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Ethernet ring protection switching

ITU-T G-series Recommendations – Supplement 52



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Supplement 52 to ITU-T G-series Recommendations

Ethernet ring protection switching

Summary

Supplement 52 to ITU-T G-series Recommendations provides supplemental information to Recommendation ITU-T G.8032/Y.1344, *Ethernet ring protection switching*. It provides examples of network application scenarios, Ethernet service support, ring interconnection examples, guidelines for configuration and management procedures, protection switching for multiple Ethernet ring protection (ERP) instances and end-to-end network/service resiliency involving ITU-T G.8032.

History

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Supplement 52 to ITU-T G-series Recommendations

Ethernet ring protection switching

1 Scope

This supplement describes how [ITU-T G.8032] can support the various Ethernet services and how it can be used in various network applications. Additionally, examples of Ethernet ring interconnection, guidelines for configuration and management procedures, protection switching for multiple Ethernet ring protection (ERP) instances and end-to-end network/service resiliency involving [ITU-T G.8032], are described.

This supplement is intended to consolidate and expand upon related material that is current in [ITU-T G.8032].

2 References

- [ITU-T G.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks*.
- [ITU-T G.806] Recommendation ITU-T G.806 (2009), *Characteristics of transport equipment – Description methodology and generic functionality*.
- [ITU-T G.808.1] Recommendation ITU-T G.808.1 (2010), *Generic protection switching – Linear trail and subnetwork protection*.
- [ITU-T G.809] Recommendation ITU-T G.809 (2003), *Functional architecture of connectionless layer networks*.
- [ITU-T G.870] Recommendation ITU-T G.870/Y.1352 (2010), *Terms and definitions for optical transport networks*.
- [ITU-T G.8001] Recommendation ITU-T G.8001/Y.1354 (2010), *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.1306 (2004), *Ethernet service characteristics*.
- [ITU-T G.8011.1] Recommendation ITU-T G.8011.1/Y.1307.1 (2009), *Ethernet private line service*.
- [ITU-T G.8011.2] Recommendation ITU-T G.8011.2/Y.1307.2 (2009), *Ethernet virtual private line service*.
- [ITU-T G.8013] Recommendation ITU-T G.8013/Y.1731 (2008), *OAM functions and mechanisms for Ethernet based networks: Amendment 1 (2010)*.
- [ITU-T G.8021] Recommendation ITU-T G.8021/Y.1341 (2011), *Characteristics of Ethernet transport network equipment functional blocks*.
- [ITU-T G.8031] Recommendation ITU-T G.8031/Y.1342 (2011), *Ethernet linear protection switching*.
- [ITU-T G.8032] Recommendation ITU-T G.8032/Y.1344 (2012), *Ethernet ring protection switching*.

- [IEEE 802.1ag] IEEE Std 802.1ag-2007, *IEEE Standard for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks – Amendment 5: Connectivity Fault Management.*
- [IEEE 802.1D] IEEE Std 802.1D-2004, *IEEE Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges.*
- [IEEE 802.1Q] IEEE Std 802.1Q-2005, *IEEE Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks.*
- [IEEE 802.3] IEEE Std 802.3-2008, *Information Technology – Local and Metropolitan Area Networks – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.*
- [MEF 6.1] The Metro Ethernet Forum, MEF Technical Specification (2008), *Ethernet Services Definitions Phase 2, April, 2008.*

3 Terms and definitions

3.1 Terms defined elsewhere

This supplement uses the following terms defined elsewhere:

3.1.1 Terms defined in [ITU-T G.806]:

- a) defect
- b) failure
- c) server signal fail (SSF)
- d) signal degrade (SD)
- e) signal fail (SF)
- f) trail signal fail (TSF)

3.1.2 Terms defined in [ITU-T G.809]:

- a) adaptation
- b) flow
- c) layer network
- d) network
- e) port
- f) transport
- g) transport entity

3.1.3 Terms defined in [ITU-T G.870]:

- a) APS protocol
- b) hold-off time
- c) non-revertive operation
- d) protection
- e) protected domain
- f) revertive operation
- g) signal
- h) switch
- i) switching time

- j) transport entity:
 - a. protection transport entity
 - b. working transport entity
- k) wait-to-restore time

3.1.4 Terms defined in [ITU-T G.8001]:

- a) maintenance entity (ME)
- b) maintenance entity group (MEG)
- c) Ethernet ring
- d) Ethernet ring node
- e) ERP instance
- f) interconnection node
- g) major ring
- h) R-APS virtual channel
- i) ring MEL
- j) ring protection link (RPL)
- k) RPL neighbour node
- l) RPL owner node
- m) sub-ring
- n) sub-ring link
- o) wait to block timer

3.1.5 Terms defined and described in [ITU-T G.8010] and [ITU-T G.8013]:

- a) maintenance entity group end point (MEP)
- b) maintenance entity group level (MEL)

3.1.6 Terms defined and described in [ITU-T G.8011]:

- a) Ethernet virtual connection (EVC)

4 Abbreviations and acronyms

This supplement uses the following abbreviations and acronyms:

APS	Automatic Protection Switching
CCM	Continuity Check Message
CE	Customer Equipment
CPE	Customer Premises Equipment
E-LAN	Ethernet LAN Service
E-Line	Ethernet Line Service
EPL	Ethernet Private Line
ERP	Ethernet Ring Protection
E-services	Ethernet services
E-Tree	Ethernet Tree Service
EVC	Ethernet Virtual Connection



FDB	Filtering Database
FS	Forced Switch
ID	Identification
IP	Internet Protocol
IPTV	Internet Protocol Television
LAN	Local Area Network
MAC	Media Access Control
MEF	Metro Ethernet Forum
MEG	Maintenance Entity Group
MEL	Maintenance Entity Group Level
MEP	Maintenance Entity Group End Point
MI	Management Information
MIP	Maintenance Entity Group Intermediate Point
MPLS	Multiprotocol Label Switching
MPLS-TP	MPLS Transport Profile
MS	Manual Switch
NR	No Request
OAM	Operations, Administration and Maintenance
OTN	Optical Transport Network
PBB-TE	Provider Backbone Bridge Traffic Engineering
PDU	Protocol Data Unit
RAN	Radio Access Network
R-APS	Ring APS
RB	RPL Blocked
RPL	Ring Protection Link
RSTP	Rapid Spanning Tree Protocol
SDH	Synchronous Digital Hierarchy
SF	Signal Fail
SONET	Synchronous Optical Network
STP	Spanning Tree Protocol
TDM	Time Division Multiplexing
UNI	User Network Interface
VID	VLAN Identifier
VLAN	Virtual LAN
VPLS	Virtual Private LAN Service
VR	Virtual Ring

5 Introduction

This supplement provides supplemental information to [ITU-T G.8032], *Ethernet ring protection switching*. It describes ITU-T G.8032 suitability to many network applications (e.g., mobile backhaul, business services, etc.), and how [ITU-T G.8032] can be used to support the various Ethernet services (e.g., E-Line, E-LAN and E-Tree services), as defined by MEF [MEF 6.1], using a common ERP protection switching mechanism. Ring interconnections examples involving ITU-T G.8032 major-rings and sub-rings, and configuration and management procedures in support of service provider network requirements and network applications, are also described.

6 ITU-T G.8032 network applications

The fundamental network requirement to operate an ITU-T G.8032 ring is the existence of a sub-network of network elements interconnected in a closed loop¹, such that there are diversely routed forwarding paths between any two network elements.

Networks are often composed of both diversely routed paths and spurs. A network spur exists when there is only a single network path providing connectivity between network elements. Consequently, spurs by their very nature do not provide diversely routed paths and thus could not leverage ITU-T G.8032. However, spurs typically connect network elements to redundant access or aggregation sub-networks. When these redundant sub-networks use diverse routing for redundancy, ITU-T G.8032 can be deployed to provide all the value propositions of this technology.

The existence of diversely routed sub-networks can be found in network architectures for various applications, such as business services, mobile/wireless backhaul and residential services. These applications can make use of ITU-T G.8032 as an access sub-network or as an aggregation transport infrastructure sub-network.

For example, ITU-T G.8032 is suitable for mobile backhaul network applications. As illustrated in Figure 1, ITU-T G.8032 can be used in the backhaul access, as well as the aggregation network, to provide service connectivity with (sub-50 ms) resiliency.

¹ A "closed loop" is a data path through the network that would result in data traffic looping, without a loop prevention mechanism. A closed loop requires diversely routed paths between two nodes within the network. It should be noted that both a major ring and a sub-ring, from a data path perspective, form a closed loop. However, the R-APS channel of a major ring forms a closed loop while the R-APS channel of a sub-ring does not.

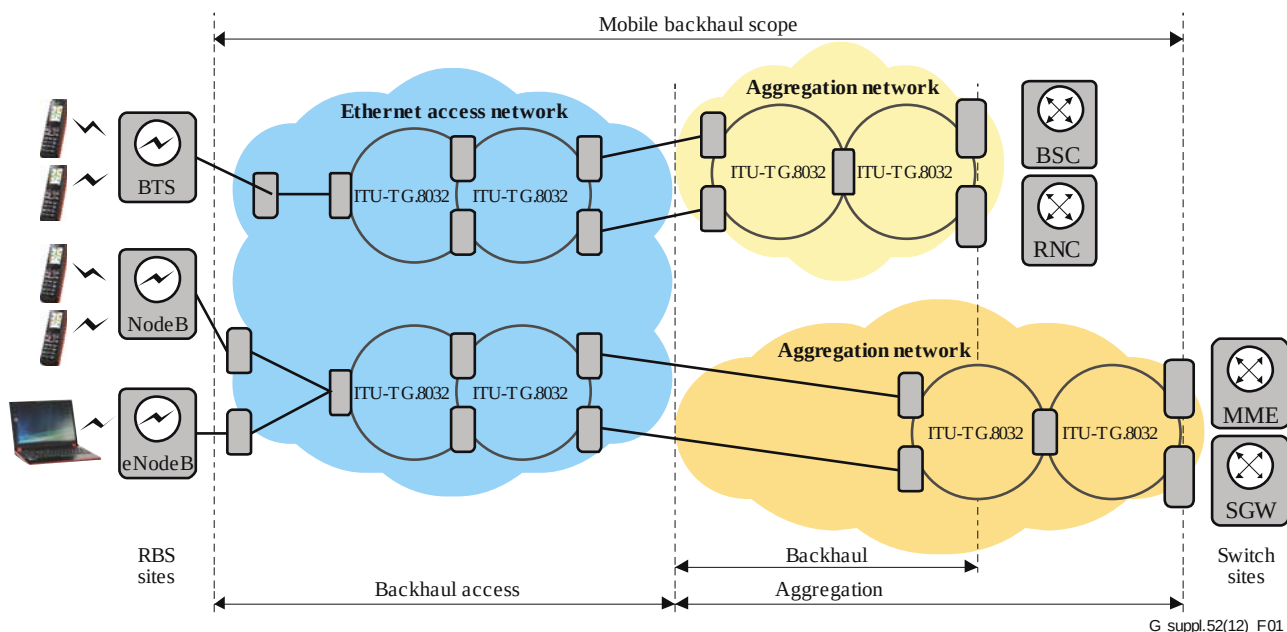


Figure 1 – ITU-T G.8032 mobile RAN and backhaul network application

As illustrated in Figure 2, ITU-T G.8032 can also be applied to business (and residential) services, by providing resilient interconnections within the aggregation network.

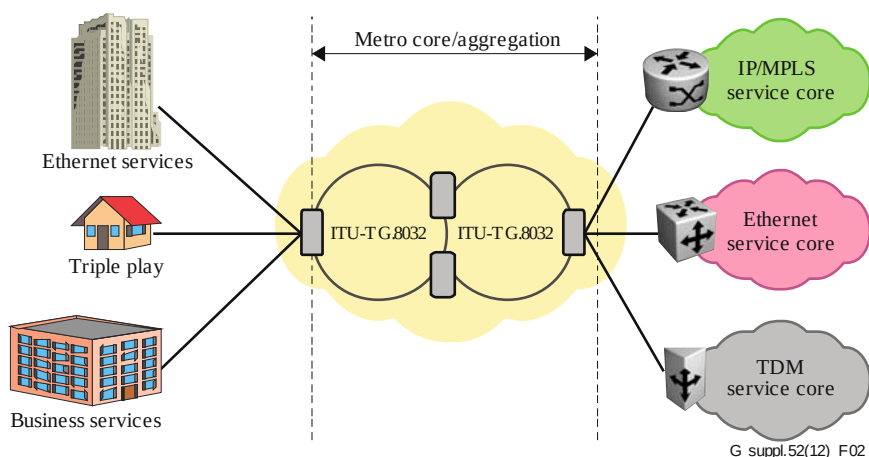


Figure 2 – ITU-T G.8032 business/residential application

7 ITU-T G.8032 support of Ethernet services

7.1 Introduction

[ITU-T G.8032] can be used to support MEF [MEF 6.1] defined E-Line, E-Tree and E-LAN services, along with [ITU-T G.8011] service definitions.

An E-Line service utilizes a point-to-point EVC (between customer UNI points) to provide service connectivity. E-Line services can be used to create Ethernet private lines, virtual private lines and Ethernet Internet access applications. An E-Line service is illustrated in Figure 3.

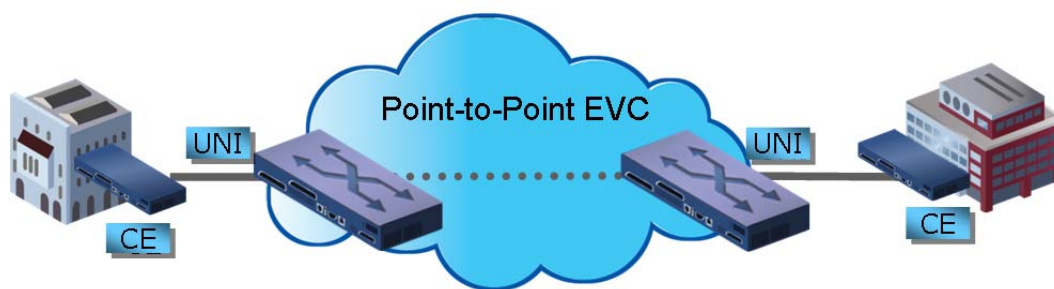


Figure 3 – E-Line service

An E-Tree service enables point-to-multipoint applications with less provisioning than a typical hub and spoke configuration using E-Lines. An E-Tree service provides traffic separation between users with traffic from one "Leaf" being allowed to arrive at one of more "Roots" but never being transmitted to other "Leaf" nodes. E-Tree services are targeted at multi-host and franchised applications where user traffic must be kept invisible to other users. An E-Tree service is illustrated in Figure 4.

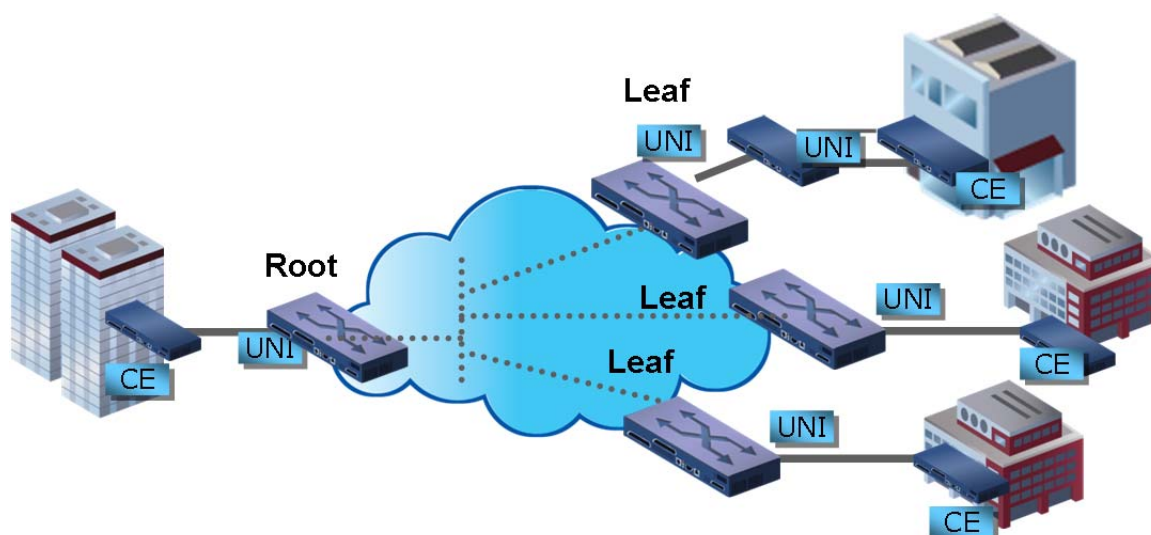


Figure 4 – E-Tree service

An E-LAN service can be used to create multipoint L2 VPNs, transparent LAN services, IPTV and multicast networks, etc. E-LAN services utilize a multipoint EVC, as illustrated in Figure 5.

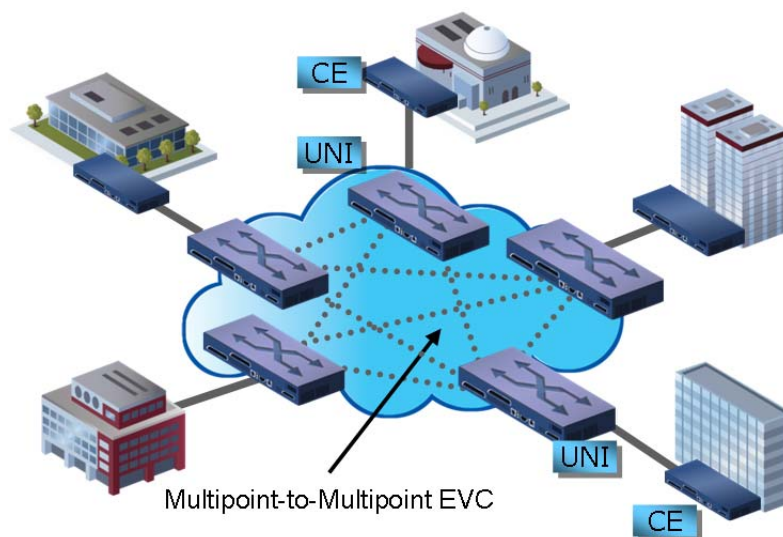


Figure 5 – E-LAN service

7.2 ITU-T G.8032 ring concepts in support of E-services

An ITU-T G.8032 ring is really a logical construct that forms a closed loop over the physical network infrastructure. It can provide (deterministic) rapid protection switching (i.e., sub 50ms). It is client- and server-layer agnostic. The connections between adjacent ring nodes (i.e., the ring spans) are assumed to be bi-directional, and can be a link, a link aggregation group, or a subnet (e.g., MPLS, PBB-TE, OTN, SONET/SDH, etc.)².

An illustration of ITU-T G.8032 [logical] rings, within an example network is illustrated in Figure 6. As illustrated, multiple [logical] rings can be supported over the same physical network infrastructure.

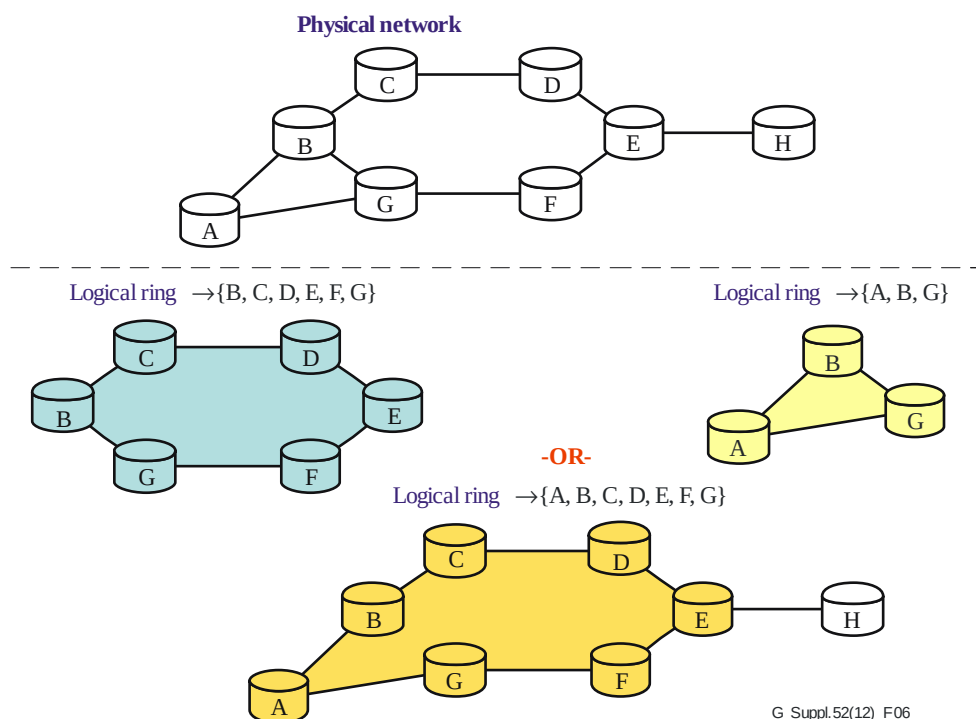


Figure 6 – ITU-T G.8032 [logical] ring

² Ring spans associated with a ring need not be the same bandwidth or server-layer technology.

Multiple ERP instances (i.e., virtual rings³) can be provided over a single ITU-T G.8032 [logical] ring. Each virtual ring is composed of an R-APS channel and a service data channel. The R-APS channel is used to transport the ring control PDUs, while the service data channel is used to transport a defined set of [client] data traffic.

Figure 7 illustrates the R-APS and data channels of a given virtual ring.

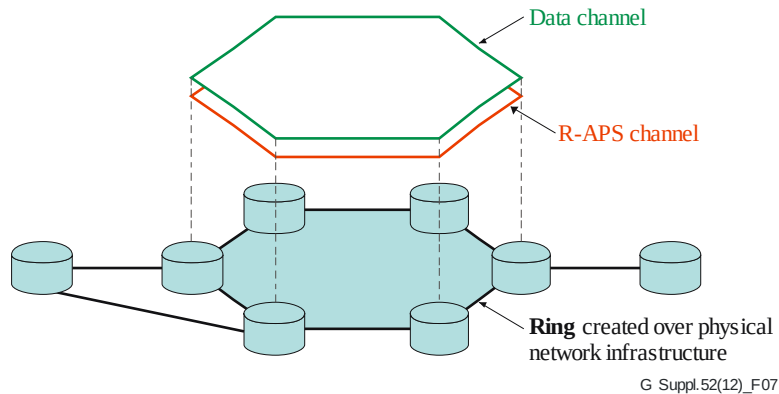


Figure 7 – Virtual ring (ERP instance) composition

Figure 8 illustrates how multiple virtual rings can be created over a single ITU-T G.8032 [logical] ring.

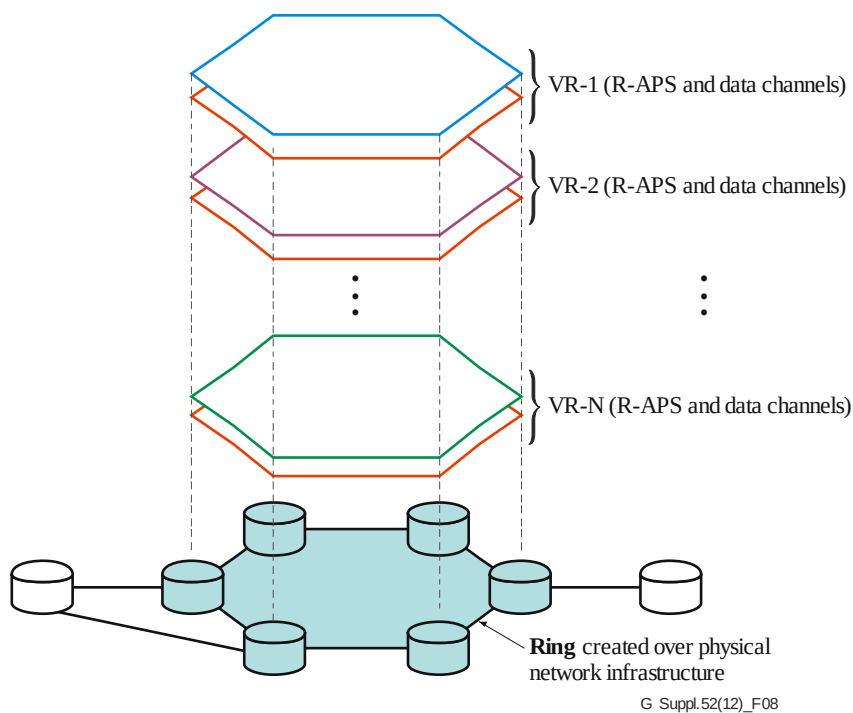


Figure 8 – Multiple virtual rings (ERP instances) → logical ring

As a result of the aforementioned properties of ITU-T G.8032, multiple and diverse E-Services can be supported over the same physical network infrastructure and the same ITU-T G.8032 [logical] ring.

³ A virtual ring (i.e., ERP instance) may be a major ring or a sub-ring.