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Architecture of Ethernet layer networks

ITU-T Recommendation G.8010/Y.1306

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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.

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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.

The bases for this Recommendation are the Ethernet specifications in IEEE 802.1D, 802.1Q and 802.3, 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 atomic functions of connection monitoring in a connectionless layer network is not addressed. This is for further study.

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*.

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– 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;

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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

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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

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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:

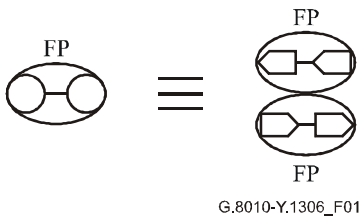

Figure 1/G.8010/Y.1306 – Diagrammatic convention for two co-located Flow Points in opposite directions

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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:

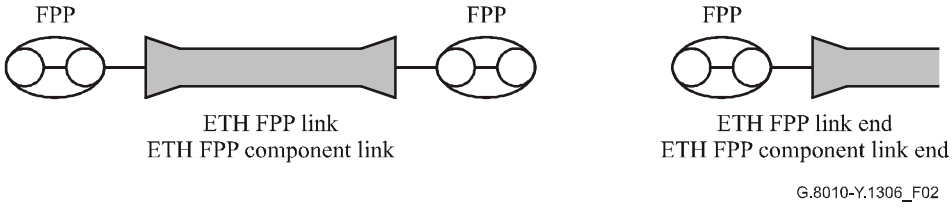

Figure 2/G.8010/Y.1306 – Diagrammatic convention for ETH FPP (component) link (end)

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

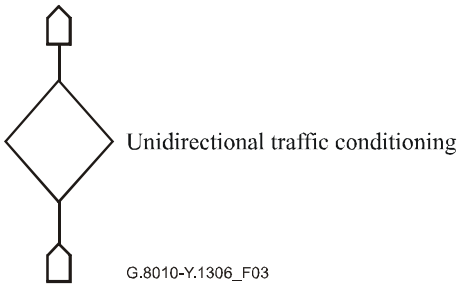

Figure 3/G.8010/Y.1306 – Diagrammatic convention for unidirectional traffic conditioning function

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).

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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).

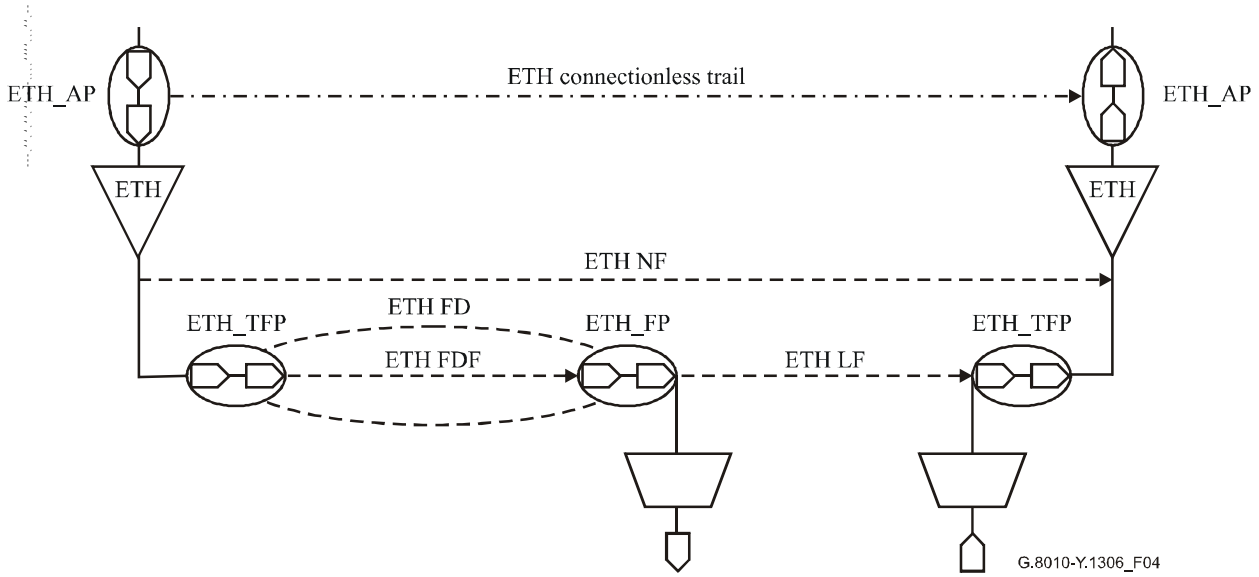

Figure 4/G.8010/Y.1306 – ETH layer network example (unicast flow)

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.

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

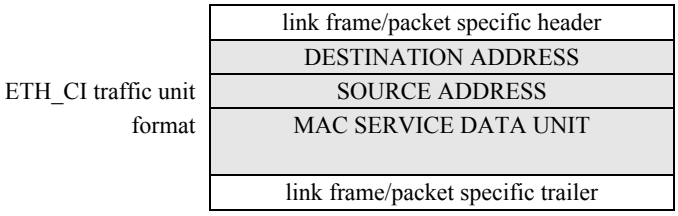

Figure 5/G.8010/Y.1306 – ETH characteristic information (ETH_CI) traffic unit format when mapped into a link specific frame or packet

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.

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