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G.8010/Y.1306

Amendment 2
(07/2010)

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

Architecture of Ethernet layer networks

Amendment 2: Application of the ITU-T G.800 functional architecture to Ethernet transport and some editorial revisions

Recommendation ITU-T G.8010/Y.1306 (2004) – Amendment 2

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Recommendation ITU-T G.8010/Y.1306

Architecture of Ethernet layer networks

Amendment 2

Application of the ITU-T G.800 functional architecture to Ethernet transport and some editorial revisions

Summary

Amendment 2 to Recommendation ITU-T G.8010/Y.1306 contains additional material to be incorporated into Recommendation ITU-T G.8010/Y.1306, Architecture of Ethernet layer networks. It presents the ITU-T G.800 model of Ethernet layer network architecture.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.8010/Y.1306	2004-02-22	15
1.1	ITU-T G.8010/Y.1306 (2004) Amend. 1	2006-05-22	15
1.2	ITU-T G.8010/Y.1306 (2004) Amend. 2	2010-07-29	15

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.

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.

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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, 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/.

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Application of the ITU-T G.800 functional architecture to Ethernet transport and some editorial revisions

1 Scope

This amendment provides updated material pertaining to the architecture of Ethernet layer networks, as described in [ITU-T G.8010]. It presents the ITU-T G.800 model of Ethernet layer network architecture including provider bridged network and provider backbone bridged network functional architecture.

This material is new material to be added to the original Recommendation as amended by Amendment 1.

2 References

[ITU-T G.8010] Recommendation ITU-T G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*, plus Amendment 1 (2006).

3 Conventions

None.

4 Additions and modifications to [ITU-T G.8010]

The following clauses contain additions and modifications to be made to [ITU-T G.8010].

4.1 Clause 2, References

Replace the reference to IEEE 802.1Q with the following:

– IEEE Standard 802.1Q-2005, *IEEE Standard for Local and metropolitan area networks: Virtual Bridged Local Area Networks*.

Add the following references:

– Recommendation ITU-T G.800 (2007), *Unified functional architecture of transport networks*.

– IEEE Standard 802.1ad-2005, *IEEE Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks, Amendment 4: Provider Bridges*.

– IEEE Standard 802.1ah-2008, *IEEE Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks, Amendment 7: Provider Backbone Bridges*.

– IEEE Standard 802.1Qaw-2009, *IEEE Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks, Amendment 9: Management of Data Driven and Data Dependent Connectivity Faults*.

– IEEE Standard 802.1aj-2009, *IEEE Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks, Amendment 11: Two-Port Media Access Control (Mac) Relay*.

4.2 Terms to be removed from [ITU-T G.8010]

The following table identifies the target terms and appropriate replacement definition text.

Original Text	Replacement Text
3.3 This Recommendation defines the following terms: **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. **3.3.2 maintenance entity group**: A maintenance entity group is defined, for the purpose of fragment/connection monitoring, between a set of flow/connection points within a fragment/connection. This set of flow/connection points may be located at the boundary of one administrative domain or a protection domain, or at the boundaries of two adjacent administrative domains. The maintenance entity group consists of one or more maintenance entities. **3.3.3 maintenance entity**: The entity between two of the flow/connection points in a maintenance entity group. **3.3.4 maintenance entity group end point compound sink function**: A compound transport processing function which accepts the characteristic information of the layer network at its input, extracts and processes the OAM information related to the maintenance entity group's monitoring, filters the OAM information from within to the maintenance entity group, adapts the information and presents it as the characteristic information of the layer or a client layer at its output, potentially as a (client) layer maintenance signal (e.g., AIS). **3.3.5 maintenance entity group end point compound source function**: A compound transport processing function which accepts the characteristic information of the layer or a client layer network at its input, adapts that information, filters it for OAM information interfering with its own OAM information, adds OAM information to allow the maintenance entity group to be monitored and presents the resulting information at its output.	**3.3** This Recommendation uses the following terms defined in Rec. ITU-T G.8001/Y.1354: **3.3.1 traffic conditioning function** **3.3.2 maintenance entity group** **3.3.3 maintenance entity** **3.3.4 maintenance entity group end point compound sink function** **3.3.5 maintenance entity group end point compound source function** **3.3.6 maintenance entity group intermediate point compound function** **3.3.7 proactive monitoring** **3.3.8 on-demand monitoring** **3.3.9 ETH_CI group** **3.3.10 ETH path** **3.3.11 ETH tandem connection** **3.3.12 ETH section** Editor's Note: The "traffic conditioning function" (defined in the original ITU-T G.8010) was redefined as "traffic conditioning and shaping function" in ITU-T G.8010 Amendment 1.

Original Text	Replacement Text
3.3.6 maintenance entity group intermediate point compound function: A compound transport processing function which accepts the characteristic information of the layer network at its input, reacts to OAM information related to the maintenance entity group's on-demand monitoring and presents the characteristic information without the OAM it reacted to at its output. **3.3.7 proactive monitoring**: A method to continuously infer the status and performance of a maintenance entity group with the purpose to detect disturbances, faults and degradations immediately after their occurrence in order to verify the service level agreement and/or initiate recovery actions to restore the service to the guaranteed level. **3.3.8 on-demand monitoring**: A method to infer a specific status or performance characteristic of a maintenance entity or a set of maintenance entities within a maintenance entity group at a specific point in time with the purpose to obtain a snapshot of the performance, or to diagnose an identified fault condition or performance degradation. **3.3.9 ETH_CI group**: A group of ETH_CI signals that is monitored as a single MEG. For this purpose, ETH OAM is added to one of the ETH_CI signals in the group. **3.3.10 ETH path**: The highest ETH MEG level in a set of eight MEG levels. **3.3.11 ETH tandem connection**: An intermediate ETH MEG level in a set of eight MEG levels. **3.3.12 ETH section**: The lowest ETH MEG level in a set of eight MEG levels.	

4.3 Modifications to clauses 6.5.2.2.3 and 6.5.1.3 and Figure V.5

In clauses 6.5.2.2.3 and 6.5.1.3 and in the title of Figure V.5 change the following acronyms:

Change "T-MPLS" to "MPLS-TP"

In clause 6.5.1.3 change "/TM" to "/MT"

In clause 6.5.2.2.3 change "TM/" to "MT/"

In clause 6.5.1.3 change the line

– Type field encapsulation (0x8847 for unicast, per RFC 3032).

to read:

– Type field encapsulation.

4.4 Add new clause 9

Add a new clause 9 as follows:

9 Transport functional architecture of Ethernet networks (using ITU-T G.800)

This clause presents the functional architecture of Ethernet layer networks based on Recommendation ITU-T G.800 – Unified functional architecture of transport networks. This functional architecture covers the Ethernet network structure and behaviour specified in the following standards:

- IEEE 802.1D-2004, *Media Access Control (MAC) Bridges*.
- IEEE 802.1Q-2005, *Virtual Bridged Local Area Networks.*
- IEEE 802.1ad-2005, *Virtual Bridged Local Area Networks, Amendment 4: Provider Bridges*.
- IEEE 802.1ag-2007, *Virtual Bridged Local Area Networks, Amendment 5: Connectivity Fault Management*.
- Recommendation ITU-T Y.1731 (2006), *OAM functions and mechanisms for Ethernet based networks*.
- IEEE 802.1ah-2008, *Virtual Bridged Local Area Networks, Amendment 7: Provider Backbone Bridges*.
- IEEE 802.1Qaw-2009, *Virtual Bridged Local Area Networks, Amendment 9: Management of Data Driven and Data Dependent Connectivity Faults*.
- IEEE 802.1aj-2009, *Virtual Bridged Local Area Networks, Amendment 11: Two-Port Media Access Control (Mac) Relay*.

The functional architecture covers functions within the Ethernet layer network and common aspects of client and server adaptation functions. It does not cover details specific to client or server layer networks or common adaptation functions that are independent of the described Ethernet layer network functions (e.g., there is no discussion of LLC/SNAP or specific PHY functions).

9.1 General principles

Ethernet transport networks provide a connectionless frame (packet) transport service for frames carrying client information. Additional functions are provided for multiplexing, supervision and survivability of the Ethernet transport entities that convey frames in the Ethernet network. The transport functional architecture of Ethernet networks is described using the generic principles defined in Recommendations ITU-T G.805 and G.800 (using conventions as noted in Appendix VIII). The architectural aspects regarding layer network structure, characteristic information, transport entities, transport processing functions, client/server associations, topology and partitioning of Ethernet transport networks are provided in this Recommendation.

9.2 Ethernet transport network layered structure

An Ethernet network layer structure may include any of a large number of media specific layer networks or other server layer networks (e.g., SDH, OTN, etc.) that can provide the MAC service Ethernet expects of its server layers. One of the most important Ethernet server layers is the IEEE 802.3 family of media specific layer networks. Figure 9-1 shows the basic Ethernet layer network structure.

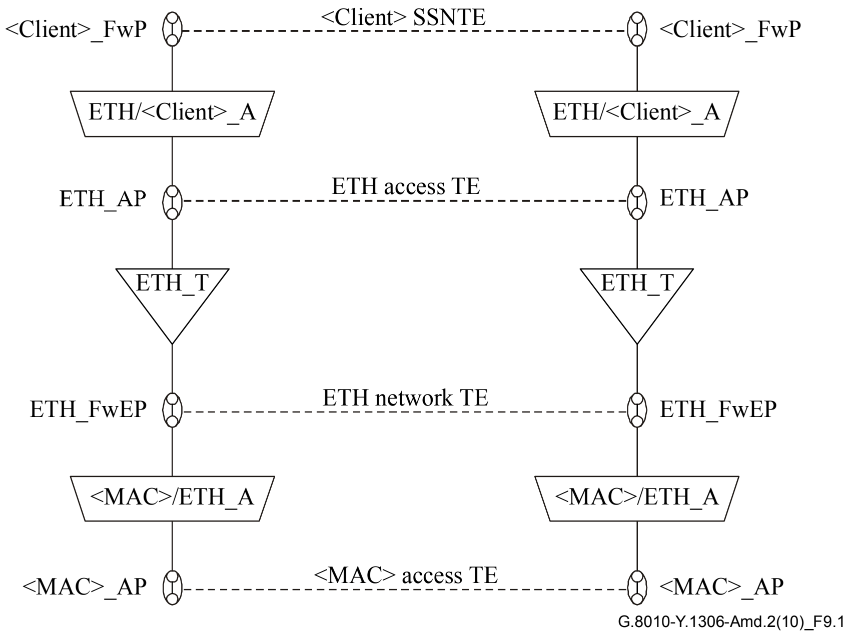

Figure 9-1 – Ethernet layer network structure

Within the media independent layer (ETH) of an Ethernet network, three types of aggregation are supported:

– Aggregation of multiple instances of ETH_CI (MAC frames) into a link connection or server subnetwork transport entity (e.g., LAN). This is shown in Figure 9-2 as "Aggregation of frames to link connection".

  NOTE – Sufficient labelling is provided by the MAC destination address (DA) and source address (SA) associated with the frame, so no additional labelling is needed.

– Aggregation of multiple ETH subnetwork transport entities (VLANs) into a monitored aggregate with the addition of a label (VID). Note that one (and only one) of the VLANs may not have a label added. This is shown in Figure 9-2 as "Aggregation of VLANs to link".

– Aggregation of multiple ETH subnetwork transport entities into another ETH subnetwork transport entity (i.e., C-VLANs into an S-VLAN) with the addition of a label (C-VID). This is shown in Figure 9-2 as "Aggregation of C-VLANs to S-VLAN".

Aggregation within an Ethernet layer network may create significant administrative sublayers that can be independently monitored and managed.

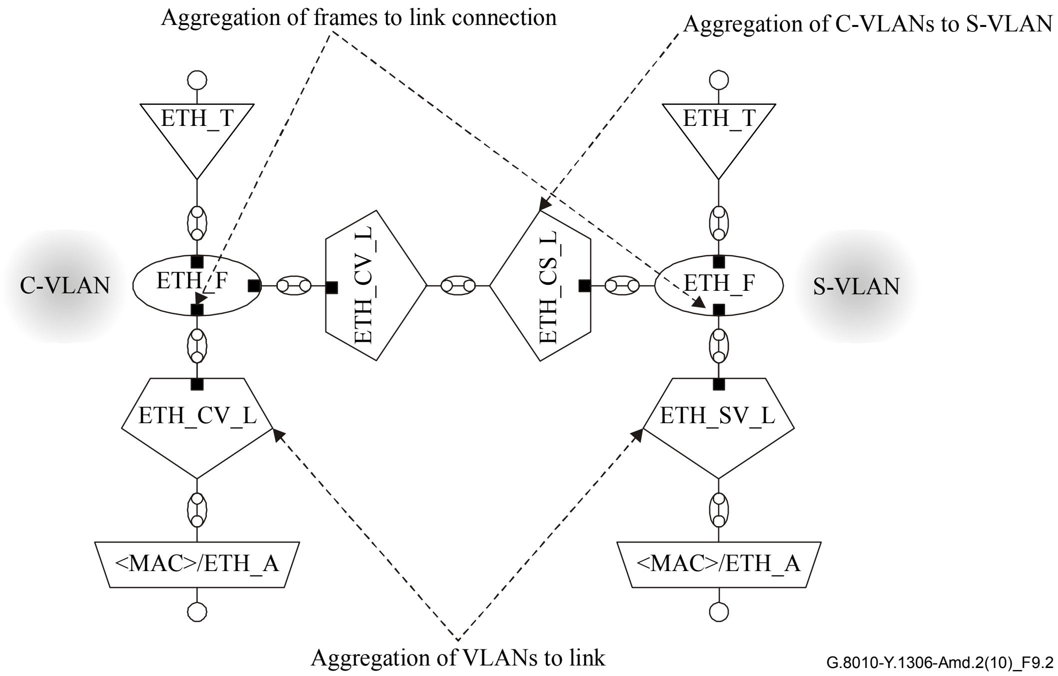

Figure 9-2 – Ethernet aggregation types

A more comprehensive picture of Ethernet layer network structure is shown in Figure 9-3. This figure combines the layering in Figure 9-1 with the aggregation options shown in Figure 9-2 and includes the layering of Ethernet over Ethernet (called provider backbone bridging). The functions shown in Figure 9-3 are described in the clauses below. In addition, Figure 9-3 is used as a reference model for describing the information structure of Ethernet layer networks shown in Table 9-1 below.

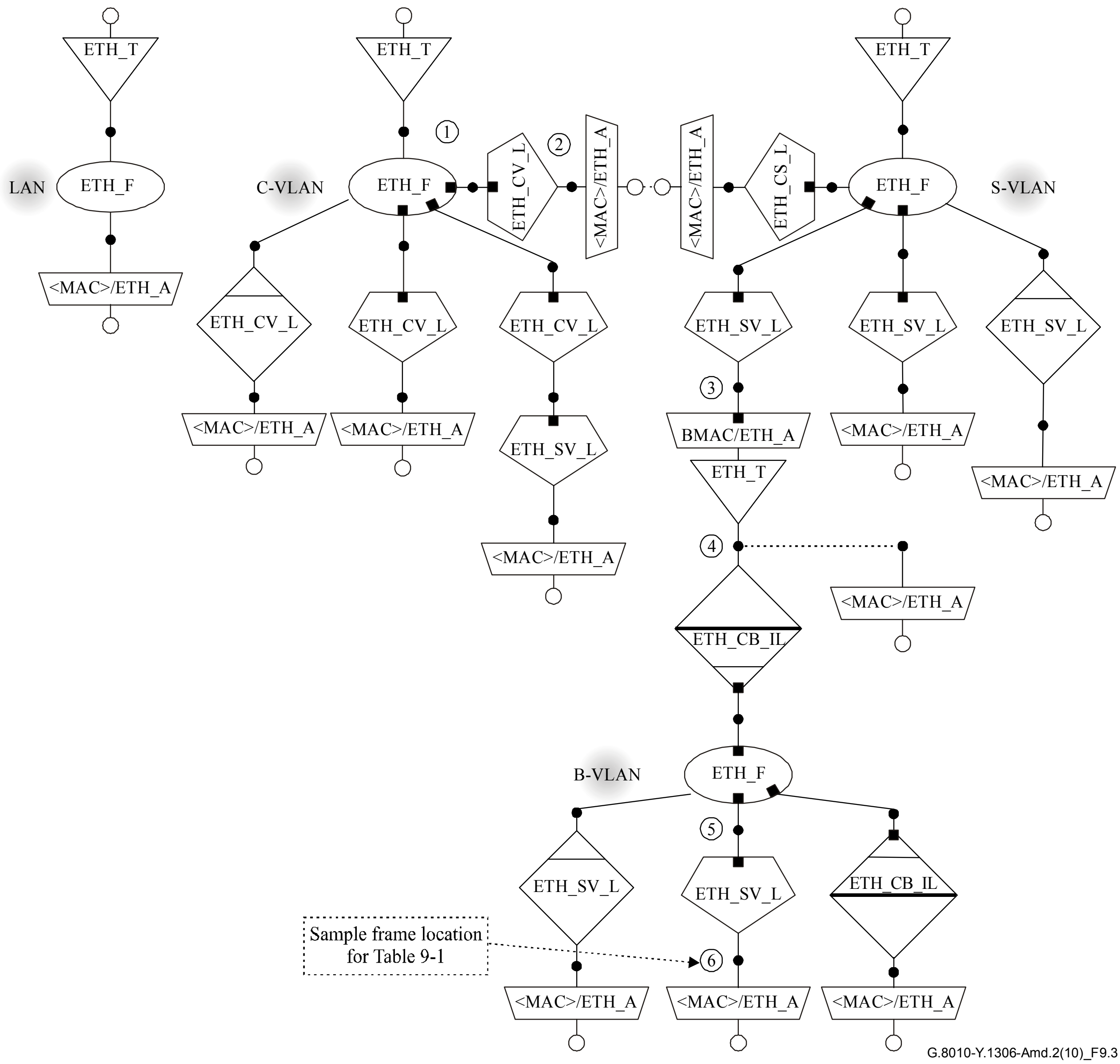

Figure 9-3 – Ethernet layer and aggregation structure

9.3 Ethernet MAC (ETH) layer network

Ethernet networks bridge (provide forwarding between) a variety of media specific and/or limited reach (local area) network technologies. Whether an Ethernet network comprises a single media network or multiple media networks interconnected by bridges is intended to be invisible to the client. For this reason the service interface is called a "media access control" or MAC service interface[1]. Therefore a "MAC service access point" (MAC SAP) corresponds to the Ethernet (ETH) layer network access point and the term "MAC termination" may be used to denote the ETH layer network termination function (ETH_T).

1 Note that the IEEE may in the future revise the definition of the MAC service, and such a revision may impact the description of the MAC service interface as used in this Recommendation.

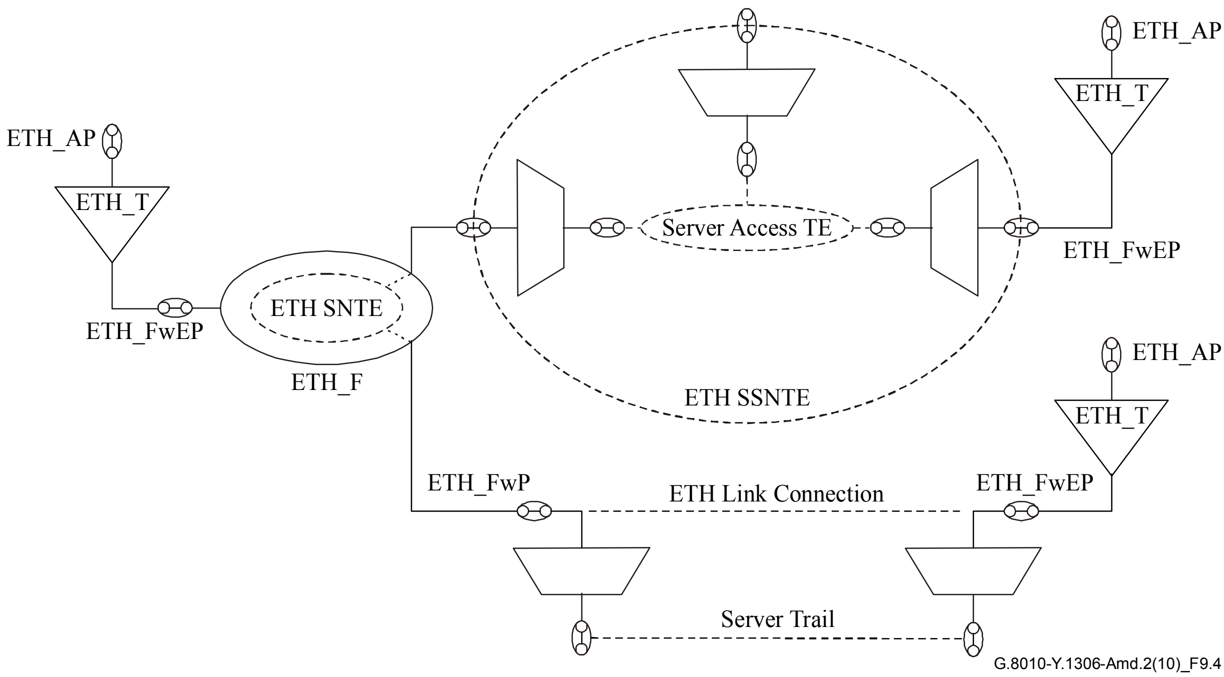

Figure 9-4 – ETH layer network example

The ETH layer network is bounded by ETH access points associated with ETH termination (MAC termination) functions. The ETH forwarding function supports multipoint subnetwork transport entities (ETH SNTEs or VLANs) and the interconnection between ETH forwarding elements may be point-to-point (ETH link connection – ETH_LC) or multipoint (ETH server subnetwork transport entity – ETH SSNTE). An ETH SSNTE must support a broadcast function allowing a single frame to be sent to all ETH forwarding elements (bridges) bound to that SSNTE. An ETH SNTE is bound to an SSNTE or LC at an ETH forwarding point (ETH_FwP). An ETH_T is bound to an ETH SNTE, SSNTE, or LC at a forwarding end point (ETH_FwEP). Figure 9-4 shows an example of a portion of an ETH layer network. Note that the diagram shows bidirectional reference points since Ethernet layer network operation depends on bidirectional connectivity.

9.3.1 ETH information structure

From the viewpoint of any given ETH transport processing function an instance of ETH_CI (an Ethernet MAC frame) comprises the following: [DA][SA][Tag(optional)][MSDU].

This information structure is decomposed into a payload to be carried transparently (the MAC service data unit – MSDU), a number of parameters passed directly between functions which include:

- destination address;
- source address;
- priority;
- discard eligible indication;
- frame check sequence;

and parameters encoded in the MSDU to pass between non-adjacent functions which include:

- tag protocol identifier;
- priority;
- discard eligible indication;
- VLAN identifier;

- backbone service instance identifier.

This information (ETH_CI) can be further classified as adapted information (ETH_AI), layer information (ETH_LI), or inter-layer information (ETH_ILI). ETH_AI is the information transferred transparently between ETH access points of a given ETH layer network. ETH_LI is the information that must be encoded by functions within the ETH layer network. ETH_LI may in some cases be encoded by an ETH/client adaptation function, but if it is not provided by the adaptation function it must be provided by a function within the ETH layer network (e.g., ETH_T). Finally, ETH_ILI is information that must be encoded by an ETH/client adaptation function and is also processed by a function within the ETH layer network.

Table 9-1 below shows the visibility of ETH characteristic information to the various ETH functions using an example based on the ETH layer network structure shown in Figure 9-3. The first column of the table is a breakdown of the structure of an example Ethernet frame which has entered Figure 9-3 at the upper middle ETH access port and is examined at the location indicated in the bottom of that figure. The columns of the table indicate the functions through which the example frame passes.

In the figure the visibility of a piece of information (row) to a given function (column) is shown by the shading of the table cell as follows:

- information that does not exist is hashed;
- information that is not visible (i.e., which is in the MSDU or is not directly represented) is shaded; and
- information that is visible is not shaded (clear).

Where a piece of information exists, the use of that piece of information by a given function is indicated by the entry in each table cell as follows:

- information that is transparently transferred by a function is marked "T" (transparent);
- information that is (or may be) processed by a function is marked "P" (processed); and
- information that is represented in the functional model as a port on the function is marked "RP" (reference port).

In Table 9-1 below, the following abbreviations are used for the information elements in the Ethernet frame:

B-DA – Backbone Destination Address

B-SA – Backbone Source Address

TPID – Tag Protocol Identifier

PCP – Priority Code Point

DEI – Discard Eligibility Indicator

I-SID – Backbone Service Instance Identifier

C-DA – Customer Destination Address

C-SA – Customer Source Address

S-VID – Service VLAN Identifier

C-VID – Customer VLAN Identifier

MSDU – MAC Service Data Unit

These terms and information elements are further defined in IEEE specifications.

Table 9-1 – Example showing ETH information visibility

Frame information (Note 1)		ETH function										
		ETH_T ①	ETH_F	ETH_CV_L ②	ETH_CS_L	ETH_F	ETH_SV_L ③	BMAC/ETH_A ④	ETH_T	ETH_CB_IL ⑤	ETH_F	ETH_SV_L ⑥
	B-DA					CID (Note 3)	CID (Note 3)	P	P	P	P	T
	B-SA					CID (Note 3)	CID (Note 3)	P	P	T	P	T
B-Tag	TPID											P
	PCP/DEI							P	T	T	T	P
	B-VID (Note 4)									RP	RP (Note 2)	P
I-Tag	TPID							P	T	P	T	T
	PCP/DEI						P	P	T	P	T	T
	I-SID						RP (Note 2)	P	T	P	T	T
	C-DA	P	P	T	T	P	T	T	T	T	T	T
	C-SA	P	P	T	T	P	T	T	T	T	T	T
S-Tag	TPID						P	T	T	T	T	T
	PCP/DEI			P	P	T	P	T	T	T	T	T
	S-VID			RP	RP	RP (Note 2)	P	T	T	T	T	T
C-Tag	TPID			P	P	T	T	T	T	T	T	T
	PCP/DEI (Note 5)	P	T	P	P	T	T	T	T	T	T	T
	C-VID	RP (Note 2)	RP (Note 2)	P	P	T	T	T	T	T	T	T
Payload	MSDU	T	T	T	T	T	T	T	T	T	T	T

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NOTE 1 – In addition to the information shown in this table, IEEE 802.1 specifications include a service access point identifier parameter (SAPID) that represents the MAC service access point or internal sublayer service access point over which a frame (service primitive) is received. This parameter is not included in the table because its role is identical to the reference points already represented. Furthermore, information that currently applies only to OAM functions (i.e., the UCA bit in the I-Tag) is not shown in the table.

NOTE 2 – In the functional model, a VID is represented in the ETH_T and ETH_F functions as a distinct forwarding end port or forwarding port rather than a parameter. These ports may be bound to ports on ETH link connections, server subnetwork transport entities, or subnetwork transport entities. Similarly, the backbone service instance is represented in the ETH_SV_L function as a forwarding port that is bound to a BMAC/ETH_A function port.

NOTE 3 – The ETH_F and ETH_SV_L functions do not have direct access to the B-DA and B-SA values; however, the BMAC/ETH_A function provides an internal parameter (connection_identifier or CID) which accompanies frames and proxies for the backbone address, enabling the client ETH_F function to "learn" how to directly reach points across the server subnetwork. The ETH_F and ETH_SV_L functions do not attach any significance to the CID value and the CID value will likely be null except at a backbone service instance MAC SAP (i.e., one supported by the BMAC/ETH_A function).

NOTE 4 – The B-VID is encoded in a service VLAN tag which is identical to the encoding of the S-VID, so the distinction between B-VLANs and S-VLANs is not made in the atomic functions but instead is a distinction made by management to describe the role of the service VLAN in the operator's layer network structure.

NOTE 5 – The DEI bit shown in the customer VLAN tag is currently specified as CFI (canonical format indicator) in IEEE 802.1Q but this bit is not used in transport applications, so in these applications the bit may be used for DEI instead (corresponding to the use of the bit in the service VLAN tag).

9.3.2 ETH transport processing functions

The ETH transport processing functions are:

- ETH termination (ETH_T)
- ETH forwarding (ETH_F)
- ETH C-VLAN layer processor (ETH_CV_L)

- ETH S-VLAN layer processor (ETH_SV_L)
- ETH C-VLAN to S-VLAN layer processor (ETH_CS_L)
- ETH customer backbone inter-layer processor (ETH_CB_IL)

9.3.2.1 ETH termination function

The ETH termination function is present at the boundary of the ETH layer network. The bidirectional ETH Termination (ETH_T) function is performed by a co-located pair of ETH termination source (ETH_T_So) and sink (ETH_T_Sk) functions.

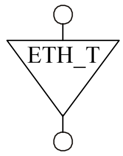

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Figure 9-5 – ETH termination function

The ETH_T_So function provides the following functions:

- receives ETH_AI at its input access port;
- sets the values of the following parameters if they are not provided by the ETH/client adaptation function:
  - destination address;
  - source address;
  - priority;
  - drop eligible;
- sends ETH_CI at its output forwarding end port.

The ETH_T_Sk function provides the following functions:

- receives ETH_CI at its input forwarding end port;
- optionally filters frames whose DA is not in a list of addresses associated with its AP;
- sends ETH_AI at its output access port.

9.3.2.2 ETH forwarding function

The ETH forwarding function (ETH_F) provides multipoint subnetwork transport entities (SNTEs) between sets of forwarding ports. Each SNTE has one or more associated VLAN identifiers (VIDs) and accepts ETH_CI traffic units (frames) at its input ports and forwards each frame to zero or more of its output ports. Forwarding of a frame within an SNTE is controlled by a set of forwarding rules from which one is selected based on the frame's DA and the SNTE's VID. Several rules are present by default, including a "flooding" rule that, if the frame's DA does not match any other forwarding rule, forwards a frame to all active output ports on the SNTE except the output port paired with the input port on which the frame was received.

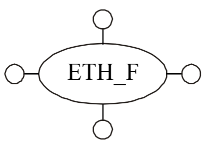

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Figure 9-6 – ETH forwarding function

When a frame is received, a forwarding rule may be "learned" associating the frame's SA with the receive port. Learned forwarding rules may be applied to one or more SNTEs. If an SNTE meets certain criteria (e.g., has exactly two ports) no rules beyond the default forwarding rules are needed.

Forwarding rules may also be provisioned (static filtering entries) and these take precedence over learned rules. Wildcard rules governing the forwarding of frames with group destination addresses and/or specified VIDs can also be provisioned.

An individual SNTE may be bidirectional (i.e., have bidirectional ports) or a bidirectional SNTE may be constructed from multiple unidirectional SNTEs (SNTEs with unidirectional ports). A bidirectional SNTE is commonly called a VLAN.

The ETH forwarding function supports three types of SNTE – "customer" (C-VLAN), "service provider" (S-VLAN), and two port MAC relay (TPMR). The default forwarding rules differ for these three SNTE types with the C-VLAN having the largest set of reserved addresses that are always filtered (i.e., never forwarded) by the VLAN and the TPMR having the smallest set.

9.3.2.3 ETH VLAN layer processor function

The bidirectional ETH VLAN layer processor functions (ETH_CV_L, ETH_SV_L) are performed by a co-located pair of ETH VLAN layer processor source (ETH_CV_L_So, ETH_SV_L_So) and sink (ETH_CV_L_Sk, ETH_SV_L_Sk) functions.

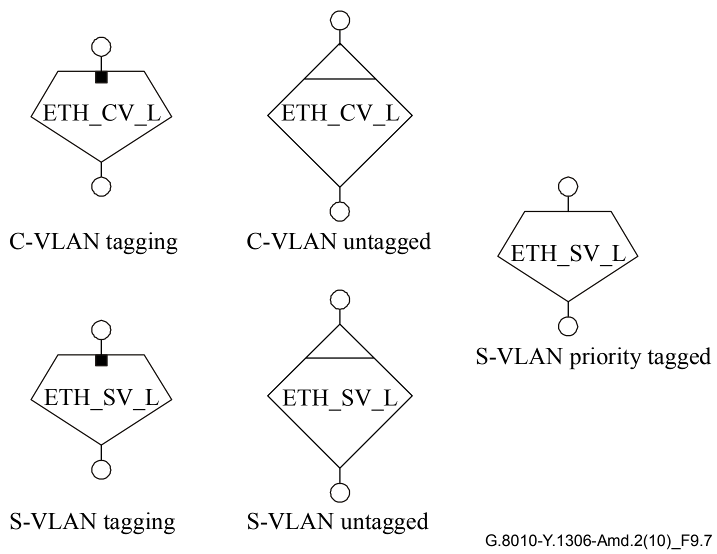

Figure 9-7 – ETH VLAN layer processor functions

The ETH_xV_L_So functions perform the following processes:

- receive ETH_CI on an input port bound to an SNTE output port;
- optionally add a VLAN tag encoding the SNTE's VID and the PCP and DEI parameters to frames received at an input port;
- optionally translate the VID value (ETH_SV_L only);
- output the resulting frame on the output port.

The ETH_xV_L_Sk functions perform the following processes:

- if a VLAN tag of the type recognized by the function is present in the MSDU received at the input port, decode the VID, PCP, and DEI and remove the tag from the frame;
- optionally discard either 1) frames whose VID is not 0 or 2) frames whose VID is 0 or have no VLAN tag of the recognized type;
- optionally translate the VID value (ETH_SV_L only);

•	if no VLAN tag of the type recognized by the function is present, provide values for the VID, PCP, and DEI parameters for the frame;
•	optionally discard frames whose VID is not in the port's VID member set;
•	output each remaining frame on the output port corresponding to the frame's VID.

ETH OAM MEP or MIP functions as specified in ITU-T Y.1731 and/or IEEE 802.1ag may be provided at the input and/or output ports of ETH_xV_L functions.

The ETH_xV_L functions can multiplex, aggregate, or merge ETH SNTEs depending on how and where they are used in an ETH layer network.

•	If ETH_xV_L functions of the same type are present at all the boundary points of a server access transport entity they can multiplex/demultiplex VLANs to/from the provided link or server subnetwork transport entity.
•	If ETH_xV_L functions of the same type are present at all the boundary points of an ETH SNTE they can aggregate/disaggregate VLANs to/from that SNTE (Service VLAN).
•	If an ETH_xV_L_So function uses the same label encoding (i.e., same VID value in the VLAN Tag or no VLAN Tag) for multiple VLANs, these VLANs are merged and cannot later be separated by a matching ETH_xV_L_Sk function.

9.3.2.4 ETH C-VLAN to S-VLAN layer processor function

The bidirectional ETH C-VLAN to S-VLAN layer processor function (ETH_CS_L) is performed by a co-located pair of ETH C-VLAN to S-VLAN layer processor source (ETH_CS_L_So) and ETH C-VLAN to S-VLAN layer processor sink (ETH_CS_L_Sk) functions. The ETH_CS_L has one C-VLAN aware port and one or more service VLAN ports.

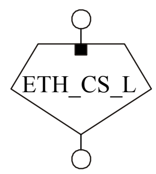

Figure 9-8 – ETH C-VLAN to S-VLAN layer processor function

The ETH_CS_L_So function performs the following processes:

•	receive ETH_CI on the C-VLAN aware input port;
•	if a C-VLAN Tag is present in the MSDU received at the input port, decode the VID, PCP, and DEI;
•	if no C-VLAN tag is present, provide values for the VID, PCP, and DEI parameters for the frame;
•	optionally discard either 1) frames whose VID is not 0 or 2) frames whose VID is 0 or have no VLAN Tag of the recognized type;
•	optionally discard frames whose VID is not in the port's VID member set;
•	if a C-VLAN tag is present in the MSDU received at the input port, optionally the C-VLAN tag may be removed;
•	if a C-VLAN tag is not present in the MSDU received at the input port, optionally a C-VLAN tag may be added using the input port's default C-VID;
•	forward the frame on an S-VLAN output port for the S-VLAN to which the frame's C-VID is assigned.

The ETH_CS_L_Sk function performs the following processes:

- receive ETH_CI on the S-VLAN input ports;
- if a C-VLAN tag is present in the MSDU received at the input port, optionally the C-VLAN tag may be removed;
- if a C-VLAN tag is not present in the MSDU received at the input port, optionally a C-VLAN tag may be added using the input port's default C-VID;
- forward frames to the C-VLAN aware output port.

9.3.2.5 ETH customer backbone inter-layer processor function

The bidirectional ETH customer backbone inter-layer processor function (ETH_CB_IL) is performed by a co-located pair of ETH customer backbone inter-layer processor source (ETH_CB_IL_So) and sink (ETH_CB_IL_Sk) functions. The ETH_CB_IL function performs backbone service instance grooming at the boundary of an ETH backbone domain. The function has one non-VLAN aware port and one or more backbone VLAN ports.

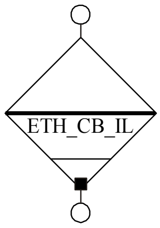

Figure 9-9 – ETH customer backbone inter-layer processor function

The ETH_CB_IL_So function accepts ETH_CI at its input port and performs the following processes:

- validates the presence of an I-Tag in the MSDU and the value of the I-SID in the I-Tag;
- assigns the frame to a backbone VLAN based on the backbone service instance identifier (I-SID);
- optionally translates the I-SID;
- optionally replaces the backbone destination address;
- sends the resulting ETH_CI on its output port associated with the assigned VLAN.

The ETH_CB_IL_Sk function accepts ETH_CI on input ports associated with backbone VLANs and performs the following processes:

- validates the presence of an I-Tag in the MSDU and the value of the I-SID in the I-Tag;
- optionally translates the I-SID;
- optionally replaces the backbone destination address;
- sends the resulting ETH_CI on its output port.

9.3.3 ETH transport entities

The transport entities in an ETH layer network include:

- ETH access transport entity;
- ETH network transport entity;
- ETH subnetwork transport entity;
- ETH link connection;
- ETH server subnetwork transport entity.

All of these transport entities transfer ETH_CI traffic units (frames) from input to outputs and all except the link connection may have more than two ports. An ETH transport entity that has more than two ports may deliver an input frame to specific output ports as determined by forwarding rules selected based on the DA of the frame. If specific forwarding rules do not apply to the frame's DA then the frame is "flooded" and delivered to all output ports associated with the frame's VID with the possible exception of the output port paired with the input port on which the frame was received.

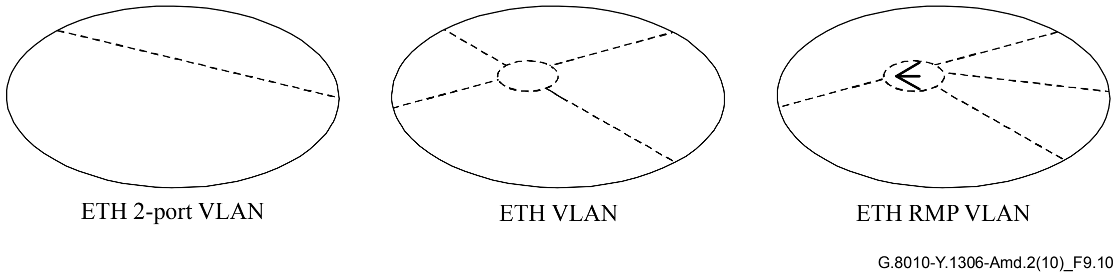

Figure 9-10 – ETH transport entities

The general form of a multipoint ETH transport entity is the LAN or VLAN in which communication is supported between all port pairs. A useful restricted form of ETH transport entity is "rooted multipoint" which has a distinguished "root" port and multiple "leaf" ports. A rooted multipoint ETH transport entity supports communication from the root port to any leaf port and from any leaf port to the root port, but not between leaf ports. A rooted multipoint ETH TE (RMP VLAN) can be formed by pairing a unidirectional point-to-multipoint TE and a unidirectional multipoint-to-point TE.

A VLAN with only two ports behaves much like a connection with the caveat that frames using reserved destination addresses are not passed transparently.

9.4 Server/client associations

An ETH layer network can provide point-to-point, point-to-multipoint, multipoint, and rooted multipoint access transport entities for use by client layer networks. In turn an ETH layer network can make use of bidirectional point-to-point, multipoint, and rooted multipoint server access transport entities to provide interconnection between ETH transport processing functions.

9.4.1 ETH/client adaptation

An ETH/client adaptation function formats client CI for transport over an ETH layer network. An ETH layer network may provide services for a variety of clients and each ETH/client_A function will have both client specific and ETH specific processes. Only generic and ETH specific aspects are described here.

An ETH/client_A_So function processes client CI received at its client input forwarding port(s) to produce MAC service data units (MSDUs) to be carried transparently across the ETH layer network. The first two octets of the MSDU contain an Ethertype value indicating the type of adapted client. The ETH/client_A_So which sends each MSDU on its output access port may also provide the following parameters:

- destination address;
- source address;
- priority;
- discard_eligible.

An ETH/client_A_Sk function receives ETH_AI (MSDU and parameters) at its input access port and reconstitutes client CI to be sent on output client forwarding ports. The parameters provided with the MSDU at the input access port may include:

- destination address;
- source address;
- priority;
- discard_eligible.

9.4.2 Server/ETH adaptation

A server/ETH adaptation function formats ETH_CI for transport over a server layer network. An ETH layer network may use services provided by a variety of servers and each server/ETH_A function will have both ETH specific and server specific processes. Only generic and ETH specific aspects are described here.

Ethernet bridging provides an extension of the service provided by an Ethernet LAN and that service is defined as a media access control (MAC) service. Therefore, an ETH layer network provides a MAC service to its clients and expects server layer networks that provide ETH links to provide a MAC service as well. Therefore, the general name used here for a server/ETH adaptation function is <MAC>/ETH_A.

The characteristics of a MAC service include the delivery of a MAC frame from an input port to either 1) the output port(s) identified with the DA in the frame (unicast or multicast behaviour) or 2) all output ports with the possible exception of the output port paired with the input port on which the frame is sent (broadcast behaviour).

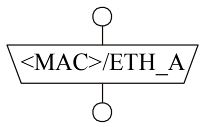

Figure 9-11 – Server/ETH adaptation function

A <MAC>/ETH_A_So function accepts ETH_CI (MSDU and parameters) at its ETH input forwarding port(s) and formats MAC frames for transmission over the server layer access transport entity. The parameters include:

- destination address;
- source address;

and may include:

- priority;
- discard_eligible;
- connection_identifier.

The connection_identifier may be used with a server subnetwork transport entity to indirectly identify a specific SSNTE output port. The CID for an address (SA) is provided by the <MAC>/ETH_A_Sk at an output ETH_FwP and may be provided to the <MAC>/ETH_A_So at an input ETH_FwP with a frame carrying a matching address (DA).

A <MAC>/ETH_A_Sk function accepts server AI at its server input AP and produces ETH_CI at its output ETH_FwPt(s). The parameters provided may include:

- destination address;
- source address;

and may include:

- priority;
- discard_eligible;
- connection_identifier.

9.4.3 BMAC/ETH adaptation

The ETH backbone service provides server subnetwork transport entities (SSNTEs) to client ETH layer networks. Since it provides an instance of the MAC service, the adaption function is called BMAC/ETH_A.

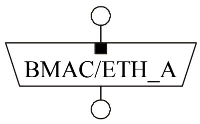

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Figure 9-12 – BMAC/ETH adaptation function

The BMAC/ETH_A_So function accepts ETH_CI from an input ETH_FwP and forms the MSDU to be carried over the server (backbone) ETH network by adding to the client MSDU an I-Tag which encodes the following parameters:

- client destination address;
- client source address;
- priority;
- discard eligible;
- backbone service instance identifier.

The I-SID value is selected based on the input ETH_FwP (and represents a corresponding backbone service instance). To form the ETH_AI for the backbone ETH layer network, a backbone destination address parameter value is set, using the CID parameter as input.

The BMAC/ETH_A_Sk function accepts ETH_AI from the input ETH_AP, validates and removes the I-Tag from the MSDU and passes ETH_CI to the output ETH_FwP identified by the I-SID value. The BMAC/ETH_A_Sk function also provides a CID parameter value which can be mapped by the BMAC/ETH_A_So to the received source address parameter (B-SA).

9.5 Ethernet network topology

An ETH layer network is the set of ETH access groups (co-located ETH_T functions) that may be associated to exchange ETH_CI. An ETH layer network has a maximal subnetwork that provides connectivity between access groups. This maximal subnetwork may be partitioned into smaller ETH subnetworks interconnected by ETH links (point-to-point) and/or ETH server subnetworks (multipoint).

Figure 9-13 shows an ETH layer network with access groups connected to either customer bridges (supporting C-VLANs) or provider bridges (supporting S-VLANs). The customer bridges are connected to each other directly or via provider bridges that form a provider bridged (sub)network (PBN). The provider bridges are connected to each other either directly or via a server subnetwork supported by an ETH server layer network or provider backbone bridged network (PBBN).

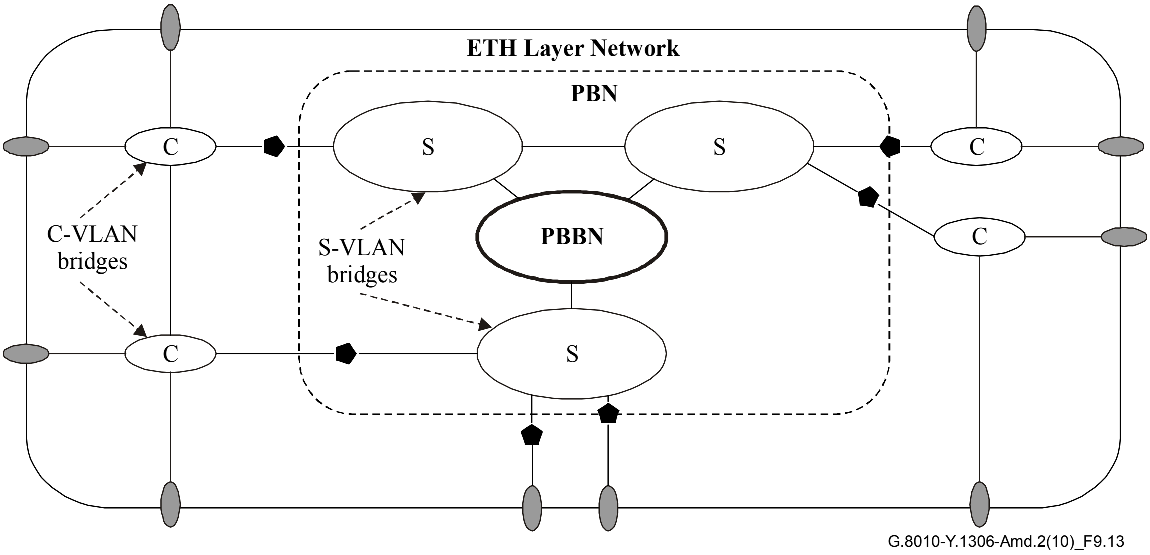


Figure 9-13 – ETH layer network topology example

While the topology shown could support transport entity topologies containing loops, the active topology of each ETH transport entity must be loop-free due to the specified ETH_F behaviour (specifically the default "flooding" rule). This property can be ensured either by management or dynamic control mechanisms.

Figure 9-13 shows a topology of an entire ETH layer network. In practice the topology of the ETH layer network may be partitioned into distinct views held by different administrations. For example, a customer (C-VLAN) network topology may show the C-VLAN bridges/subnetworks and links separately, but show the PBN as a single subnetwork (i.e., the customer has no visibility into the PBN topology). Similarly, the PBN administration may see a topology that ends at the PBN boundary (not showing any detail of C-VLAN bridges or links outside the PBN). In the PBN administration's view, the PBBN may be shown as a single server subnetwork (as in the figure), or it may be partitioned to show server layer detail if the administration has responsibility for both layers. Alternatively the PBBN may be under a separate administration which has its own view of the PBBN topology and limited visibility outside the PBBN layer network boundary.

9.5.1 Provider bridged networks

Provider bridged networks (PBNs) are constructed using service VLAN (S-VLAN)-aware bridges also called provider bridges (PBs). A provider edge bridge (PEB) includes additional functionality to map customer VLANs (C-VLANs) to service VLANs (S-VLANs) in the PBN. Figure 9-14 is a topology diagram for an example PBN.

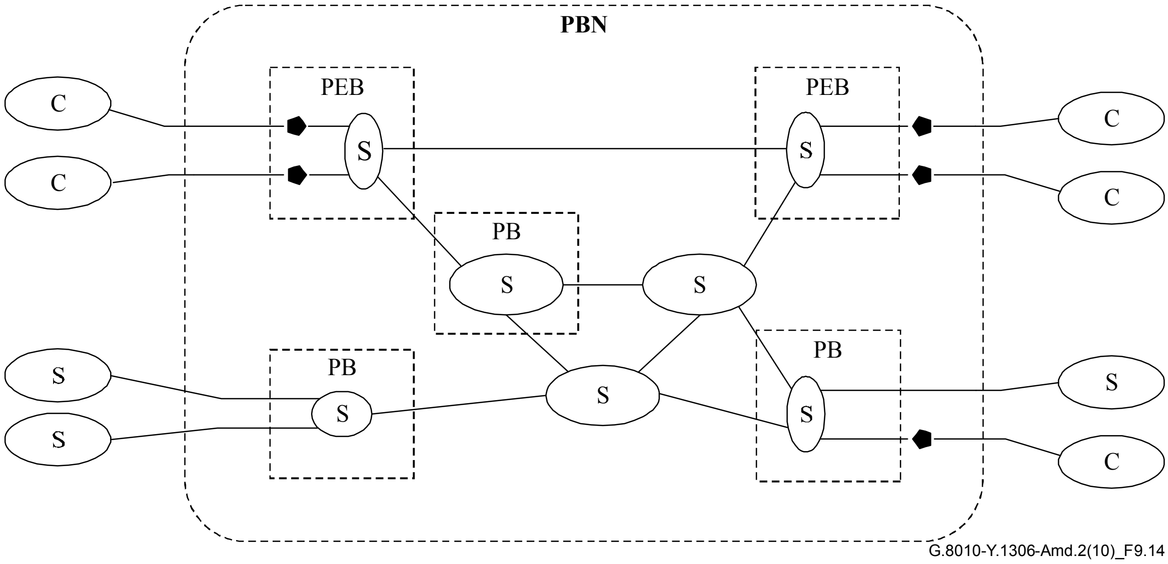


Figure 9-14 – ETH PBN topology example

The links connecting C-VLAN aware subnetworks to S-VLAN aware subnetworks are shown as transitional links because the relationship between C-VLAN forwarding points and S-VLAN forwarding points is not 1:1. In particular, multiple C-VLANs may be aggregated into a single S-VLAN. In addition, the bridge port (link port) relationship is not always 1:1. For example, a single C-VLAN link port may be related to multiple S-VLAN link ports as sets of C-VLANs are mapped to different S-VLANs in the PBN.

Figure 9-15 shows the topology of an example VLAN supported by the PBN shown in Figure 9-14. Link ports are shown as grey circles with forwarding points shown within. Two C-VLANs are shown (long-dashed blue and short-dashed red ovals) mapped to a single S-VLAN (black oval). It is not necessary that the extent of the S-VLAN exactly match the extent of the C-VLANs that are mapped into it. C-VLAN frames delivered to S-VLAN ports where the C-VLAN is not provisioned are discarded.

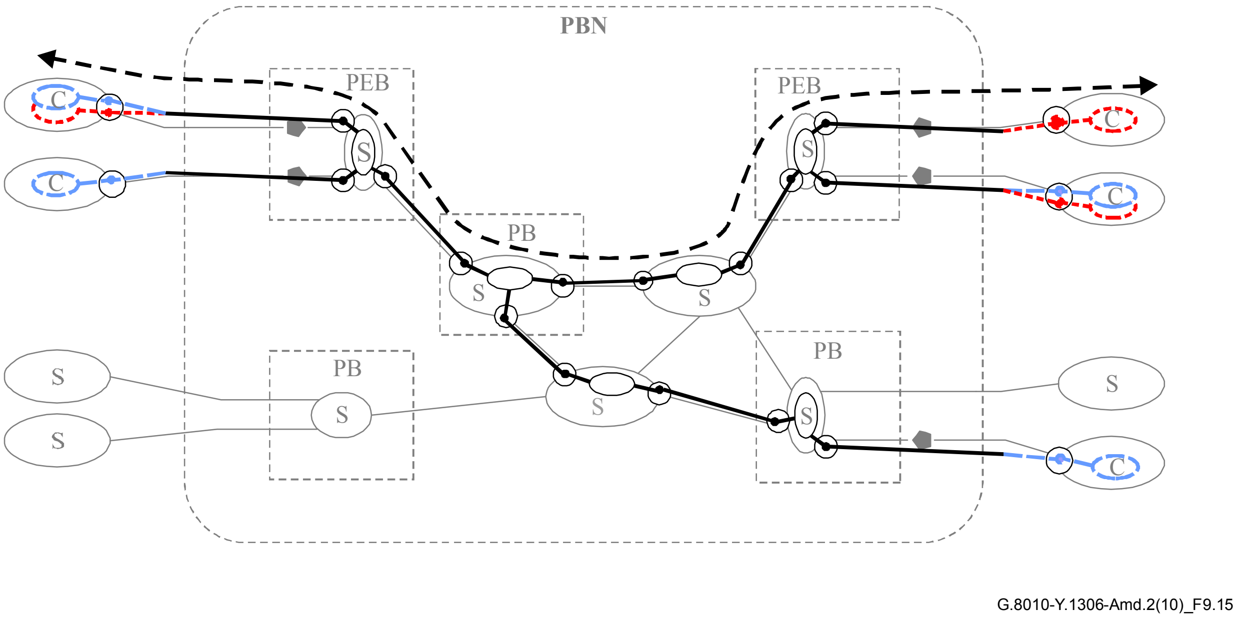


Figure 9-15 – ETH PBN VLAN topology example

Figure 9-16 shows the functional structure of the path indicated in Figure 9-15 by the thick dashed line. On the left, both C-VLANs are mapped to the S-VLAN by a PEB using the ETH_CS_L function. On the right, the (short-dashed red line) C-VLAN is mapped to the S-VLAN using a port-based service interface (no C-VLAN aware mapping).

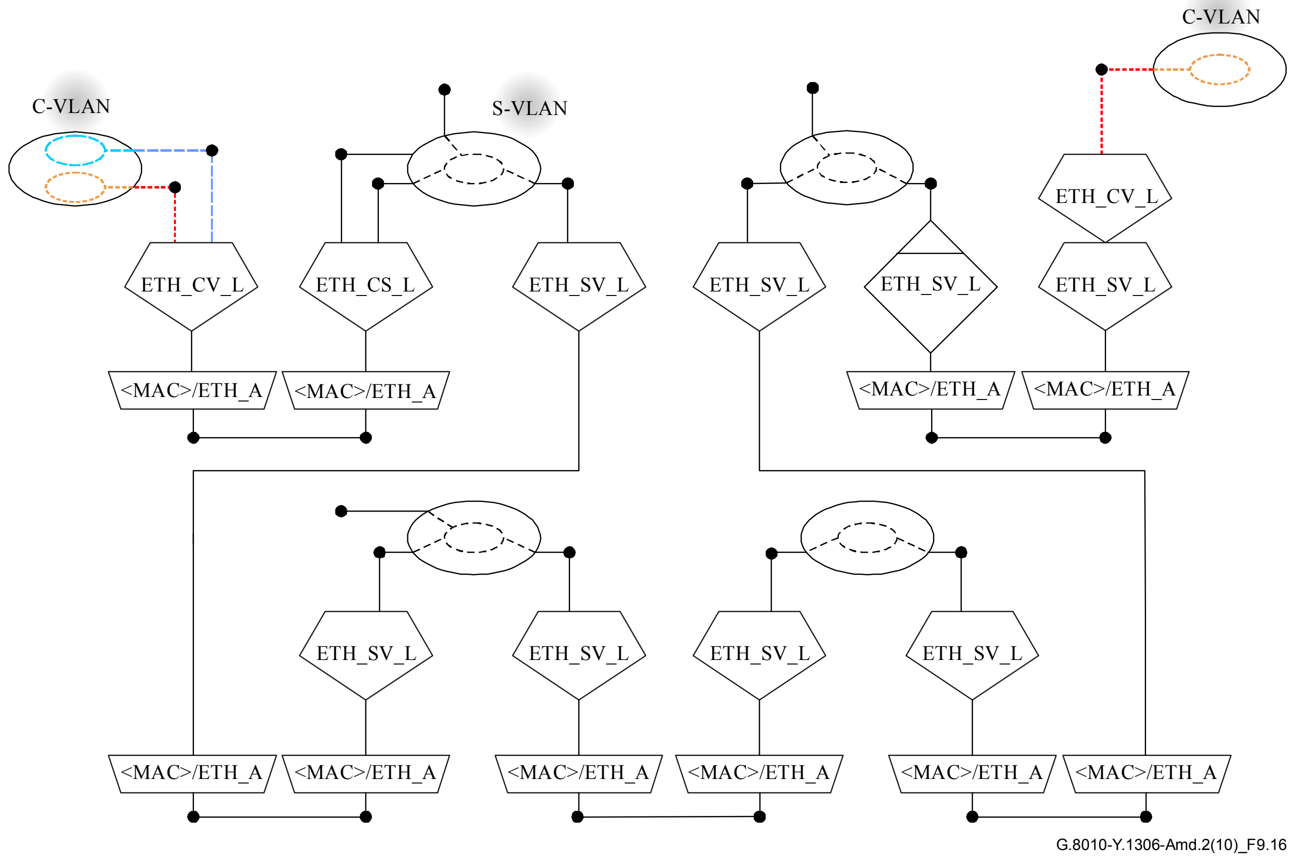


Figure 9-16 – ETH PBN functional path example

The provider bridges in the middle of the path have no C-VLAN awareness at all.

9.5.2 Provider backbone bridged networks

Figure 9-17 shows the topology of an example provider backbone bridged network (PBBN). The PBBN topology has client layer provider bridges at its boundary connected to server layer provider bridges by transitional links indicating the adaptation from the ETH client layer to the ETH server layer network. These transitional links are within network elements designated as either IB-BEB or I-BEB. The provider bridges within the PBBN that have no edge function (BCB) are identical in function to the provider bridges in the PBN that provide no edge function (PB).

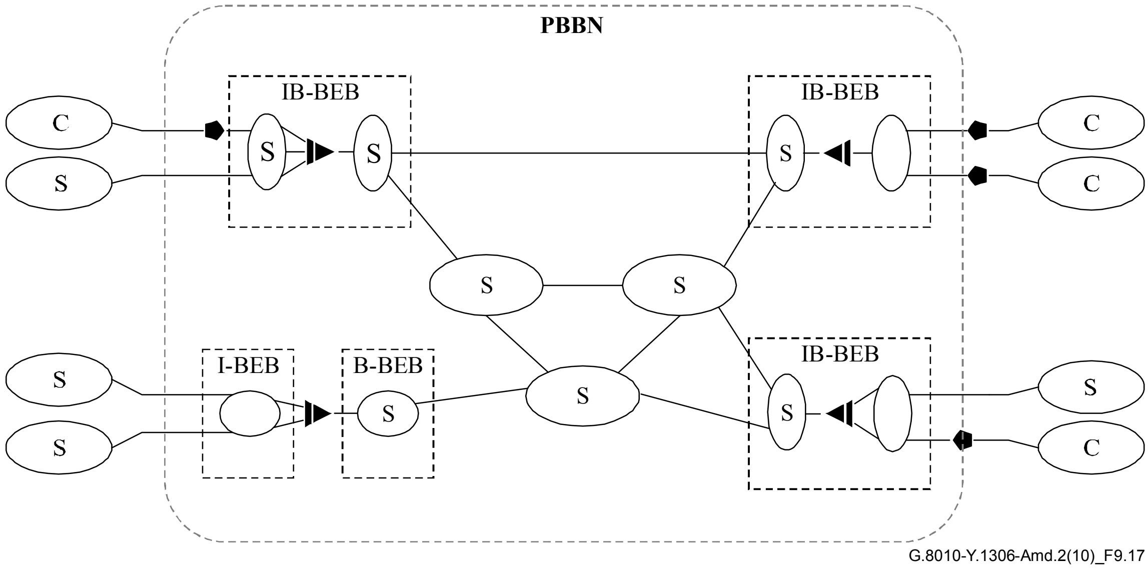


Figure 9-17 – ETH backbone topology example

The provider backbone bridges providing edge functions support either BMAC/ETH_A (I-BEB), ETH_CB_IL (B-BEB), or both (IB-BEB). External links that map C-VLANs to S-VLANs are shown as transitional links as in the PBN example above.

Figure 9-18 presents the topology of an example B-VLAN in the PBBN. The B-VLAN provides transport between backbone edge bridges (BEBs) for one or more backbone service instances (BSIs).

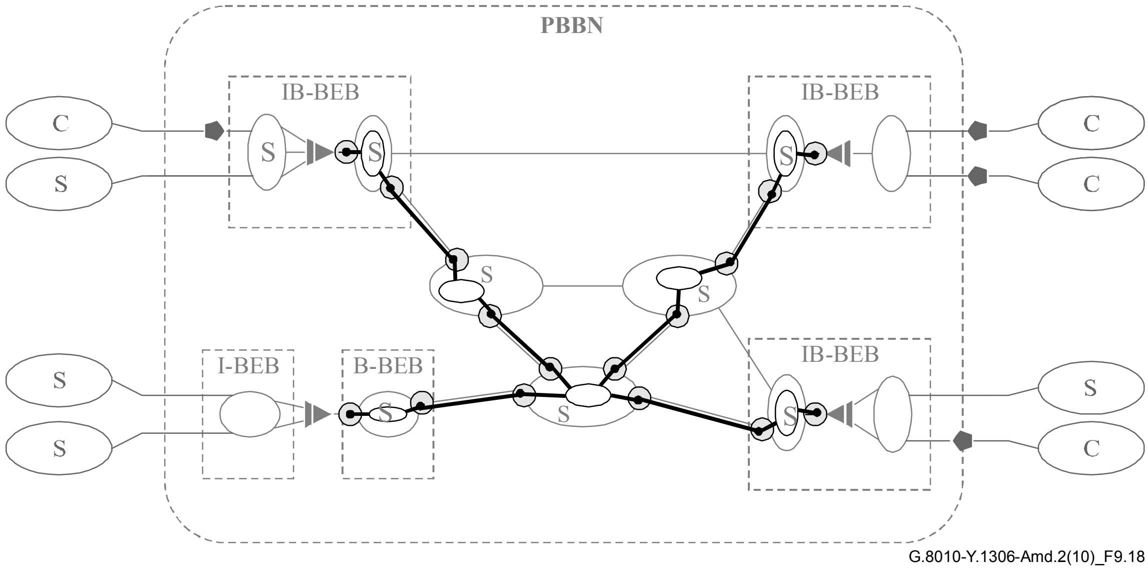


Figure 9-18 – ETH PBBN B-VLAN topology example

Figure 9-19 shows two example BSIs that are supported by the B-VLAN shown in Figure 9-18. Each BSI provides a server subnetwork to the client ETH S-VLAN-aware network. These BSI-supported SSNs are essentially in parallel but may include different sets of BEB endpoints.

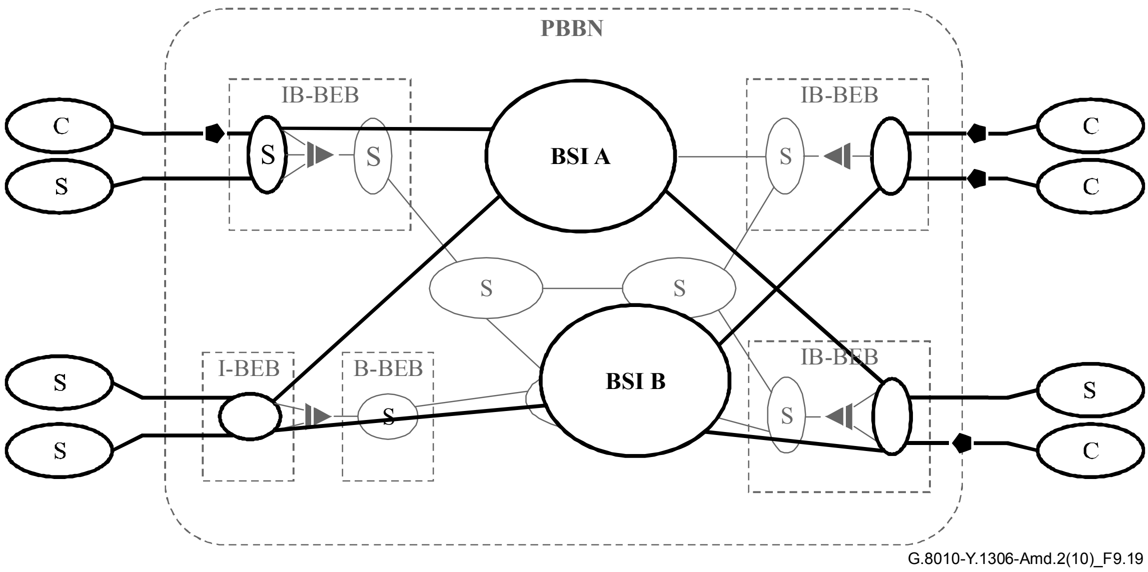


Figure 9-19 – ETH PBBN BSI topology example

Client S-VLANs can use the BSI SSNs to provide interconnection between client subnetworks.

Figure 9-20 shows the topology of a PBBN client S-VLAN (black). BSI B's SSN is used to provide an SSNTE for the S-VLAN.

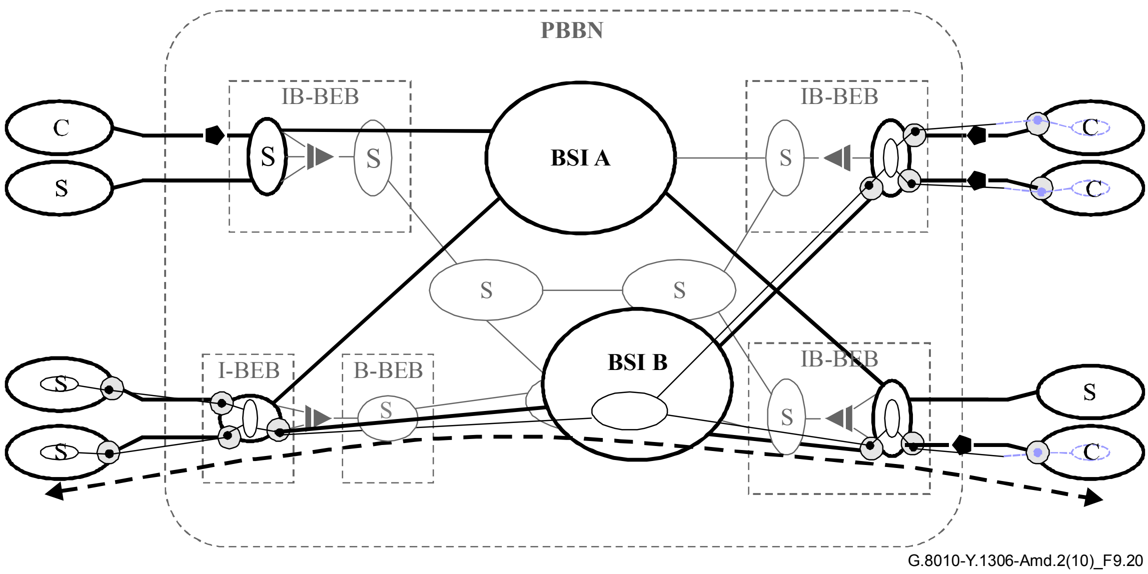


Figure 9-20 – ETH PBBN S-VLAN topology example

Figure 9-21 shows the functional structure of the path indicated in Figure 9-20 by the thick dashed line. On the left side the structure of a separate I-BEB and B-BEB is shown in which the provider instance port and customer backbone port functions reside in different bridges. On the right side the structure of an I-BEB is shown as well as a port-based service interface for a C-VLAN (long-dashed line) that is carried over the S-VLAN.

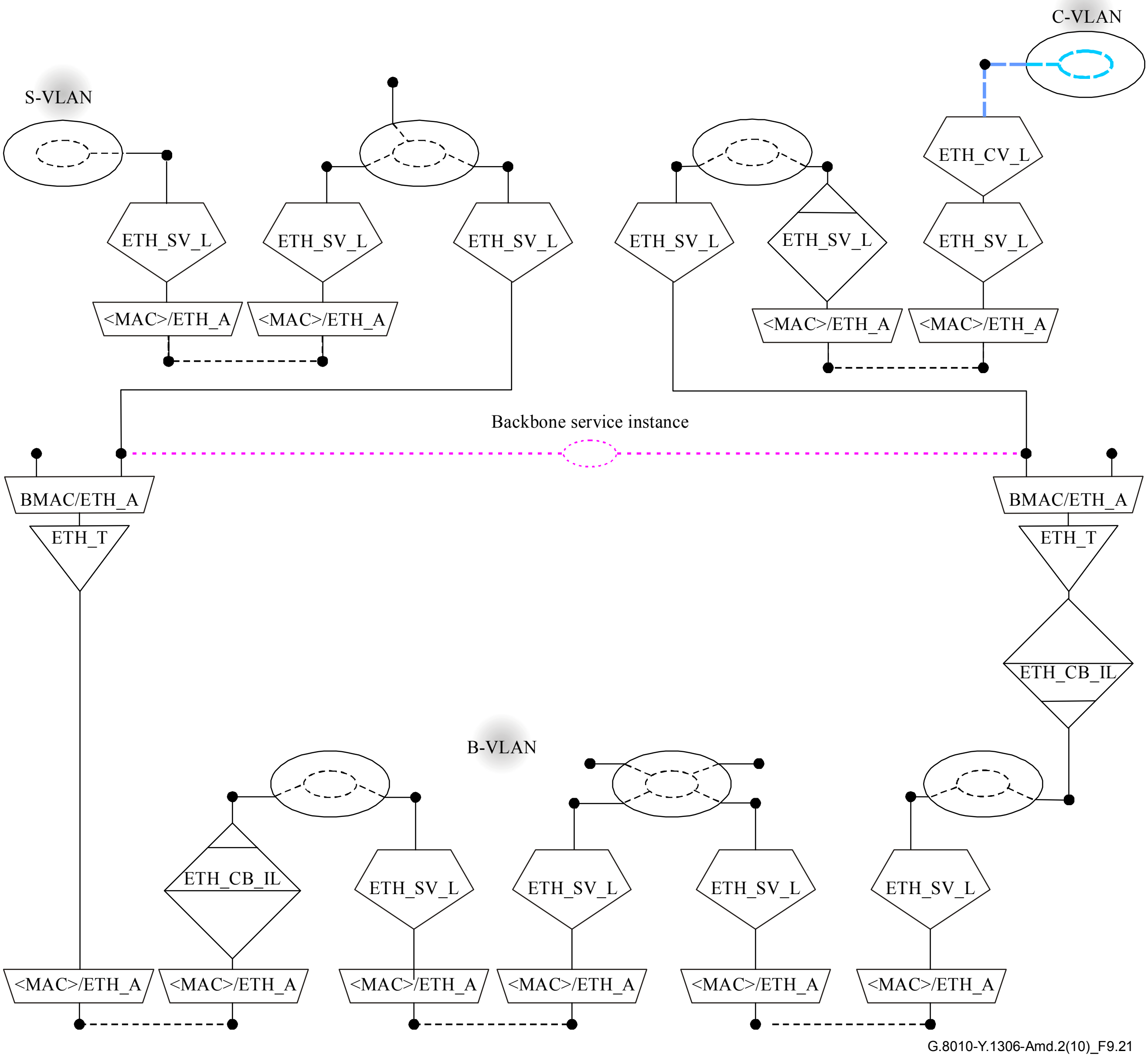


Figure 9-21 – ETH PBBN functional path example

Figure 9-22 shows two modes of interconnection between provider backbone networks. PBBN 1 is connected to PBBN 2 in a client-server relationship by interconnecting a backbone core bridge of PBBN 1 (BCB) to a backbone edge bridge of PBBN 2 (IB-BEB). PBBN 2 is connected as a peer to PBBN 3 by interconnecting backbone edge bridges providing only ETH_CB_IL functions (B-BEB).

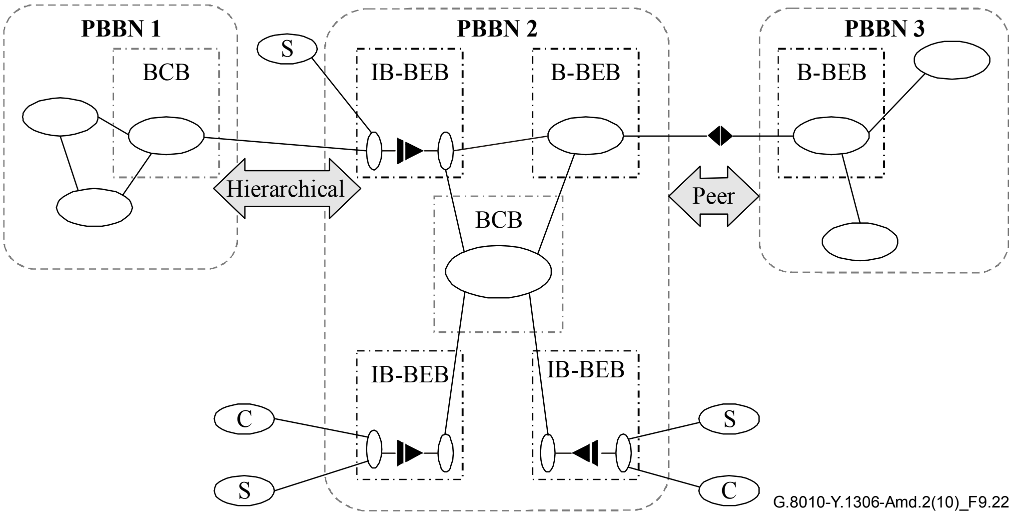


Figure 9-22 – ETH backbone interconnection

In this arrangement PBBN 1 will see PBBN 2 and PBBN 3 as a server subnetwork. PBBN 2 and PBBN 3 will see each other as peer domains in a larger provider backbone ETH layer network.

9.6 Ethernet network management

Recommendation ITU-T Y.1731, IEEE 802.1ag and 802.1Qaw specify functions for monitoring the performance of ETH transport entities and detecting, reporting, and diagnosing defects that affect this performance. The set of reference points belonging to the monitored ETH transport entity is called a maintenance entity group (MEG). OAM functions may be located at a boundary point or MEG end point (MEP) or at an intermediate point (MIP).

The OAM functions supported for monitoring and diagnosing ETH transport entities include:

- connectivity and continuity verification among MEPs;
- loopback from a MEP to a MEP or MIP;
- trace of forwarding rules for a specified unicast address;
- frame loss measurement between a pair of MEPs in a P-P transport entity;
- frame delay measurement between a pair of MEPs;
- insertion and detection of ETH maintenance signals;
- selection of specific traffic units at a reference point and redirection of (a copy of) these traffic units to an analysis function located elsewhere in the network;
- delivery of test traffic to a selected reference point and injection of the traffic at that point.

These OAM functions are provided for transport entities associated with the reference points shown in Figure 9-3 by inclusion of OAM transport processing functions in the atomic functions shown. In addition, the ETH_CB_IL function can provide backbone service instance MIPs and maintenance signal processing internally (these reference points are not shown in Figure 9-3). Detailed specification of the ETH transport processing functions, including the available OAM functions, is provided in Recommendation ITU-T G.8021/Y.1341.

4.5 Add new Appendix VIII

Appendix VIII

ITU-T G.800 Modelling Conventions

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

Clause 9 uses ITU-T G.805 and ITU-T G.800 functional modelling terminology and diagrammatic conventions to describe the Ethernet layer network architecture with the additions described in this appendix.

VIII.1 Terminology

The following terms are used in this Recommendation:

aggregation: Combining instances of characteristic information, with sufficient labelling to distinguish and later separate them, into a single transport entity without providing full client/server layer network independence (i.e., without full information independence).

multiplexing: Combining instances of characteristic information, with sufficient labelling to distinguish and later separate them, into a server layer access transport entity providing full client/server layer network independence (i.e., full information independence).

server subnetwork transport entity: A transport entity with multiple (more than two) forwarding points supported by one or more server layer access transport entities.

ITU-T G.8010 (2004) uses ITU-T G.809 terminology, while clause 9 uses ITU-T G.800 terminology. The following general correspondence of terms is provided to clarify the relationship between terms used in clause 9 and other terms commonly used.

Table VIII.1 – Terminology correspondence

ITU-T G.809	ITU-T G.8010 (2004)	ITU-T G.800 Amendment 1	ITU-T G.8010 Clause 9	IEEE 802.1
flow domain	flow domain	subnetwork	subnetwork	bridged network
	flow domain fragment (FDFr)	subnetwork transport entity	subnetwork transport entity	virtual LAN (VLAN)
flow domain flow	flow domain flow	forwarding rule	forwarding rule	FDB entry
link flow	link flow	link connection	link connection	
			server subnetwork	local area network (LAN) segment
flow point	flow point	forwarding point	forwarding point	
flow point pool	flow point pool			
flow point pool link	flow point pool link	link	link	point-to-point link/LAN
connectionless trail	connectionless trail	access transport entity	access transport entity	

VIII.2 Diagrammatic conventions

A few diagrammatic conventions are used in the models in clause 9 that are not as yet described in another Recommendation. These conventions are:

- paired versus singleton layer processor symbols;
- inter-layer processor indication;
- transitional link.

VIII.2.1 Paired versus singleton layer processor symbols

Two symbols have been defined for layer processor functions, a pentagon and a diamond. So far the diamond symbol has been used for singleton layer processor functions (i.e., functions that do not require a paired function to deliver proper behaviour, e.g., traffic conditioning). The pentagon symbol has been used for layer processor functions that must be paired, e.g., VLAN tagging functions. In this Recommendation, this convention is followed in that layer processor functions that must be paired are shown as pentagons and those that do not require pairing (even if this is commonly done) are shown using the diamond symbol.

For example, the VLAN tagging functions ETH_CV_L and ETH_SV_L are shown as pentagons:

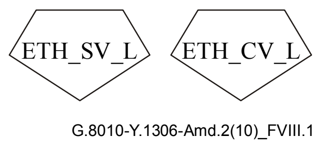


Figure VIII.1 – Symbol examples for paired layer processor

and the customer backbone port function ETH_CB_IL and S-VLAN port based service interface version of ETH_SV_L are shown as diamonds:

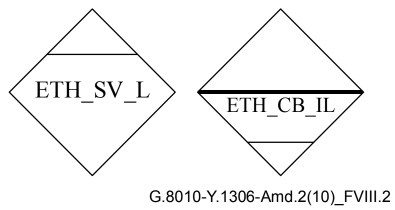


Figure VIII.2 – Symbol examples for singleton layer processor

VIII.2.2 Inter-layer processor indication

When a layer processor function depends on information that is not considered layer information but instead is adaptation information (belonging to an inter-layer adaptation function) or client characteristic information, this is indicated by a line through the middle of the layer processor symbol. This indicates there is an inter-layer information dependency. The strength of the dependency is indicated by the type of line. A dashed line indicates the inter-layer information is not mandatory and a solid line indicates that the inter-layer information is mandatory (that is, traffic units that do not include the inter-layer information are blocked).

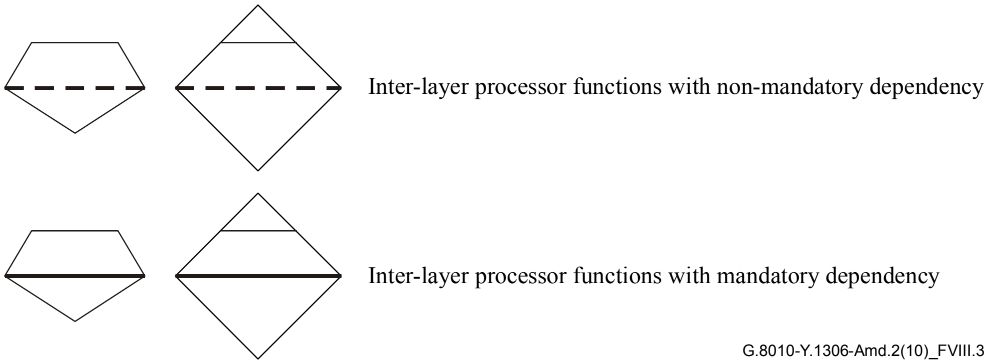


Figure VIII.3 – Symbol examples for interlayer processors

This convention is used for the ETH_CB_IL function that has a mandatory dependency on the presence of an I-Tag provided by the BMAC/ETH_A inter-layer adaptation function.

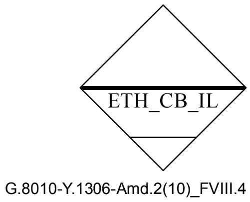


Figure VIII.4 – Symbol for ETH_CB_IL interlayer processor

VIII.2.3 Transitional link

A link whose endpoints contain forwarding points in different layer networks is called a transitional link. Such a link is indicated in topology diagrams by adding a triangle icon to the line representing the link. The triangle icon indicates the presence of client/server (adaptation/termination) functions within the link.

Figure VIII.5 – Symbol for layer transitional link

This is used, for example, to show a link between a client S-VLAN aware subnetwork and a server B-VLAN aware subnetwork at the boundary of a PBBN.

There are cases in which the structure (number) of link points is different for the two subnetworks connected by a transitional link. This can be shown by the number of link ends included as part of the link.

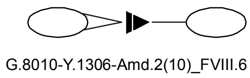
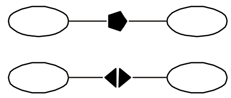


Figure VIII.6 – Layer transitional link with two client link points and one server link point

Note that this is not a generalized multipoint structure (i.e., server subnetwork) but a point-to-point structure in which multiple link points at one end are related to one link point at the other. The relationship is governed by the server/client adaptation function.

VIII.2.4 Sublayer transitional link

A link whose endpoints contain forwarding points in the same layer network but within which a transformation occurs so that the relationship between forwarding points is not fully transparent is called a sublayer transitional link. This type of link is shown in topology diagrams by adding a pentagon or diamond icon to the line representing the link. The icon indicates the presence of a layer processor function within the link that governs the relationship between the forwarding points at the link endpoints.



G.8010-Y.1306-Amd.2(10)_FVIII.7

Figure VIII.7 – Symbols for sublayer transitional links

This convention is used, for example, to show the relationship between C-VLAN link points and S-VLAN link points at the boundary of a PBN or to show a link containing a customer backbone port at the boundary of a PBBN domain. The relationship between the link points and forwarding points at each end of the link is governed by the layer processor function(s) within the link.

4.6 Add new Appendix IX

Appendix IX

Mapping between clause 9 and clause 6/7 architectural components

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

The architectural components described in ITU-T G.8010 (2004) correspond to architectural components described in clause 9 as follows:

Table IX.1 – Relationship between ITU-T G.8010 (2004) and clause 9 architectural components

ITU-T G.8010 (2004)	Clause 9
ETH flow termination (ETH_FT)	ETH termination (ETH_T)
ETH traffic conditioning (ETH_TC)	within <MAC>/ETH_A (not specifically described)
ETH/BP adaptation (ETH/BP_A)	within <MAC>/ETH_A (not specifically described)
ETH/IP adaptation (ETH/IP_A)	form of ETH/client adaptation (not specifically described)
Srv/ETH adaptation (Srv/ETH_A)	<MAC>/ETH_A
Srv/ETH-m adaptation (Srv/ETH-m_A)	ETH_CV_L or ETH_SV_L + <MAC>/ETH_A
ETYn/ETH adaptation (ETYn/ETH_A, ETYn/ETH-m_A)	part of <MAC>/ETH_A (not specifically described)
SDH Path/ETH adaptation (S/ETH_A, S/ETH-m_A)	form of <MAC>/ETH_A (not specifically described)
OTN path/ETH adaptation (ODU/ETH_A, ODU/ETH-m)	form of <MAC>/ETH_A (not specifically described)

Table IX.1 – Relationship between ITU-T G.8010 (2004) and clause 9 architectural components

ITU-T G.8010 (2004)	Clause 9
MPLS/ETH adaptation (MPLS/ETH_A)	form of <MAC>/ETH_A (not specifically described)
ATM VC/ETH adaptation (VC/ETH_A)	form of <MAC>/ETH_A (not specifically described)
Not described	ETH forwarding function (ETH_F)
Not described	ETH C-VLAN to S-VLAN layer processor function (ETH_CS_L)
Not described	ETH customer backbone inter-layer processor function (ETH_CB_IL)
Not described	BMAC/ETH adaptation (BMAC/ETH_A)

The additional architectural components described in ITU-T G.8010 Amendment 1 (2006) correspond to architectural components described in clause 9 as follows:

Table IX.2 – Relationship between Amendment 1 and clause 9 architectural components

ITU-T G.8010 Amendment 1 (2006)	Clause 9
ETH flow termination (ETH*x*_FT, *x* = P, T, S)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH group flow termination (ETHG)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH diagnostic flow termination (ETHD)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH traffic conditioning and shaping (ETH_TCS)	within <MAC>/ETH_A (not specifically described)
ETH*x*/ETH adaptation (ETH*x*/ETH_A, *x* = P, T, S)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH*x*/ETH-m adaptation (ETH*x*/ETH-m_A)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH*x*/ETH adaptation (ETH*x*/ETH_A)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH*x*/ETHG adaptation	OAM function that may be placed at appropriate reference points (not specifically described)
ETHG/ETH adaptation (ETHG/ETH_A)	OAM function that may be placed at appropriate reference points (not specifically described)
ETHD/ETH adaptation (ETHD/ETH_A)	OAM function that may be placed at appropriate reference points (not specifically described)
ETH/MPLS adaptation (ETHP/MPLS_A)	form of ETH/client adaptation (not specifically described)
MPLS path/ETH adaptation (MPLS/ETH_A)	form of <MAC>/ETH_A (not specifically described)

4.7 Add new Appendix X

Appendix X

Mapping between clause 9 and IEEE 802.1 architectural components

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

Table X.1 shows the relationship between various architectural or functional elements specified by IEEE 802 and corresponding architectural components defined in the ITU-T G.800 model in clause 9. These relationships are presented in an effort to make the relationship between IEEE specified functions and the functional modelling components described in clause 9 clear to readers familiar with IEEE specifications and perhaps less familiar with functional modelling methodology.

Table X.1 – Relationship between IEEE 802 and clause 9 architectural entities

IEEE 802	Clause 9
LLC	form of ETH/client adaptation (not specifically described, not normally used in transport applications)
MAC	corresponds to the ETH layer (a generalization of the Ethernet (IEEE 802.3) frame to provide transport service)
PHY	form of <MAC>/ETH_A and functions below (not specifically described)
IEEE 802.1Q	
MAC Relay	ETH_F
Support of the EISS	ETH_CV_L or ETH_SV_L
Support of the ISS/EISS by Provider Instance Ports	combination of ETH_SV_L, BMAC/ETH_A, and ETH_T
Support of the EISS by Customer Backbone Ports	ETH_CB_IL
Support of the ISS for attachment to a Provider Bridged Network	ETH_SV_L
Provider Edge Bridge C-VLAN component	ETH_CS_L

The following examples of functional model diagrams are provided as an aid to understanding the correspondence between the architectural components in the functional model and elements specified in IEEE 802.1 bridge specifications.

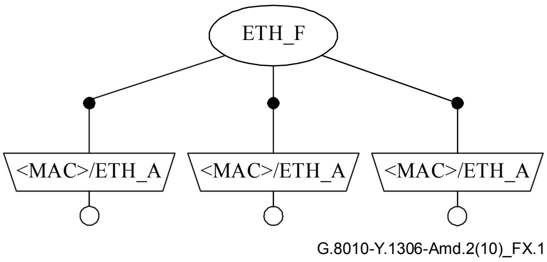


Figure X.1 – VLAN unaware bridge

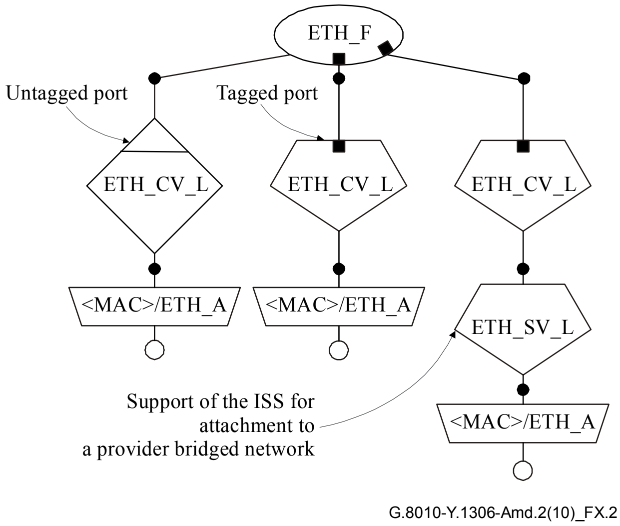


Figure X.2 – C-VLAN aware bridge

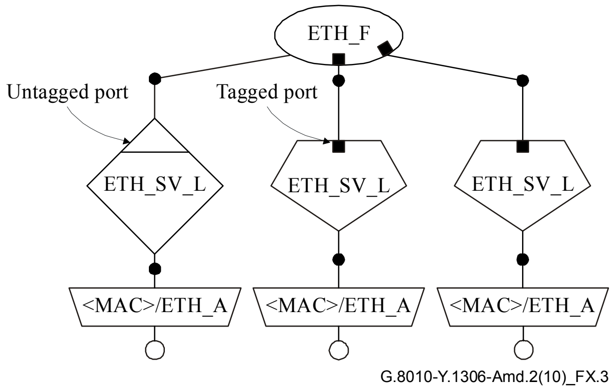


Figure X.3 – S-VLAN aware bridge, e.g., provider bridge (PB) or provider backbone core bridge (BCB)

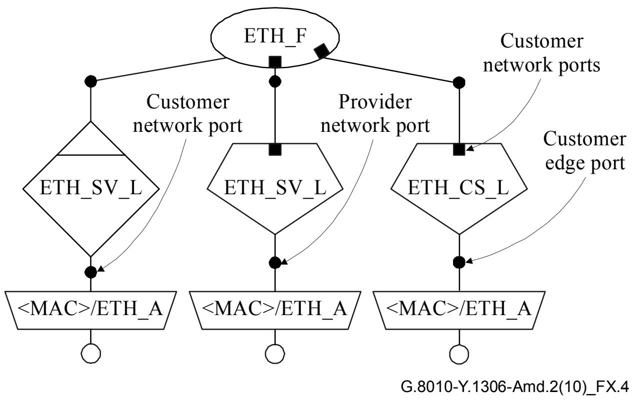


Figure X.4 – Provider edge bridge (PEB)

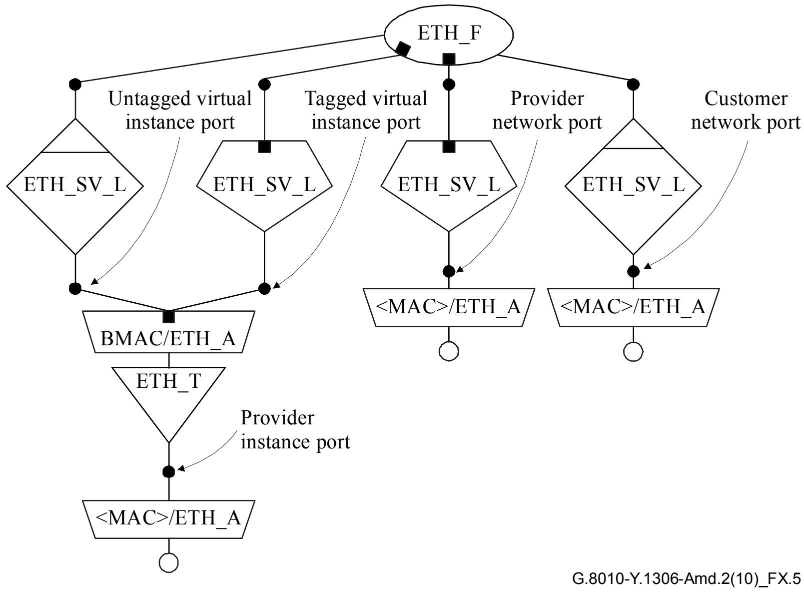


Figure X.5 – I type backbone edge bridge (I-BEB)

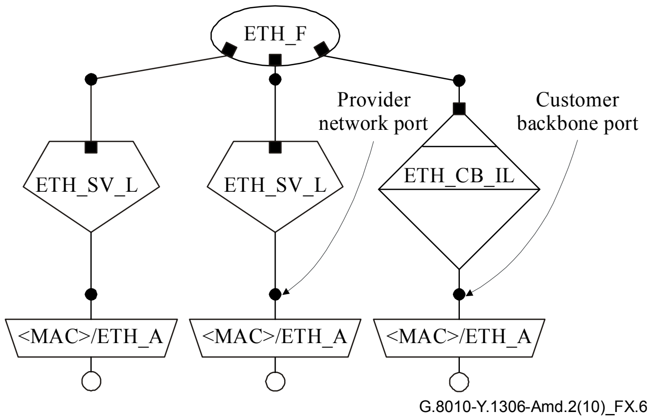


Figure X.6 – B type backbone edge bridge (B-BEB)

4.8 Add new Appendix XI

Appendix XI

Rooted multipoint using asymmetric VLANs

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

A form of rooted multipoint (RMP) ETH transport can be provided by configuration of an asymmetric VLAN. A bidirectional RMP VLAN is formed (as shown in Figure XI.1) by creating a unidirectional MP-P SNTE with leaf input ports and a root output port and pairing it with a unidirectional P-MP SNTE with the root input port and leaf output ports.

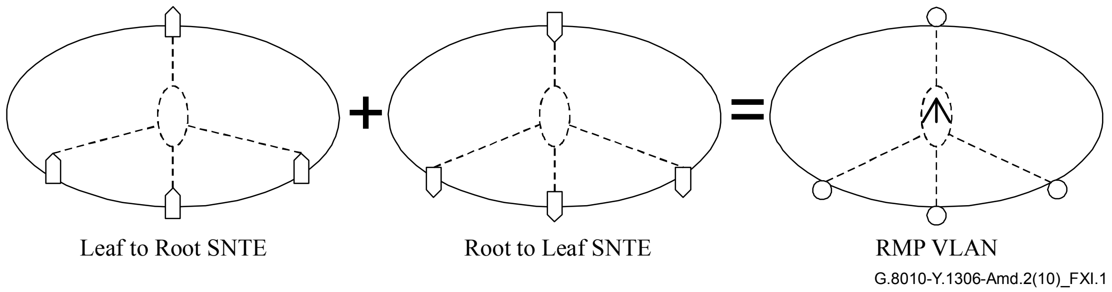


Figure XI.1 – RMP VLAN using asymmetric SNTEs

If the two SNTEs are configured for shared learning of MAC address forwarding information, the forwarding rules learned as frames are forwarded from a leaf port to the root in the MP-P SNTE and can be used to forward frames with corresponding addresses travelling from the root to that leaf port in the P-MP SNTE.

Figure XI.2 shows an example of an aggregation network that allows each leaf access point to communicate with the root access point, but does not allow direct communication between leaf access points.

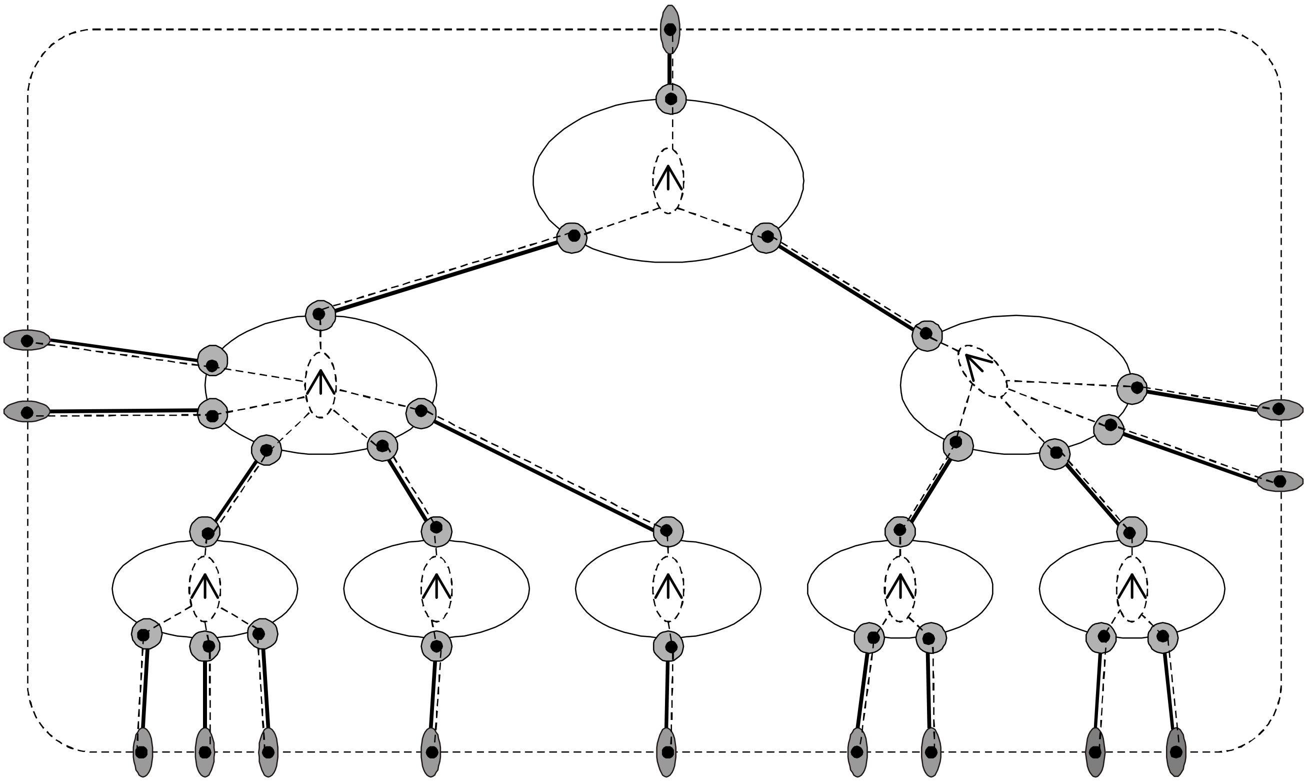


Figure XI.2 – Aggregation network using RMP VLAN

This aggregation architecture may be used in cases in which a number of customers require access to a service provider but must be protected from directly communicating with each other or observing other customer's communications with the service provider.

In scenarios requiring high availability for the RMP root, multiple root access points may be provided. This is supported by having multiple sinks (i.e., multiple roots) in the leaf-to-root SNTE and allowing root access points to be bidirectional in the root-to-leaf SNTE (allowing root access points to communicate directly with each other). This combination is illustrated in Figure XI.3.

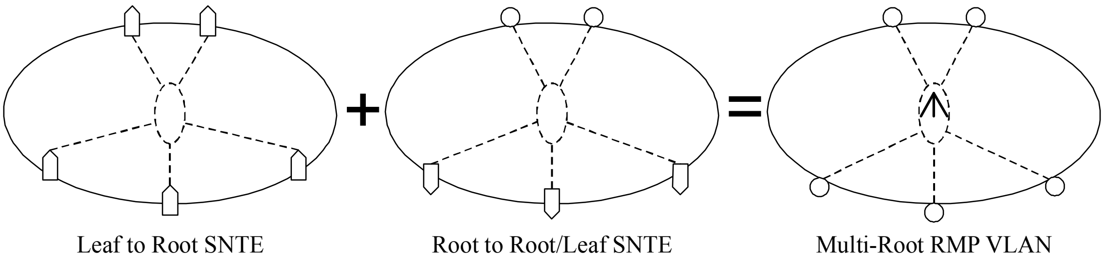


Figure XI.3 – Multi-root RMP VLAN using asymmetric SNTEs

The root forwarding ports are shown at the top and leaf forwarding ports at the bottom of the figure. Both of the root forwarding ports shown are sinks in the leaf-to-root SNTE and are bidirectional ports in the root-to-root/leaf SNTE. The combination of these two SNTEs creates a multi-root RMP SNTE that allows root ports to communicate with other root ports and leaf ports and allows leaf ports to communicate only with root ports.

4.9 Add new Appendix XII

Appendix XII

Rooted multipoint use in MP-MP service (split horizon)

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

A form of rooted multipoint (RMP) ETH transport is used when a "split horizon" rule is applied to a group of ports belonging to an ETH SNTE. This approach may be used, for example, to provide ETH multipoint service over a P-P transport infrastructure. The "split horizon" rule provides that a frame received on a port belonging to a "split horizon group" may not be forwarded to another port belonging to the same group.

Figure XII.1 shows a four port ETH VLAN implemented in a network by multipoint ETH SNTEs interconnected by link connections. A tree topology must be provided to support ETH flooding behaviour. In this example, traffic between the two ports on the right side must traverse all four subnetworks.

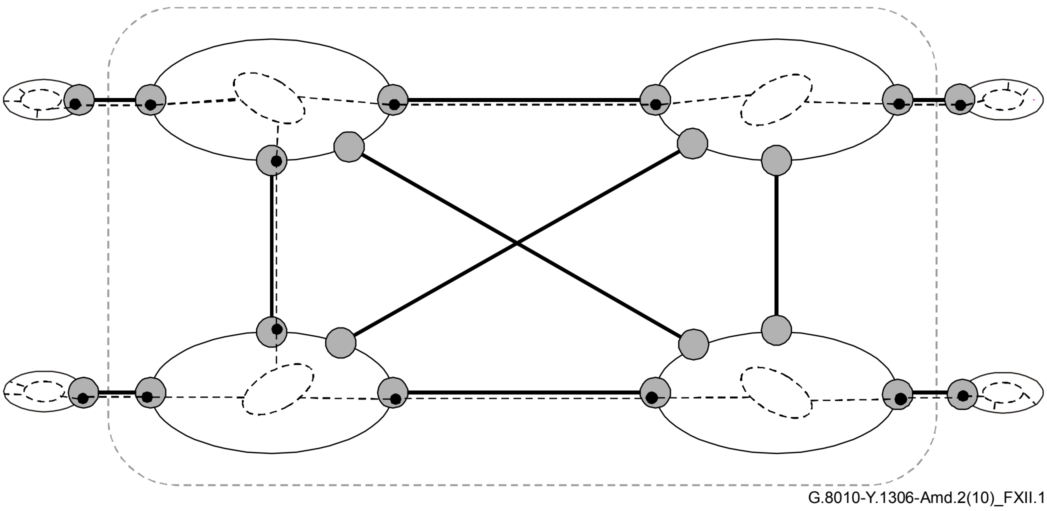


Figure XII.1 – VLAN using multipoint SNTEs

Figure XII.2 shows an example of a four port VLAN implemented in a network by four RMP SNTEs interconnected with a full mesh of ETH link connections. In this example an ETH RMP SNTE can be provided at each subnetwork by putting the ports providing ETH links to the other three ETH subnetworks into a split horizon group.

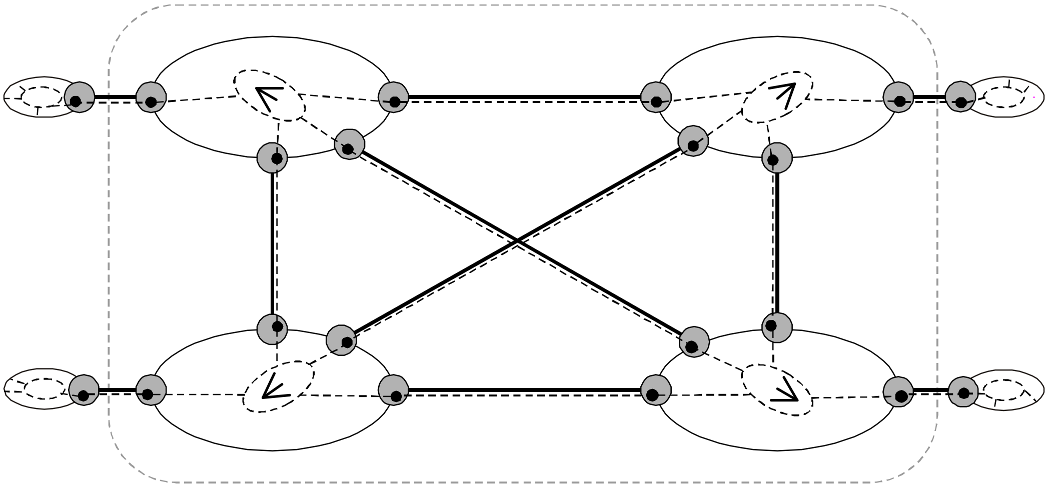


Figure XII.2 – VLAN using split horizon RMP SNTEs

In this case, traffic between any two ports will traverse only two subnetworks.

4.10 Bibliography

Remove the reference to IEEE Project P802.1ad.

Add the following reference:

[1] IEEE Standard 802.1ag-2007, *IEEE Standard for Local and metropolitan area networks: Virtual Bridged Local Area Networks, Amendment 5: Connectivity Fault Management*.

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