International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.8032/Y.1344

Amendment 1

(04/2009)

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

Ethernet ring protection switching

Amendment 1: Interconnection of Ethernet rings

Recommendation ITU-T G.8032/Y.1344 (2008) – Amendment 1

ITU-T

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Recommendation ITU-T G.8032/Y.1344

Ethernet ring protection switching

Amendment 1

Interconnection of Ethernet rings

Summary

Amendment 1 contains additional material to be incorporated into Recommendation ITU-T G.8032/Y.1344, Ethernet ring protection switching. It presents enhancements to support interconnection of G.8032 Ethernet rings.

Source

Amendment 1 to Recommendation ITU-T G.8032/Y.1344 (2008) was approved on 22 April 2009 by ITU-T Study Group 15 (2009-2012) under Recommendation ITU-T A.8 procedures.

FOREWORD

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Recommendation ITU-T G.8032/Y.1344

Ethernet ring protection switching

Amendment 1

Interconnection of Ethernet rings

1) Scope

This amendment provides updated material pertaining to Ethernet ring protection switching as described in Recommendation ITU-T G.8032/Y1344. It presents enhancements to support interconnection of G.8032 Ethernet rings.

2) New clauses to clause 3.2

Add new clauses with the following text:

3.2.6 interconnection node: An interconnection node is an Ethernet ring node which is common to two or more Ethernet rings.

3.2.7 sub-ring: A sub-ring is an Ethernet ring which is connected to another ring or network through the use of interconnection nodes. On their own, the sub-ring links do not form a closed physical loop. A closed loop may be formed by the sub-ring links and the link between interconnection nodes that is controlled by other ring or network.

This version only supports topologies with a single ring link between the interconnection nodes on the ring where a sub-ring connects to.

3.2.8 R-APS virtual channel: The R-APS virtual channel is the R-APS channel connection between two interconnection nodes of a sub-ring over a network or other ring. Its connection characteristics (e.g., path, performance, etc.) are influenced by the characteristics of the network (e.g., ring) providing connectivity between the interconnection nodes.

3.2.9 sub-ring link: A sub-ring link is a span (e.g., link/port) connecting adjacent sub-ring nodes that are under the control of the ERP control process of the sub-ring.

3) Clause 6

Change the last paragraph of clause 6 as follows:

The Ethernet rings could support a multi-ring/ladder network that consists of conjoined Ethernet rings by one or more interconnected nodes. The protection switching mechanisms and protocol defined in this Recommendation shall be applicable for multi-ring/ladder network, if the following principles are followed:

– R-APS channels are not shared across ring interconnections;
– On each link, each traffic channel and each R-APS channel are controlled (e.g., for blocking or flushing) by the ERP control process of only one ring;
– Each ring or sub-ring must have one RPL.

4) Clause 7.3

Add the following text to the end of the clause:

In case of ring interconnection of G.8032 sub-rings to G.8032 rings, the R-APS messages of one sub-ring that is inserted into the R-APS virtual channel will take on performance characteristics (e.g., delay, jitter, packet drop probability, etc.) of the links and nodes it crosses over the interconnected ring. In this case, if the R-APS channel and R-APS virtual channel exceed the number of nodes or fibre circumference defined before, the protection switching of the sub-ring may exceed 50 ms.

5) Clause 9.7

Replace clause 9.7 with the following:

9.7 Protection switching model for interconnection

This model supports the multi-ring/ladder topologies as those illustrated in Appendix II.

Figure 9-5 depicts an example of the ring protection model on a multi-ring/ladder network defined in this Recommendation. If the multi-ring/ladder network is in its normal condition, the RPL Owner Node of each ring blocks the transmission and reception of traffic over the RPL for that ring. Figure 9-5 presents the configuration when no failures are present on any ring link.

In Figure 9-5, there are two interconnected rings. Ring ERP1 is composed of nodes A, B, C and D and by the links between these nodes. Ring ERP2 is composed of nodes C, D, E and F and by the links C-to-F, F-to-E, E-to-D. The link between D and C is used for traffic of rings ERP1 and ERP2. On their own, ERP2 links do not form a closed physical loop. A closed loop may be formed by the ring links of ERP2 and the link between interconnection nodes that is controlled by ERP1; ERP2 is a sub-ring. Node A is RPL Owner Node for ERP1, Node E is RPL Owner Node for ERP2. The nodes (Nodes A and E) are responsible for blocking the traffic channel on the RPL for ERP1 and ERP2, respectively. There are no restrictions to which link on a ring may be defined as RPL. For example, the RPL of ERP1 could be defined as the link between node C and node D.

Nodes C and D, connecting ERP1 and ERP2, are called the interconnection nodes. The ring links between the interconnection nodes are controlled and protected by the ERP ring they belong to. In the example of Figure 9-5, the link between nodes C and D is part of ERP1, and as such controlled and protected by ERP1. The ETH characteristic information (ETH_CI) traffic corresponding to the traffic channel may be transferred over a common ETH_C function for ERP1 and ERP2 through the interconnection nodes C and D. Interconnection nodes C and D have separate ERP control processes for each ring.

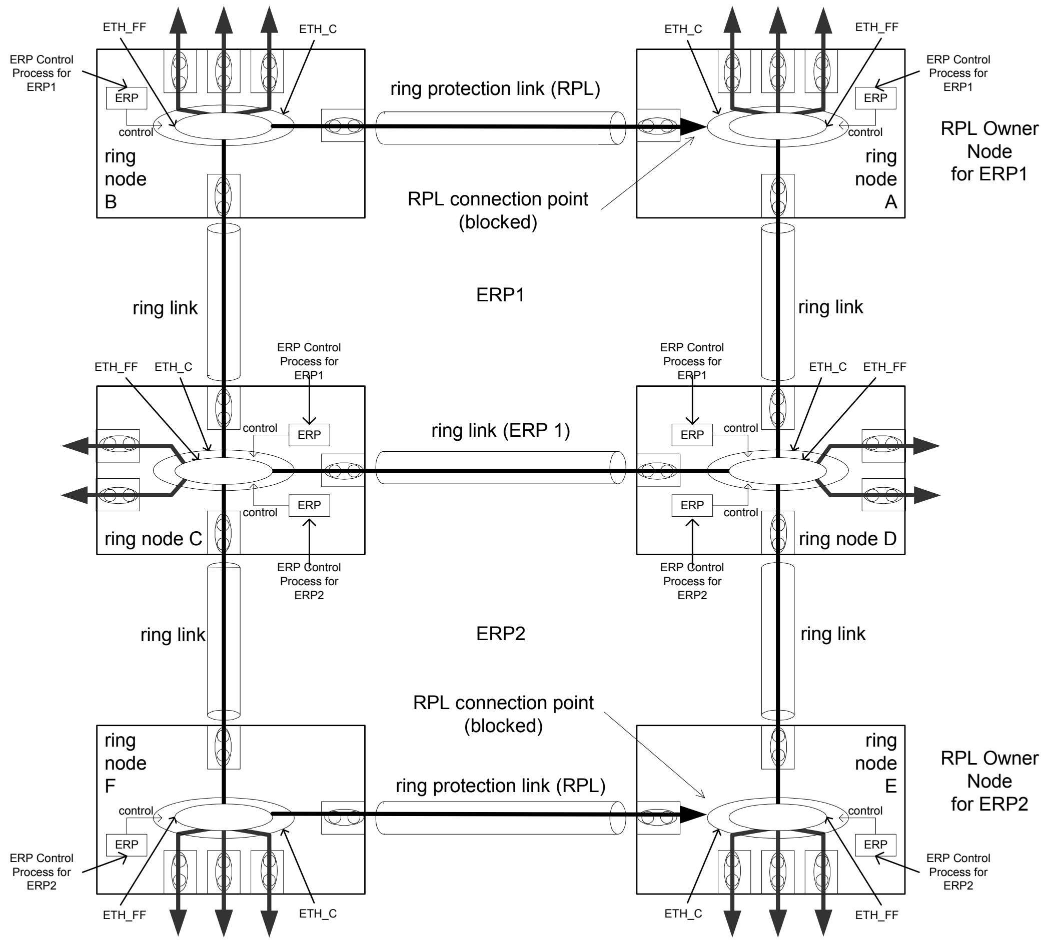

Figure 9-5 – Ethernet ring interconnection architecture – Normal condition (multi-ring/ladder network)

Figure 9-6 illustrates a situation where protection switching has occurred due to a signal-fail condition on the link between interconnection nodes C and D. The failure of this link triggers protection only on the ring it belongs to, in this case ERP1. The traffic and R-APS channels are blocked bidirectionally on the ports where the failure is detected and bidirectionally unblocked at the RPL connection point on ERP1. The traffic channels remain bidirectionally blocked at the RPL connection point on ERP2. This prevents the formation of a loop.

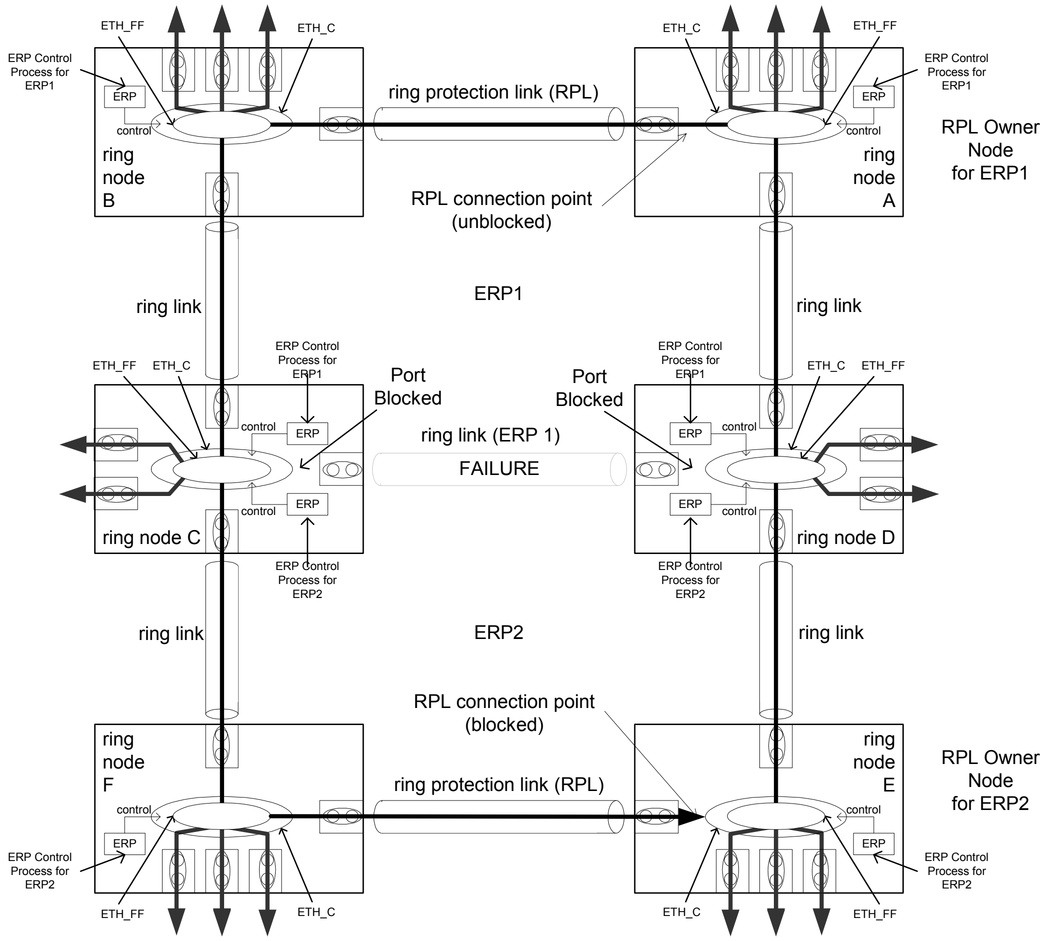

Figure 9-6 – Ethernet ring interconnection architecture – Signal fail condition on a link between interconnection nodes (multi-ring/ladder network)

The interconnection nodes include functions to support the two rings. Nodes C and D have a set of functions similar to Figure 9-4 to support ring ERP1. Sub-ring ERP2 on these nodes only controls and protects one ring link; for this reason, the model required to support ring ERP2 on these nodes is as represented in Figure 9-7.

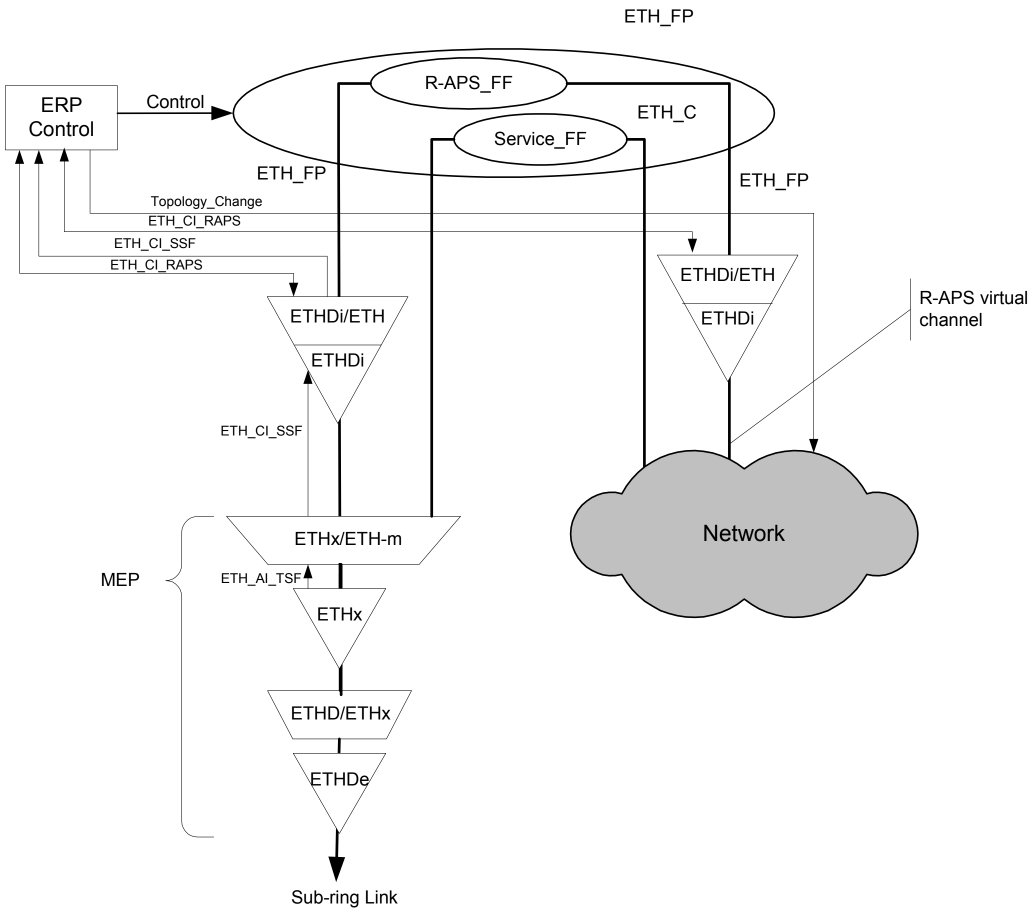

Figure 9-7 – MEPs and R-APS insertion function in sub-ring interconnection node

For the sub-ring, the connectivity at the interconnection node is provided between a sub-ring link and the domain of another network; in the example illustrated in Figure 9-5, this network corresponds to ring ERP1. An R-APS virtual channel provides R-APS connectivity between this interconnection node and the other interconnection node of the same sub-ring, over the network. The R-APS virtual channel may follow the same path as the traffic channel over the network. ERP control function of the sub-ring is capable to receive and insert R-APS messages over the R-APS virtual channel.

R-APS messages of this sub-ring that are forwarded over its R-APS virtual channel are broadcasted or multicasted over the interconnected network. For this reason, the broadcast/multicast domain of the R-APS virtual channel could be limited to the necessary links and nodes. For example, the R-APS virtual channel could span only the interconnecting rings or sub-rings that are necessary for forwarding R-APS messages of this sub-ring. Care must be taken to ensure that the local R-APS messages of the sub-ring being transported over the R-APS virtual channel into the interconnected network can be uniquely disambiguated from those of other interconnected ring R-APS messages. This can be achieved, for example, using separate VIDs for R-APS virtual channels of different sub-rings.

Sub-ring topology changes may impact flow forwarding over the domain of the other network, as such topology change events are signalled to the domain of the other network using the Topology_Change signal. It is out of scope of this Recommendation to define the use of Topology_Change signal by other technologies such as STP or VPLS.

Figure 9-8 represents the model of an interconnection node combining the functions required to support the two rings.

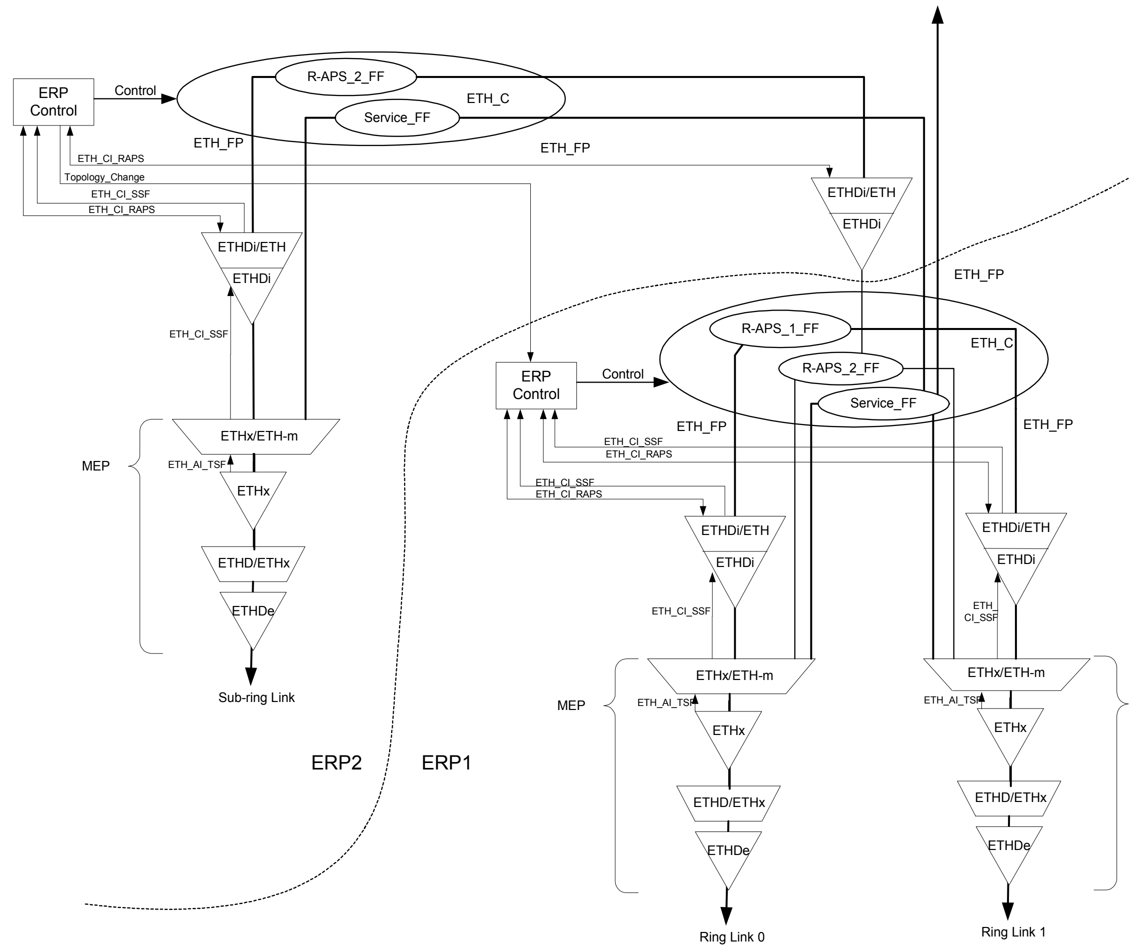

Figure 9-8 – MEPs and R-APS insertion function in interconnection node (different R-APS VIDs)

The MEPs on ring link 0 and on ring link 1 are used for monitoring the ring links of ERP1. The MEP on the sub-ring link monitors the ring link of the sub-ring ERP2. In the model of this figure, R-APS channels are separated in ERP1 using different R-APS VIDs. Ring APS messages for ERP1 are received on ring link 0 or ring link 1 and separated based on the VID used for R-APS_1 flow at the ETHx/ETH-m_A function. The ETHDi/ETH_A functions extract ETH_CI_RAPS information from the received RAPS PDUs and send the ETH_CI_RAPS information to the ERP control process of ERP1. The R-APS messages of the sub-ring received on ring link 0 and on ring link 1 are separated based on the VID used for R-APS_2 flow at the ETHx/ETH-m_A function, they are then forwarded by the R-APS_2-FF function to the ETHDi/ETH_A function where it extracts ETH_CI_RAPS information from the received RAPS PDUs and sends the ETH_CI_RAPS information to the ERP control process of ERP2. If not blocked at the ETH_C function of ERP2, these messages are then further transmitted to the sub-ring port.

The R-APS VID of ERP2 may be considered as protected traffic spanning all ring links of ERP1, being blocked on the links of ERP1 by the same function that blocks the traffic channel on the links of that ring. Figure 9-8 is only one example, other options for the construction of the R-APS virtual channel may be used.

NOTE – Other solutions for the construction of the R-APS virtual channel are for further study.

Service traffic may be forwarded between any of the three ring ports, or even other ports. This forwarding is also subject to the blocking state of the ring and sub-ring ports as defined by the respective ERP control functions.

Topology_Change signal is generated from ERP2 to ERP1 control process whenever ring ERP2 performs a protection switching event that results in a topology change, this occurs when a flush is generated for the ERP2 termination node. Depending on the configuration, this signal may be used by the ERP1 control process to initiate actions to also trigger a topology update over nodes on ring ERP1.

6) Clauses 10.1

Replace the existing Figure 10-1:

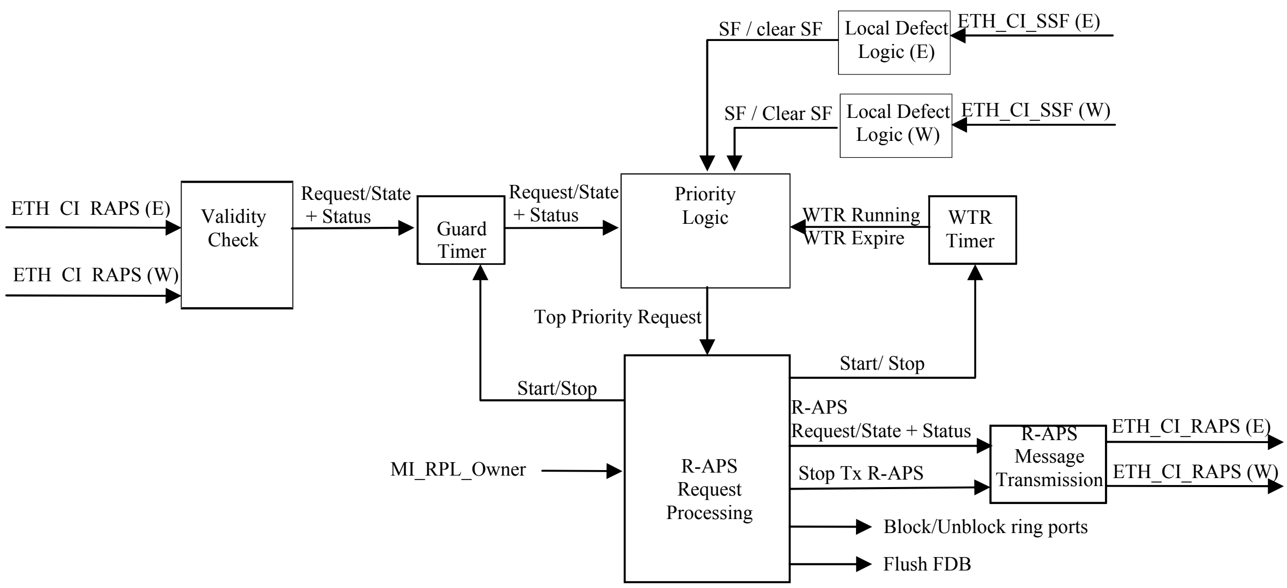

Figure 10-1 – Decomposition of Ethernet ring protection control process
(Old figure)

with the following new Figure 10-1:

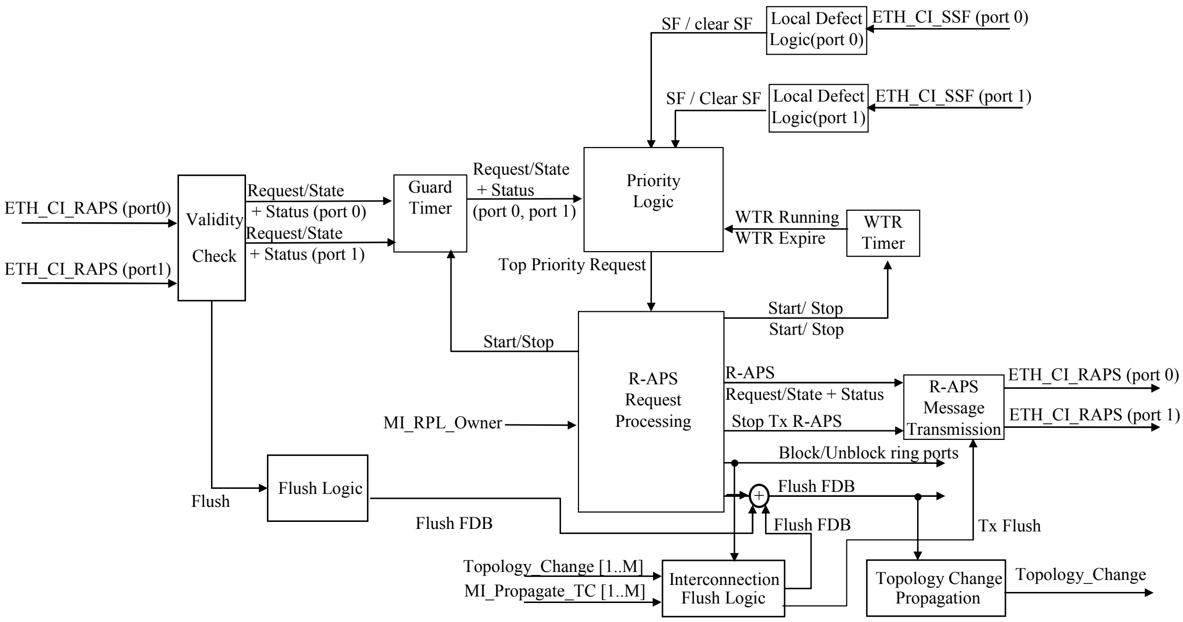

Figure 10-1 – Decomposition of Ethernet ring protection control process

7) Clause 10.1

Insert the following text to clause 10.1:

a) At the end of the fourth paragraph:

On the ERP control process of a sub-ring interconnection node, only one local defect logic process exists, assigned to the sub-ring link of that node.

b) At the end of the fifth paragraph:

On interconnection sub-ring nodes, the R-APS messages may be received via a sub-ring link or R-APS virtual channel.

c) At the end of the clause:

The flush logic is described in clause 10.1.9. It receives as inputs R-APS requests received over the ring ports. R-APS messages with the encoding of "event" result in triggering flush.

The topology change propagation process is described in clause 10.1.11. It generates a signal to inform the entities of other network domains of topology changes on the sub-ring. This process exists only on the ERP control processes of sub-ring interconnection nodes.

The interconnection flush logic is described in clause 10.1.10. It receives topology change notifications from other connected entities, e.g., a sub-ring ERP control process, and if MI_Propagate_TC is enabled it flushes the FDB for the local ring links and triggers transmission of R-APS event requests to both ring ports. This logic is included on the ERP control processes of the interconnection nodes of Ethernet rings that sub-rings connect to. This logic is not present on nodes which are not interconnection nodes.

8) Clause 10.1.2

Insert the following text at the end of clause 10.1.2:

In the multi-ring/ladder scenario, a failure on the link connecting the interconnection nodes will trigger the above actions only on the ring that it is configured to be part of that ring. In the case of a link failure in one of the sub-rings, protection switching is triggered on the sub-ring(s) that the link is part of. However, in this latter case, when the link between the interconnection nodes is blocked (for whatever reason), this may cause the propagation of the flush event as described in clause 10.1.10.

9) Clause 10.1.3

Insert the following text at the end of clause 10.1.3:

On interconnection nodes of a sub-ring, the R-APS frames are always transmitted over the sub-ring link and the R-APS virtual channel. This is in general also applied in cases where transmission of messages is described to be performed over "both ports" .

The transmission of R-APS "event" messages is performed only as a single burst of three messages, i.e., it is not continuously repeated beyond this burst. Contrary to other messages, the transmission of this message is done in parallel to other existing transmissions. It does not stop the transmission of other messages and is not stopped by the transmission of other messages. Flush messages are R-APS "event" messages transmitted using Reserved 1 field with value "0000" and with Status field with value "00000000" .

10) Clause 10.1.6

Insert the following text at the end of clause 10.1.6:

When an R-APS frame is received with Request/State field = "1110", and Reserved 1 field is "0000" and Status field has value "00000000", the flush indication is signalled to the flush logic. It is disabled after a period of 10 ms. R-APS messages with Request/State field = "1110" are not forwarded towards guard timer.

11) New clauses to clause 10.1

Add the following clauses to clause 10.1:

10.1.9 Flush logic

Flush logic triggers a FDB flush action when it receives a flush indication from Validity Check.

10.1.10 Interconnection flush logic

Interconnection flush logic receives as inputs the topology change signal Topology_Change[1..M] and the MI_Propagate_TC[1..M] management information, where M is the number of sub-rings connected to the interconnection node. When the following conditions are fulfilled:

- one of these Topology_Change signals toggles from disabled to enabled, and
- the corresponding MI_Propagate_TC management information is enabled,

a Flush FDB action is triggered. When this Flush FDB action is triggered and if any of the nodes ring links is blocked, then a transmission of a burst of three R-APS "event" messages is triggered over the R-APS channel of the ring where the sub-ring is connected. MI_Propagate_TC accepts the values enabled and disabled. The default value of the MI_ Propagate_TC shall be disabled.

Topology_Change [1..M] and MI_ Propagate_TC [1..M] have the same multiplicity as the number of sub-rings connected to the ring instance controlled by this ERP control process.

10.1.11 Topology change propagation

Topology change propagation sets the Topology_Change signal to true, when a topology change occurs in a sub-ring as a result of protection switching events. When a Flush FDB action is triggered by the ERP control process of the sub-ring, it enables the Topology_Change signal for this sub-ring and transmits this signal to the interconnection flush logic (see clause 10.1.10) of the ERP control process that belongs to the ring which the sub-ring is connected to.

12) Clause 10.3

a) Add a new row between the row of "1011" and the row of "0000" to Table 10-3:

1110	Event

b) Insert the following text at the end of clause 10.3:

Reserved 1 field and Status field are encoded as all zeroes when transmitting R-APS messages with Request/State encoding of "1110".

c) Replace the description of Reserved 1 field by the following:

Reserved 1 (4 bits) – This field is reserved for future extension of requests or for indication of protection type. In the current version of this Recommendation, this field shall be encoded as "0000". This field is verified to be encoded as "0000" upon reception for R-APS messages with Request/State encoding of "1110". It is ignored upon reception for other messages.

d) Replace the description of Status Reserved field by the following:

Status Reserved (6 bits) – For future specification. This field shall be transmitted encoded all zeroes. This field is verified to be encoded as "0000" upon reception for R-APS messages with Request/State encoding of "1110". It is ignored upon reception for other messages.

13) New Appendix V

Add the following new Appendix V:

Appendix V

Ring protection network objectives for multi-ring/ladder network

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

The following are objectives for multi-ring/ladder network protection.

1) Multi-ring/ladder network should not require changes to the single ring protection mechanism. Although there may be a need to add features to the APS protocol, the basic messages and interactions should not be affected.
2) When a link used for traffic of both rings fails, it is necessary to prevent formation of a super loop, as would be the case if both rings served the role of protection at the same time.
3) A signal failure on a link between interconnection nodes (when the ring is in idle state) should only trigger protection switching within the ring where the link failed; other rings should be unaware of the event.
4) The solution adopted for interconnected rings shall allow the operation of transforming one ring into a sub-ring interconnected to another ring without decommissioning the services already supported on the first ring. It is acceptable that this operation may result in temporary traffic interruption due to protection switching events that result from reconfiguration of the rings. It is also acceptable that during the operation, new link failures are not correctly protected.

14) New Appendix VI

Add the following new Appendix VI:

Appendix VI

Interconnected rings example

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

Figure VI.1 represents an example of a topology composed of two interconnected rings. The lower ring is a sub-ring.

The R-APS channel of ring A is consistent with the definition of ITU-T G.8032.

The R-APS channel of the sub-ring is complemented by the use of the R-APS virtual channel to enable R-APS channel connectivity between sub-ring ERP control processes of the two interconnection nodes.

The link between the two interconnection nodes is under the control of the ERP control processes of ring A. These entities will be responsible to trigger protection switching events upon the failure of this link, and will perform block and unblock operations for traffic on that link. The sub-ring is not aware of the existence of such an operation.

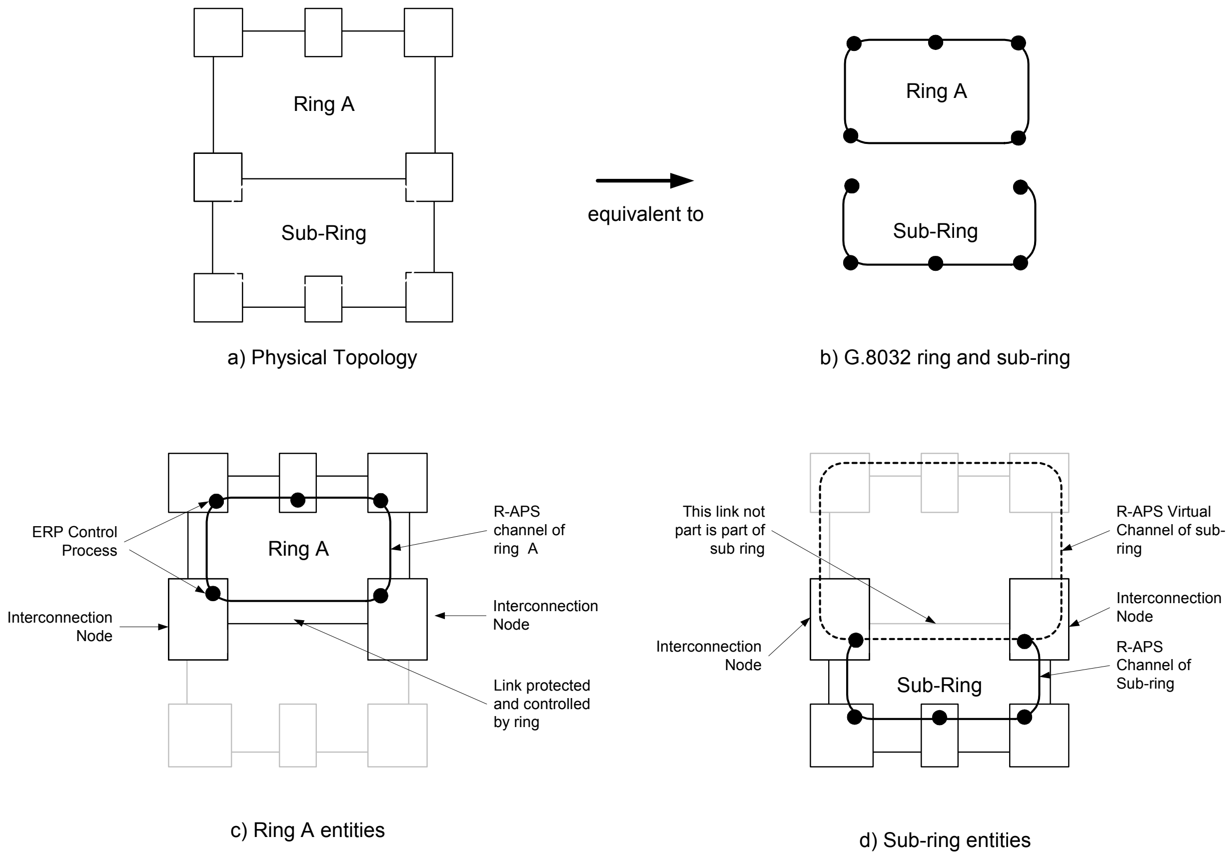

Figure VI.1 – Interconnected rings example

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