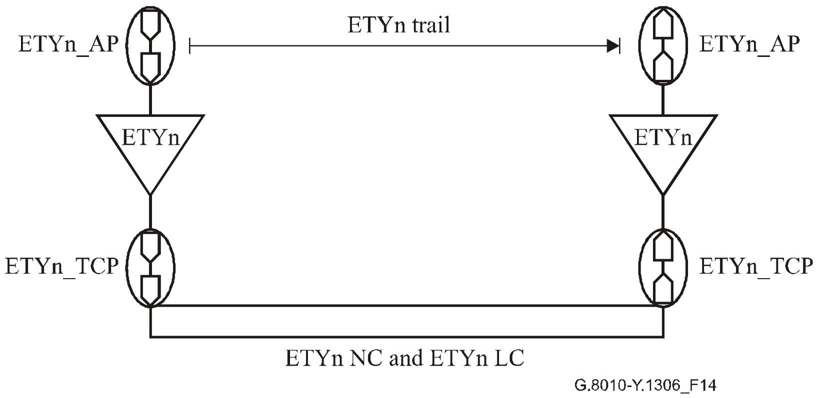

Figure 14/G.8010/Y.1306 – ETYn layer network example

6.4.1 ETYn characteristic information

The ETYn layer network characteristic information is a digital, optical or electrical (coded) signal of defined power, bit rate, pulse width and wavelength transported over the physical medium. Specific ETYn signal types are defined in IEEE 802.3. Examples of those signal types, grouped by rate, are shown in Table 1.

Table 1/G.8010/Y.1306 – ETYn signal type examples

n	ETYn
1	10BASE set of signals
2	100BASE set of signals
3	1000BASE set of signals
4	10GBASE set of signals

6.4.2 ETY topological components

The ETYn topological components are:

– ETYn layer network;
– ETYn link;
– ETYn access group.

The ETYn link connection is supported by the medium (e.g., fibre, copper).

6.4.3 ETY transport entities

The ETYn transport entities are:

– ETYn link connection;
– ETYn network connection;
– ETYn trail.

6.4.4 ETY transport processing functions

The ETYn transport processing functions are:

– ETYn trail termination function;
– ETYn to ETH adaptation function.

6.4.4.1 ETY trail termination function

The bidirectional ETYn Trail Termination (ETYn_TT) function is performed by a co-located pair of ETYn trail termination source (ETYn_TT_So) and sink (ETYn_TT_Sk) functions.

The ETYn_TT_So function performs the following process between its input and its output:

– Generates the physical signal on the medium.

The ETYn_TT_Sk function performs the following process between its input and its output:

– Receives the physical signal from the medium.

6.4.5 ETY reference points

The ETY reference points (see Figure 14) are:

• ETY access point;
• ETY termination connection point.

6.5 Server/Client associations

6.5.1 ETH/Client adaptation

The ETH/Client adaptation (ETH/Client_A) is considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the client-specific processes is outside the scope of this Recommendation.

The adaptations make use of either type or length field encapsulation as specified in IEEE 802.3 clause 3.

When using type field encapsulation, the type field indicates the type of the payload (e.g., IP). This indicates the source/destination client.

When using length field encapsulation, the length field indicates the length of the payload. A Logical Link Control (LLC) header that indicates the source and destination client follows the length field. The LLC sublayer is defined in IEEE 802.2.

Two examples of server-specific ETH/Client adaptations are described below.

6.5.1.1 ETH/Bridge protocols

The bidirectional ETH/BP adaptation (ETH/BP_A) function is performed by a co-located pair of ETH/BP adaptation source (ETH/BP_A_So) and sink (ETH/BP_A_Sk) functions.

The ETH/BP_A_So performs one of the following server-specific processes between its input and output:

– Length field encapsulation.
– Set the protocol ID and destination address value.
– Multiplex the frame towards the ETH_FT.

The ETH/BP_A_Sk performs one of the following server-specific processes between its input and output:

– Demultiplex the frame towards the BP client.
– Remove the length field encapsulation.
– Remove the protocol ID.

6.5.1.2 ETH/IP

The bidirectional ETH/IP adaptation (ETH/IP_A) function is performed by a co-located pair of ETH/IP adaptation source (ETH/IP_A_So) and sink (ETH/IP_A_Sk) functions.

The ETH/IP_A_So performs one of the following server-specific processes between its input and output:

– Type field encapsulation.
– Multiplex the frame towards the ETH_FT.

The ETH/IP_A_Sk performs one of the following server-specific processes between its input and output:

– Demultiplex the frame towards the IP client.
– Remove the type field encapsulation.

6.5.2 Server/ETH adaptation

The Server/ETH adaptation function provides the ETH link end functionality.

The Server/ETH adaptation function is considered to consist of two types of processes: client-specific processes and server-specific processes. The client-specific processes are associated with the ETH_CI traffic units, which ingress/egress via the ETH_FPs.

There are two basic types of Server/ETH adaptation functions as illustrated in Figure 15: single ETH flow point (Srv/ETH_A) and multiple ETH flow points (Srv/ETH-m_A).

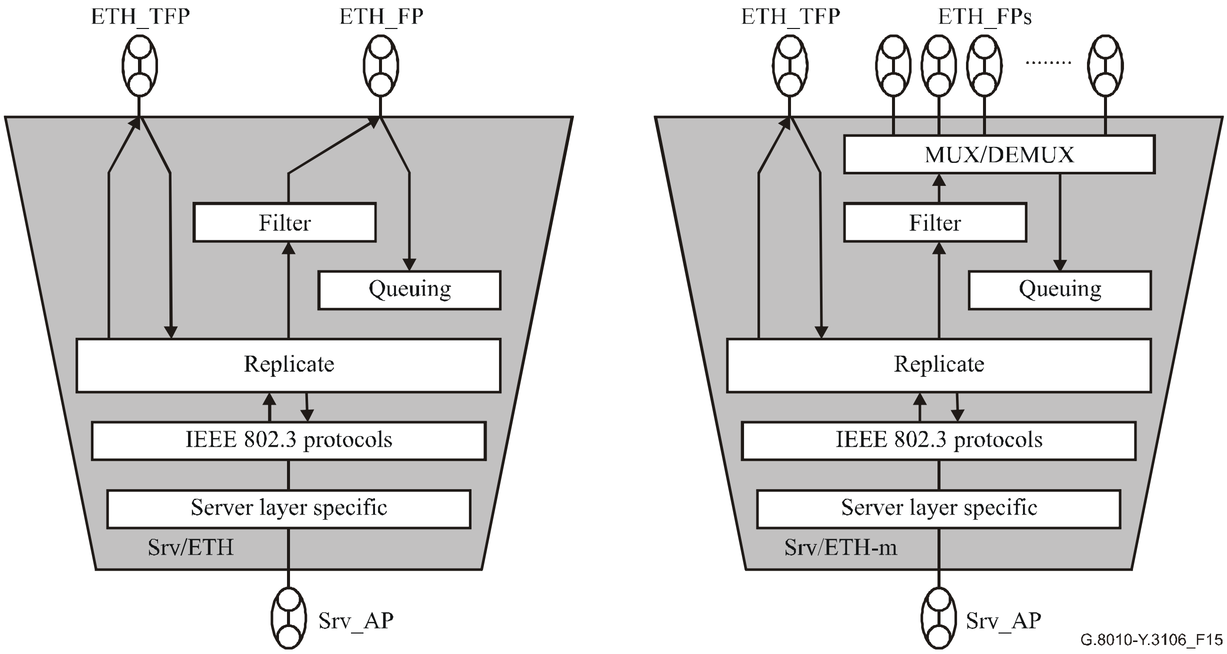

Figure 15/G.8010/Y.1306 – Server to ETH adaptation functions

Each of these adaptation functions has an ETH_TFP and one or more ETH_FPs. The ETH_TFP represents the binding with an ETH_FT function; the ETH_FPs represent the bindings with either an ETH flow domain, or an Srv/ETH(-m)_A function.

The Srv/ETH_A function has *one* ETH_TFP and *one* ETH_FP associated with it. These flow points allow any valid ETH_CI traffic unit to be transported across it.

The Srv/ETH-m_A function has *one* ETH_TFP and N (N = 1..4094) ETH_FPs associated with it. Each of the ETH_FPs is associated with a separate ETH FPP component link. ETH link frames/packets include an identifier, which relates a frame/packet to one of the ETH FPP component links. This identifier is the VLAN ID (VID) value in the VLAN Tag (optional) in the M_SDU (see Figure 16) within the ETH link frame/packet. This adaptation function operates either in customer mode, or in service provider mode as configured. Refer to Appendix III.

M_SDU format	VLAN Tag (optional)
	Remainder of M_SDU

Figure 16/G.8010/Y.1306 – MAC service data unit format with optional VLAN tag

The bidirectional Srv/ETH adaptation (Srv/ETH_A) or Srv/ETH-m adaptation (Srv/ETH-m_A) functions are performed by a co-located pair of source and sink Srv/ETH or Srv/ETH-m adaptation functions.

The Srv/ETH_A and Srv/ETH-m_A source functions perform the following processes between their inputs and output:

- For the case of the Srv/ETH-m_A source function, multiplex ETH_CI traffic units from the N ETH_FPs and insert a VLAN Tag as appropriate.
- Perform queuing and scheduling.
- Replicate ETH_CI traffic units received on the input from the queuing process and deliver them to the ETH_TFP and IEEE 802.3 protocol processes. Replicate ETH_CI traffic units

received on the input from the ETH_TFP and deliver them to the filter process and IEEE 802.3 protocol process.

- Optionally generate and insert IEEE 802.3 protocol (e.g., PAUSE) ETH_CI traffic units.
- Server layer related specific source processes as described in the subclauses hereafter.

The Srv/ETH_A and Srv/ETH-m_A sink functions perform the following processes between their input and outputs:

- Server layer related specific sink processes as described in the subclauses hereafter.
- Optionally terminate IEEE 802.3 protocol ETH_CI traffic units (e.g., PAUSE).
- Replicate ETH_CI traffic units received on the input from the IEEE 802.3 protocol process and deliver them to the ETH_TFP and filter process.
- Filtering of ETH_CI traffic units that have their Destination Address matching a configured subset of the Reserved and GARP Application addresses specified in IEEE 802.1D.
- For the case of the Srv/ETH-m adaptation function, demultiplex ETH_CI traffic units according to the VID value in the VLAN Tag or the configured VID value.
- Output the ETH_CI traffic unit via the associated ETH_FP.

6.5.2.1 ETY/ETH adaptation

The bidirectional ETYn/ETH adaptation (ETYn/ETH_A, ETYn/ETH-m_A) function is performed by a co-located pair of source and sink ETYn/ETH and ETYn/ETH-m adaptation functions. The ETYn/ETH and ETYn/ETH-m adaptations can be further decomposed for the purpose of transporting for example an 8B/10B encoded stream using GFP-T. The adaptations can be decomposed into an ETCn/ETH and ETCn/ETH-m adaptation (ETC, Ethernet Coding), an ETCn source/sink termination, and an ETYn/ETCn adaptation function (see Figure 17).

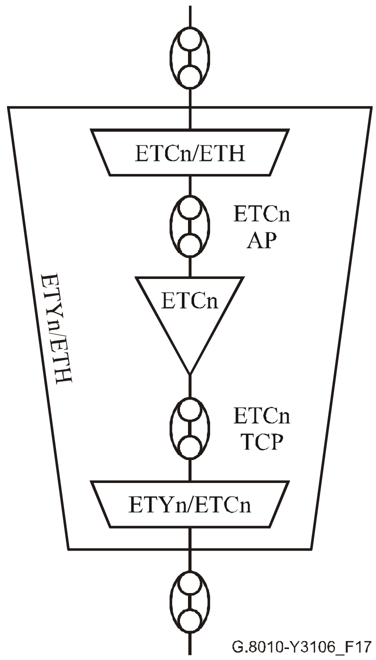

Figure 17/G.8010/Y.1306 – Decomposition of ETYn/ETH adaptation function

The exact processes performed in the different functions depend on the specific PHY used (e.g., 10BASE-T, 100BASE-T); this clause only lists possible functions.

6.5.2.1.1 ETCn/ETH adaptation

The ETCn/ETH and ETC/ETH-m adaptation source (ETCn/ETH_A_So, ETCn/ETH-m_A_So) functions perform (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Compute MAC FCS over the ETH_CI traffic unit.

– Map the ETH_CI traffic unit and its FCS into an ETH link (i.e., MAC) frame.

– Other processes such as insertion of preamble, inter-frame gaps, line encoding, etc., as specified in IEEE 802.3.

The ETCn/ETH and ETC/ETH-m adaptation sink (ETCn/ETH_A_Sk, ETCn/ETH-m_A_Sk) functions perform (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Perform line decoding, frame alignment, etc., as specified in IEEE 802.3.

– Check MAC FCS and discard corrupted link (MAC) frames.

– Demap ETH_CI traffic units from their link (MAC) frames.

6.5.2.1.2 ETC trail termination

The bidirectional ETCn trail termination (ETCn_TT) function is performed by a co-located pair of source and sink ETCn trail termination functions.

The ETCn_TT_So function connects its input and output and does not perform any specific functions.

The ETCn_TT_Sk function connects its input and output and checks the encoded stream for code violations.

The ETCn_CI is the stream of 8-bit characters and their data/control indication ("8+control") as defined within the various PCS blocks in IEEE 802.3.

6.5.2.1.3 ETYn/ETCn adaptation

The ETYn/ETCn adaptation source (ETYn/ETCn_A_So) performs one or more of the following processes between its input and its output:

– Serialization of code groups, encoding the ETCn_CI, etc., as specified in IEEE 802.3.

The ETYn/ETCn adaptation sink (ETYn/ETCn_A_Sk) performs one or more of the following processes between its input and its output:

– De-serialization of code groups, codegroup alignment, decoding the ETCn_CI, clock recovery, etc., as specified in IEEE 802.3.

6.5.2.2 TP/ETH adaptation

The transmission path (TP) layer networks provide the transport of adapted ETH characteristic information through a TP trail between TP access points. The adapted information is a continuous bit stream with appropriate encapsulation and mapping as specified in other ITU-T Recommendations, for example, G.7041/Y.1303, G.707/Y.1322 and G.709/Y.1331.

6.5.2.2.1 SDH Path/ETH adaptation

The adaptation to the SDH VC-n and VC-n-Xc path layer networks is performed in Sn/ETH, Sn/ETH-m, Sn-Xc/ETH, Sn-Xc/ETH-m, Sn-X/ETH and Sn-X/ETH-m adaptation (S/ETH_A, S/ETH-m_A) functions. The S/ETH_A and S/ETH-m_A are considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the server-specific processes is outside the scope of this Recommendation.

The bidirectional S/ETH and S/ETH-m adaptation functions are performed by a co-located pair of source and sink S/ETH and S/ETH-m adaptation functions.

The S/ETH and S/ETH-m adaptation source (S/ETH_A_So, S/ETH-m_A_So) functions perform (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Compute MAC FCS over the ETH_CI traffic unit.
– Map the ETH_CI traffic unit and its FCS into the ETH link specific frame as specified in the appropriate Recommendation.
– Map the stream of link specific frames into the payload of the SDH VC signal (e.g., VC-n/VC-n-Xv/VC-n-Xc).

The S/ETH and S/ETH-m adaptation sink (S/ETH_A_Sk, S/ETH-m_A_Sk) functions perform (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Extract the ETH link specific frame stream from the payload of the TP signal.
– Demap the ETH_CI traffic unit and its FCS from the link specific frame as specified in the appropriate Recommendation.
– Check MAC FCS and discard corrupted ETH_CI traffic units.

6.5.2.2.2 OTN path/ETH adaptation

The adaptation to the OTN ODUk path layer networks is performed in ODUkP/ETH, ODUkP/ETH-m, ODUkP-X/ETH and ODUkP-X/ETH-m adaptation (ODU/ETH_A, ODU/ETH-m) functions. The ODU/ETH_A and ODU/ETH-m_A are considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the server-specific processes is outside the scope of this Recommendation.

The bidirectional ODU/ETH and ODU/ETH-m adaptation functions are performed by a co-located pair of source and sink ODU/ETH and ODU/ETH-m adaptation functions.

The ODU/ETH and ODU/ETH-m adaptation source (ODU/ETH_A_So, ODU/ETH-m_A_So) functions perform (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Compute MAC FCS over the ETH_CI traffic unit.
– Map the ETH_CI traffic unit and its FCS in a GFP-F frame as specified in ITU-T Rec. G.7041/Y.1303.
– Map the GFP frame stream into the payload of the OTN ODU signal (e.g., ODUk/ODUk-Xv) as specified in ITU-T Rec. G.709/Y.1331.

The ODU/ETH and ODU/ETH-m adaptation sink (ODU/ETH_A_Sk, ODU/ETH-m_A_Sk) functions perform (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Extract the GFP frame stream from the payload of the TP signal.
– Demap the ETH_CI traffic unit and its FCS from the GFP-F frame as specified in ITU-T Rec. G.7041/Y.1303.
– Discard corrupted ETH_CI traffic units.

6.5.2.2.3 MPLS path/ETH adaptation

The adaptation to the MPLS path layer networks is performed in MPLS/ETH adaptation (MPLS/ETH_A) functions. The MPLS/ETH_A is considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the server-specific processes is outside the scope of this Recommendation.

The bidirectional MPLS/ETH adaptation function is performed by a co-located pair of source and sink MPLS/ETH adaptation functions.

The MPLS/ETH adaption source (MPLS/ETH_A_So) function performs (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Map the ETH_CI traffic unit in the ETH over MPLS specific frame.
– Map the ETH over MPLS link specific frame in the payload of the MPLS packet.

The MPLS/ETH adaptation sink (MPLS/ETH_A_Sk) function performs (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific process:

– Extract ETH_CI traffic units from the MPLS payload field.

6.5.2.2.4 ATM VC/ETH adaptation

The adaptation to the ATM VC layer network is performed in VC/ETH adaptation (VC/ETH_A) functions. The VC/ETH_A is considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the server-specific processes is outside the scope of this Recommendation.

The bidirectional VC/ETH adaptation function is performed by a co-located pair of source and sink VC/ETH adaptation functions.

The VC/ETH adaptation source (VC/ETH_A_So) function performs (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Compute MAC FCS over the ETH_CI traffic unit.
– Map the ETH_CI traffic unit with or without its MAC FCS in the ETH over ATM specific frame as specified in IETF RFC 2684.
– Map the ETH over ATM link specific frame in the payload of the ATM cell.

The VC/ETH adaptation sink (VC/ETH_A_Sk) function performs (in addition to the server layer non-specific processes as described in 6.5.2) the following server layer related specific processes:

– Perform Ethernet over ATM related processing.
– Extract ETH_CI traffic units from the payload of the ATM cell.
– Discard corrupted ETH_CI traffic units if MAC FCS is present.

6.5.3 TP/ETCn adaptation

The transmission path (TP) layer networks provide the transport of adapted ETCn characteristic information through a TP trail between TP access points. The adapted information is a continuous bit stream with appropriate encapsulation and mapping as specified in other ITU-T Recommendations, for example, G.7041/Y.1303 and G.707/Y.1322.

6.5.3.1 VC-4-7v/ETC3 adaptation

The VC-4-7v path layer networks provide the transport of adapted ETC3 characteristic information through a VC-4-7v trail between VC-4-7v access points.

The adaptation to the SDH VC-4-7v path layer networks is performed in S4-7/ETC3 functions. The S4-7/ETC3_A is considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the server-specific processes is outside the scope of this Recommendation.

The bidirectional S4-7/ETC3 adaptation function is performed by a co-located pair of source and sink S4-7/ETC3 adaptation functions.

The S4-7/ETC3 adaptation source (S4-7/ETC3_A_So) function performs the following client-specific process between its input and its output:

– Map the ETC3_CI stream via GFP-T into the payload of the VC-4-7v, as defined in ITU-T Recs G.7041/Y.1303 and G.707/Y.1322.

The S4-7/ETC3 adaptation sink (S4-7/ETC3_A_Sk) function performs the following client-specific process between its input and its output:

– Demap the ETC3_CI stream within GFP-T from the payload of the VC-4-7v, as defined in ITU-T Recs G.7041/Y.1303 and G.707/Y.1322.

6.5.3.2 VC-4-64c/ETC4 adaptation

The VC-4-64c path layer networks provide the transport of adapted ETC4 characteristic information through a VC-4-64c trail between VC-4-64c access points.

The ETC4_CI is the signal at the output of the 10GBASE-R PCS coding block in IEEE 802.3ae, including the 64B/66B coding and the rate adaptation to the SDH (VC-4-64c payload) clock.

The adaptation to the SDH VC-4-64c path layer networks is performed in S4-64/ETC4 functions. The S4-64/ETC4_A is considered to consist of two types of processes: client-specific processes and server-specific processes. The description of the server-specific processes is outside the scope of this Recommendation.

The bidirectional S4-64/ETC4 adaptation function is performed by a co-located pair of source and sink S4-64/ETC4 adaptation functions.

The S4-64/ETC4 adaptation source (S4-64/ETC4_A_So) performs the following client-specific process between its input and its output:

– Map the ETC4_CI stream into the payload of the VC-4-64c, as defined in Annex F/G.707/Y.1322.

The S4-64/ETC4 adaptation sink (S4-64/ETC4_A_Sk) performs the following client-specific process between its input and its output(s):

– Demap the ETC4_CI stream from the payload of the VC-4-64c, as defined in Annex F/G.707/Y.1322.

6.6 Ethernet network topology

An ETH layer network contains one or more ETH links and zero or more ETH flow domains. Such an ETH layer network is able to support point-to-point connectivity and/or multipoint connectivity between two or more flow points and/or termination flow points at the edges of the ETH layer network administrative domain.

Furthermore, the ETC sublayer in the ETY layer network is able to support point-to-point connections between two of its connection points at the edges of the ETC sublayer network administrative domain.

6.6.1 Point-to-point ETH connection

A point-to-point ETH connectivity is provided via an ETH FPP link or ETH serial compound FPP link between an ETH flow point A and an ETH flow point Z located at the edge of the ETH layer network administrative domain (see Figures 18 and 19).

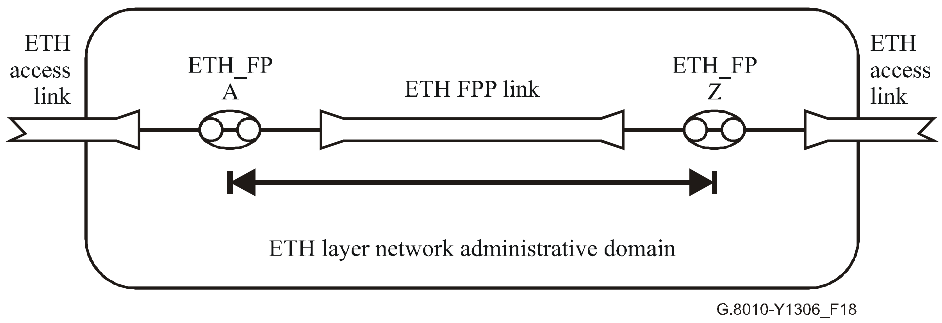

Figure 18/G.8010/Y.1306 – Point-to-point ETH connection (single link)

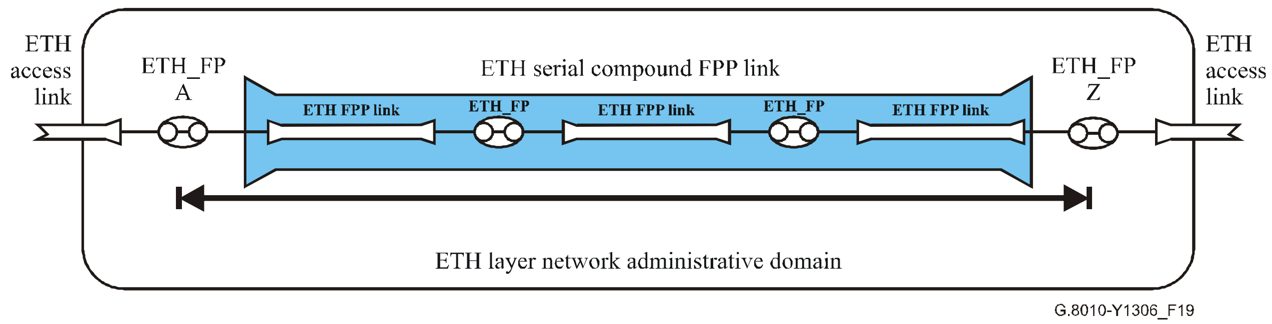

Figure 19/G.8010/Y.1306 – Point-to-point ETH connection (serial compound link)

6.6.2 Multipoint ETH connectivity

Multipoint ETH connectivity is provided via an ETH flow domain between two or more ETH flow points located at the edge of the ETH layer network administrative domain (see Figure 20).

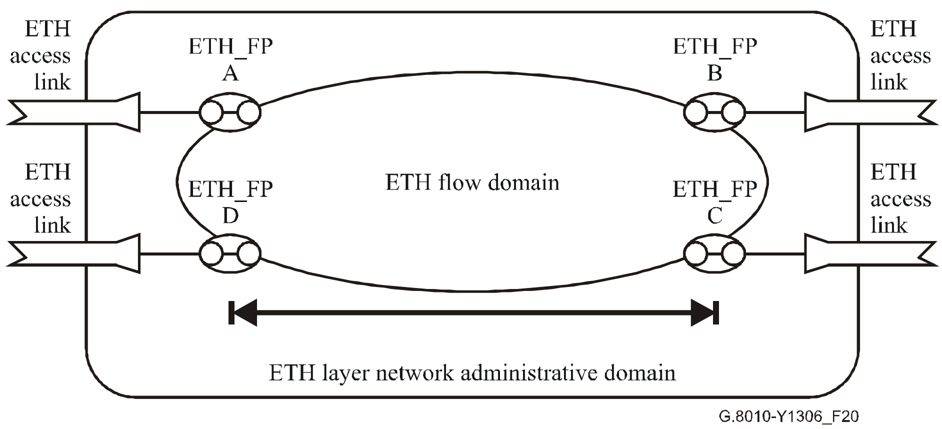

Figure 20/G.8010/Y.1306 – Multipoint ETH connectivity

The ETH flow domain in a multipoint ETH connectivity can be decomposed into one or more ETH flow domains and zero or more ETH FPP links as illustrated in Figure 21.

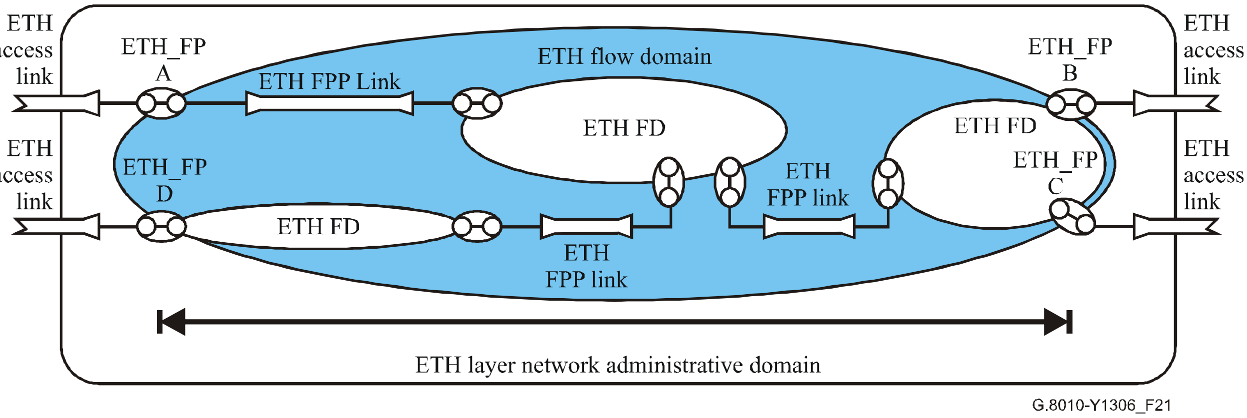

Figure 21/G.8010/Y.1306 – Example of ETH flow domain partitioning for multipoint ETH connectivity

6.6.3 Point-to-point ETC connection

A point-to-point ETC connection is provided via an ETC link between an ETC connection point A and an ETC connection point Z located at the edge of the ETC sublayer network administrative domain (see Figure 22).

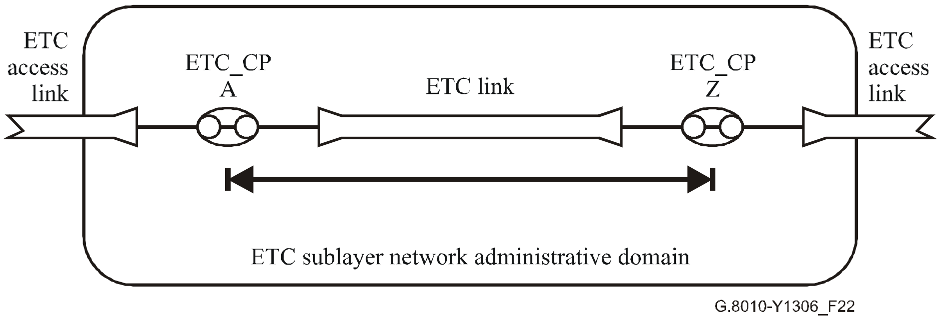

Figure 22/G.8010/Y.1306 – Point-to-point ETC connection

7 Ethernet network management

This clause describes network management for the Ethernet transport network. In particular, it describes the maintenance entities, maintenance entity supervision techniques and layer network management requirements.

7.1 Ethernet maintenance entities

The basic maintenance entities in the Ethernet network are the ETYn (section) trail (see Figure 14) and the ETH (path) connectionless trail (see Figure 4). Those (connectionless) trails monitor the ETY network connection and the ETH network flow between a pair of termination connection/flow points at the boundary of their layer network.

The ETH layer network may contain multiple administrative domains: e.g., user, service provider and one or more network operator domains. Each of these administrative domains has an associated maintenance entity located between a pair of ETH flow points at the boundaries of that ETH layer network administrative domain. Maintenance entities also exist between a pair of ETH flow points at the boundary of two adjacent ETH layer network administrative domains. Figures 23 (top left, bottom) and 24 illustrate such ETH layer network administrative domain maintenance entities for the point-to-point and multipoint connection cases.

NOTE – Figure 23 (top right) illustrates a second case; an ETH FPP link is supported over multiple (e.g., two) network operator administrative domains. There are no ETH flow points at the boundary of the two networks and the ETH intra-domain maintenance entities are single-ended. Monitoring of those (virtual) maintenance entities is not possible at the ETH layer network and is to be performed at the ETH's server layer.

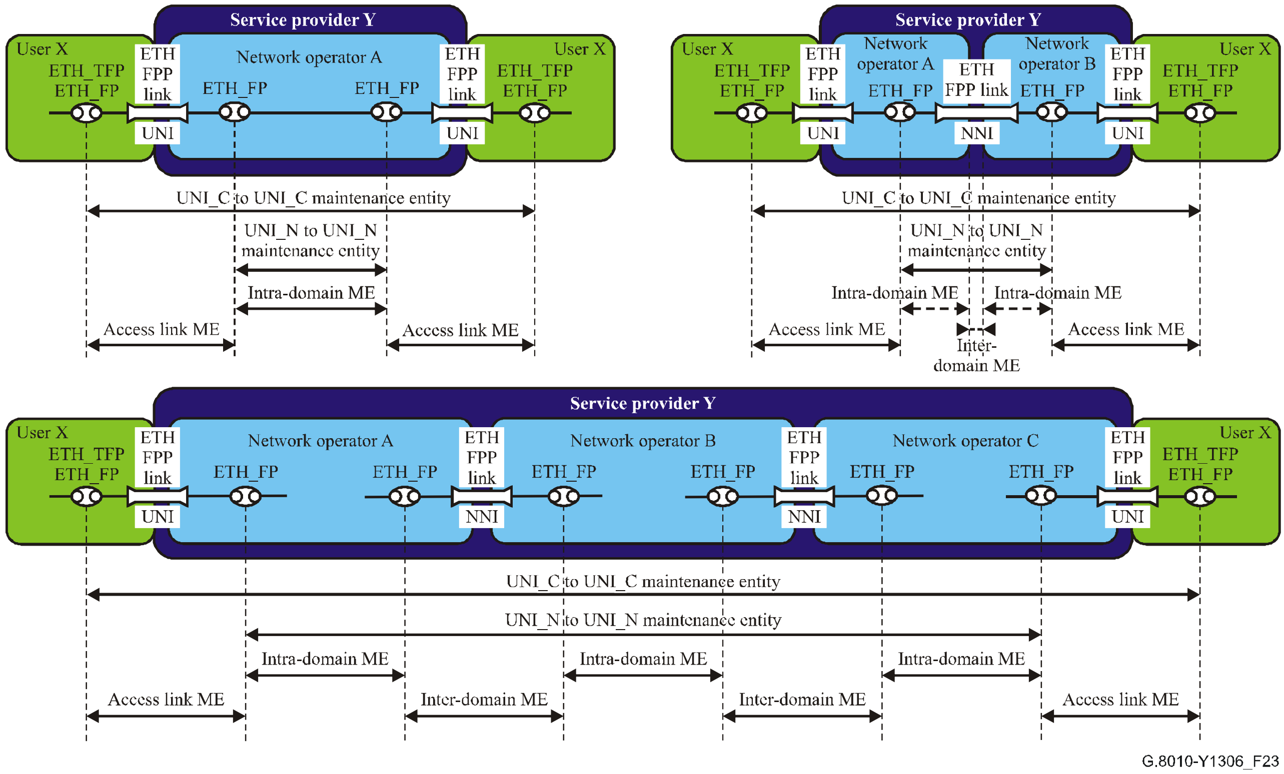

Figure 23/G.8010/Y.1306 – Point-to-point ETH connection administrative domain associated maintenance entities

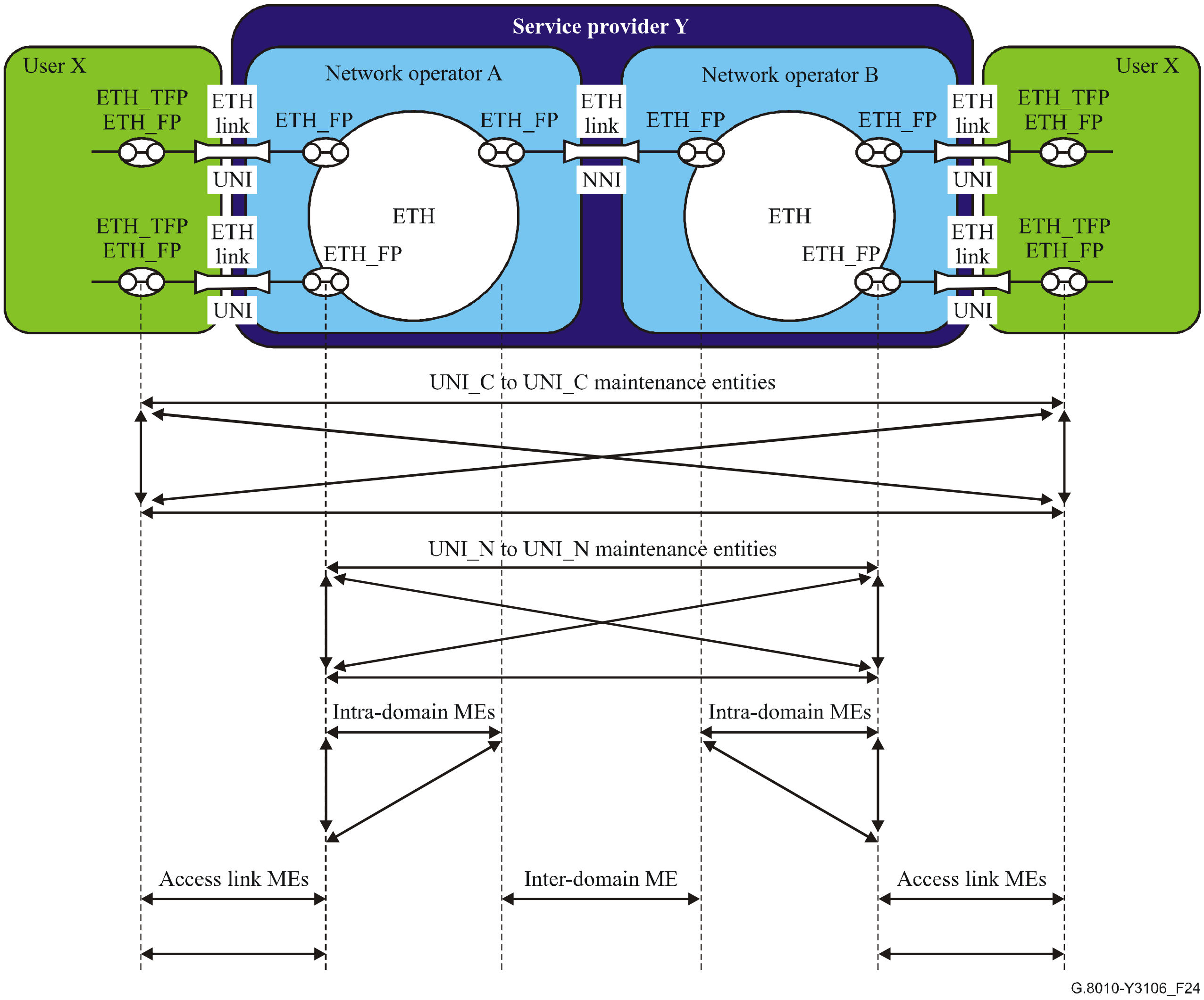

Figure 24/G.8010/Y.1306 – Multipoint ETH connectivity administrative domain associated maintenance entities

Protection switching/restoration applications as well as testing applications may require the presence of ETH layer network maintenance entities for their operation. Such maintenance entities can be between any two ETH flow points in the ETH layer network.

The ETC sublayer creates a maintenance entity associated with an ETC connection (see Figure 25).

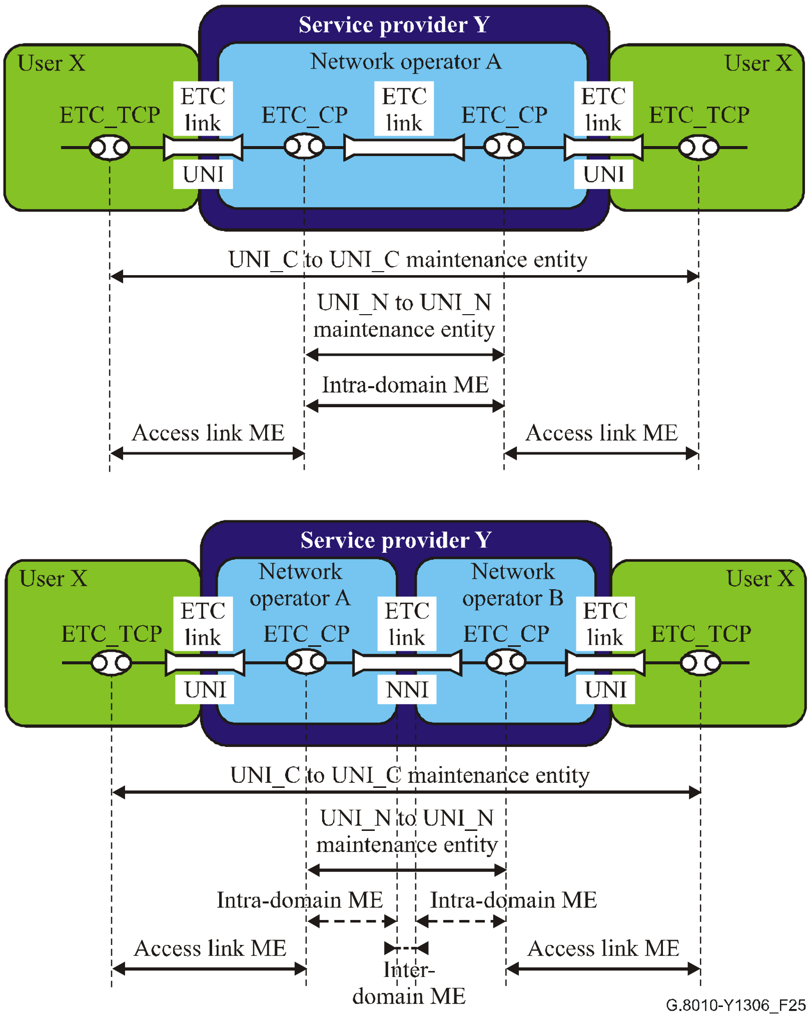

Figure 25/G.8010/Y.1306 – ETC connection administrative domain associated maintenance entities

7.2 Ethernet maintenance entity supervision techniques

Maintenance entity supervision is the process of monitoring the integrity of a given maintenance entity in the Ethernet section (ETYn) layer, ETC sublayer or Ethernet path (ETH) layer networks. The integrity may be verified by means of detecting and reporting continuity, connectivity and transmission performance defects for a given maintenance entity. ITU-T Rec. G.805 defines four types of monitoring techniques for maintenance entities.

The maintenance entity supervision process can be applied to network connections or connection segments (an arbitrary series of subnetwork connections and link connections) and network flows and flow domain segments (an arbitrary series of flow domain flows and link flows).

7.2.1 Inherent monitoring

Ethernet maintenance entities may be indirectly monitored by using the inherently available data from the server layers and computing the approximate state of the client connection from the available data.

ETH layer network maintenance entities may be indirectly monitored by using the inherently available data from the ETH server layers (e.g., SDH VC, OTH ODU, MPLS LSP, ATM VC) and computing the approximate state of the ETH maintenance entity from the available data.

ETC sublayer network maintenance entities may be indirectly monitored by using the inherently available data from the ETC server layers SDH VC and ETY and computing the approximate state of the ETC maintenance entity from the available data.

Inherent monitoring is not applicable in the ETY as the server layer is the physical media and provides no data.

7.2.2 Non-intrusive monitoring

For further study.

7.2.3 Intrusive monitoring

For further study.

7.2.4 Sublayer monitoring

Additional OAM is added to the original characteristic information such that the maintenance entity of interest can be directly monitored by a (connectionless) trail created in a sublayer. With this technique all parameters can be tested directly. This scheme can provide for nested sublayer (connectionless) trail monitored maintenance entities.

ETH layer network maintenance entities may be directly monitored by means of insertion of segment monitoring OAM at the ingress of the maintenance entity and extraction and processing of this OAM at the egress of the maintenance entity. Insertion and extraction and processing of this segment monitoring OAM is functionally performed in ETH segment flow termination functions ETHS_FT, which establish ETH connectionless segment trails. For this purpose, the ETH_FP is expanded into an ETH_FP, ETHS/ETH_A function, ETHS_AP, ETHS_FT and ETH_TFP as illustrated in Figure 26.

NOTE – ETH OAM requirements are defined in ITU-T Rec. Y.1730. ETH OAM mechanisms are for further study.

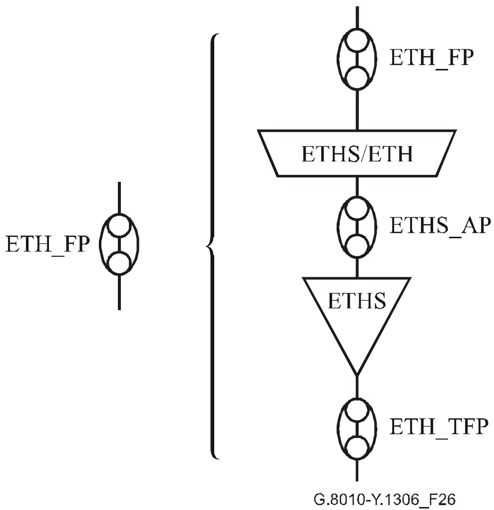

Figure 26/G.8010/Y.1306 – Creating an ETH sublayer by expansion of an ETH_FP

Sublayer monitoring is not available for ETY layer and ETC sublayer.

7.2.5 Layer monitoring

OAM is added to the adapted information such that the network connection c.q. network flow can be directly monitored by a (connectionless) trail created in the layer network. With this technique all parameters can be tested directly.

ETH network flows may be directly monitored by means of insertion of connection monitoring OAM at the ingress of the ETH connectionless trail and extraction and processing of this OAM at the egress of the connectionless trail. Insertion and extraction and processing of this connection monitoring OAM is functionally performed in ETH flow termination functions ETH_FT, which establish ETH connectionless trails.

NOTE – ETH OAM requirements are defined in ITU-T Rec. Y.1730. ETH OAM mechanisms are for further study.

ETY network connections are monitored for continuity by the ETY trail.

7.3 Ethernet layer network management requirements

Refer to ITU-T Rec. Y.1730 for ETH OAM requirements based on ETH reference models and MEs. Further Ethernet layer network management requirements are for further study.

7.4 Ethernet layer network traffic management

ETH traffic management refers to all network actions aiming to meet the network performance objectives and negotiated Quality of Service commitments, and to avoid congested conditions. One of the elements of this traffic management concerns the conditioning of the ingress traffic in an ETH administrative domain to enforce it to be within the boundaries of the service level agreement (SLA). For this purpose, the ETH_FP can be expanded into an ETH_FP, ETH_TC function and ETH_FP as illustrated in Figure 27.

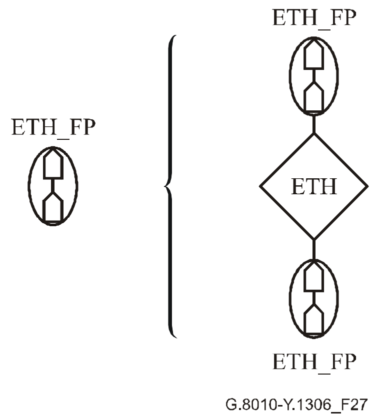

Figure 27/G.8010/Y.1306 – Expanding an ETH_FP for the purpose of traffic conditioning

8 Ethernet survivability techniques

For further study.

Annex A

Flow domain fragments

In general, any flow domain allows for any input flow point to be associated with any output flow point. In such a case the diagrammatic convention of showing a flow domain and its complete set of input and output flow points is sufficient to illustrate the allowable connectivity.

It is also possible to group flow points such that connectivity within the flow domain is limited to being between the members within each group. Each group represents a fragment of the flow domain connectivity and is referred to as a flow domain fragment (FDFr). This concept can be applied to any flow domain. When used in a matrix, the fragments are referred to as matrix fragments. The relationship between a flow domain and its fragments is illustrated in Figure A.1. A flow domain fragment may be labelled by its associated layer network name, fragment number or by the means of grouping flow points into a particular fragment, in the ETH layer network, for example, by VLAN identifier.

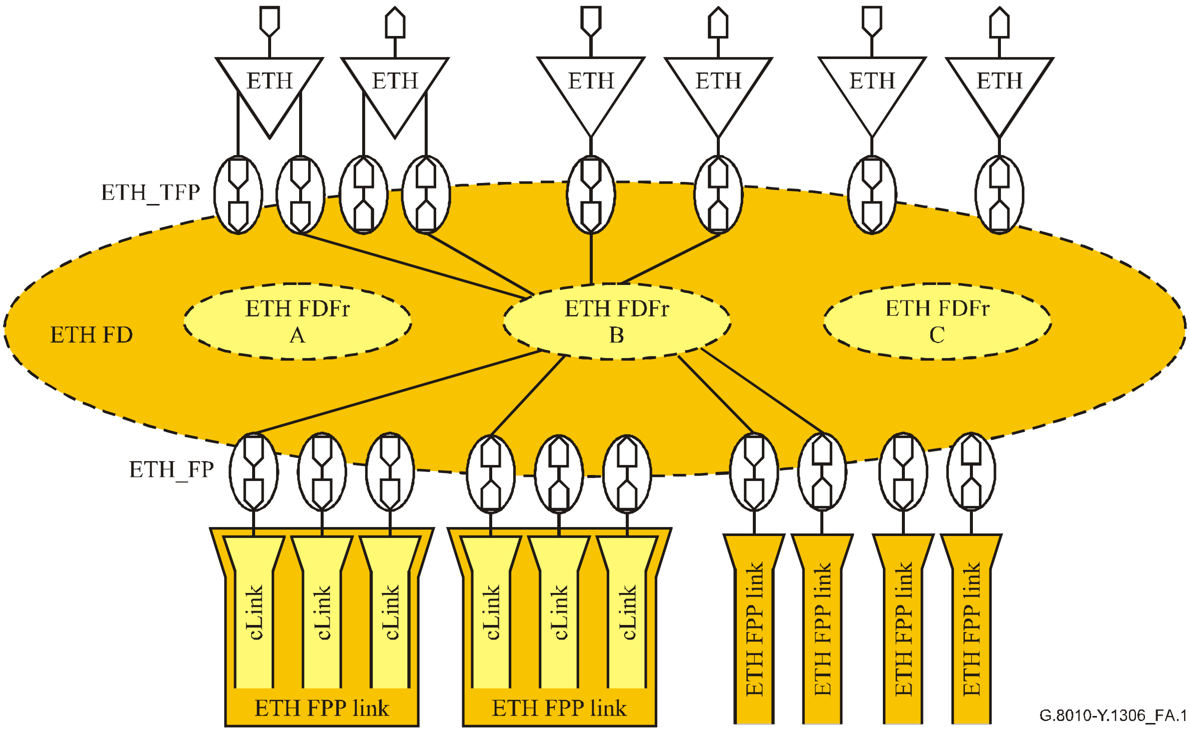

Figure A.1/G.8010/Y.1306 – Flow domain fragments and their relationship to a flow domain

A fragment of one flow domain is associated with a fragment in another flow domain by means of the interconnecting component link or FPP link.

Appendix I

Flows and their properties

In a circuit switched network, connections are bound to connection points and both the connection point and the connection are managed. The lifetime of the connection and its relationship to the connection point is reflected in the state of the related managed object.

This is very different to the case of connectionless networks. Here each packet is the "connection". The packet (frame) is bound to the flow point for the duration of the time it takes to traverse the flow point. The flow point is then available for the next "connection". There is no implied relationship between a previous packet and a future packet that traverses the flow point. The packet (frame) represents a flow from which aggregated flows can be constructed.

Examples of flows

In this appendix, different forms of flow are illustrated in Figure I.1. The examples given are for illustration and are not intended to be an exhaustive list.

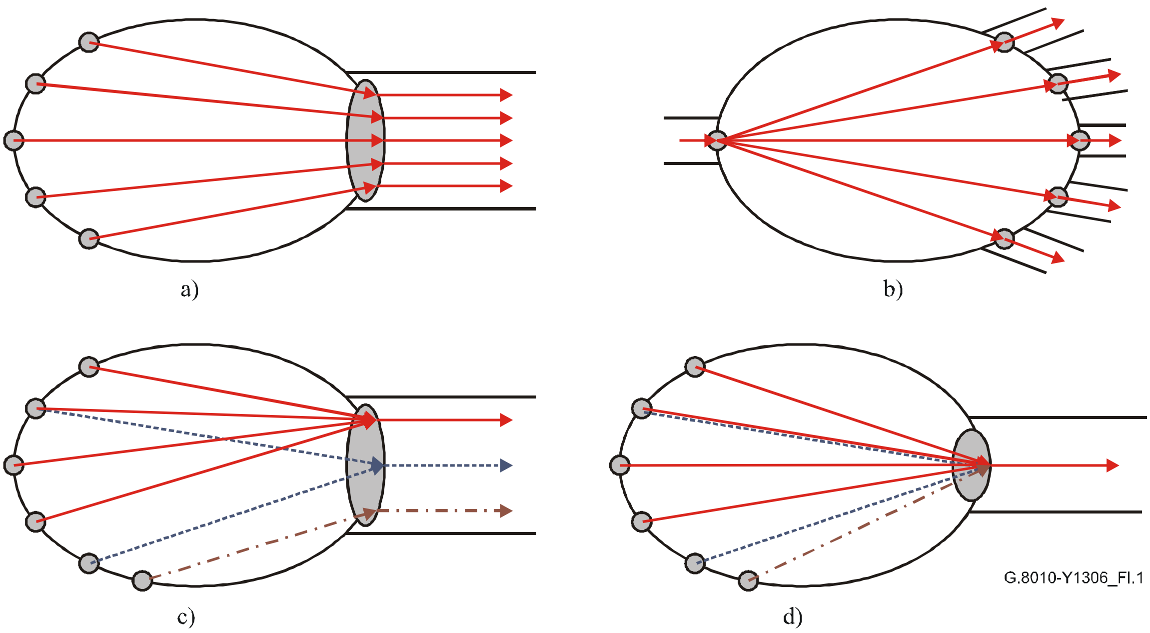

Figure I.1/G.8010/Y.1306 – Some examples of flows

Figure I.1 a) illustrates a flow domain with five input flow points and one output flow point (other output links are not shown for sake of simplicity). Each flow can be considered as corresponding to a source-destination, or network, flow. Each flow is characterized by frames with the same source and destination address. Downstream at the next flow domain, the flows may be separately routed to output flow points as necessary.

Figure I.1 b) illustrates a broadcast flow from a single input flow point to all output flow points. A flow that goes to multiple output flow points but not all is a multicast flow.

Figure I.1 c) illustrates a flow domain with six input flow points and one output flow point (other output flow points are not shown for the sake of simplicity). Each of the flows on the link represents a destination-based flow. Each of these flows is characterized by frames with the same destination address (multiple source addresses). Destination flows may contain multiple source-destination flows. Individual flows across the flow domain may represent a source-destination flow (so directly flowing into the flow domain from a source) that is aggregated at the output flow point, or a number of destination based flows that have already been aggregated from multiple sources (and have therefore arrived from an upstream flow domain). Further note that there are two multipoint-to-point flows and one point-to-point flow present in the figure. The flows are directed as appropriate at the next flow domain.

Finally, Figure I.1 d) represents a multipoint-to-point flow between six input flow points and one output flow point of a flow domain. The resultant flow may be directed toward a single destination (everything entering the link has the same destination address) or may be the aggregation of all incoming flows to create a link flow between flow points, in which case it is the aggregation of all the frames passing over the link.

The examples given above are intended to illustrate the concept of a flow as defined in ITU-T Rec. G.809. It should be obvious that a packet (frame) can belong to many levels of flow at the same time.

Examples of flows

A flow can be defined in terms of a n-tuple **<A,….N>**, where each entry in the n-tuple represents a common property of each traffic unit in the flow. In the case of Ethernet, examples of forms of flow that can be defined in the ETH layer network are:

– **<Source MAC Address, Destination MAC Address>** 2-tuple where all frames have the same source address and destination address;

– **<Destination MAC Address>** 1-tuple where all frames have the same destination address, but need not have the same source address.

A flow may also be described in relation to a topological component. For example: a link flow, a flow domain flow or a network flow.

The network flow is between termination flow points, but there is no requirement for traffic units within the flow to follow the same route.

A link flow is the aggregation of all frames that traverse a link or it can be considered as the set of source-destination flows on the link, or the set of destination flows on the link (in this case they are equivalent in membership).

Flow point properties

A flow point, from the network viewpoint, is transparent to both the source address and destination address of any packet that traverses it. A flow point is a member of a flow point pool. For the ETH layer network, in the absence of logically separated VPNs, there is only one member of the flow point pool.

A flow point can be partitioned to generate new flow points. The new flow point may have the same properties as the original flow point. This mechanism is used to generate additional flow points in the ETH layer network as a result of creating logically separated VPNs. This results from the partitioning of a flow domain, resulting in one flow point for each of the partitions attached to the link containing the flow points. Such new flow points are of interest to both the network view and network management view. The set of flow points that results from this partitioning is contained within a flow point pool.

The following n-tuples are examples of flows between ETH FPs (case of VLAN being the VPN identifier):

– **<Source MAC Address, Destination MAC Address, VLAN ID, Priority>** quadruple where all frames in the flow have the same source and destination addresses and VLAN ID and Priority;

– **<Source MAC Address, Destination MAC Address, VLAN ID>** triple where all frames in the flow have the same source and destination addresses and VLAN ID;

– **<Destination MAC Address, VLAN ID>** 2-tuple where all frames in the flow have the same destination address and VPN ID but need not have the same source address;

– **<VLAN ID>** 1-tuple where all frames have the same VLAN ID but need not have the same source or destination address.

A flow point may also be partitioned such that the properties of each of the new flow points are not the same as the original flow point. However, the aggregated properties must be the same as that of the original flow point. Such partitioning may not be of general interest in either the network or management viewpoint.

A flow point pool can be partitioned to generate new flow point pools. This mechanism is used to generate additional flow point pools in the ETH layer network as a result of creating stacked VLANs. This results from the partitioning of the flow domain based on an additional level of VLANs. This results in one flow point pool for each of the partitions, created by the additional VLAN level, attached to the link. The set of resulting flow point pools is contained within a single higher level flow point pool. This process can be repeated as a result of further levels of partitioning to create higher level flow point pools.

The generic rules for partitioning flow points are outside the scope of this Recommendation.

Appendix II

G.8010/Y.1306 model of 2-port bridge

Figure II.1 presents the G.8010/Y.1306-based models of 2-port IEEE 802.1D and IEEE 802.1Q bridges.

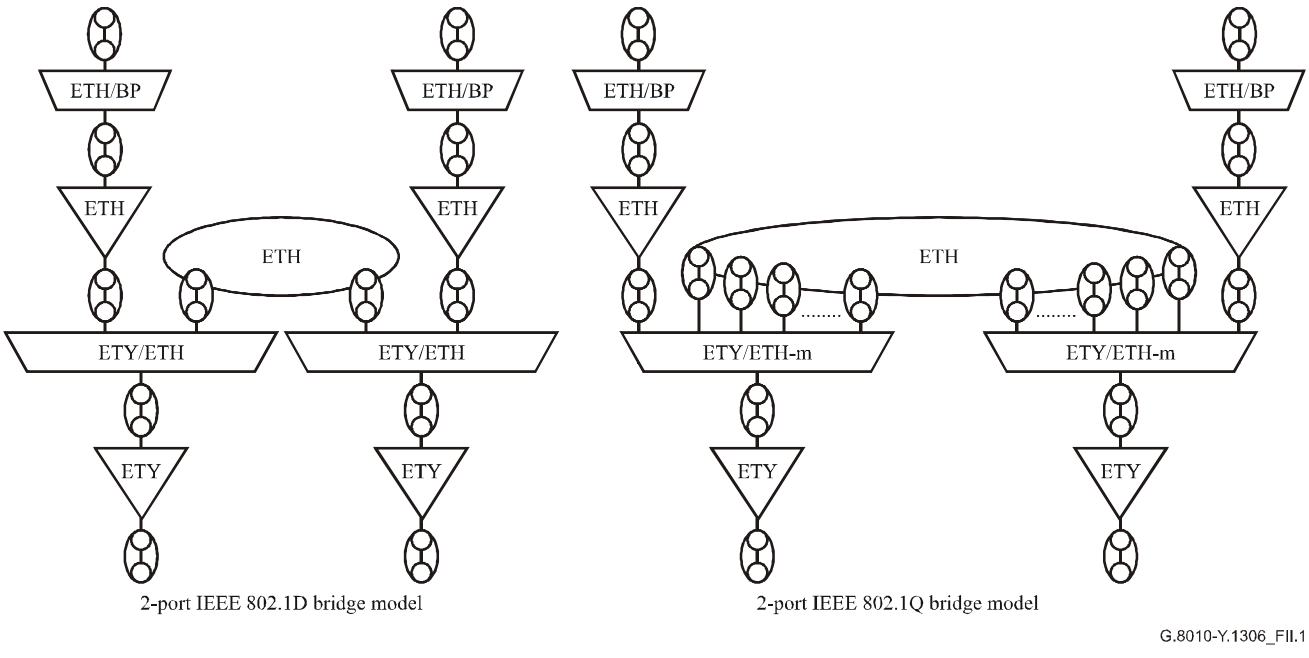

Figure II.1/G.8010/Y.1306 – 2-port bridge models

Appendix III

Overview of the VLAN ID in the MAC SDU and VLAN ID processing

As noted in 6.3.2.5.3, a VLAN ID may be used to identify the ETH VLAN a frame belongs to. The VLAN ID is part of an optional VLAN tag in the MAC SDU (described in IEEE 802.3 and IEEE 802.1Q).

NOTE – This field includes also priority information.

All ETH links and ETH flow domains carry the MAC SDU (with or without the optional VLAN tag).

The VLAN ID is processed by the Srv/ETH-m_A function described in 6.5.2. The Srv/ETH-m_A function has N (N = 1..4094) ETH_FPs associated with it. When a VLAN ID is present in the MAC SDU, it is used to demultiplex the combined flow of MAC frames to individual ETH_FPs (one per VLAN). MAC frames without a VLAN ID are assigned to a default FP (default VLAN). This allows a link to carry MAC frames with or without a VLAN ID.

Depending on the network application, the Srv/ETH-m_A function may add and remove the VLAN ID or may use it and pass it on.

The Srv/ETH_A function, described in 6.5.2, has *only one* ETH_FP associated with it and therefore ignores the VLAN ID.

IEEE P802.1ad will add a further optional field to the MAC SDU that is used to convey a second (service provider) VLAN ID. This may also be used by a Srv/ETH-m_A function (in service provider mode) to demultiplex the combined flow to individual ETH_FPs (one per service provider VLAN). The customer (802.1Q) VLAN IDs that may be part of the MAC SDU are ignored in this case and transparently forwarded. They may be used in downstream Srv/ETH-m_A functions to further demultiplex the flow (into customer VLANs).

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