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ITU-T G.8011.4/Y.1307.4

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TELECOMMUNICATION
STANDARDIZATION SECTOR
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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Packet over Transport aspects – Ethernet over Transport aspects

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Ethernet virtual private rooted multipoint service

Recommendation ITU-T G.8011.4/Y.1307.4

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Recommendation ITU-T G.8011.4/Y.1307.4

Ethernet virtual private rooted multipoint service

Summary

Recommendation ITU-T G.8011.4/Y.1307.4 defines the service attributes and parameters for carrying Ethernet characteristic information over dedicated-bandwidth or shared-bandwidth, rooted multipoint connections, provided by synchronous digital hierarchy (SDH), plesiochronous digital hierarchy (PDH), asynchronous transfer mode (ATM), multi-protocol label switching (MPLS), optical transport hierarchy (OTH), Ethernet PHY layer network (ETY) or Ethernet MAC layer network (ETH) server layer networks. This type of service is referred to as Ethernet private tree (EP-Tree) and Ethernet virtual private tree services. This Recommendation is based on the Ethernet service framework as defined in Recommendation ITU-T G.8011/Y.1307.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.8011.4/Y.1307.4	2010-02-06	15	11.1002/1000/10425-en
2.0	ITU-T G.8011.4/Y.1307.4	2013-08-29	15	11.1002/1000/12027-en

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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.

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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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Recommendation ITU-T G.8011.4/Y.1307.4

Ethernet virtual private rooted multipoint service

1 Scope

This Recommendation defines the service attributes and parameters for carrying Ethernet characteristic information over dedicated-bandwidth or shared-bandwidth, rooted multipoint connections, provided by SDH, ATM, MPLS, PDH, ETY, OTH or ETH server layer networks. This type of service is referred to as Ethernet private tree (EP-Tree) and virtual private tree (EVP-Tree) services. The initial focus of this Recommendation will be on uni-root and bi-root EP-Tree and EVP-Tree services. This Recommendation is based on the Ethernet service framework as defined in [ITU-T G.8011] and is aligned with the EP-Tree and EVP-Tree services specified in [MEF 6.1].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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

[ITU-T G.8001] Recommendation ITU-T G.8001/Y.1354 (2013), *Terms and definitions for Ethernet frames over transport*.

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

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

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

[ITU-T G.8012.1] Recommendation ITU-T G.8012.1/Y.1308.1 (2012), *Interfaces for the Ethernet transport network*.

[ITU-T G.8013] Recommendation ITU-T G.8013/Y.1731 (2013), *OAM functions and mechanisms for Ethernet based networks*.

[ITU-T G.8021] Recommendation ITU-T G.8021/Y.1341 (2010), *Characteristics of Ethernet transport network equipment functional blocks*.

[IEEE 802.1aq] IEEE 802.1aq-2012, *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks—Amendment 20: Shortest Path Bridging*.

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

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

[IEEE 802.3] IEEE 802.3-2012, *IEEE Standard for Ethernet*.

[MEF 6.1] The Metro Ethernet Forum, Technical Specification MEF 6.1 (2008), *Ethernet Services Definitions – Phase 2*.

[MEF 6.1.1] The Metro Ethernet Forum, Technical Specification MEF 6.1.1 (2012), *Layer 2 Control Protocol Handling Amendment to MEF 6.1*.

[MEF 10.2] The Metro Ethernet Forum, Technical Specification MEF 10.2 (2009), *Ethernet Services Attributes – Phase 2*.

[MEF 12.1] The Metro Ethernet Forum, Technical Specification MEF 12.1 (2010), *Ethernet Services Attributes Phase 2*.

[MEF 26.1] The Metro Ethernet Forum, Technical Specification MEF 26.1 (2012), *External Network Network Interface (ENNI) – Phase 2*.

[MEF 30] The Metro Ethernet Forum, Technical Specification MEF 30 (2011), *Service OAM Fault Management Implementation Agreement*.

[MEF 35] The Metro Ethernet Forum, Technical Specification MEF 35 (2012), *Service OAM Performance Monitoring Implementation Agreement*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 ENNI: [MEF 26.1].

3.1.2 EP-tree service: [ITU-T G.8001].

3.1.3 ETH link: See clause 6.6 of [ITU-T G.8010].

3.1.4 Ethernet connection (EC): [ITU-T G.8001].

3.1.5 Ethernet private tree (EP-Tree) service: [ITU-T G.8001].

3.1.6 Ethernet virtual connection: (EVC) [ITU-T G.8001].

3.1.5 Ethernet virtual private tree (EVP-Tree) service: [ITU-T G.8001].

3.1.7 EVP-tree type 1 service: [ITU-T G.8001].

3.1.8 EVP-tree type 2 service: [ITU-T G.8001].

3.1.9 EVP-tree type 3 service: [ITU-T G.8001].

3.1.10 flow point: [ITU-T G.809].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

APS Automatic Protection Switching

ATM Asynchronous Transfer Mode

CBS Committed Burst Size

CCM Continuity Check Message

CE	Customer Edge
CF	Coupling Flag
CFM	Connectivity Fault Management
CI	Characteristic Information
CIR	Committed Information Rate
CM	Colour Mode
CoS	Class of Service
DA	Destination Address
DM	Delay Measurement
DMM	Delay Measurement Message
DMR	Delay Measurement Reply
DSCP	Differentiated Services Code Point
EBS	Excess Burst Size
EC	Ethernet Connection
EFM	Ethernet in the First Mile
EIR	Excess Information Rate
E-LMI	Ethernet Local Management Interface
ENNI	External Network Network Interface
ETH	Ethernet MAC layer network
ETH_C	Ethernet Connection (function)
ETH_CI	Ethernet MAC Characteristic Information
ETH_FP	Ethernet flow point
ETH_SNC	Ethernet Subnetwork Connection
ETY	Ethernet PHY layer network
EVC	Ethernet Virtual Connection
EVP-Tree	Ethernet Virtual Private Tree
LACP	Link Aggregation Control Protocol
LBM	Loopback Message
LM	Loss Measurement
LTM	Link Trace Message
MAC	Media Access Control
MEG	Maintenance Entity Group
MEN	Metro Ethernet Network
MEP	MEG End Point
MIP	MEG Intermediate Point
MPLS	Multi-Protocol Label Switching
MTU	Maximum Transmission Unit

NNI	Network-to-Network Interface
OAM	Operation, Administration, Maintenance
OTH	Optical Transport Hierarchy
OTN	Optical Transport Network
OVC	Operator Virtual Connection
PDH	Plesiochronous Digital Hierarchy
PHY	PHYsical layer entity
RSTP	Rapid Spanning Tree Protocol
SA	Source Address
SDH	Synchronous Digital Hierarchy
STP	Spanning Tree Protocol
S-VLAN	Service VLAN
UNI	User Network Interface
UNI-C	Customer side of UNI
UNI-N	Network side of UNI
VLAN	Virtual Local Area Network

5 Conventions

In this Recommendation, the Ethernet connection (EC) is functionally equivalent to the EC defined in [MEF 12.1]. The EC is used to describe the network underlying the Ethernet private tree (EP-Tree) and Ethernet virtual private tree (EVP-Tree) services. To describe the EP-Tree and EVP-Tree services, this Recommendation uses the term Ethernet virtual connection (EVC) as equivalent to the EVC[1] as defined in [MEF 10.2].

In this Recommendation, the EP-Tree and EVP-Tree services are functionally equivalent to the EP-Tree and EVP-Tree services defined in [MEF 6.1].

6 EVP-Tree service

6.1 Description

An EVP-Tree service is an Ethernet service based upon a rooted-multipoint EVC as described in terms of "an Ethernet Tree Service type" in section 6.3 of [MEF 6.1]. A rooted-multipoint EVC is an EVC for which each UNI is designated either as root or leaf. Ingress service frames at a root UNI can be delivered to one or more of any of the leaf UNIs in the EVC. Ingress service frames at a leaf UNI can only be delivered to one or more root UNIs in the EVC.

For an EVP-Tree service, service multiplexing may occur at none, one, or more than one of the UNIs in the EVC.

[1] NOTE – The 2010 ITU-T G.8011.4 Ethernet Connection (EC) definition was based on the 2009 ITU-T G.8011 definition that made the EC and EVC essentially equivalent. However, additional clarifications from [MEF 12.1] Figure 10 align with the original (2004) ITU-T G.8011 that excluded the UNI-N from the EC. As a result, ITU-T G.8011 (2012), on which this Recommendation is based, reinstates the difference between EC and EVC. Exactly where the start of the EVC is located depends on the underlying server layer.

The EVP-Tree service with only one root (i.e., uni-root) is illustrated in Figure 6.1-1.

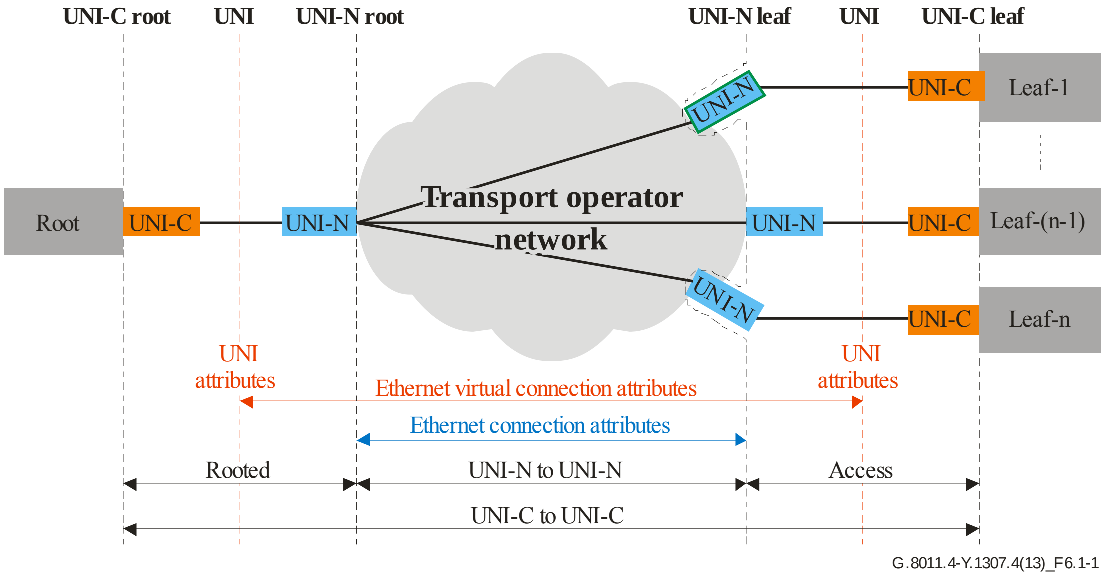

Figure 6.1-1 – Uni-root EVP-Tree service model

This is the "simplest form" of an EVP-Tree service as further described in terms of "an Ethernet Tree Service type" in section 6.3 of [MEF 6.1].

The EVP-Tree service with two roots (i.e., bi-root) is a possible multi-root EVP-Tree service as illustrated in Figure 6.1-2. This is an example of "more sophisticated forms" of an EVP-Tree service as described in terms of "an Ethernet Tree Service type" in section 6.3 of [MEF 6.1]. It should be noted that leaves would always behave as if there were a traditional unicast relationship from the leaf to the active root. There is no interaction among leaves, not even when they are redundantly attached to other roots; i.e., when they belong to multiple trees.

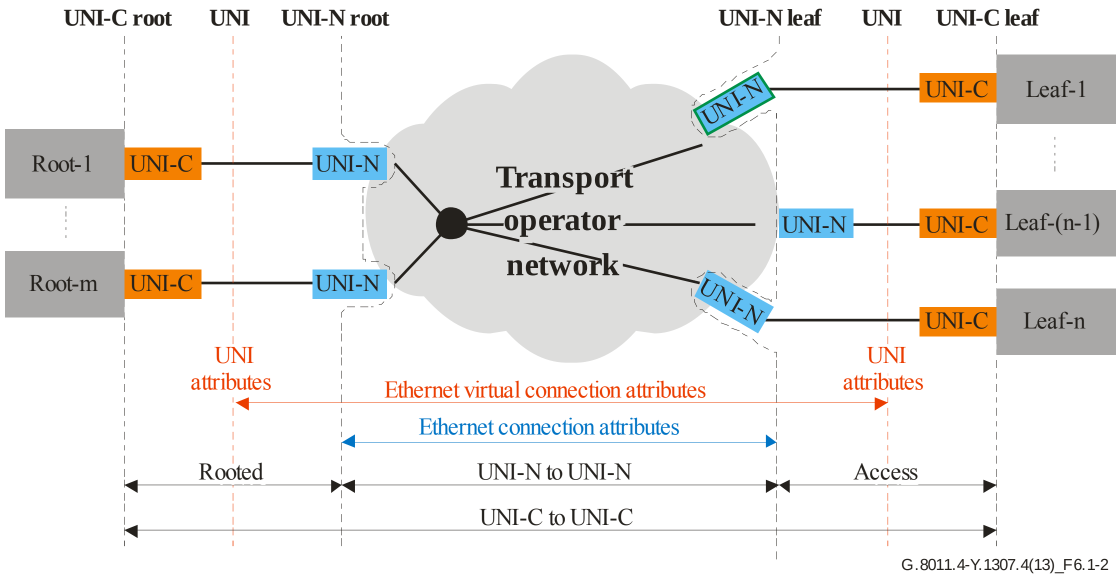

Figure 6.1-2 – Multi-root EVP-Tree service model

Load balancing and redundancy scenarios for multi-root EVP-Tree service are for further study.

More sophisticated cases such as hierarchical or cascaded EVP-Tree service architectures are also for further study.

6.2 EVP-Tree service architecture

EVP-Tree service supports multiplexed access and uses either a dedicated or a shared server layer, which leads to the three types of EVP-Tree services listed in Table 6.2-1:

Table 6.2-1 – EP-Tree service and EVP-Tree service types

Type	Shared server layer	Multiplexed access
EP-Tree service	N	N
EVP-Tree type 1 service	N	Y
EVP-Tree type 2 service	Y	N
EVP-Tree type 3 service	Y	Y

Annex A describes EP-Tree service.

Appendix I describes use cases for each type.

EVP-Tree type 1 and type 3 services can be further classified into three subtypes listed in Table 6.2-2 according to the position where multiplexed access occurs:

Table 6.2-2 – EVP-Tree service subtypes

Subtype	Multiplexed root access	Multiplexed leaf access
a	Y	N
b	N	Y
c	Y	Y

The basic architecture for EVP-Tree type 1 (1a, 1b and 1c), type 2 and type 3 (3a, 3b and 3c) services are described in clauses 6.2.1, 6.2.2 and 6.2.3, respectively.

6.2.1 EVP-Tree type 1 service

Figure 6.2-1 illustrates the basic architecture of a rooted-multipoint EC supporting EVP-Tree type 1 service. The ETY layer is terminated at the rooted UNI-N, and the multiplexed ETH frames are forwarded over single Ethernet flow points (ETH_FPs) to the dedicated server layer. The rooted UNI uses the VLAN tag for multiplexing at the demarcation point[2]. Multiplexed access based on the service multiplexing ETH UNI service attribute (per clause 8.1 of [ITU-T G.8011]) indicates that multiple service instances exist across a single Ethernet UNI demarcation. Since multiplexed access is the principal feature of EVP-Tree type 1 service ingress, EVP-Tree type 1 service is also referred to as multiplexed access service.

EVP-Tree type 1 service can be further classified into the following three types, depending on whether multiplexing occurs at the root, the leaves or both:

a) EVP-Tree type 1a service: Dedicated server layer; multiplexed root access (see Figure 6.2-1);

b) EVP-Tree type 1b service: Dedicated server layer; multiplexed leaf access (see Figure 6.2-2);

c) EVP-Tree type 1c service: Dedicated server layer; multiplexed root and leaf access (see Figure 6.2-3).

[2] Note that the choice of customer or provider VLAN tags depends on the agreement with the service provider.

A rooted-multipoint EC supporting EVP-Tree type 1a service is illustrated in Figure 6.2-1 below:

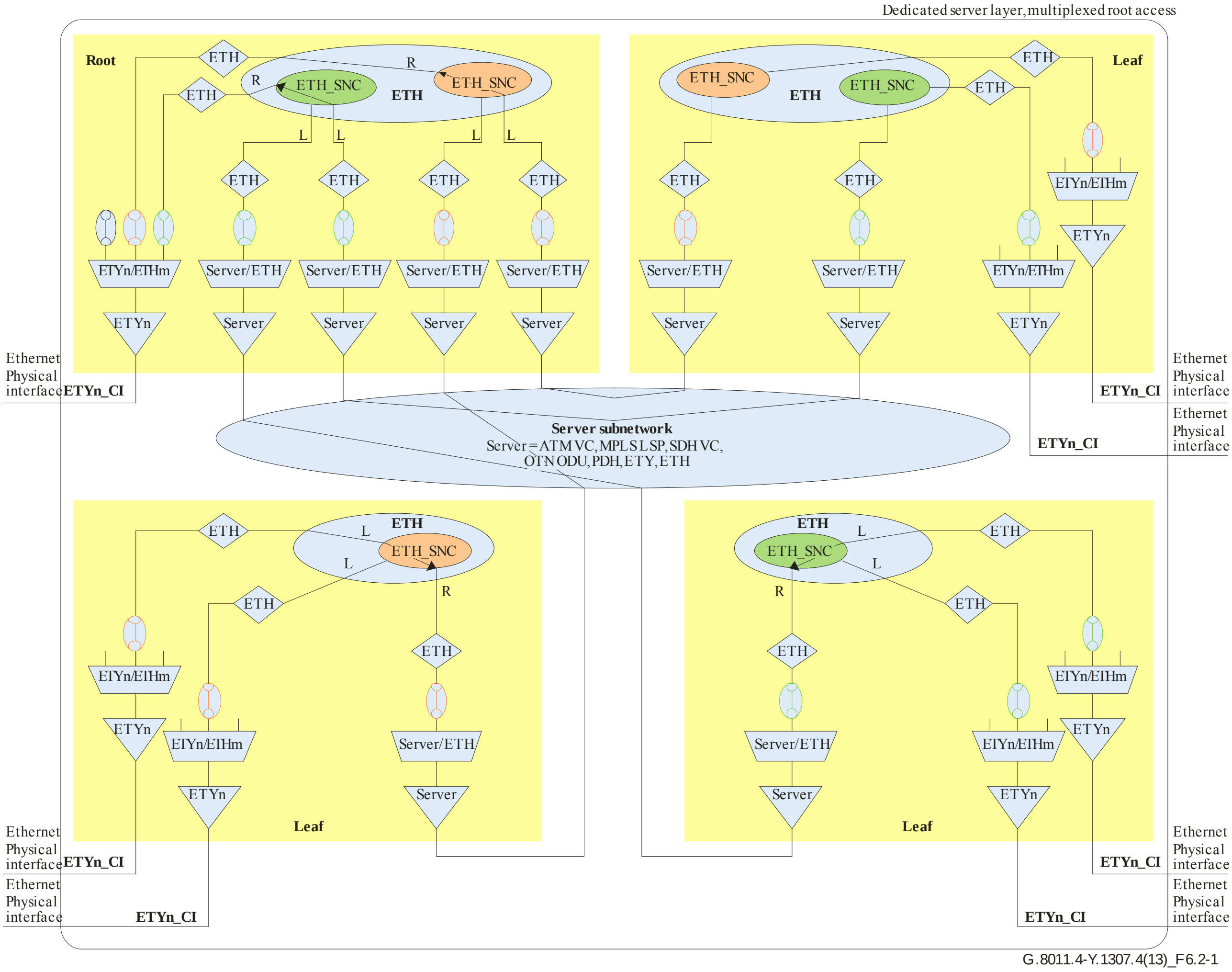

Figure 6.2-1 – A rooted-multipoint EC supporting EVP-Tree type 1a[3] service

3 EVP-Tree service can use asymmetric flow port grouping or VLANs. Only asymmetric flow port grouping is illustrated.

A rooted-multipoint EC supporting EVP-Tree type 1b service is illustrated in Figure 6.2-2 below:

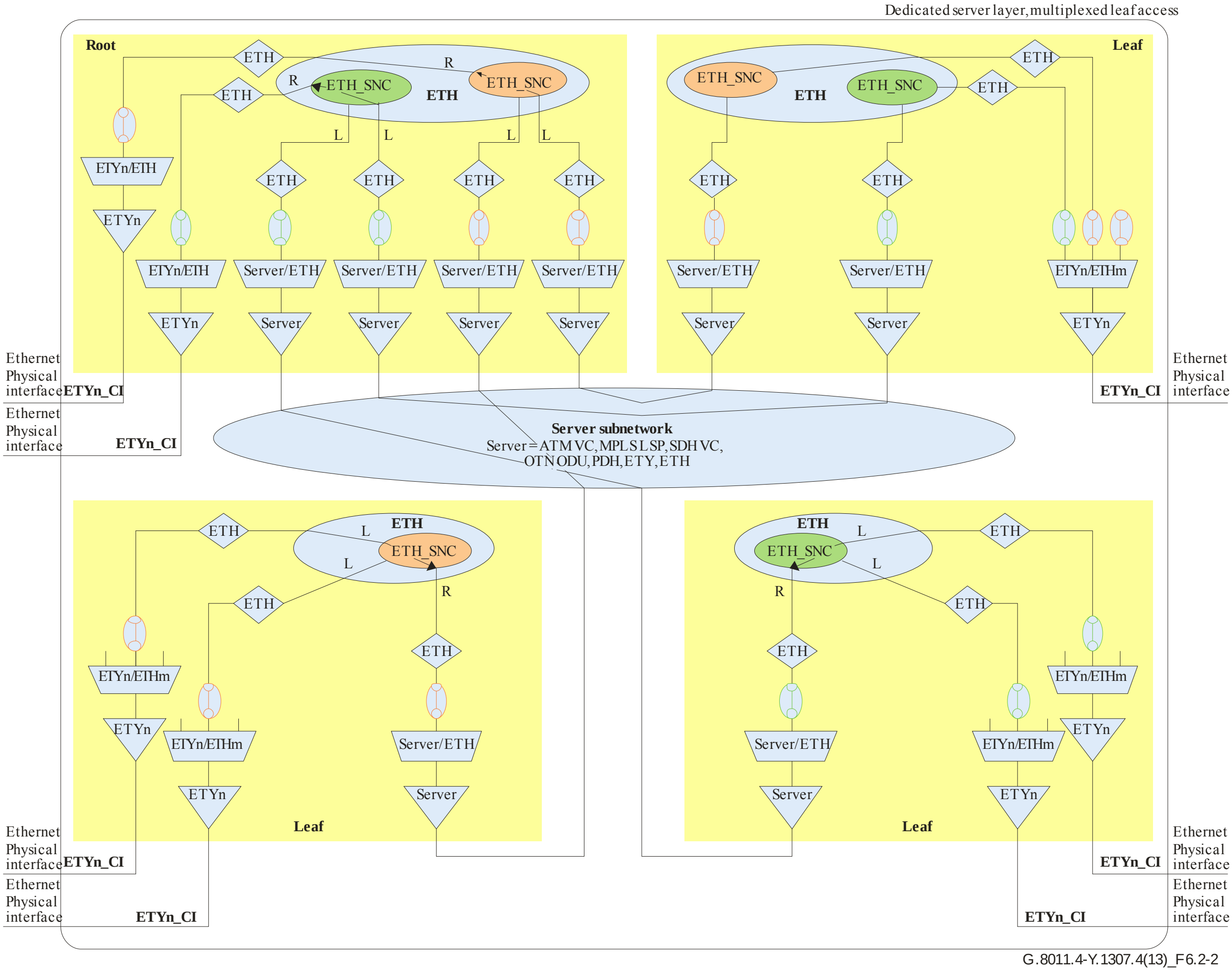

Figure 6.2-2 – A rooted-multipoint EC supporting EVP-Tree type 1b service

A rooted-multipoint EC supporting EVP-Tree type 1c service is illustrated in Figure 6.2-3 below:

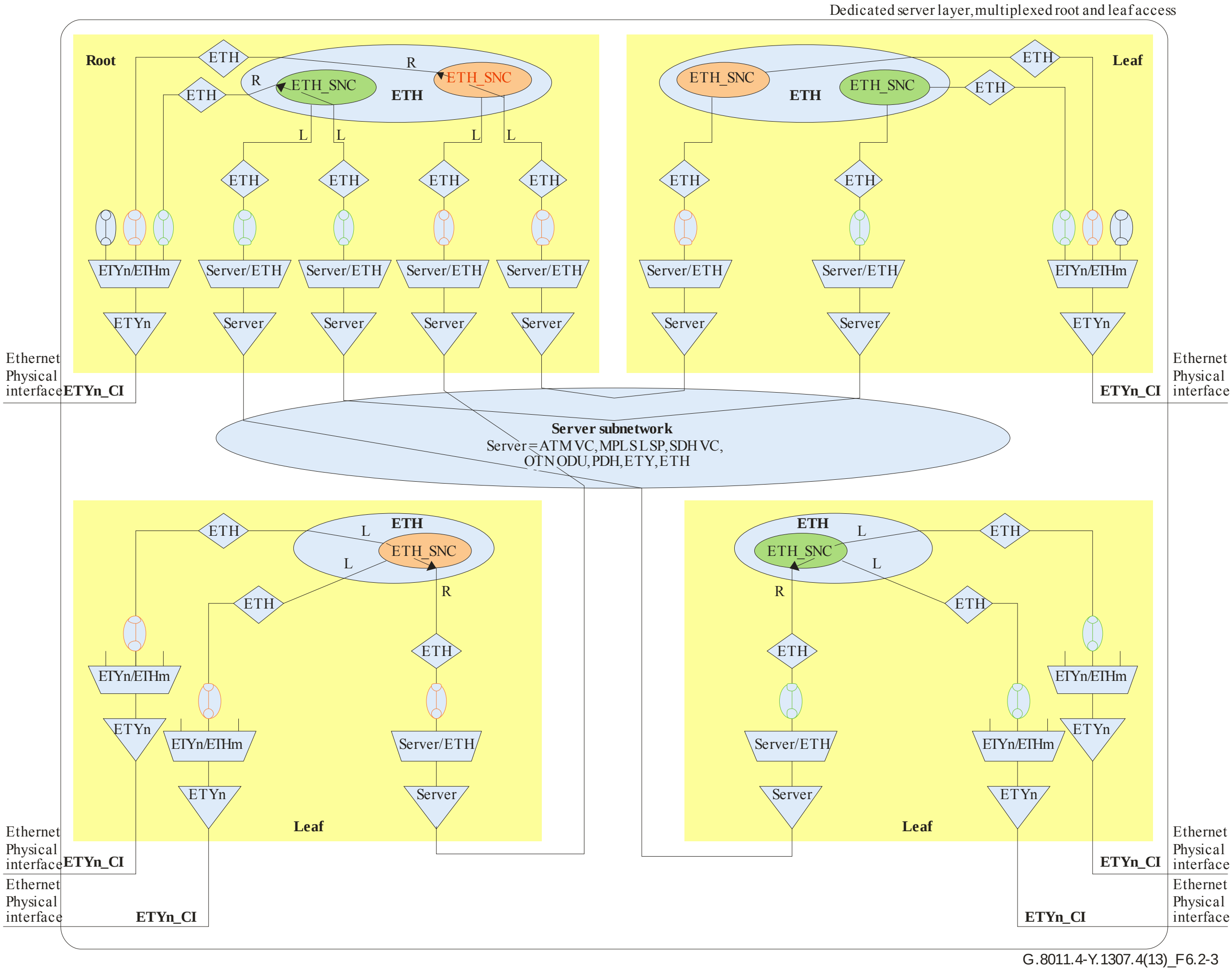

Figure 6.2-3 – A rooted-multipoint EC supporting EVP-Tree type 1c service

6.2.2 EVP-Tree type 2 service

Figure 6.2-4 illustrates the basic architecture of a rooted-multipoint EC supporting EVP-Tree type 2 service. Each service instance has dedicated access to the rooted UNI-N. The ETY layer is terminated at the rooted UNI-N and the ETH frames are forwarded over ETH_FPs to the shared server layer. A service provider VLAN (S-VLAN) tag is associated with each frame in the server layer (i.e., logical separation) to support multiplexing.

A rooted-multipoint EC supporting EVP-Tree type 2 service is illustrated in Figure 6.2-4 below:

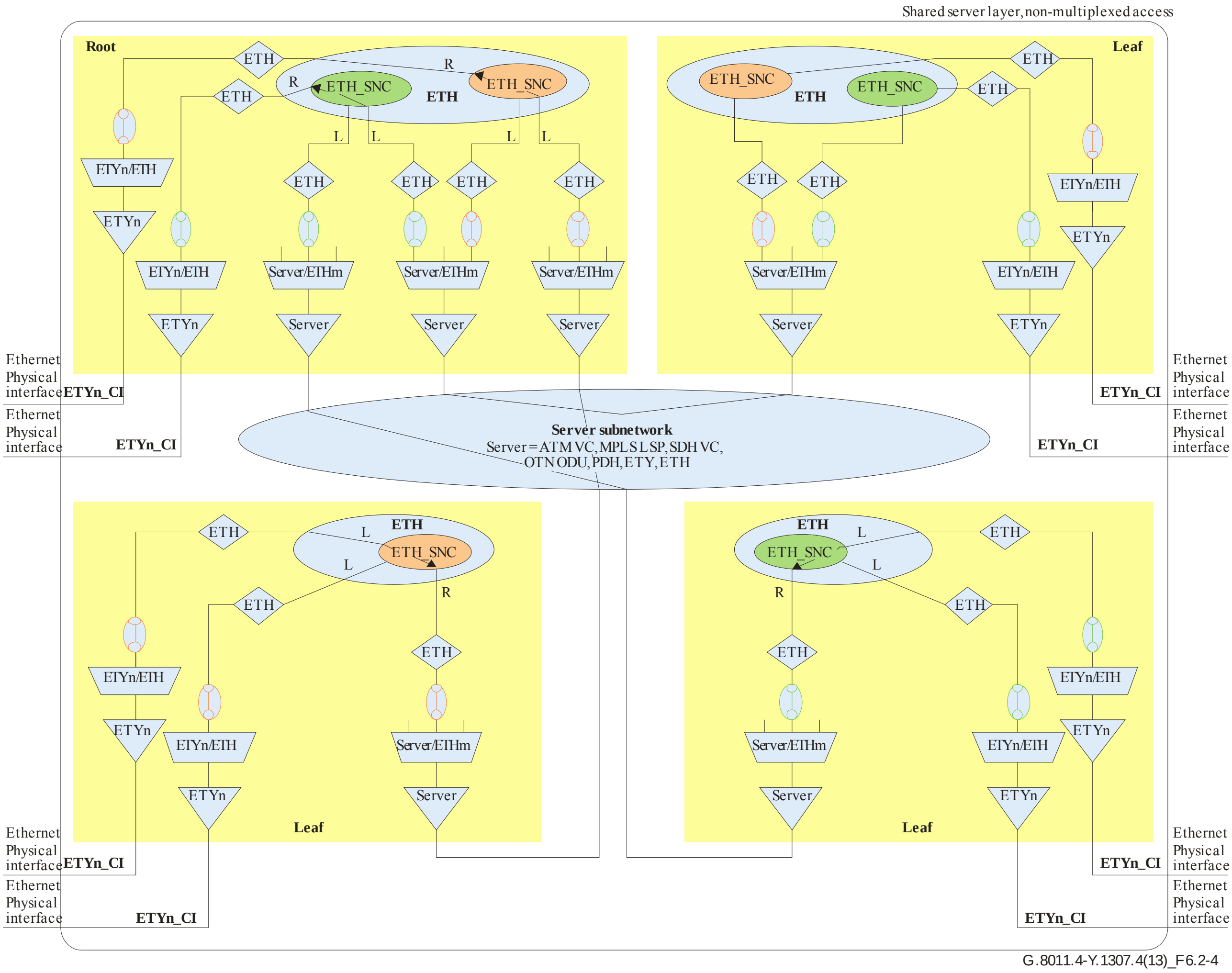

Figure 6.2-4 – A rooted-multipoint EC supporting EVP-Tree type 2 service

6.2.3 EVP-Tree type 3 service

Figure 6.2-5 illustrates the basic architecture of a rooted-multipoint EC supporting EVP-Tree type 3 service. Each service instance is separated either logically or spatially at the rooted UNI-N. The ETY layer is terminated at the rooted UNI-N and the multiplexed ETH frames (i.e., logical separation) are forwarded over ETH_FPs to the shared server layer. In the EVP-Tree type 3 service, a tag is used for multiplexing in the access network and in the server layer subnetwork. The access network may use VLAN tags and the server layer subnetwork may use VLAN tags (S-VLAN) or MPLS labels.

EVP-Tree type 3 service can be further classified into the following three types, depending on whether multiplexing occurs at the root, the leaves or both (see Table 6.2-2):

a) EVP-Tree type 3a service: Shared server layer; multiplexed root access (see Figure 6.2-5);

b) EVP-Tree type 3b service: Shared server layer; multiplexed leaf access (see Figure 6.2-6);

c) EVP-Tree type 3c service: Shared server layer; multiplexed root and leaf access (see Figure 6.2-7).

A rooted-multipoint EC supporting EVP-Tree type 3a service is illustrated in Figure 6.2-5 below:

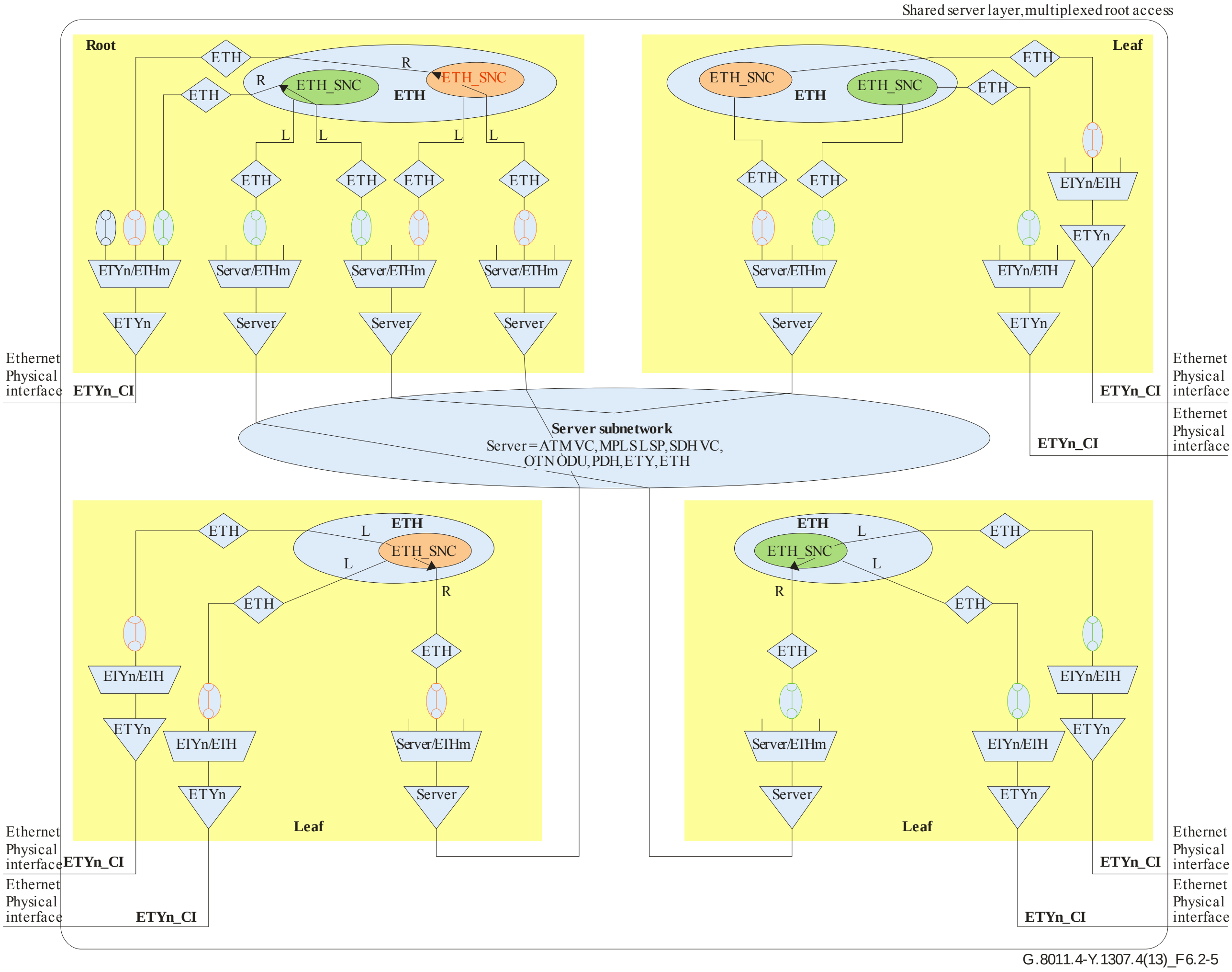

Figure 6.2-5 – A rooted-multipoint EC supporting EVP-Tree type 3a service

A rooted-multipoint EC supporting EVP-Tree type 3b service is illustrated in Figure 6.2-6 below:

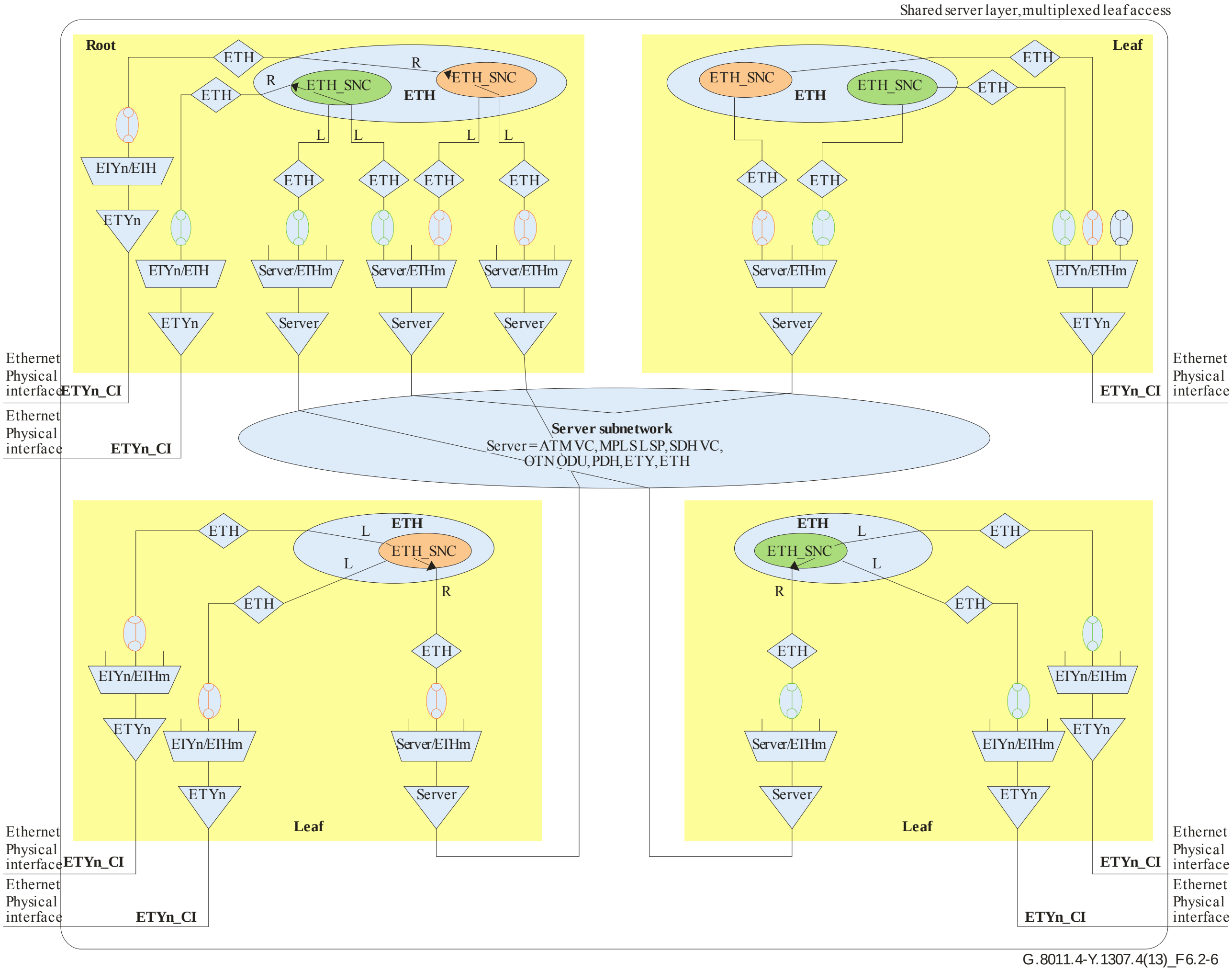

Figure 6.2-6 – A rooted-multipoint EC supporting EVP-Tree type 3b service

A rooted-multipoint EC supporting EVP-Tree type 3c service is illustrated in Figure 6.2-7 below:

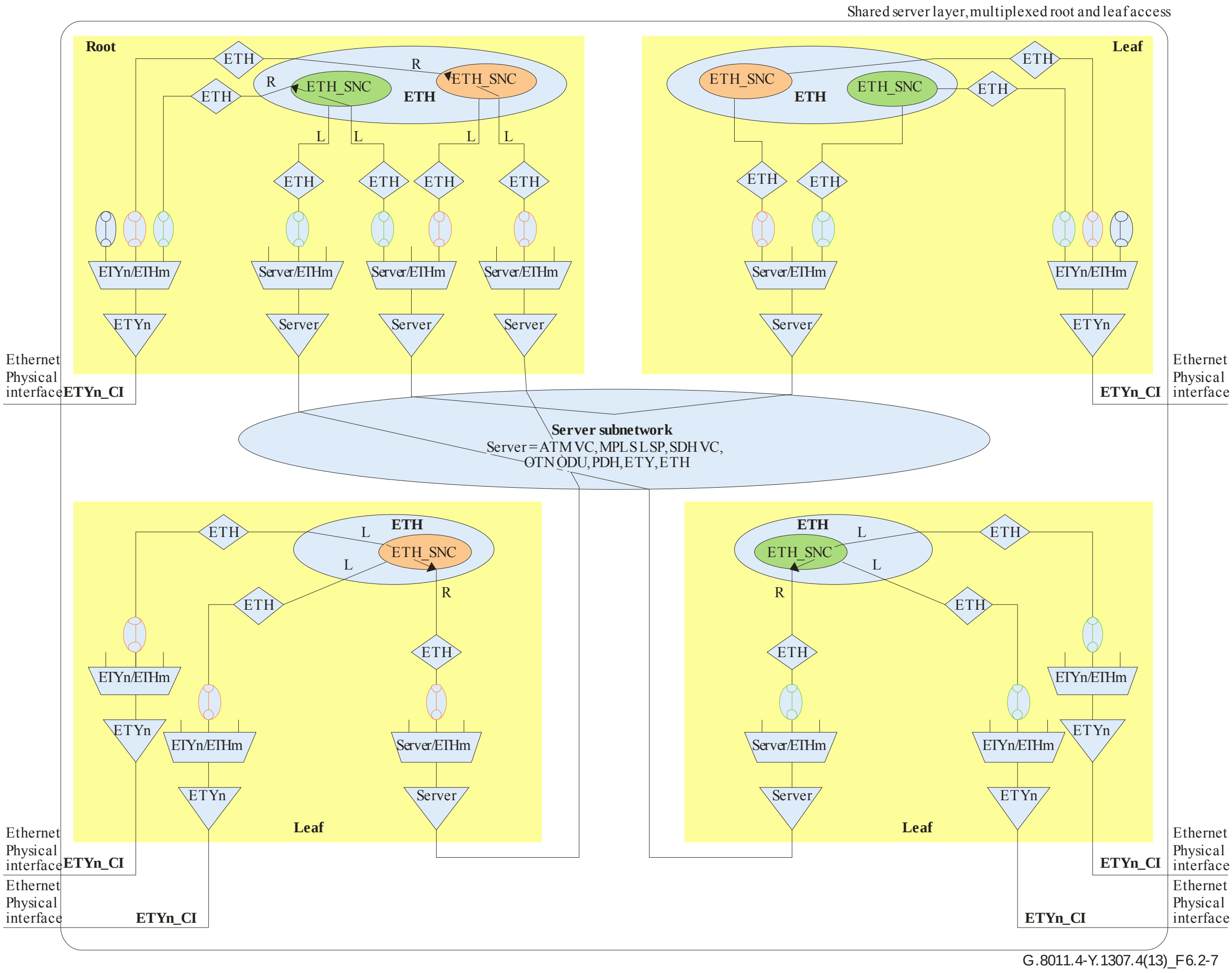

Figure 6.2-7 – A rooted-multipoint EC supporting EVP-Tree type 3c service

7 EVC and EC service attributes for the EVP-Tree service

7.1 EVC service attributes

This clause describes EVC service attributes for the EVP-Tree service. The base set of EVC service attributes is the same as the EVC service attributes defined in Table 29 of [MEF 6.1]. Table 7.1-1 summarizes the EVC service attributes, parameters, and values for the EVP-Tree service.

Table 7.1-1 – EVC service attributes, parameters and values for the EVP-Tree service

EVC service attribute	Service attribute parameters and values	[MEF 10.2] reference
EVC type	**MUST** be Rooted-Multipoint	6.1
EVC ID	An arbitrary string, unique across the MEN, for the EVC supporting the service instance	6.2

Table 7.1-1 – EVC service attributes, parameters and values for the EVP-Tree service

EVC service attribute	Service attribute parameters and values	[MEF 10.2] reference
UNI list	**MUST** list the UNIs associated with the EVC. The UNI Type for at least 1 UNI **MUST** be Root. All UNIs that are not UNI Type Root **MUST** be UNI Type Leaf. An EVP-Tree service may have no leaves, for example, during times when leaf UNIs are being added or removed	6.3
Maximum number of UNIs	Integer. **MUST** be ≥ 2	6.4
EVC MTU size	**MUST** be 1522 ≤ Integer ≤ 2000	6.10
CE-VLAN ID preservation	**MUST** be either Yes or No	6.6.1
CE-VLAN CoS preservation	**MUST** be either Yes or No	6.6.2
Unicast service frame delivery	Deliver Unconditionally or Deliver Conditionally. If Delivered Conditionally, **MUST** specify the delivery criteria	6.5.2, 6.5.1.1
Multicast service frame delivery	Deliver Unconditionally or Deliver Conditionally. If Delivered Conditionally, **MUST** specify the delivery criteria	6.5.2, 6.5.1.2
Broadcast service frame delivery	Deliver Unconditionally or Deliver Conditionally. If Delivered Conditionally, **MUST** specify the delivery criteria	6.5.2, 6.5.1.3
Layer 2 control protocols processing (only applies for L2CP frame passed to the EVC)	**MUST** specify in accordance with section 8.1 (Table C) of [MEF 6.1.1] and section 8.1.6 of [MEF 6.1.1]	6.5.2, 6.7
EVC performance	At least one CoS is **REQUIRED**. **MUST** specify CoS ID, per section 6.8 of [MEF 10.2]. For each CoS, **MUST** list values for each of the following attributes {Frame Delay, Frame Delay Variation, Frame Loss Ratio, and Availability}, where Not Specified (N/S) is an acceptable value, for one or more sets of ordered UNI pairs where each ordered pair contains at least one Root UNI. Each ordered UNI pair containing at least one Root UNI in the EVC **MUST** be mapped to at least one CoS	6.8, 6.9

NOTE – The upper bound of 2000 bytes for EVC MTU size is not indicated in [MEF 10.2]. It only applies for transport server layers that impose this restriction (e.g., 802.3 PHYs per [IEEE 802.3]).

7.2 EC service attributes

This clause describes EC service attributes for the EVP-Tree service. Table 7.2-1 summarizes the EC service attributes, parameters, and values for the EVP-Tree service. These attributes are in addition to those defined in [MEF 6.1] and summarized in clause 7.1.

Table 7.2-1 – EC service attributes, parameters and values for the EVP-Tree service

EC service attribute	Service attribute parameters and values	Clause
Link type	Dedicated, shared	7.2.1
Survivability	None, Ethernet protection or server specific	7.2.2

7.2.1 Link type

The server link is referred to as dedicated for EVP-Tree type 1 service, as defined in clause 7.2.1.1 of [ITU-T G.8011]. The server link is referred to as shared for EVP-Tree types 2 and 3 services, as defined in clause 7.2.1.2 of [ITU-T G.8011].

7.2.2 Survivability

The transport network (server layer) can provide survivability for the EVP-Tree service. The survivability options for the ETH link are, for example:

a) No protection;

b) Protection by means of SDH or OTH or ATM or MPLS or ETH protection schemes;

c) Restoration by means of SDH or OTH or ATM or MPLS or ETH restoration schemes.

The applicability of survivability by means of linear protection switching and ring protection switching based on APS can also be an option.

Other options include:

- [IEEE 802.1AX] – Link aggregation.
- [IEEE 802.1Q] (RSTP, MSTP, GVRP, MVRP) – Spanning tree restoration.
- [IEEE 802.1aq] – Shortest path bridging.

When a failure occurs, the entire tree can be switched to the backup (protection) tree, or only the broken link between the leaf and root is switched to the backup (protection) link. An illustration of this is given in Appendix II.

8 UNI service attributes for the EVP-Tree service

This clause describes UNI service attributes that characterize a particular instance of an EVP-Tree service at the demarcation of the UNI. The base set of UNI service attributes is the same as the UNI service attributes defined in [MEF 6.1] Table 27 and the EVC per UNI service attributes defined in [MEF 6.1] Table 28. They are summarized in Table 8-1 (with ITU-specific information provided as applicable).

A UNI can have a number of characteristics affecting how the CE sees the EVP-Tree service. One of the key aspects of an EVP-Tree service description is the allowable mix of UNIs with different characteristics in an EVC. For example, a specific (simple) service might require all UNIs to have the same speed at the physical layer. A more sophisticated service may allow a wide variety of speeds.

Table 8-1 – UNI service attributes and parameters for the EVP-Tree service

Layer	UNI service attribute	Service attribute parameters and values	[MEF 10.2] reference
ETH	UNI identifier	Arbitrary text string to identify the UNI	7.1
	MAC layer	[IEEE 802.3]	7.3
	UNI MTU size	**MUST** be 2000 ≥ Integer ≥ 1522	7.4
	Service multiplexing	**SHOULD** be supported at one or more UNIs. EVP-Tree type 1 and 3 service: **SHOULD** be supported. EVP-Tree type 2 service: **MUST** be No	7.5
	UNI EVC ID	A string formed by the concatenation of the UNI ID and the EVC ID	7.6.2

Table 8-1 – UNI service attributes and parameters for the EVP-Tree service

Layer	UNI service attribute	Service attribute parameters and values	[MEF 10.2] reference
	CE-VLAN ID for untagged and priority tagged service frames	**MUST** specify CE-VLAN ID for untagged and priority tagged Service Frames in the range of 1-4094	7.6.1
	CE-VLAN ID/EVC map	**MUST** specify mapping table of CE-VLAN IDs to the EVC ID	7.7
	Maximum number of EVCs	**MUST** be ≥ 1	7.8
	Bundling	Yes or No. If Yes, then CE-VLAN ID Preservation **MUST** be Yes	7.9
	All to one bundling	**MUST** be No	7.10
	Ingress bandwidth profile per UNI	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of ingress bandwidth profile	7.11.2.1, 7.11.1
ETH	Ingress bandwidth profile per EVC	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of ingress bandwidth profile	7.11.2.2, 7.11.1
	Ingress bandwidth profile per CoS identifier	**OPTIONAL**. If supported, **MUST** specify CoS ID per section 6.8 of [MEF 10.2], and **MUST** specify <CIR, CBS, EIR, EBS, CM, CF> for each CoS. **MUST NOT** be combined with any other type of ingress bandwidth profile	7.11.2.3, 7.11.1
	Egress bandwidth profile per UNI	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of egress bandwidth profile	7.11.3.1, 7.11.1
	Egress bandwidth profile per EVC	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of egress bandwidth profile	7.11.3.2, 7.11.1
	Egress bandwidth profile per CoS identifier	**OPTIONAL**. If supported, **MUST** specify CoS ID per section 6.8 of [MEF 10.2], and **MUST** specify <CIR, CBS, EIR, EBS, CM, CF> for each CoS. **MUST NOT** be combined with any other type of egress bandwidth profile	7.11.3.3, 7.11.1
	Layer 2 control protocols processing	A list of Layer 2 Control Protocols with each being labelled with one of Discard, Peer, Pass to EVC, Peer and Pass to EVC. **MUST** specify in accordance with [MEF 6.1.1] sections 8.1, 8.1.6 and 8.2	7.13
ETY	Physical medium	A standard Ethernet PHY	7.2
	Speed	10 Mbit/s, 100 Mbit/s, 10/100 Mbit/s auto-negotiation, 10/100/1000 Mbit/s auto-negotiation, 1 Gbit/s, or 10 Gbit/s	7.2
	Mode	**MUST** be Full Duplex	7.2

NOTE – The upper bound of 2000 bytes for UNI MTU size is not indicated in [MEF 10.2]. It only applies for transport server layers that impose this restriction (e.g., 802.3 PHYs per [IEEE 802.3]).

9 NNI service attributes for the EVP-Tree service

9.1 INNI service attributes

As it is internal to a network operator's network, this Recommendation does not specify INNI service attributes. However, an operator may specify service attributes to characterize a particular instance of an EVP-Tree service at the demarcation line of the Internal NNI noted in Figure 6-2 of [ITU-T G.8011]. There is an INNI defined at each of the ETH and server layers. These are described in [ITU-T G.8012] and [ITU-T G.8012.1].

9.2 ENNI service attributes

This clause describes ENNI service attributes that characterize a particular instance of an EVP-Tree service at the demarcation line of the External NNI noted in Figure 6-3 of [ITU-T G.8011]. The base set of ENNI service attributes is the same as the ENNI service attributes defined in Table 2 of [MEF 26.1]. They are summarized in Table 9.2-1.

Table 9.2-1 – ENNI service attributes for the EVP-Tree service

ENNI service attribute	Service attribute parameters and values	[MEF 26.1] reference
Operator ENNI identifier	A string that is unique across the Operator MEN	7.1.1
Physical layer	One of the PHYs listed in [R5] of [MEF 26.1]	7.1.2
Frame format	Frame formats as specified in section 7.1.3 of [MEF 26.1]	7.1.3
Number of links	An integer with value 1 or 2	7.1.4
Protection mechanism	Link Aggregation, none, or other	7.1.5
ENNI maximum transmission unit size	An integer number of bytes greater than or equal to 1526	7.1.6
End-point map	A table with rows of the form <S-VLAN ID value, End Point Identifier, End Point Type>	7.1.7
Maximum number of OVCs	An integer greater than or equal to 1	7.1.8
Maximum number of OVC end-points per OVC	An integer greater than or equal to 1	7.1.9

10 Connectivity monitoring for the EVP-Tree service

While EVP-Tree services must be supported by rooted-multipoint Ethernet (VLAN) connections that include ETH_C functions, server layer OAM (used in inherent monitoring) is unable to determine the status of those rooted-multipoint Ethernet connections. Such status can only be determined by means of Ethernet OAM (proactive or on-demand).

Status monitoring of rooted-multipoint Ethernet connections requires the use of Ethernet OAM specified in [ITU-T G.8013] and ETH MEP and ETH MIP functions specified in [ITU-T G.8021]. ETH MEP and ETH MIP functions and their ownership (customer, service provider, network operator) are illustrated in Figure 10-1.

Figure 10-1 provides the typical OAM configurations on UNI-N and intra domain NNI ports for EVP-Tree services supported by a single network operator.

a) ETH MIP functions on the UNI-N ports which are accessible from ETH MEP functions located in the customer network;

b) ETH MEP functions on the UNI-N ports which are accessible by the service provider (which is the network operator); and

c) ETH MIP functions on the intra domain NNI ports which are accessible from the service provider ETH MEP functions.

The service provider ETH MEP functions are responsible for UNI-N-to-UNI-N connectivity monitoring.

The ETH MIP functions on the UNI-N ports are used to help locating connectivity faults observed by the customer, which are not observed by the network. The ETH MIP functions on the intra domain NNI ports are used to help locating connectivity faults inside the network.

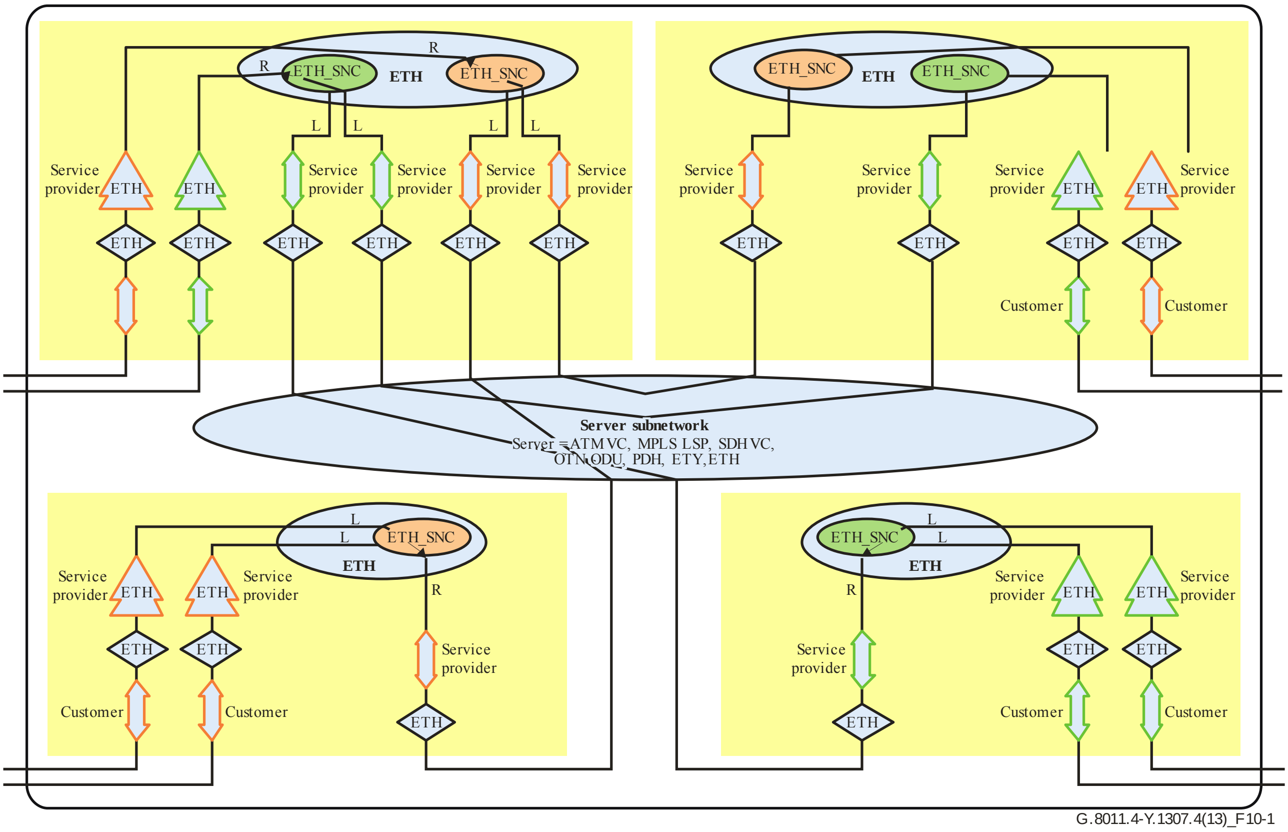

Figure 10-1 – Basic ETH MEP and MIP functions for all EVP-Tree service types

Additional specifications on the use of CFM as service OAM for fault management are defined in [MEF 30] and for performance monitoring are defined in [MEF 35].

Service OAM fault management [MEF 30] and service OAM performance monitoring [MEF 35] are used to implement the "EVC performance" EVC attribute.

Annex A

EP-Tree service – Ethernet private tree service

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

A.1 EP-Tree service

An EP-Tree service is an Ethernet service based upon a rooted-multipoint EVC as described in terms of "an Ethernet Tree Service type" in section 6.3 of [MEF 6.1]. Figure A.1 illustrates the basic architecture of the EP-Tree service. Each service instance has dedicated access to the rooted UNI-N and to leaf UNI-N. The ETY layer is terminated at the rooted UNI-N and the ETH frames are forwarded over single ETH_FPs to the dedicated server layer. A S-VLAN tag is associated with each frame in the server layer (i.e., logical separation).

EP-Tree service is illustrated in Figure A.1:

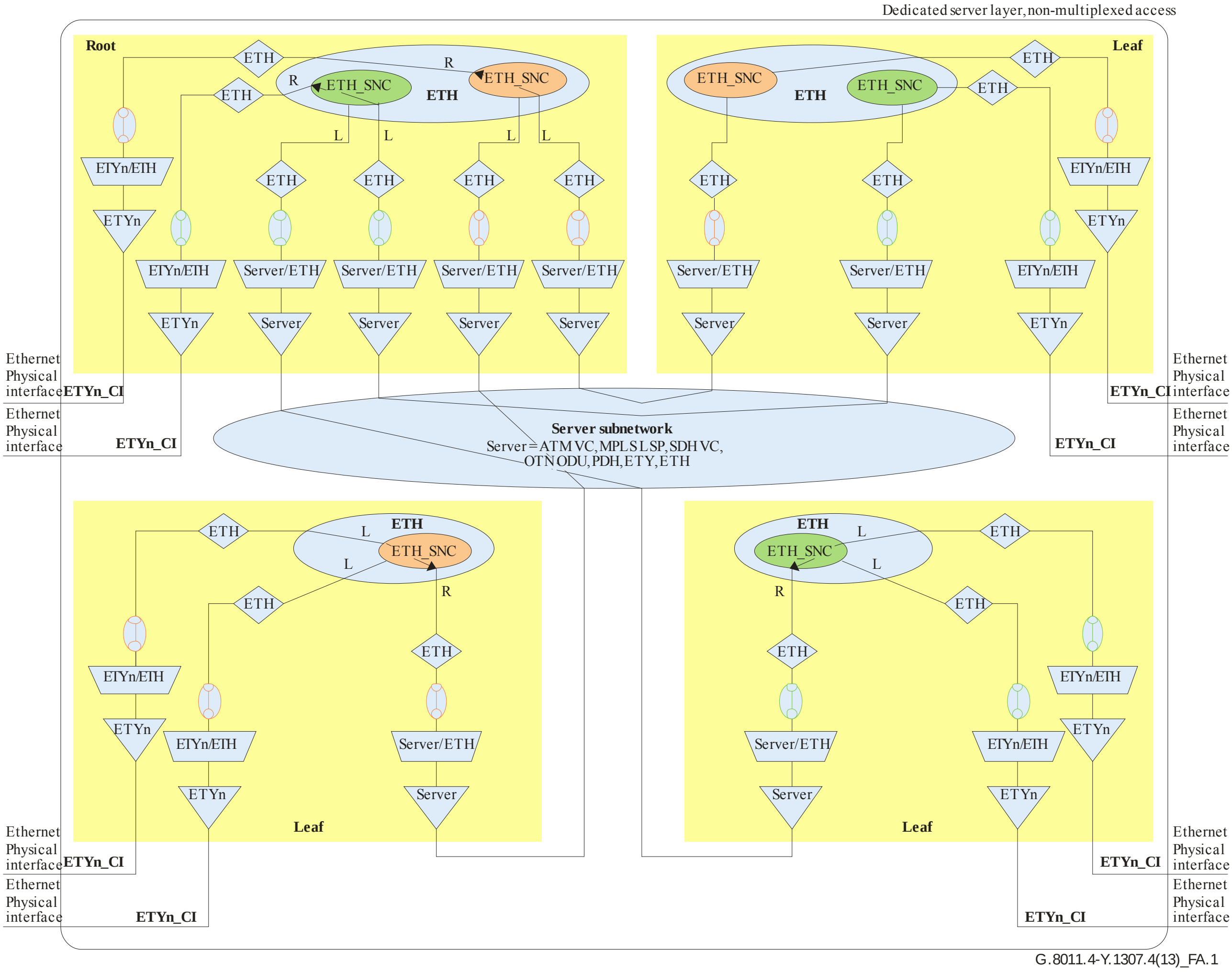

Figure A.1 – EP-Tree service

A.2 EVC and EC service attributes for the EP-Tree service

A.2.1 EVC service attributes

The base set of EVC service attributes for the EP-Tree service is the same as the EVC service attributes defined in Table 26 of [MEF 6.1]. Table A.1 summarizes the EVC service attributes, parameters and values for the EP-Tree service.

Table A.1 – EVC service attributes, parameters and values for the EVP-Tree service

EVC service attribute	Service attribute parameters and values	[MEF 10.2] reference
EVC type	**MUST** be Rooted-Multipoint	6.1
EVC ID	An arbitrary string, unique across the MEN, for the EVC supporting the service instance	6.2
UNI list	**MUST** list the UNIs associated with the EVC. The UNI Type for at least 1 UNI **MUST** be Root. All UNIs that are not UNI Type Root **MUST** be UNI Type Leaf. An EP-Tree service may have no leaves, for example, during times when leaf UNIs are being added or removed	6.3
Maximum number of UNIs	Integer. **MUST** be ≥ 2	6.4
EVC MTU size	**MUST** be 1522 ≤ Integer ≤ 2000	6.10
CE-VLAN ID preservation	**MUST** be Yes	6.6.1
CE-VLAN CoS preservation	**MUST** be Yes	6.6.2
Unicast service frame delivery	Deliver Unconditionally or Deliver Conditionally. If Delivered Conditionally, **MUST** specify the delivery criteria	6.5.2, 6.5.1.1
Multicast service frame delivery	Deliver Unconditionally or Deliver Conditionally. If Delivered Conditionally, **MUST** specify the delivery criteria	6.5.2, 6.5.1.2
Broadcast service frame delivery	Deliver Unconditionally or Deliver Conditionally. If Delivered Conditionally, **MUST** specify the delivery criteria	6.5.2, 6.5.1.3
Layer 2 control protocols processing (only applies for L2CP frame passed to the EVC)	**MUST** specify in accordance with section 8.1 (Table B) of [MEF 6.1.1] and section 8.1.5 of [MEF 6.1.1]	6.5.2, 6.7
EVC performance	At least one CoS is **REQUIRED**. **MUST** specify CoS ID, per section 6.8 of [MEF 10.2]. For each CoS, **MUST** list values for each of the following attributes {Frame Delay, Frame Delay Variation, Frame Loss Ratio, and Availability}, where Not Specified (N/S) is an acceptable value, for one or more sets of ordered UNI pairs where each ordered pair contains at least one Root UNI. Each ordered UNI pair containing at least one Root UNI in the EVC **MUST** be mapped to at least one CoS	6.8, 6.9

NOTE – The upper bound of 2000 bytes for EVC MTU size is not indicated in [MEF 10.2]. It only applies for transport server layers that impose this restriction (e.g., 802.3 PHYs per [IEEE 802.3]).

A.2.2 EC service attributes

This clause describes EC service attributes for the EP-Tree service. Table A.2 summarizes the EC service attributes, parameters and values for the EP-Tree service. These attributes are in addition to those defined in [MEF 6.1] and summarized in clause A.2.1.

Table A.2 – EC service attributes, parameters and values for the EVP-Tree service

EC service attribute	Service attribute parameters and values	Clause
Link type	Dedicated	A.2.2.1
Survivability	None, Ethernet protection or server specific	7.2.2

A.2.2.1 Link type

The server link is referred to as dedicated for EP-Tree service, as defined in clause 7.2.1.1 of [ITU-T G.8011].

A.2.2.2 Survivability

The transport network (service layer) can provide survivability for the EP-Tree service. This is as described for the EVP-Tree service in clause 7.2.2.

A.3 UNI service attributes for the EP-Tree service

This clause describes service UNI service attributes that characterize a particular instance of an EP-Tree service at the demarcation of the UNI. The base set of UNI service attributes is the same as the UNI service attributes defined in Table 24 of [MEF 6.1] and the EVC per UNI service attributes defined in Table 25 of [MEF 6.1]. They are summarized in Table A.3 (with ITU-specific information provided as applicable).

A UNI can have a number of characteristics affecting how the CE sees the EP-Tree service. One of the key aspects of an EP-Tree service description is the allowable mix of UNIs with different characteristics in an EVC. For example, a specific (simple) service might require all UNIs to have the same speed at the physical layer. A more sophisticated service may allow a wide variety of speeds.

Table A.3 – UNI service attributes and parameters for the EP-Tree service

Layer	UNI service attribute	Service attribute parameters and values	[MEF 10.2] reference
ETH	UNI identifier	Arbitrary text string to identify the UNI	7.1
	MAC layer	[IEEE 802.3]	7.3
	UNI MTU Size	**MUST** be 2000 ≥ Integer ≥ 1522	7.4
	Service multiplexing	**MUST** be No	7.5
	Bundling	**MUST** be No	7.9
	All to one bundling	**MUST** be Yes	7.10
	CE-VLAN ID for untagged and priority tagged service frames	All untagged and priority tagged Service Frames at the UNI **MUST** map to the same EVC as is used for all other Service Frames	7.6.1
	Maximum number of EVCs	**MUST** be 1	7.8
	Ingress bandwidth profile per UNI	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of ingress bandwidth profile	7.11.2.1, 7.11.1

Table A.3 – UNI service attributes and parameters for the EP-Tree service

Layer	UNI service attribute	Service attribute parameters and values	[MEF 10.2] reference
	Egress bandwidth profile per UNI	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of egress bandwidth profile	7.11.3.1, 7.11.1
	Layer 2 control protocols processing	**MUST** specify in accordance with [MEF 6.1.1] sections 8.1, 8.1.5 and 8.2	7.13
	UNI EVC ID	A string formed by the concatenation of the UNI ID and the EVC ID	7.6.2
	CE-VLAN ID/EVC map	All Service Frames at the UNI **MUST** map to the Rooted-Multipoint EVC	7.7
	Ingress bandwidth profile per EVC	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of ingress bandwidth profile	7.11.2.2, 7.11.1
	Ingress bandwidth profile per CoS identifier	**OPTIONAL**. If supported, **MUST** specify CoS ID per section 6.8 of [MEF 10.2], and **MUST** specify <CIR, CBS, EIR, EBS, CM, CF> for each CoS. **MUST NOT** be combined with any other type of ingress bandwidth profile	7.11.2.3, 7.11.1
	Egress bandwidth profile per EVC	**OPTIONAL**. If supported, **MUST** specify <CIR, CBS, EIR, EBS, CM, CF>. **MUST NOT** be combined with any other type of egress bandwidth profile	7.11.3.2, 7.11.1
	Egress bandwidth profile per CoS identifier	**OPTIONAL**. If supported, **MUST** specify CoS ID per section 6.8 of [MEF 10.2], and **MUST** specify <CIR, CBS, EIR, EBS, CM, CF> for each CoS. **MUST NOT** be combined with any other type of egress bandwidth profile	7.11.3.3, 7.11.1
ETY	Physical medium	A standard Ethernet PHY	7.2
	Speed	10 Mbit/s, 100 Mbit/s, 10/100 Mbit/s auto-negotiation, 10/100/1000 Mbit/s auto-negotiation, 1 Gbit/s, or 10 Gbit/s	7.2
	Mode	**MUST** be Full Duplex	7.2

NOTE – The upper bound of 2000 bytes for UNI MTU size is not indicated in [MEF 10.2]. It only applies for transport server layers that impose this restriction (e.g., 802.3 PHYs per [IEEE 802.3]).

A.4 NNI service attributes for the EP-Tree service

INNI and ENNI service attributes for the EP-Tree service are as described for the EVP-Tree service in clause 9.

A.5 Connectivity monitoring for the EP-Tree service

Connectivity monitoring for the EP-Tree service is as described for the EVP-Tree service in clause 10.

Appendix I

Examples of EVP-Tree services

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

This appendix presents some examples of EVP-Tree services.

I.1 Single root

Single root is the simplest EVP-Tree service example. It comprises one root and multiple leaves. The left part of Figure I.1 describes the abstract model of the single-root EVP-Tree service, while the right part describes the concrete model.

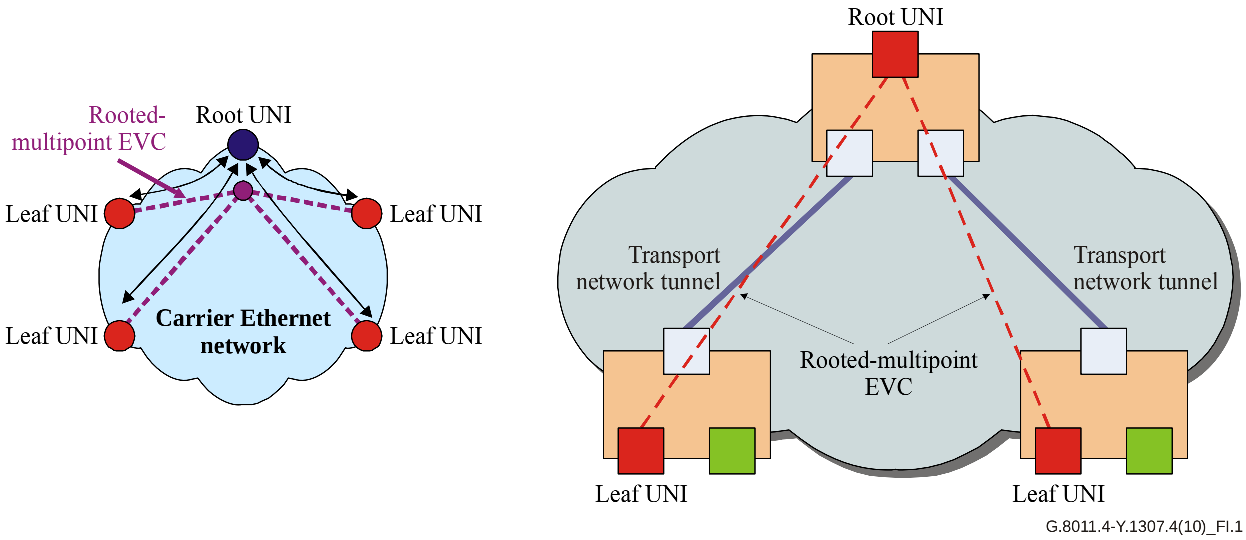

Figure I.1 – Single-root model

This example is easy for deployment, but if the root fails, the whole EVP-Tree service will collapse.

I.2 Redundant root

As Figure I.2 illustrates, the redundant root EVP-Tree service example has two roots and multiple leaves. Only one of the two roots should be active at any given time: the other root, which is redundant for the active root, should be standing by. To maintain this state, the two roots should exchange status messages and monitor the state of the other root. In case of a failure, the standby root can take over the failing root to ensure continuation of service.

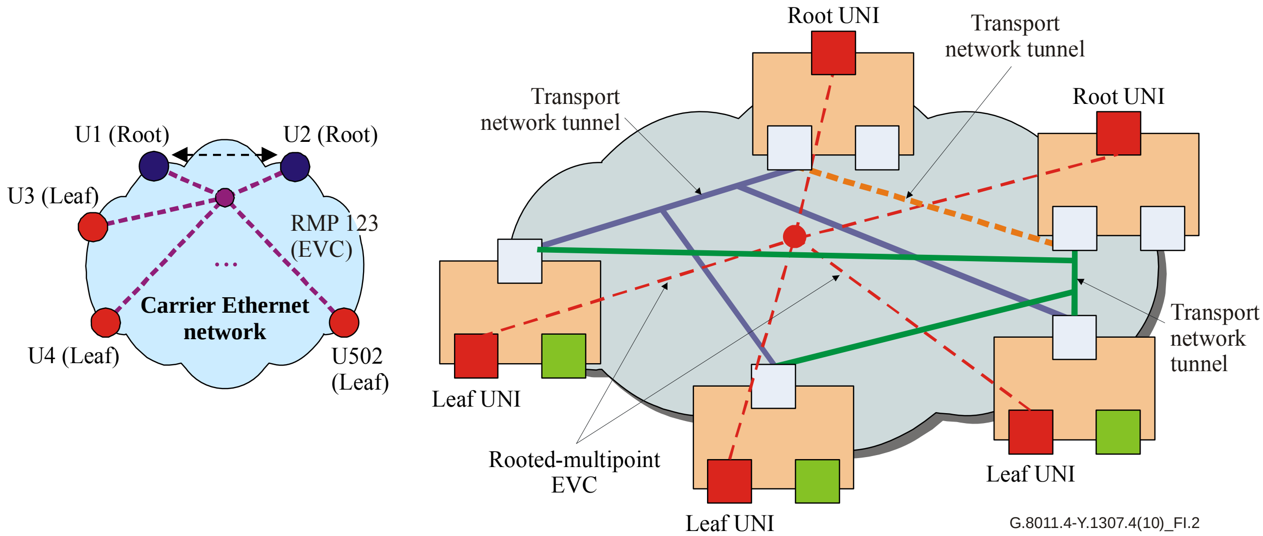

Figure I.2 – Redundant-root model

The configuration illustrated in this example provides reliable protection for the root node, which is important for applications.

I.3 Load-balance root

As Figure I.3 illustrates, the load-balance root EVP-Tree service example has multiple roots and multiple leaves. The multiple roots always work together for the same service, and service traffic is distributed among the roots.

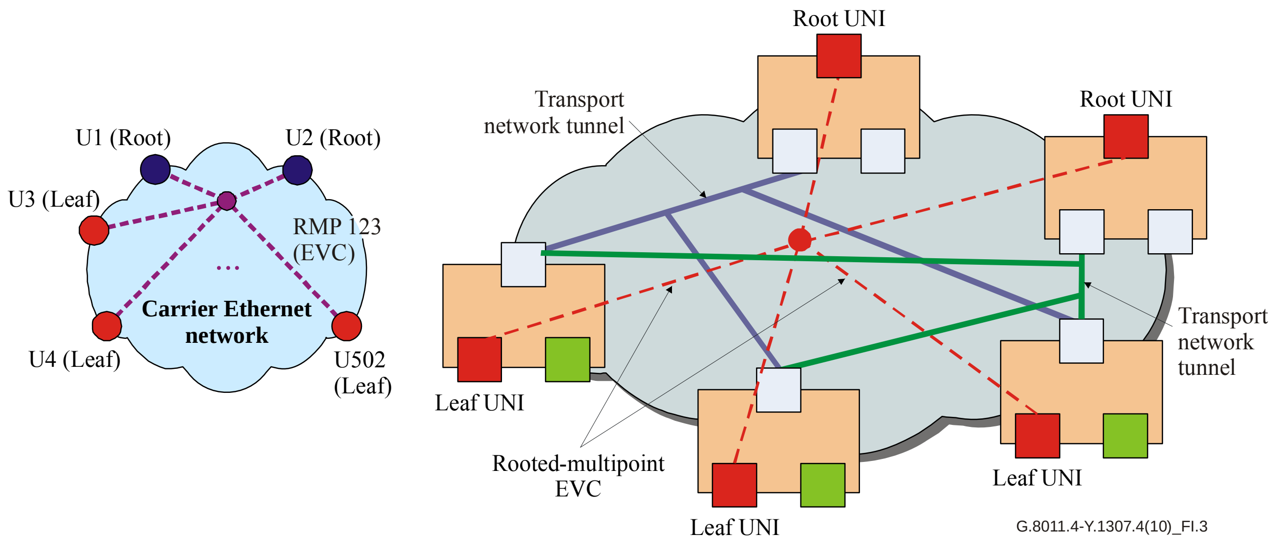

Figure I.3 – Load-balance root model

This example provides load balancing ability for the root node. It is applicable when all of the server access nodes are in heavy load and thus none can provide enough capacity to transport all of the service traffic. Actually, this model can be viewed as the combination of multiple EVP-Tree services.

I.4 Hierarchical branch

The hierarchical branch EVP-Tree service example has one or more branch NNIs. As Figure I.4 illustrates, it can be used to describe the case in which the Ethernet service spans multiple transport networks.

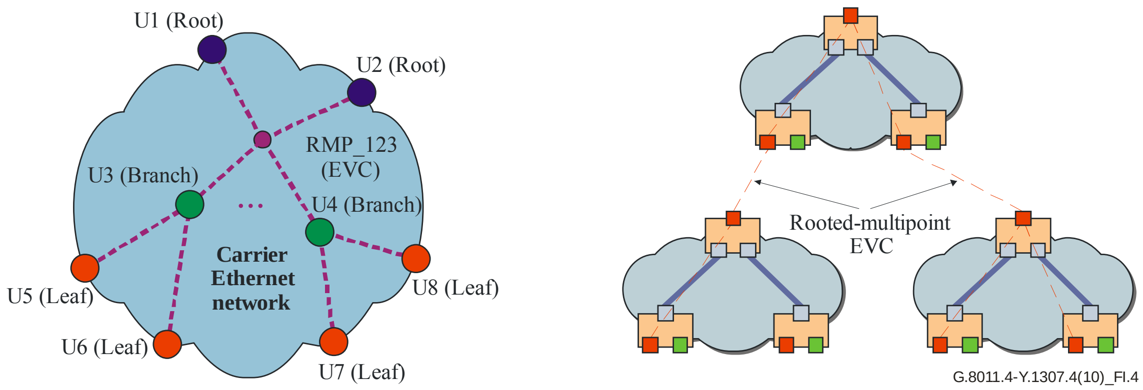

Figure I.4 – Hierarchical-branch model

Appendix II

Protection of EVP-Tree service

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

This appendix describes EVP-Tree service 1+1 and 1:1 protection switching.

II.1 1+1 protection switching architecture

The 1+1 multicast protection switching architecture is illustrated in Figure II.1. One protection tree is dedicated to one working tree. The working traffic is permanently bridged to the working and protection trees at the root node. The leaves receive traffic only by using the selective selector on the working tree.

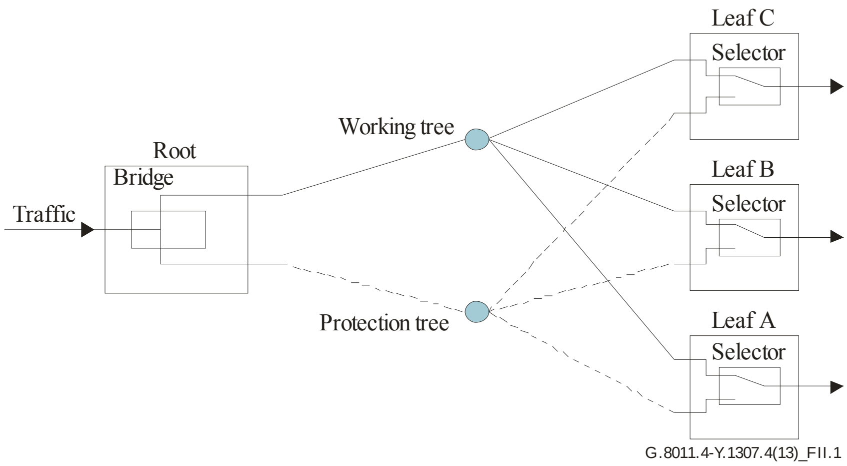

Figure II.1 – 1+1 protection switching architecture

If for example a defect occurs in the working tree and the traffic to leaf node C is affected, as illustrated in Figure II.2, the defect will be detected at node C. All the leaves can be switched to the protection tree by using a 2-phase APS protocol. The protocol is as follows:

a) Node C detects the defect and switches the selector to the protection tree after validating the priority.

b) The APS protocol from node C to the root requests a protection switch.

c) The root node sends APS protocol to all leaves for a protection switch.

d) After all other leaves validate the priority of the protection request, the selectors of these leaves are switched to the protection tree.

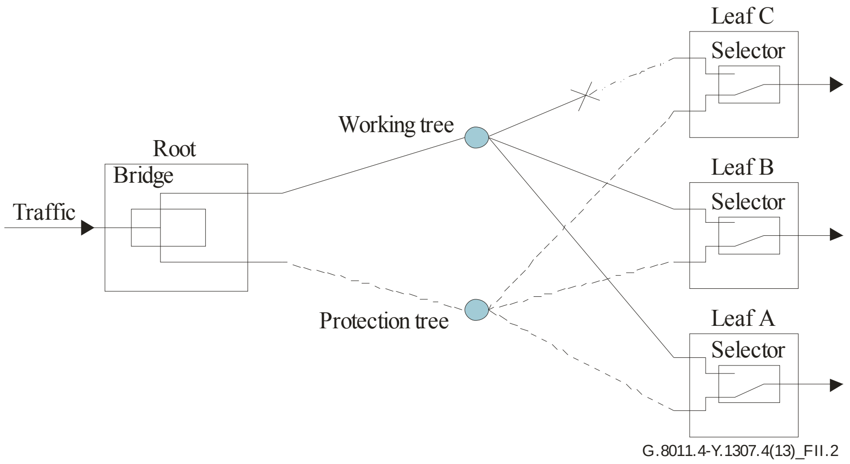

**Figure II.2 – 1+1 protection switching architecture –
All leaves switch to protection**

In the case in which only the affected leaf (e.g., only node C) is switched to the protection tree after protection switching, the other leaves will still work on the working tree. The APS protocol is not necessary. When node C detects the defect, it switches the selector to the protection tree directly after validating the priority. The scenario is illustrated in Figure II.3.

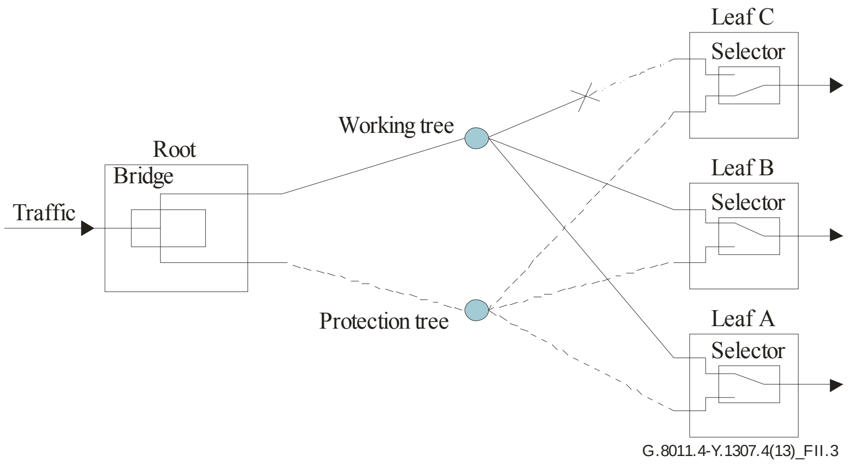

**Figure II.3 – 1+1 protection switching architecture –
Only the affected leaf switches to protection**

II.2 1:1 protection switching architecture

The 1:1 multicast protection switching architecture is illustrated in Figure II.4. One protection tree is dedicated to one working tree. The working traffic is normally only transmitted on the working tree. The leaves receive traffic only by using the selective selector on the working tree.

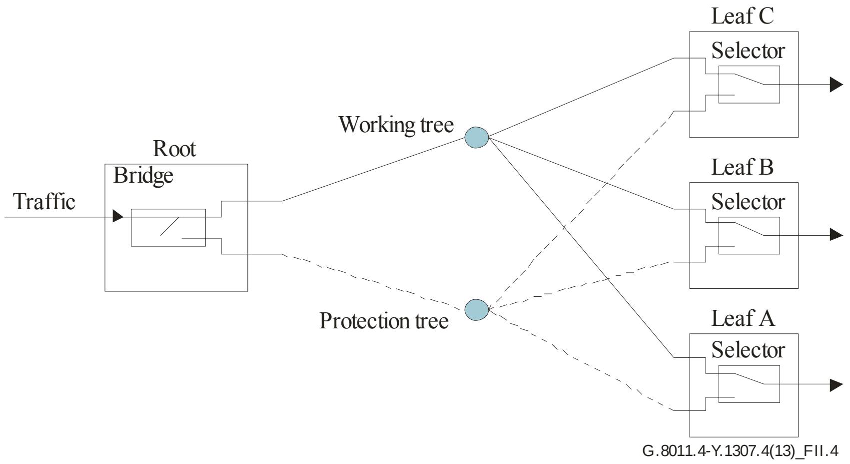

Figure II.4 – 1:1 protection switching architecture

If for example a defect occurs on the working tree and the traffic to node C is affected, as illustrated in Figure II.5, the defect will be detected at node C. All the leaves can be switched to the protection tree by using a 2-phase APS protocol. The protocol is as follows:

a) Node C detects the defect and switches the selector to the protection tree after validating the priority.

b) The APS protocol from node C to root requests a protection switch.

c) After the root node validates the priority of the protection request, it operates the bridge to the protection tree.

(NOTE – The working traffic will be bridged to both the working tree and the protection tree after the root operates the broadcast bridge).

d) The root sends APS protocol to all leaves for a protection switch.

e) After all other leaves validate the priority of the protection request, the selectors of these leaves are switched to the protection tree.

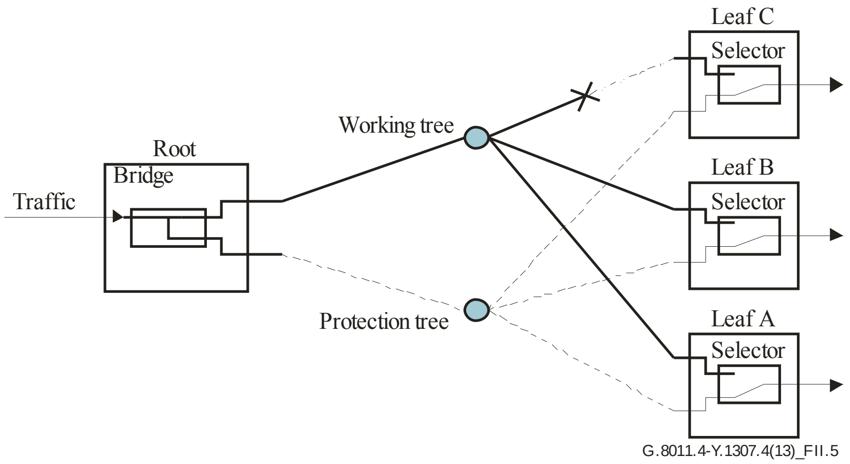

Figure II.5 – 1:1 protection switching architecture – All leaves switch to protection

In the case in which only the affected leaf (e.g., only node C) is switched to the protection tree after protection switching, the other leaves will still work on the working tree. A 1-phase APS protocol is used. The process of the APS protocol is similar to the one mentioned above, but steps d) and e) are not necessary. After the protection switching, the affected leaf receives the working traffic on the protection tree, and the other leaves receive the traffic on the working tree. The scenario is illustrated in Figure II.6.

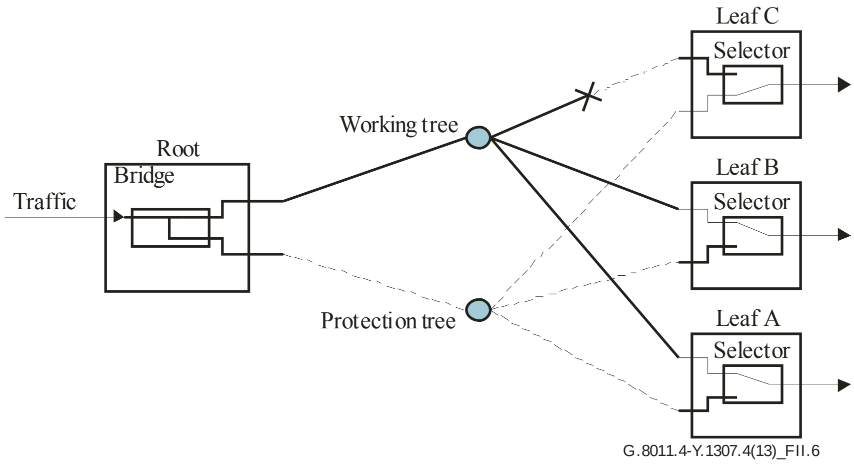

Figure II.6 – 1:1 protection switching architecture –
Only the affected leaf switches to protection

In the 1:1 protection switching architecture illustrated in Figure II.7, the root sends the working traffic only on the working tree or on the protection tree, and all leaves are permanently set to receive from both trees.

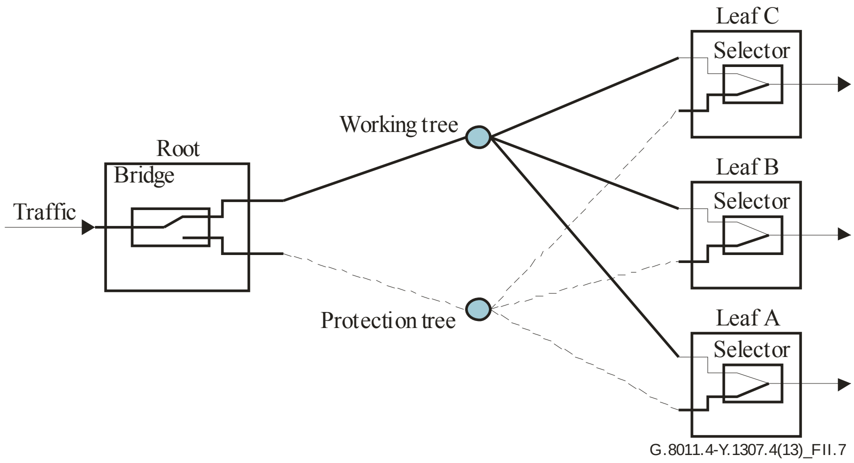

Figure II.7 – 1:1 protection switching architecture

If for example a defect occurs on the working tree and the traffic to node C is affected, as illustrated in Figure II.8, the defect will be detected at node C. When the root is switched to the protection tree after protection switching, all leaves will receive the working traffic on the protection tree. A 1-phase APS protocol is used. The protocol is as follows:

f) Node C detects the defect, then the APS protocol from node C to root requests a protection switch.

g) After the root node validates the priority of the protection request, it operates the selective bridge to the protection tree.

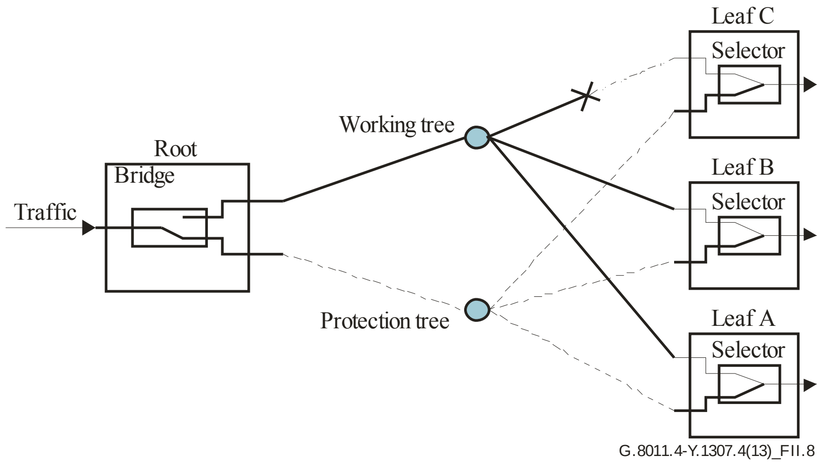

Figure II.8 – 1:1 protection switching architecture – All traffic is switched to the protection tree

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