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

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Internet protocol aspects – Transport

Resilience information/data models for the Ethernet transport network element

Recommendation ITU-T G.8052.2/Y.1346.2

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Recommendation ITU-T G.8052.2/Y.1346.2

Resilience information/data models for the Ethernet transport network element

Summary

Recommendation ITU-T G.8052.2/Y.1346.2 specifies the resilience information models and data models for the Ethernet transport network element (NE) to support specific interface protocols and specific management and control (MC) functions.

The information models are interface protocol neutral and specified using the unified modelling language (UML).

The data models are interface protocol specific and translated from these information models. The specific data models considered in this Recommendation include, but are not limited to, YANG data models.

The specific MC functions for resilience covered by this Recommendation include the ITU-T G.8031 Ethernet linear protection and ITU-T G.8032 Ethernet ring protection.

The YANG data model in this version of the Recommendation covers the Ethernet linear protection mechanism defined in Recommendation ITU-T G.8031/Y.1342.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.8052.2/Y.1346.2	2021-08-06	15	11.1002/1000/14632

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Carrier Ethernet, data model, Ethernet, information model, management, protection, resilience, restoration, unified modelling language (UML), YANG.

* 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.

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Resilience information/data models for the Ethernet transport network element

1 Scope

This Recommendation specifies the resilience information models and data models for Ethernet transport network element (NE) to support specific interface protocols and specific management and control (MC) functions.

The specific MC functions for resilience covered by this Recommendation are the ITU-T G.8031 Ethernet linear protection and the ITU-T G.8032 Ethernet ring protection.

The information models are interface protocol neutral and specified using the unified modelling language (UML). The information model of this Recommendation is derived through pruning and refactoring from the ITU-T G.7711 core information model and ITU-T G.8052 foundation Ethernet transport NE information model.

The data models are interface protocol specific and translated from these information models. The specific data models considered in this Recommendation include, but are not limited to, YANG data models.

The YANG modules of this Recommendation are aimed to be compatible with and when necessary extend the YANG modules defined in [IEEE 802.1Qcp], [IEEE 802.1Qcx] and [ITU-T G.8052.1].

The YANG data model in this version of the Recommendation covers the Ethernet linear protection mechanism defined in [ITU-T G.8031].

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.7711] Recommendation ITU-T G.7711/Y.1702 (2018), *Generic protocol-neutral information model for transport resources*.

[ITU-T G.8021] Recommendation ITU-T G.8021/Y.1341 (2018), *Characteristics of Ethernet transport network equipment functional blocks*.

[ITU-T G.8031] Recommendation ITU-T G.8031/Y.1342 (2015), *Ethernet linear protection switching*.

[ITU-T G.8032] Recommendation ITU-T G.8032/Y.1344 (2020), *Ethernet ring protection switching*.

[ITU-T G.8051] Recommendation ITU-T G.8051/Y.1345 (2020), *Management aspects of the Ethernet transport (ET) capable network element*.

[ITU-T G.8052] Recommendation ITU-T G.8052/Y.1346 (2018), *Protocol-neutral management information model for the Ethernet transport capable network element*.

[ITU-T G.8052.1]	Recommendation ITU-T G.8052.1/Y.1346.1 (2021), *Operation, administration, maintenance (OAM) management information and data models for the Ethernet-transport network element*.
[IEEE 802.1Q]	IEEE 802.1Q (2018), *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks.*
[IEEE 802.1Qcp]	IEEE 802.1Qcp (2018), *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks – Amendment 30: YANG Data Model.*
[IEEE 802.1Qcx]	IEEE 802.1Qcx (2020), *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks Amendment: YANG Data Model for Connectivity Fault Management.*
[IETF RFC 7950]	RFC IETF RFC 7950 (2016), *The YANG 1.1 Data Modeling Language*.
[IETF RFC 8340]	RFC IETF RFC 8340 (2018), *YANG Tree Diagrams*.
[IETF RFC 8342]	RFC IETF RFC 8342 (2018), *Network Management Datastore Architecture (NMDA).*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 1+1 protection architecture [b-ITU-T G.808]

3.1.2 1:n protection architecture [b-ITU-T G.808]

3.1.3 forced switch [b-ITU-T G.808]

3.1.4 hold-off time [b-ITU-T G.808]

3.1.5 manual switch [b-ITU-T G.808]

3.1.6 protection [b-ITU-T G.808]

3.1.7 protection group [b-ITU-T G.808]

3.1.8 signal degrade (SD) [b-ITU-T G.806]

3.1.9 signal fail (SF) [b-ITU-T G.806]

3.1.10 switch [b-ITU-T G.808]

3.1.11 unidirectional protection switching [b-ITU-T G.780]

3.1.12 wait-to-restore time [b-ITU-T G.808]

3.1.13 clear [b-ITU-T G.808]

3.1.14 exercise signal [b-ITU-T G.808]

3.1.15 server signal fail (SSF) [b-ITU-T G.806]

3.1.16 steering [b-ITU-T G.808]

3.1.17 wrapping [b-ITU-T G.808]

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

APS	Automatic Protection Switching
CASC	Configuration and Switch Control
CTP	Connection Termination Point
ELP	Ethernet Linear Protection
ERP	Ethernet Ring Protection
ET	Ethernet Transport
ETH	Ethernet
FC	Forwarding Construct
FF	Flow Forwarding
FP	Flow Point
LTP	Logical Termination Point
MCC	Management Control Continuum
MCS	Management and Control System
MEG	Maintenance Entity Group
MEP	MEG End Point
NE	Network Element
NMDA	Network Management Datastore Architecture
RAPS	Ring Automatic Protection Switching
SNC	Subnetwork Connection
SNCP	Subnetwork Connection Protection
UML	Unified Modelling Language
VID	VLAN Identifier
VLAN	Virtual Local Area Network

5 Conventions

5.1 Information modelling conventions

5.1.1 UML modelling conventions

See [ITU-T G.7711] clause 5.1.

5.1.2 Model artefact lifecycle stereotypes conventions

See [ITU-T G.7711] clause 5.2.

5.1.3 Forwarding entity terminology conventions

See [ITU-T G.7711] clause 5.3.

5.1.4 Conditional package conventions

See [ITU-T G.7711] clause 5.4.

5.1.5 Pictorial diagram conventions

See [ITU-T G.7711] clause 5.5.

6 Carrier Ethernet resilience functions

This clause identifies the carrier Ethernet resilience functions that are modelled by the information model and data models of this Recommendation.

6.1 Ethernet linear protection function

The Ethernet linear protection function is defined in [ITU-T G.8031]. [ITU-T G.8031] specifies linear protection switching architectures for point-to-point VLAN-based ETH subnetwork connection. The related "management information" is listed in [ITU-T G.8021] and further clarified in [ITU-T G.8031].

This function is modelled by the ETH_SubNetworkConnectionProtectionGroup (ETH_SNCP_Group) object class, defined in [ITU-T G.8052]. Figure 6-1 shows a generic model of Ethernet linear protection function. The model is applicable to various operation modes (e.g., 1+1/1:1, unidirectional/bidirectional, APS/noAPS, and revertive/non-revertive) specified in [ITU-T G.8031].

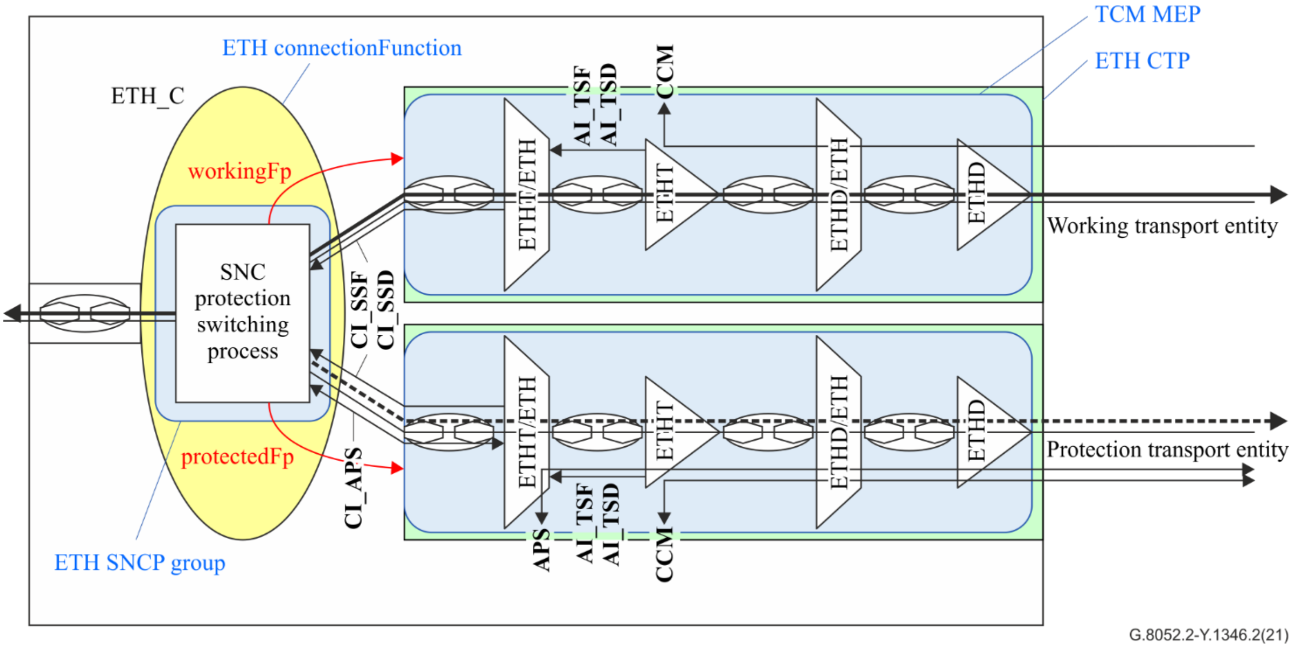

Figure 6-1 – Generic model of Ethernet linear protection function

(based on Figure 10-3 of [ITU-T G.8031])

6.2 Ethernet ring protection function

The Ethernet ring protection function is defined in [ITU-T G.8032]. [ITU-T G.8032] specifies ring protection switching architectures for Ethernet layer network (ETH) ring topologies. The related "management information" is listed in [ITU-T G.8021] and further clarified in [ITU-T G.8032].

Each ring protection control process is modelled by the ETH_RingAutomaticProtectionSwitchingGroup (ETH_RAPS_Group) object class defined in [ITU-T G.8052]. The following Figure 6-2 shows a generic model of Ethernet ring protection function. The model is applied to a single ring configuration.

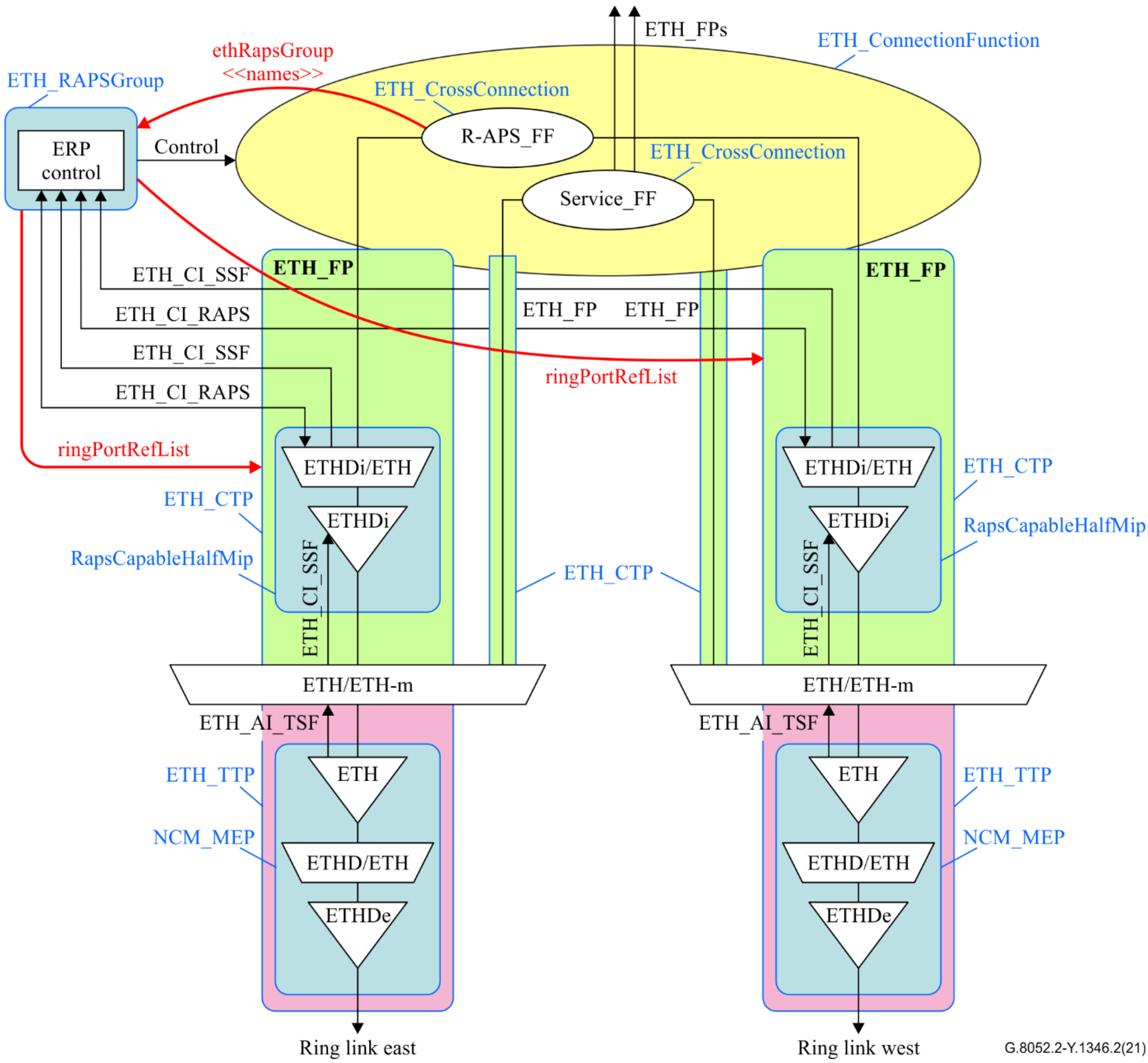

Figure 6-2 – Generic model of Ethernet ring protection function
(based on Figure 9-4 of [ITU-T G.8032])

For the ring interconnection protection, the ring protection architecture defined in [ITU-T G.8032] includes ring interconnection model with a ring automatic protection switching (R-APS) virtual channel and ring interconnection model without an R-APS virtual channel. Figure 6-3 shows the maintenance entity group end points (MEPs) and R-APS insertion function in an interconnection node with an R-APS virtual channel from [ITU-T G.8032]. Figure 6-4 shows the MEPs and R-APS insertion function in a sub-ring interconnection node without an R-APS virtual channel from [ITU-T G.8032].

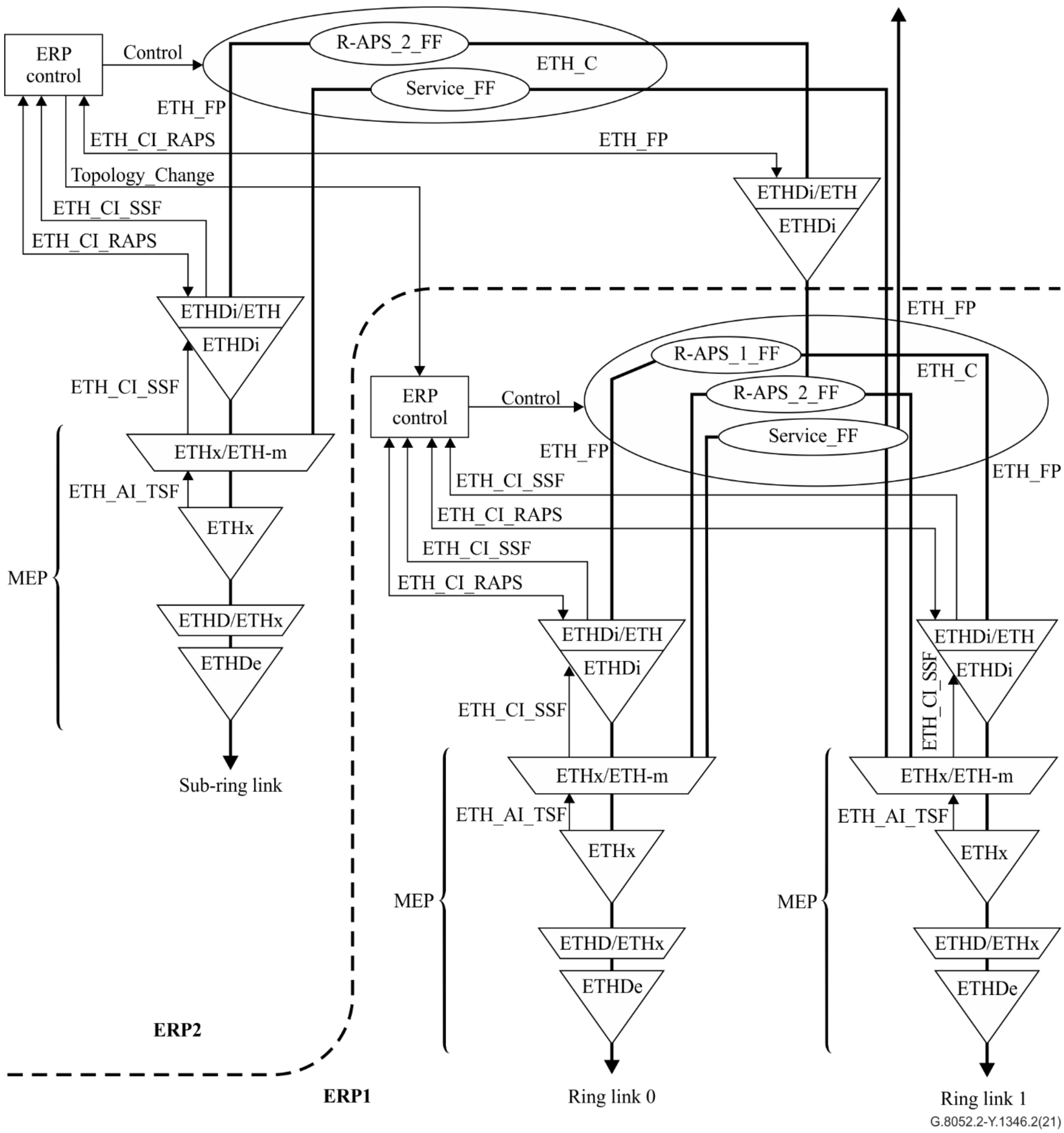

Figure 6-3 – MEPs and R-APS insertion function in an interconnection node with an R-APS virtual channel (different R-APS VIDs)

(based on Figure 9-8 of [ITU-T G.8032])

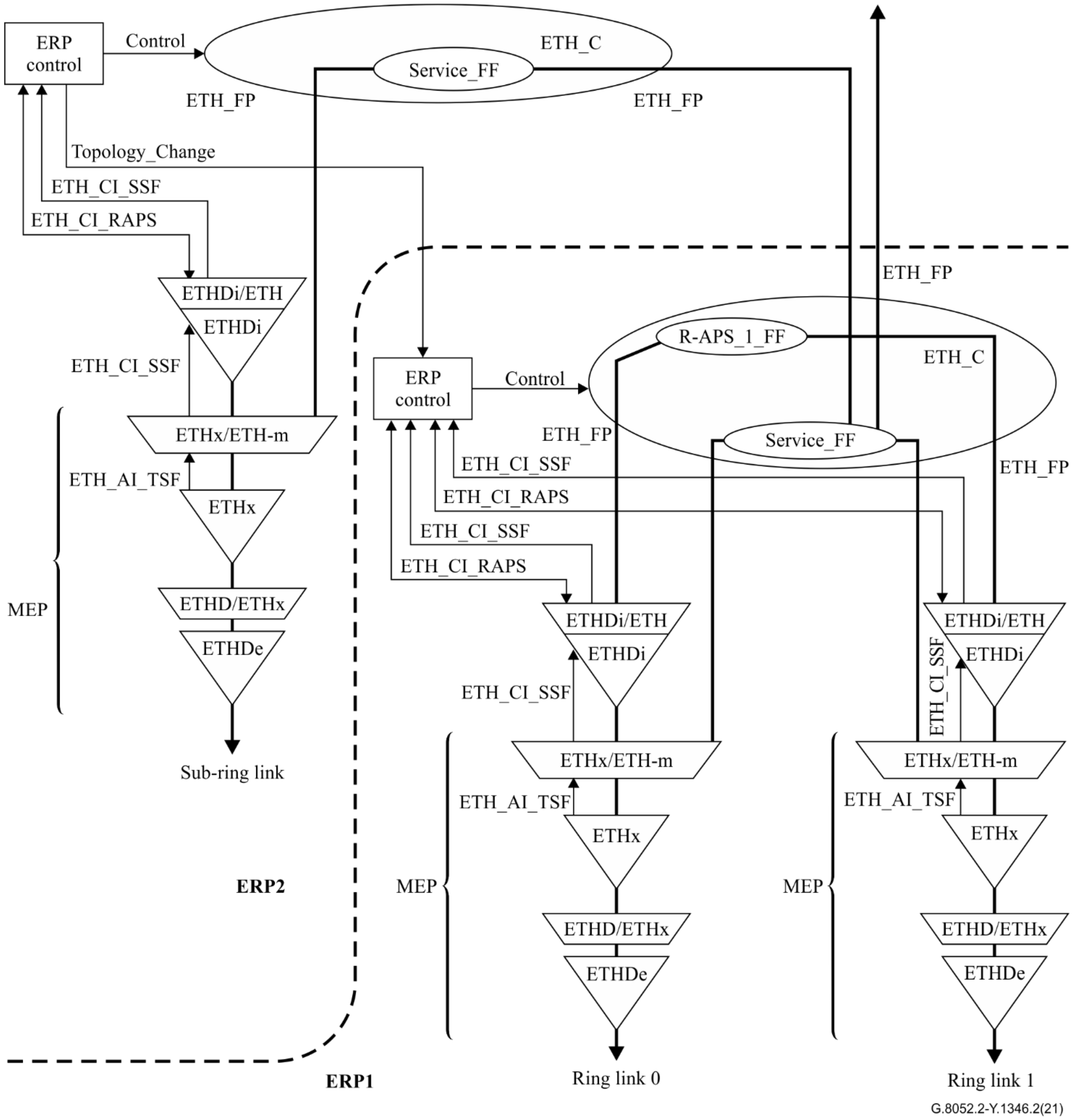

Figure 6-4 – MEPs and R-APS insertion function in a sub-ring interconnection node without an R-APS virtual channel (for a sub-ring connected to a major ring)

(based on Figure 9-10 of [ITU-T G.8032])

7 Ethernet protection information model

7.1 Ethernet linear protection information model

This clause specifies the UML information model of the Ethernet linear protection functions identified in clause 6.1. This information model is derived through pruning and refactoring the ITU-T G.7711 core information model and ITU-T G.8052 foundation Ethernet transport NE information model.

7.1.1 ITU-T G.8052 base object classes considered for Ethernet linear protection

To manage the Ethernet linear protection functions identified in clause 6.1, the following ITU-T G.8052 object classes are considered for pruning/refactoring to meet ITU-T G.8052.2 needs:

– ETH_SubNetworkConnectionProtectionGroup

7.1.2 Ethernet linear protection attributes and operations

[ITU-T G.8052] defines attributes for linear protection classes, and Table 7-1 and Table 7-2 verify the requirements of attributes and operations from [ITU-T G.8052] for the ITU-T G.8052.2 model.

Table 7-1 – Linear protection attributes verification

	Attributes in [ITU-T G.8052]	Consideration in ITU-T G.8052.2 model
1.	ETH_SubNetworkConnectionProtectionGroup::protectionBridgeType	This attribute is required to configure the type of the subnetwork connection protection (SNCP) group
2.	ETH_SubNetworkConnectionProtectionGroup::holdOffTime	This attribute is required
3.	ETH_SubNetworkConnectionProtectionGroup::sncpGroupState	This attribute is required defined as experimental to report the protection state of the SNCP group
4.	ETH_SubNetworkConnectionProtectionGroup::isSdProtectionEnabled	This attribute is required
5.	ETH_SubNetworkConnectionProtectionGroup::workingFp	This attribute has to be refactored (see clause 7.1.4)
6.	ETH_SubNetworkConnectionProtectionGroup::protectingFp	This attribute has to be refactored (see clause 7.1.4)
7.	ETH_SubNetworkConnectionProtectionGroup::protectedFp	This attribute is not required
8.	ETH_SubNetworkConnectionProtectionGroup::associatedMepRef	This attribute has to be refactored (see clause 7.1.4)

Table 7-2 – Linear protection operations verification

	Operations in [ITU-T G.8052]	Consideration in ITU-T G.8052.2 model
1.	ETH_SubNetworkConnectionProtectionGroup::lockoutProtection( )	This operation is required
2.	ETH_SubNetworkConnectionProtectionGroup::forceSwitch( )	This operation is required
3.	ETH_SubNetworkConnectionProtectionGroup::clearExternalCommandAndWaitToRestoreState( )	This operation is required
4.	ETH_SubNetworkConnectionProtectionGroup::manualSwitch	This operation is required
5.	ETH_SubNetworkConnectionProtectionGroup::Exercise( )	This operation is required
6.	ETH_SubNetworkConnectionProtectionGroup::localFreeze( )	This operation is required
7.	ETH_SubNetworkConnectionProtectionGroup::clearLocalFreeze( )	This operation is required

7.1.3 Relationship with the IEEE 802.1Qcx CFM reverse-engineered UML

The ITU-T G.8052.2 YANG references the IEEE 802.1Qcx CFM YANG to identify the underlying maintenance entity groups (MEGs) monitoring the working and protection transport entities.

To assist Ethernet linear protection UML pruning and refactoring and to ensure that the translated Ethernet linear protection YANG can seamlessly refer to the IEEE 802.1Qcx CFM YANG, the

CFM YANG modules have been manually reverse-engineered into UML form. Therefore, the ITU-T G.8052.2 UML model will thus also refer to the reverse-engineered IEEE 802.1Qcx CFM UML.

Figure 7-1 provides an overview of the relationship between the IEEE 802.1Qcx classes and the ITU-T G.8052.2 classes. It illustrates, at high level, that

– EthLinearProtection has two reference associations to MaintenanceGroup of the CFM model to indicate the working path MaintenanceGroup and the protection path MaintenanceGroup. Note that these two associations have a restriction that they shall point to two different instances of MaintenanceGroup. Such restriction is modelled by using the "Cond" stereotype of the "EthLinearProtectionHasProtectionPathMg" association.

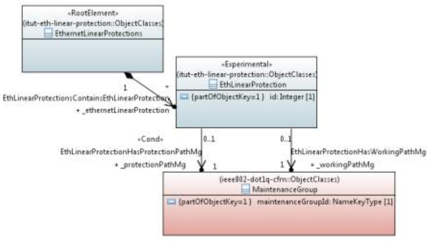

Figure 7-1 – IEEE 802.1Qcx and ITU-T linear protection relationship

7.1.4 Relationship with the IEEE 802.1Q bridge reverse-engineered UML

For the ITU-T G.8031 ETH linear protection to be supported in the Ethernet network, the working and protection transport entities need to be associated with the forwarding plane of the Ethernet network.

Since the Ethernet linear protection YANG model defined in this Recommendation references the IEEE 802.1Qcx MaintenanceGroups object class, to configure the MEGs used to monitor the working and protection transport entities, the association of the ETH linear protection with the forwarding plane is inherited from the association of the MEPs of the working and protection MEGs with the forwarding plane.

Thus, in the case IEEE 802.1Q bridges are deployed in the Ethernet network, the MEPs on the working and protection transport entities are associated with the IEEE 802.1Qcp BridgePort, as defined in the ITU-T G.8052.1 MepBridgePortSpec object class. The VLAN IDs used on these bridge ports by the working and protection transport entities are defined in the ITU-T G.8052.1 MgBridgeSpec object class.

Figure 7-2 shows the IEEE 802.1Q bridge and ITU-T linear protection relationship.

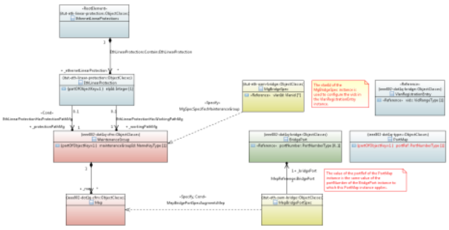

Figure 7-2 – IEEE 802.1Q bridge and ITU-T linear protection relationship

In order to enable Ethernet flow forwarding through the Ethernet linear protection working and protection transport entities, the system should configure the IEEE 802.1Q VlanRegistrationEntry object class based on the Ethernet Linear Protection and OAM configuration:

– The vlanId of the ITU-T G.8052.1 MepBridgePortSpec object class instances, representing the MEGs monitoring the working and protection paths, is used to configure the vids in the IEEE 802.1Q VlanRegistrationEntry object class instance;

– The portNumber of the IEEE 802.1Q BridgePort instances, referenced by the ITU-T G.8052.1 MepBridgePortSpec object class instances, representing the MEPs on the working and protection paths, are used to configure the portRef in the IEEE 802.1Q PortMap object class instances.

Informative examples of configuration and operation for Ethernet linear protection (ELP) with IEEE 802.1Q bridges are provided in Appendix I.

7.2 Ethernet ring protection information model

7.2.1 Touch point approaches

Figure 7-3 shows the logical termination point (LTP) spec model. A spec object classes named EthRapsCtpSpec are associated with LTP. The attributes of the spec class are imported from [ITU-T G.8052].

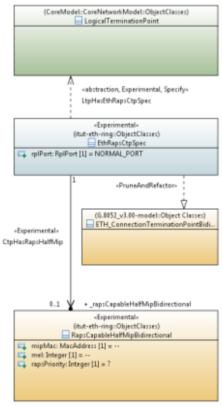

Figure 7-3 – LTP spec model

Figure 7-4 shows the forwarding construct (FC) spec model. A spec object classes named EthRapsFcSpec and is associated with the FC and ControlParameters_Pac, respectively. The attributes of these two spec classes are imported from [ITU-T G.8052] and modified as per clause 7.2.2.

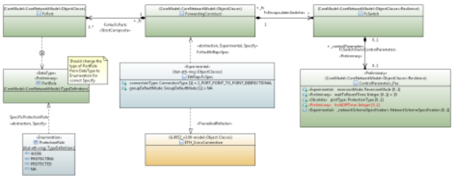

Figure 7-4 – FC spec model

Figure 7-5 shows the configuration and switch control (CASC) (ConfigurationAndSwitchControl) spec model for [ITU-T G.8032]. A spec object class named EthRapsCascSpec specifies the CASC. According to the description in clause XIV.3.5 of [ITU-T G.7711], a ring can be represented by a superior CASC that groups the nodal CASCs for the ring. So EthRapsCascSpec contains two packages, one for the nodal CASC and the other one for the superior CASC. The attributes of NodalCasc_Pac are imported from [ITU-T G.8052]. The attributes of SuperiorCasc_Pac are not currently specified in [ITU-T G.8052] and need to be defined. An association with MepBidirectional is also imported from [ITU-T G.8052].

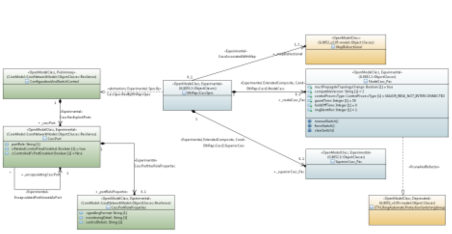

Figure 7-5 – CASC spec model for [ITU-T G.8032]

7.2.2 Ethernet ring protection object classes

Figure 6-2 specifies the generic model of ELP, and Annex E of [ITU-T G.7711] has the generic resilience model applicable for the ring protection switching schemes. Figure 7-6 shows the artefacts mapping between [ITU-T G.8052.2] and [ITU-T G.7711] for the generic model of Ethernet ring protection (ERP).

Figure 7-7 gives the modelling of the ring interconnection with an R-APS virtual channel. In Figure 7-7, the service FC propagates traffic between ERP1 and ERP2. The R-APS2 FCs propagates the ring virtual local area network identifiers (VIDs) to support R-APS virtual channel. CASC 1 and CASC 2 coordinate topology change information.

Figure 7-8 gives the modelling of the ring interconnection without an R-APS virtual channel. The R-APS channel of the ERP2 is terminated at the sub-ring link LTP (purple). The R-APS1 FC propagates the ring VIDs to support ERP1.

Table 7-3 shows a brief comparison among [ITU-T G.8032], [ITU-T G.8052] and [ITU-T G.7711] models for ERP.

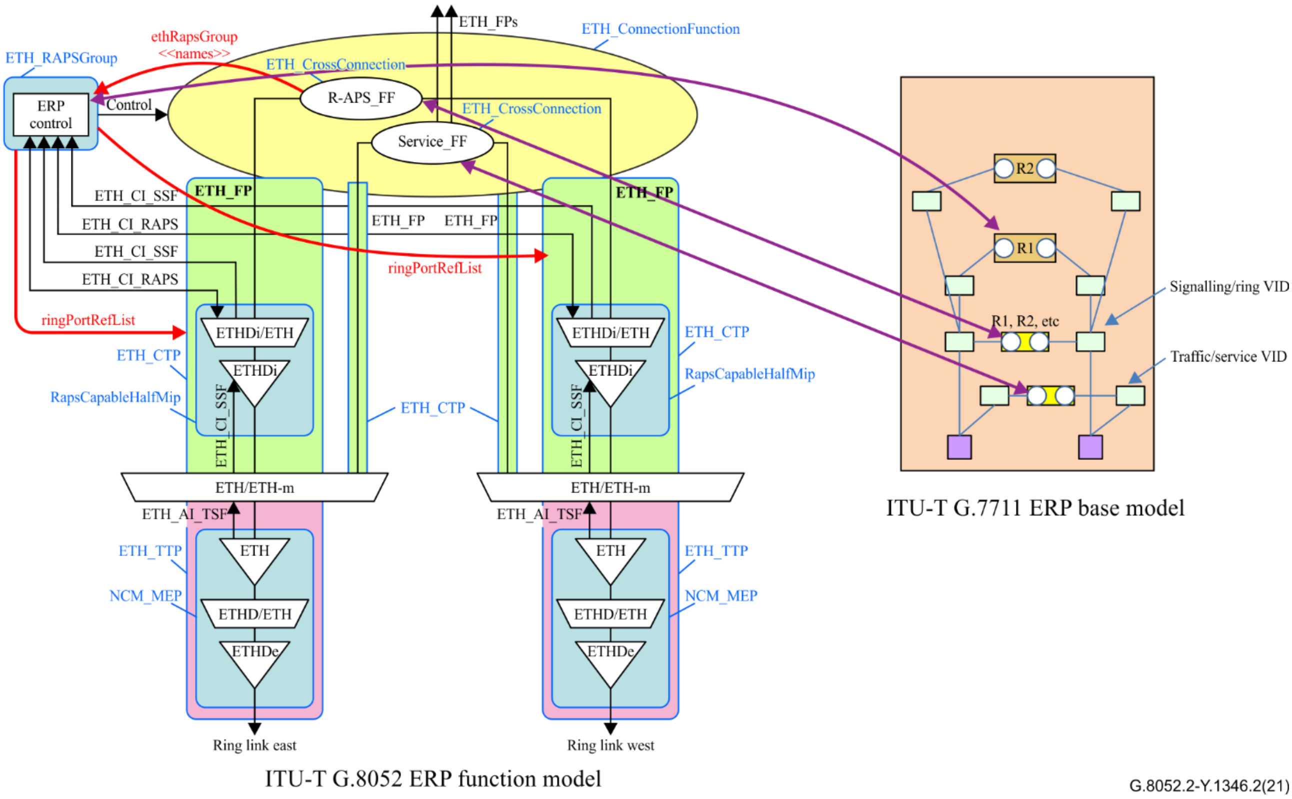

Figure 7-6 – Artefacts mapping between ITU-T G.8052 and ITU-T G.7711 for ERP

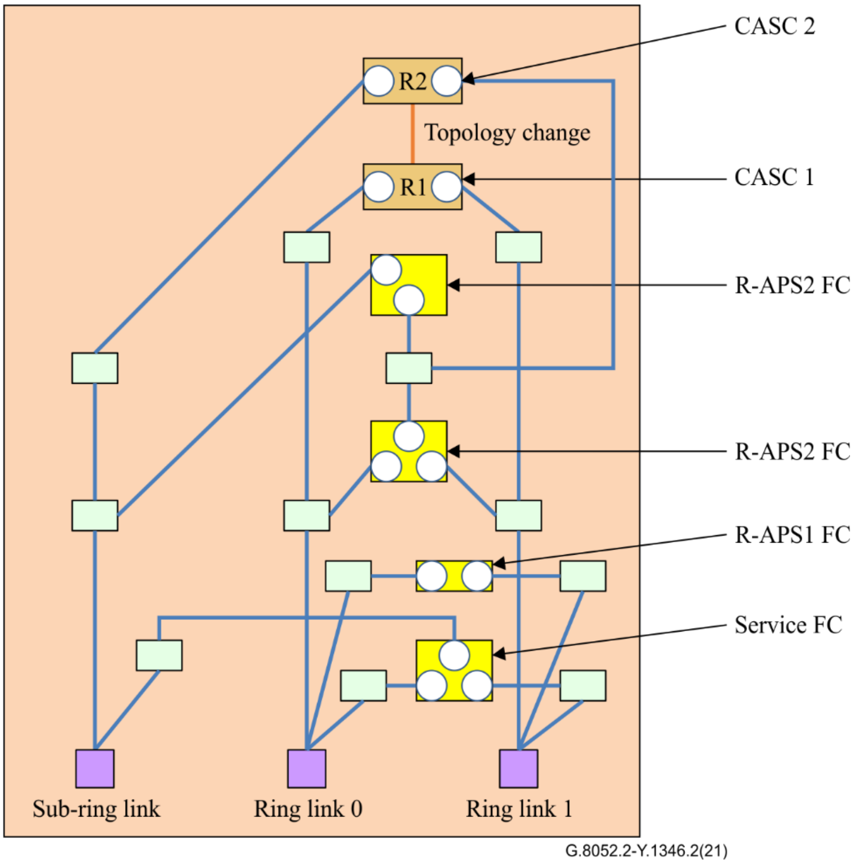

Figure 7-7 – Modelling of the ring interconnection with an R-APS virtual channel

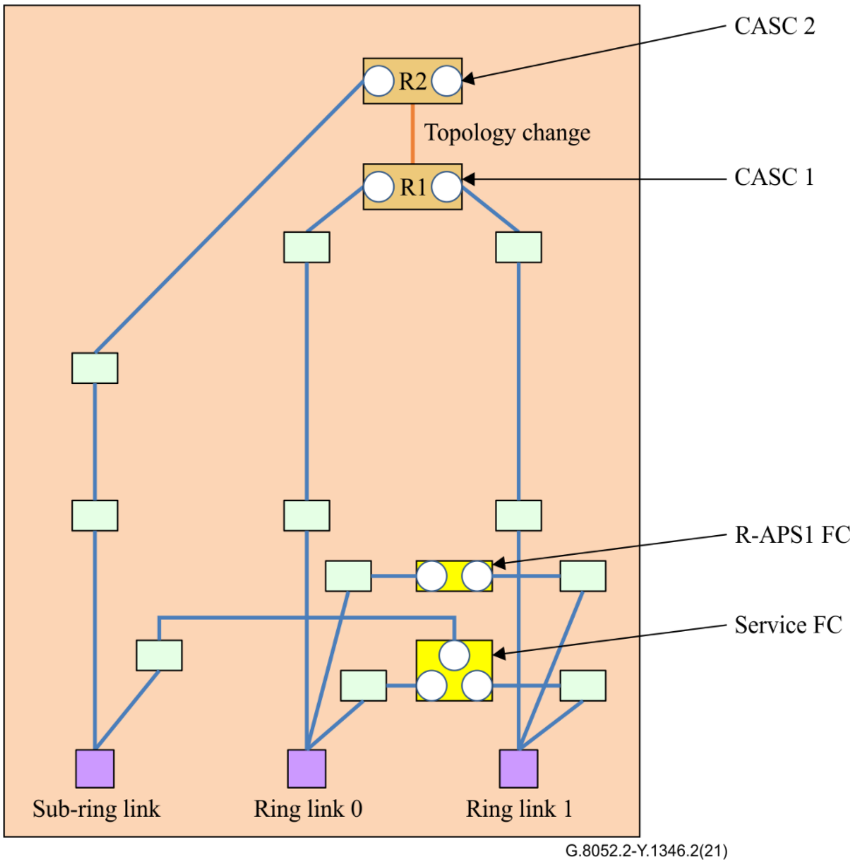

Figure 7-8 – Modelling of the ring interconnection without an R-APS virtual channel

Table 7-3 – Artefacts mapping among ITU-T G.8032, ITU-T G.8052 and ITU-T G.7711 for ERP

ITU-T G.8032	ITU-T G.8052	ITU-T G.7711
ERP control	ETH_RAPS_Group	CASC+CascPort+Spec
R-APS_FF	ETH_CrossConnection	FC+FcPort+Spec
Service_FF	ETH_CrossConnection	FC+FcPort+Spec
ETH_FP	ETH_CTP, ETH_TTP	LTP+Spec
MEP	MEP	LTP+MEP+Spec
ETHDi/ETH, ETHDi	RapsHalfMip	LTP+MIP+Spec
Network Element	ConstraintDomain	ConstraintDomain

Figure 7-9 shows the resilience model for ERP and is based on Figure XIV.3-31 of [ITU-T G.7711].

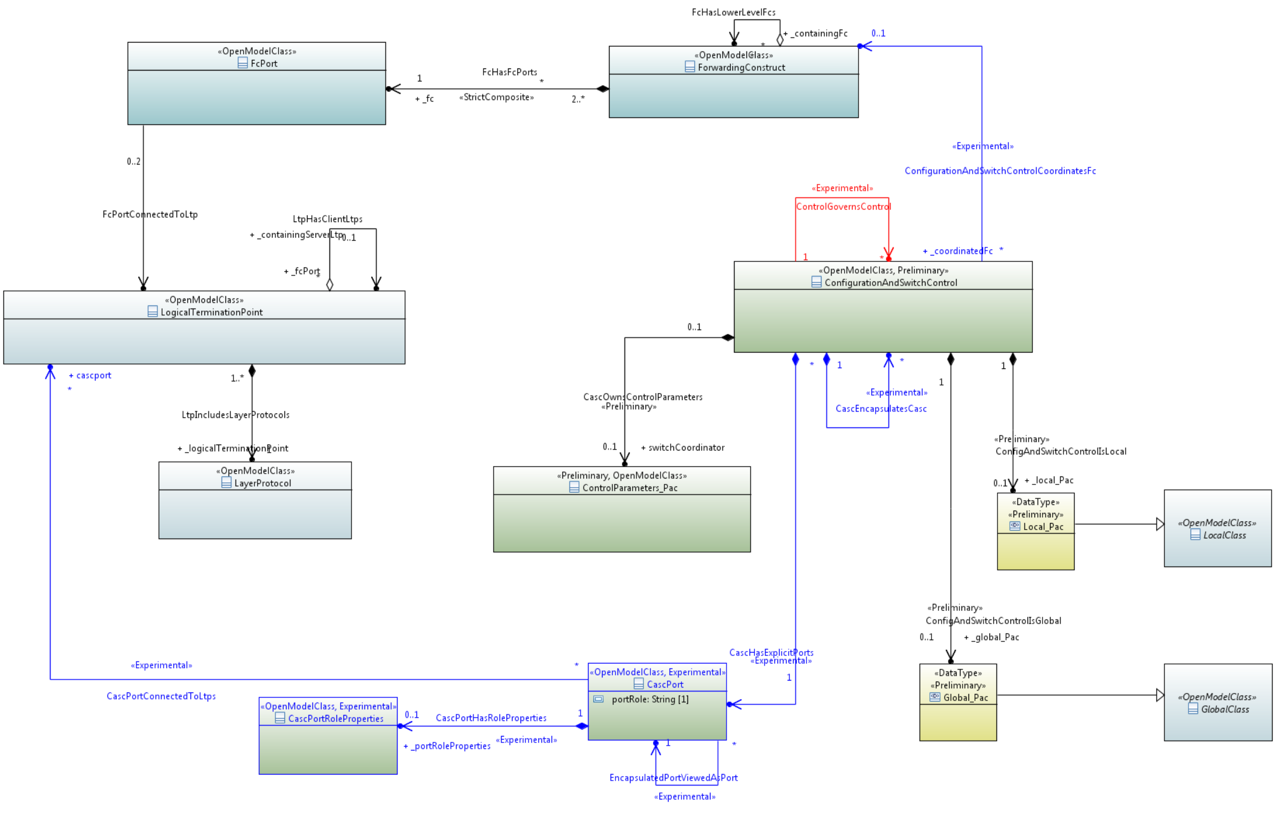

Figure 7-9 – Resilience model for G.8032

(based on Figure XIV.3-31 of [ITU-T G.7711])

7.2.3 Ethernet ring protection attributes and operations

[ITU-T G.8052] defines attributes for ring protection classes, and Table 7-4 and Table 7-5 verify the compatibility in attributes and operations level between [ITU-T G.8052] and [ITU-T G.7711].

Table 7-4 – Ring protection attributes verification

	Attributes in [ITU-T G.8052]	Consideration in spec model
1.	ETH_RingAutomaticProtectionSwitchingGroup::mustPropagateTopologyChange	This is an ERP specific parameter. This attribute should be in NodalCasc_Pac of EthRapsCascSpec which specifies CASC.
2.	ETH_RingAutomaticProtectionSwitchingGroup::compatibleVersion	This is an ERP specific parameter. This attribute should be in NodalCasc_Pac of EthRapsCascSpec which specifies CASC.
3.	ETH_RingAutomaticProtectionSwitchingGroup::controlProcessType	This is an ERP specific parameter. This attribute should be in NodalCasc_Pac of EthRapsCascSpec which specifies CASC.
4.	ETH_RingAutomaticProtectionSwitchingGroup::guardTime	This is an ERP specific parameter. This attribute should be in NodalCasc_Pac of EthRapsCascSpec which specifies CASC.
5.	ETH_RingAutomaticProtectionSwitchingGroup::holdOffTime	(generic) specified in ControlParameters_Pac.
6.	ETH_RingAutomaticProtectionSwitchingGroup::ringIdentifier	This is an ERP specific parameter. This attribute should be in NodalCasc_Pac of EthRapsCascSpec which specifies CASC.
7.	ETH_RingAutomaticProtectionSwitchingGroup::_associatedMepRefList	This parameter identifies the LTPs that contain the MEPs which monitors the ring links. To be associated with LTP.
8.	ETH_RingAutomaticProtectionSwitchingGroup::ringPortRefList	This parameter identifies the LTPs that contain the RAPS-capable half MIPs which carries the RAPS signal. To be associated with LTP.
9.	ETH_RingAutomaticProtectionSwitchingGroup::reversionMode	(generic) specified in ControlParameters_Pac.
10.	ETH_RingAutomaticProtectionSwitchingGroup::waitToRestoreTime	(generic) specified in ControlParameters_Pac.

Table 7-5 – Ring protection operations verification

	Operations in [ITU-T G.8052]	Operations in [ITU-T G.7711]
1.	ETH_RingAutomaticProtectionSwitchingGroup::manualSwitch( )	It should be specified in NodalCasc_Pac.
2.	ETH_RingAutomaticProtectionSwitchingGroup::forceSwitch( )	It should be specified in NodalCasc_Pac.
3.	ETH_RingAutomaticProtectionSwitchingGroup::clearSwitch( )	It should be specified in NodalCasc_Pac.

7.3 UML model files

A zip file that contains the ITU-T G.8052.2 linear and ring protection UML model developed using the Papyrus open-source modelling tool can be downloaded from https://www.itu.int/ITU-T/formal-language/itu-t/g/g8052.2/2021/g8052.2_v0.09_uml.zip.

The zip file contains the following:

- The ITU-T G.8052.2 uml model, which consists of the following files:
  - The papyrus project file
    - .project
  - The .di, .notation, and .uml files of the itut-eth-linear-protection module
    - itut-eth-linear-protection.di
    - itut-eth-linear-protection.notation
    - itut-eth-linear-protection.uml
  - The .di, .notation, and .uml files of the itut-eth-ring-protection module
    - itut-eth-ring-protection.di
    - itut-eth-ring-protection.notation

    - ▪ itut-eth-ring-protection.uml
- The following UML profiles that define the properties of the UML artifacts:
  - – The OpenModelProfile folder, which contains the .di, .notation, and uml of the open model profile
  - – The OpenInterfaceModelProfile folder, which contains the .di, .notation, and uml of the open model interface profile
  - – The ProfileLifecycleProfile folder, which contains the .di, .notation, and uml of the profile lifecycle profile
  - – The ClassDiagramStyleSheet.css style sheet
- The UML models that are needed (i.e., imported) by the ITU-T G.8052.2 model:
  - – ITU-T G.7711 core information model
  - – ITU-T G.8052 base Ethernet information model
  - – IEEE models, i.e., the UML models that are reverse-engineered from the IEEE Yang data models

8 Ethernet protection data models

This clause contains the interface-protocol-specific data models of the Ethernet resilience functions identified in clause 6. These data models are translated from the interface-protocol-neutral UML information specified in clause 7.

8.1 Ethernet protection YANG data models

This clause contains the ITU-T G.8052.2 YANG data models.

The YANG data models defined in this Recommendation uses the YANG 1.1 language defined in [IETF RFC 7950].

The tree format defined in [IETF RFC 8340] is used for the YANG data model tree representation.

The YANG data models defined in this Recommendation conforms to network management datastore architecture in [IETF RFC 8342].

8.1.1 Ethernet linear protection YANG data model

The ITU-T G.8052.2 linear protection YANG data model is translated from the UML information model provided in clause 7.3. The translation is done with the assistance of the Open Source translation tooling xmi2yang, which is developed according to the [b-ONF TR-531] mapping guidelines.

At the time of publication of this Recommendation, the xmi2yang mapping tool is still a work in progress. Therefore, manual modifications on the tool-generated YANG are necessary. The YANG with such manual modifications can be downloaded from:

https://www.itu.int/ITU-T/formal-language/itu-t/g/g8052.2/2021/g8052.2_v2021-03-25YANG.zip.

8.1.2 Ethernet ring protection YANG data model

Since the base UML model of shared ring protection is still preliminary, the YANG model is also preliminary and needs further study.

Appendix I

Examples of ELP configuration with IEEE 802.1Q bridges

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

This appendix provides some examples of how the Ethernet linear protection YANG model defined in this Recommendation could be used, together with the bridge YANG model defined in [IEEE 802.1Qcp], to configure and operate Ethernet linear protection.

These examples consider the reference network shown in Figure I.1 with the assumption that the data plane is configured only by the management and control system (MCS) through static configuration.

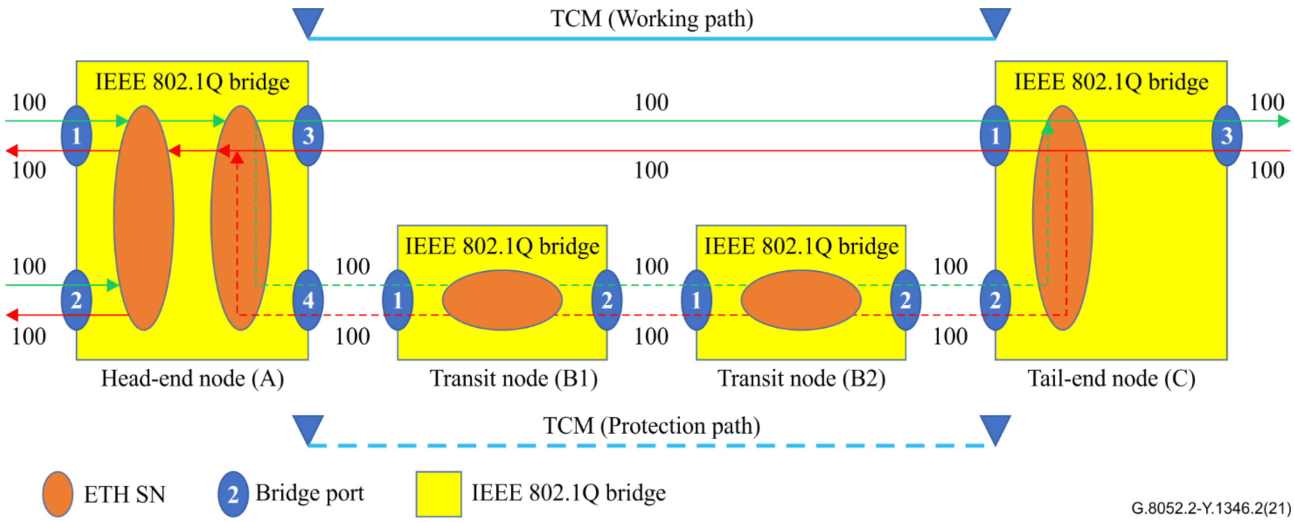

Figure I.1 – Example reference network

This example shows that the protected point-to-point ETH SNC can, in general, belong to a multipoint ETH SNC.

From a functional point of view, each node in Figure I.1 is an IEEE 802.1Q provider bridge where the ETH SNCs describe the forwarding behaviour for different S-VLANs.

In order to describe the forwarding behaviour for S-VLAN 100 within node A, two ETH SNCs are shown: one representing the Ethernet linear protection switching between bridge ports 3 and 4 and another representing the Ethernet any-to-any connectivity between bridge ports 1, 2 and the ETH SNC linear protection switching.

The zip file that can be downloaded from https://www.itu.int/ITU-T/formal-language/itu-t/g/g8052.2/2021/g8052.2_JSON.zip contains JSON codes that are provided as examples of instances of the configuration and operational datastores of the YANG models defined in this Recommendation, together with the bridge YANG model, defined in [IEEE 802.1Qcp], and Ethernet OAM YANG models, defined in [IEEE 802.1Qcx] and [ITU-T G.8052.2], to support different operational scenarios, defined in different sub-clauses of this appendix.

I.1 Setup of an ETH SCN with ELP protection

In this scenario, ELP protection is configured during the ETH SNC setup.

The initial applied configuration of the bridges within the reference network of Figure I.1 is shown in the start-up.zip JSON code. It encompasses the configuration of all the bridges and bridge ports.

The vlan-registration-entry, the maintenance-domain and the maintenance-group lists are not shown in the *start-up.zip* JSON code since there is no VLAN registration entry for VLAN 100 nor none of the MEG shown in Figure I.1. However, other VLANs or MEGs which are outside the scope of this example may be present but not show in the *start-up.zip* JSON code.

In this scenario, the MCS should perform the following configuration on the head-end node A:

- Register VLAN 100 on bridge ports 1 and 2 (optionally, also on bridge port 3 and bridge port 4)
- Configure MEGs and Ethernet linear protection
  1. Configure MEGs
     - Configure the MEG monitoring the working transport entity
     - Configure the MEG monitoring the protection transport entity
  2. Configure Ethernet linear protection (need to reference the MEGs on working and protection transport entities)

This configuration can be provided as a single protocol transaction or a sequence of atomic protocol operations: in the latter case the configuration of Ethernet linear protection (step #2 in the list above) should be done after the configuration of the MEGs on the working and protection transport entities (step #1).

A similar configuration should be provided by the MCS on the tail-end node C.

The MCS should also configure VLAN registration on bridge ports 1 and 2 on the transit nodes B1 and B2, to enable forwarding along the protection path.

The *elp-configuration.zip* JSON code shows the configuration that the MCS should provide on all the bridges (A, B1, B2 and C) within the reference network of Figure I.1.

It is worth noting that the registration of VLAN 100 on bridge ports 3 and 4 of the head-end node A and bridge ports 1 and 2 of the tail-end node C is not required, but also not forbidden, as long as it is consistent with the Ethernet linear protection configuration and no forwarding loops are created. The *elp-configuration.zip* JSON code assumes that the MCS does not register VLAN 100 on these bridge ports.

As described in clause 7.1.4, bridge A can automatically configure the VLAN registration on its bridge ports 3 and 4, if nor already present:

- The vlan-id list (VLAN 100 in this example) of the working and protection MEGs is used to configure the vids of the VLAN registration entry;
- The port-number of the interfaces referenced by the bridge-port of the MEPs on the working and protection MEGs (bridge ports 3 and 4 in this example) are used to configure the port-ref of the VLAN registration entry's port map.

In a similar way, bridge C can automatically configure the VLAN registration on bridge ports 1 and 2, if nor already present.

Following the network management datastore architecture (NMDA) architecture of [IETF RFC8342], this configuration is applied by bridges A and C in their operational datastore, as shown in *elp-operational.zip* JSON code.

I.2 Adding ELP configuration on existing ETH SCN

In this scenario, ELP protection is configured after the ETH SNC has been setup.

The *unprotected-working.zip* show the configuration that has been provided by the MCS when the unprotected ETH SNC has been setup. In this case, the MCS needs to register VLAN 100 on port 3 of bridge A and on port 1 of bridge C to enable frame forwarding.

The MEG between bridge port 3 of bridge A and bridge port 1 of bridge C may or may not be configured during the ETH SNC setup. The *unprotected-working.zip* example assumes that this MEG has not been set up.

In this scenario, the MCS should provide the following configuration on the head-end node A:

- Configure MEGs and Ethernet linear protection
  1. Configure MEGs
     - Configure the MEG monitoring the working transport entity, if not yet present
     - Configure the MEG monitoring the protection transport entity
  2. Configure Ethernet linear protection (need to reference the MEGs on working and protection transport entities)
  3. The MCS may also optionally remove the VLAN 100 registration on bridge port 3 (after having configured the Ethernet linear protection to make this operation hitless).

A similar configuration should be provided by the MCS on node C.

The MCS should also register VLAN 100 on bridge ports 1 and 2 on nodes B1 and B2 to enable forwarding along the protection path.

The *elp-add.zip* show the configuration that needs to be provided by the MCS on all the bridges (A, B1, B2 and C), assuming that the VLAN 100 registration on bridge port 3 of bridge A and on bridge port 1 of bridge C is not removed, since not necessary.

The *elp-add.zip* configuration is almost identical to the *elp-configuration.zip* configuration, shown in clause I.1: the only difference being the VLAN registration on bridge port 3 of node A and on bridge port 1 of node C.

Based on the configuration of the Ethernet linear protection, bridge A can automatically configure the VLAN registration on bridge port 4, if not already present. In a similar way, bridge C can automatically configure the VLAN registration on bridge port 2, if not already present.

The applied configuration would be exactly the same as shown in *elp-operational.zip* in clause I.1.

I.3 ELP removal keeping working path

In this scenario, the ELP configuration is removed but the ETH SNC is not removed and the ELP working path is used by the ETH SNC after ELP configuration has been removed.

The initial configuration, provided by the MCS, can be either the *elp-configuration.zip* or the *elp-add.zip*: the latter contains VLAN registration for bridge port 3 on node A and bridge port 1 on node C while the former does not.

The MCS should perform the following configuration on the head-end node A:

1. Configure, if not yet present, the VLAN registration on bridge port 3
2. Remove Ethernet linear protection configuration (after VLAN 100 has been registered on bridge port 3 to avoid hit on the traffic)

3. Remove the MEGs (no longer referenced by the removed Ethernet linear protection)
    - Remove the MEG monitoring the protection transport entity
    - Optionally remove also the MEG monitoring the working transport entity

A similar configuration should be provided by the MCS on node C.

The MCS should also remove VLAN registration on bridge ports 1 and 2 on nodes B1 and B2.

The *unprotected-working.zip* show the configuration that needs to be provided by the MCS on all the bridges (A, B1, B2 and C) within the referenced network of Figure I.1.

I.4 ELP removal keeping protection path

In this scenario, the ELP configuration is removed but the ETH SNC is not removed and the ELP protection path is used by the ETH SNC after ELP configuration has been removed.

The initial configuration, provided by the MCS, can be either the *elp-configuration.zip* or the *elp-add.zip*: the latter contains VLAN registration for bridge port 3 on node A and bridge port 1 on node C while the former does not.

The MCS should perform the following configuration on the head-end node A:

1. Update VLAN registration and force the traffic on the protection path
    - Configure, if not yet present, the VLAN registration on bridge port 4
    - Remove, if present, the VLAN registration on bridge port 3
    - Apply a forced switch external commands to force the traffic to take the protection path
2. Remove Ethernet linear protection configuration (after VLAN 100 has been registered on bridge port 4 and force switch has been applied to avoid hit on the traffic)
3. Remove the MEGs (no longer referenced by the removed Ethernet linear protection)
    - Remove the MEG monitoring the working transport entity
    - Optionally remove also the MEG monitoring the protection transport entity

A similar configuration should be provided by the MCS on node C.

The *unprotected-protection.zip* show the configuration that needs to be provided by the MCS on all the bridges (A, B1, B2 and C) within the referenced network of Figure I.1.

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