Ethernet Ring Protection Switching

G.8032 (ERPS)

TEJAS®
N E T W O R K S

Software Enabled Transformation
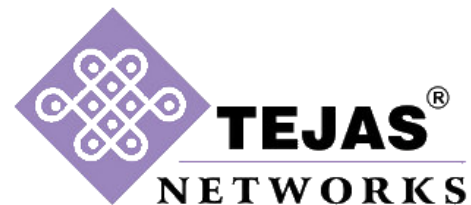
ERPS

- Protection switching on **Ethernet layer**

- Use of Ethernet OAM frames called **R-APS message** for protection behavior

- **Preventing any loops** by blocking mechanism

- VLAN based protection switching

- **Sub-50msec** protection switching

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Multiple ERP Instances (Ringlets) on single ring

- An Ethernet Ring may support multiple traffic channels that may be grouped into different sets of VLANs.

- It is possible to define an ERP instance (Ringlet) as an entity that is responsible for the protection of a subset of the VLANs that transport traffic over the physical ring.

- Each Ringlet is independent of other Ringlets that may be configured on the physical Ethernet Ring.

- When multiple protection Ringlets are configured for an Ethernet Ring, each Ringlets should configure its own RPL, RPL Owner Node, and RPL Neighbour Node.
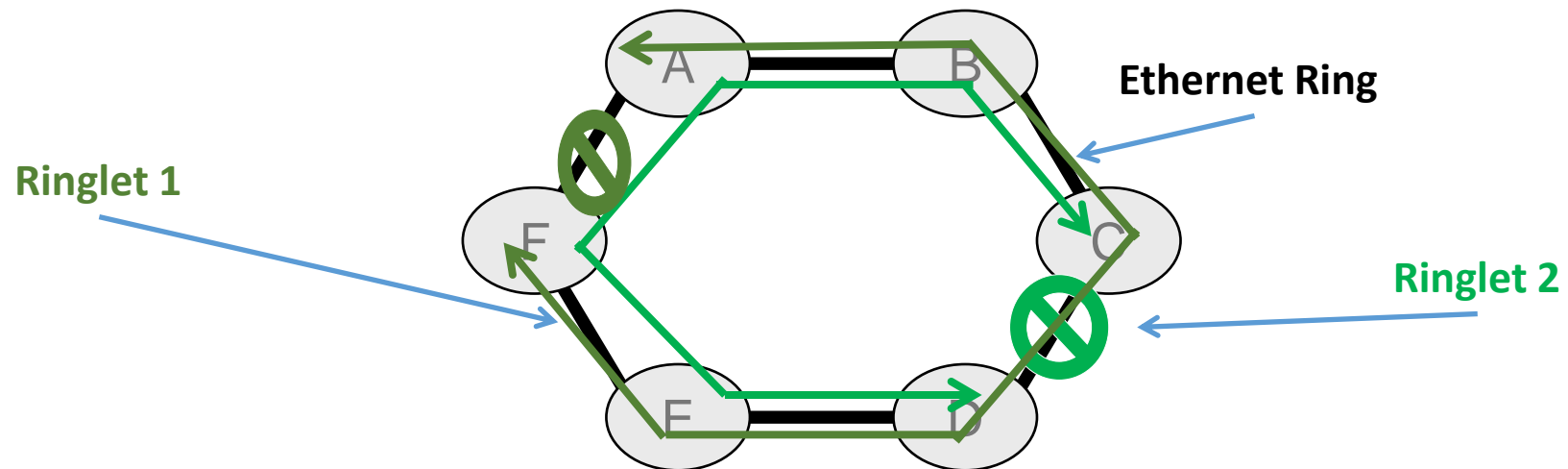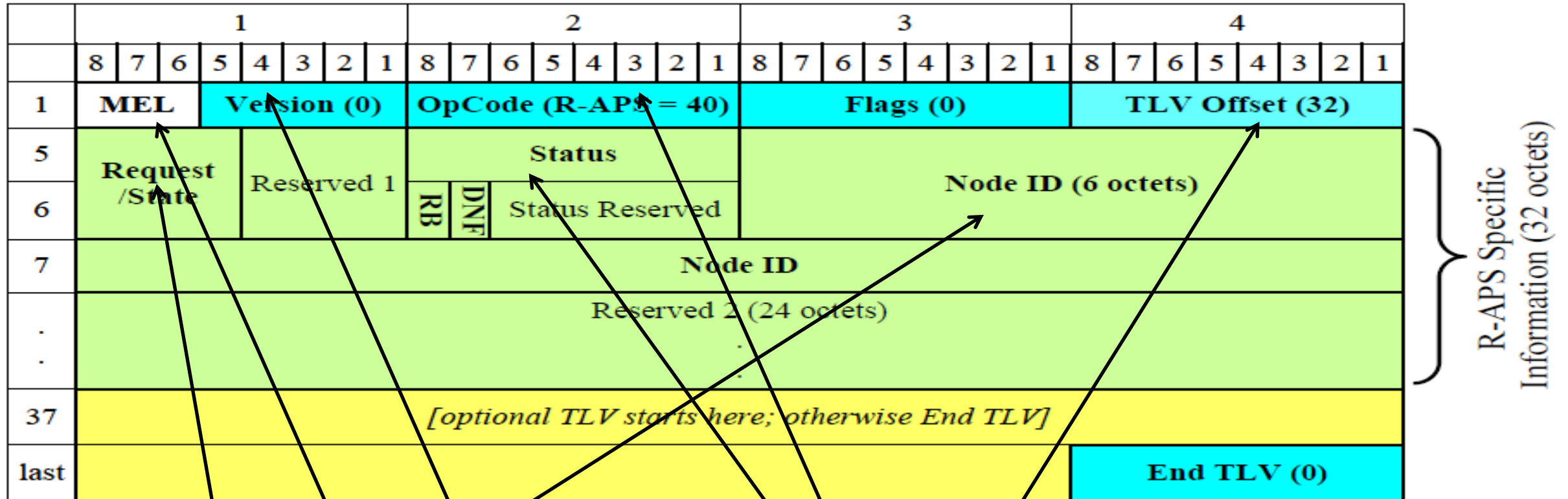
Terms and concepts

- **Ring Protection Link (RPL)** – Link designated by mechanism that is blocked during Idle state to prevent loop on Bridged ring

- **RPL Owner** – Node connected to RPL that blocks traffic on RPL during Idle state and unblocks during Protected state

- **Link Monitoring** – Links of ring are monitored using standard ETH CC OAM messages (CFM)

- **Signal Fail (SF)** – Signal Fail is declared when ETH trail signal fail condition is detected

- **No Request (NR)** – No Request is declared when there are no outstanding conditions (e.g., SF, etc.) on the node

- **Ring APS (R-APS) Messages** – Protocol messages defined in Y.1731 and G.8032

- **Automatic Protection Switching (APS) Channel** - Ring-wide VLAN used exclusively for transmission of OAM messages including R-APS messages

Timers

- **Delay Timers** –Used by the RPL Owner to verify that the network has stabilized before blocking the RPL
  - ➢ After SF condition –Wait-to-Restore timer used to verify that SF is not intermittent
  - ➢ WTB timer may be shorter than the WTR timer

- **Guard Timer** –Used by all nodes when changing state, blocks latent outdated messages from causing unnecessary state changes

- **Hold-off timers** –Used by underlying ETH layer to filter out intermittent link faults
  - ➢ Faults will only be reported to the ring protection mechanism if this timer expires

R-APS PDU format

	1								2								3								4							
	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
1	MEL			Version (0)					OpCode (R-APS = 40)								Flags (0)								TLV Offset (32)							
5	Request /State			Reserved 1					Status								Node ID (6 octets)															
6									RB	DNF	Status Reserved																					
7	Node ID																															
. . .	Reserved 2 (24 octets)																															
37	[optional TLV starts here; otherwise End TLV]																															
last																									End TLV (0)							

R-APS Specific Information (32 octets)

Version: CFM Version (0)   **OPcode**: CFM Opcode (R-APS:40)

MEL: maintenance entity group level (CFM MD level)

Node ID: MAC address of message source node. Informational

TLV Offset: Type Length Value(32)
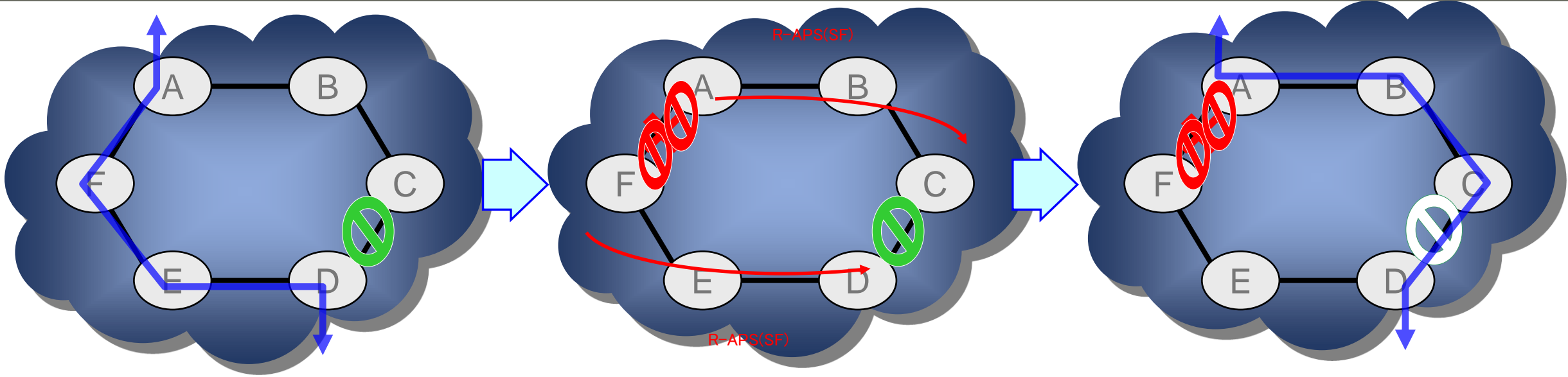
Status: RB->Set when RPL is blocked (used by RPL Owner in NR)

Request/state: 1. Signal Fail->1011

DNF-> Set when FDB Flush is not necessary (Future)

2. No Request->0000

Basic protection mechanism

- Normal condition
  - Block RPL (Ring Protection Link)

- Failure condition
  - Block failed link
  - Send R-APS messages
  - Unblock RPL
  - Perform FDB flush on all ring node as needed

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Basic protection mechanism

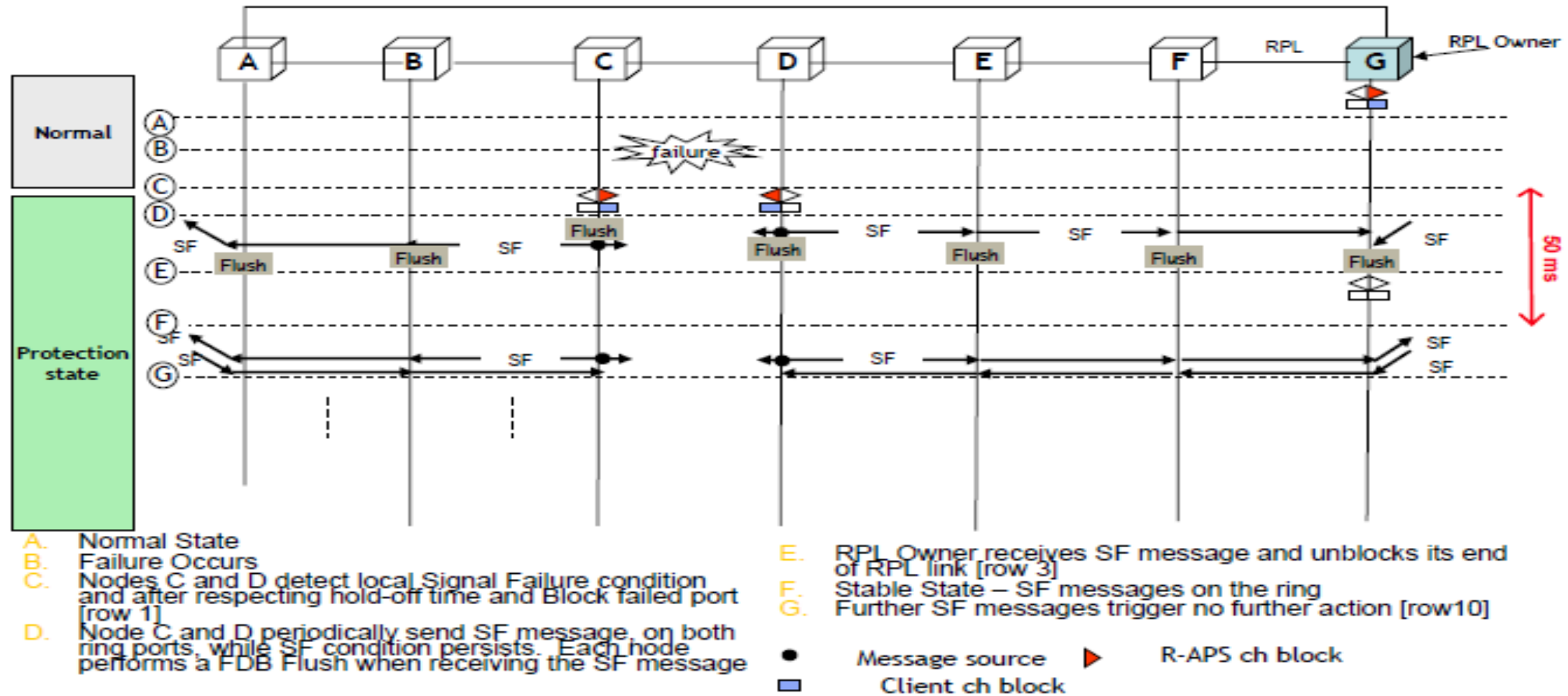R-APS requests control the communication and states of the
ring nodes

- Two basic R-APS messages specified - R-APS(SF) and R-APS(NR)
- RPL Owner may modify the R-APS(NR) indicating the RPL is blocked:
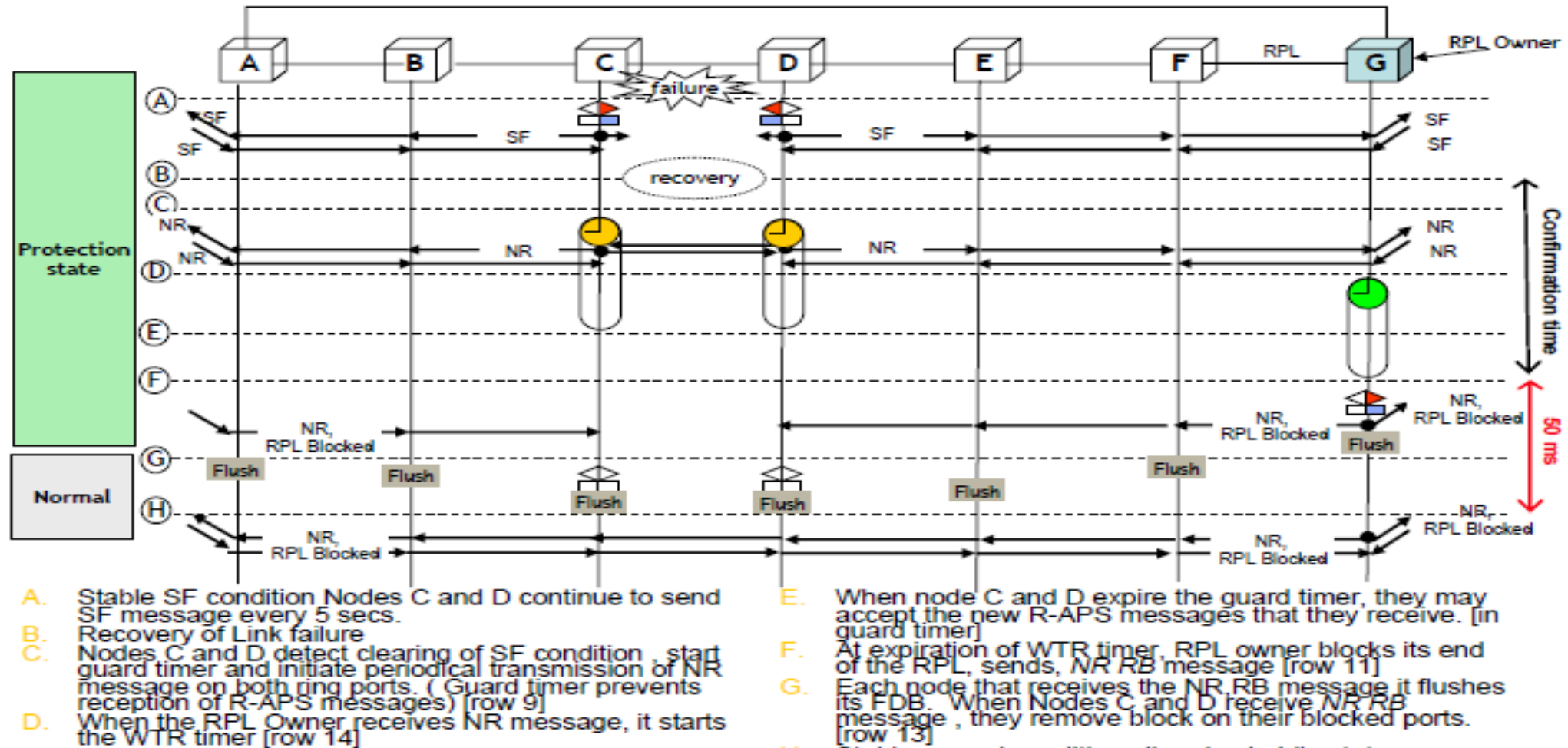 R-APS(NR,RB)

Ring nodes may be in one of two states
Idle – normal operation, no link/node faults detected in ring
Protecting – Protection switching in effect after identifying a signal fault

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From Normal state to Protect state

A. Normal State
B. Failure Occurs
C. Nodes C and D detect local Signal Failure condition and after respecting hold-off time and Block failed port [row 1]
D. Node C and D periodically send SF message, on both ring ports, while SF condition persists. Each node performs a FDB Flush when receiving the SF message

E. RPL Owner receives SF message and unblocks its end of RPL link [row 3]
F. Stable State – SF messages on the ring
G. Further SF messages trigger no further action [row10]

● Message source   ▶ R-APS ch block
▢ Client ch block

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Recovery

A.   Stable SF condition Nodes C and D continue to send SF message every 5 secs.
B.   Recovery of Link failure
C.   Nodes C and D detect clearing of SF condition , start guard timer and initiate periodical transmission of NR message on both ring ports. (Guard timer prevents reception of R-APS messages) [row 9]
D.   When the RPL Owner receives NR message, it starts the WTR timer [row 14]

E.   When node C and D expire the guard timer, they may accept the new R-APS messages that they receive. [in guard timer]
F.   At expiration of WTR timer, RPL owner blocks its end of the RPL, sends, NR RB message [row 11]
G.   Each node that receives the NR,RB message it flushes its FDB. When Nodes C and D receive NR RB message , they remove block on their blocked ports. [row 13]

Interconnected Rings

- Interconnection nodes –are the ring nodes that are common to both interconnected rings (Nodes D & E) in figure

- **Major Ring** –An Ethernet ring that controls a full physical ring and is connected to the Interconnection nodes on two ports, the ring A-B-C-E-D-A in the figure

- **Sub-Ring** –An Ethernet ring that is connected to a Major Ring at the Interconnection Nodes. By itself, the Sub-Ring does not constitute a closed ring. A Sub-Ring is connected to the Interconnection nodes on only one port. The ring D-F-G-H-E in the figure.
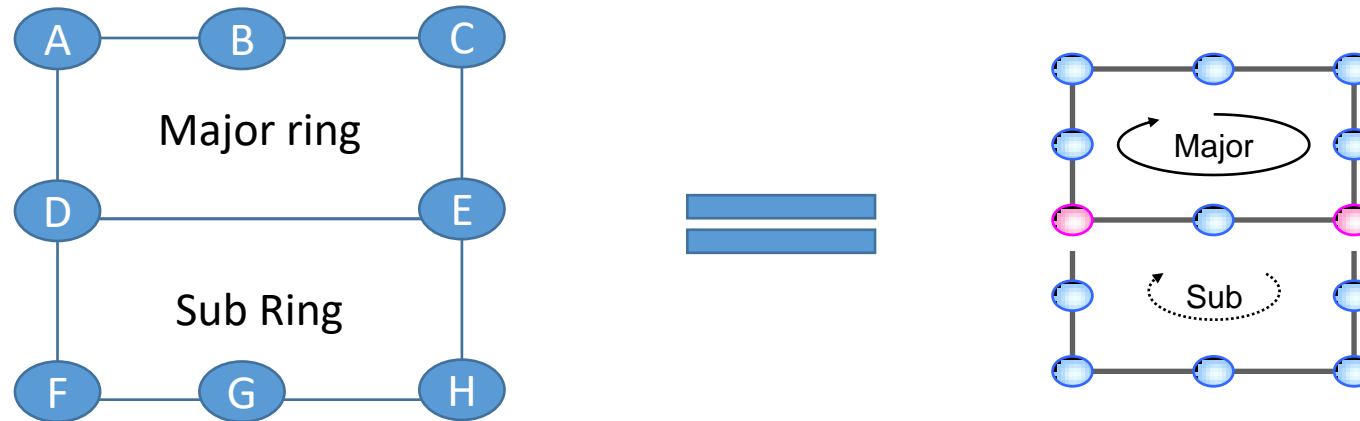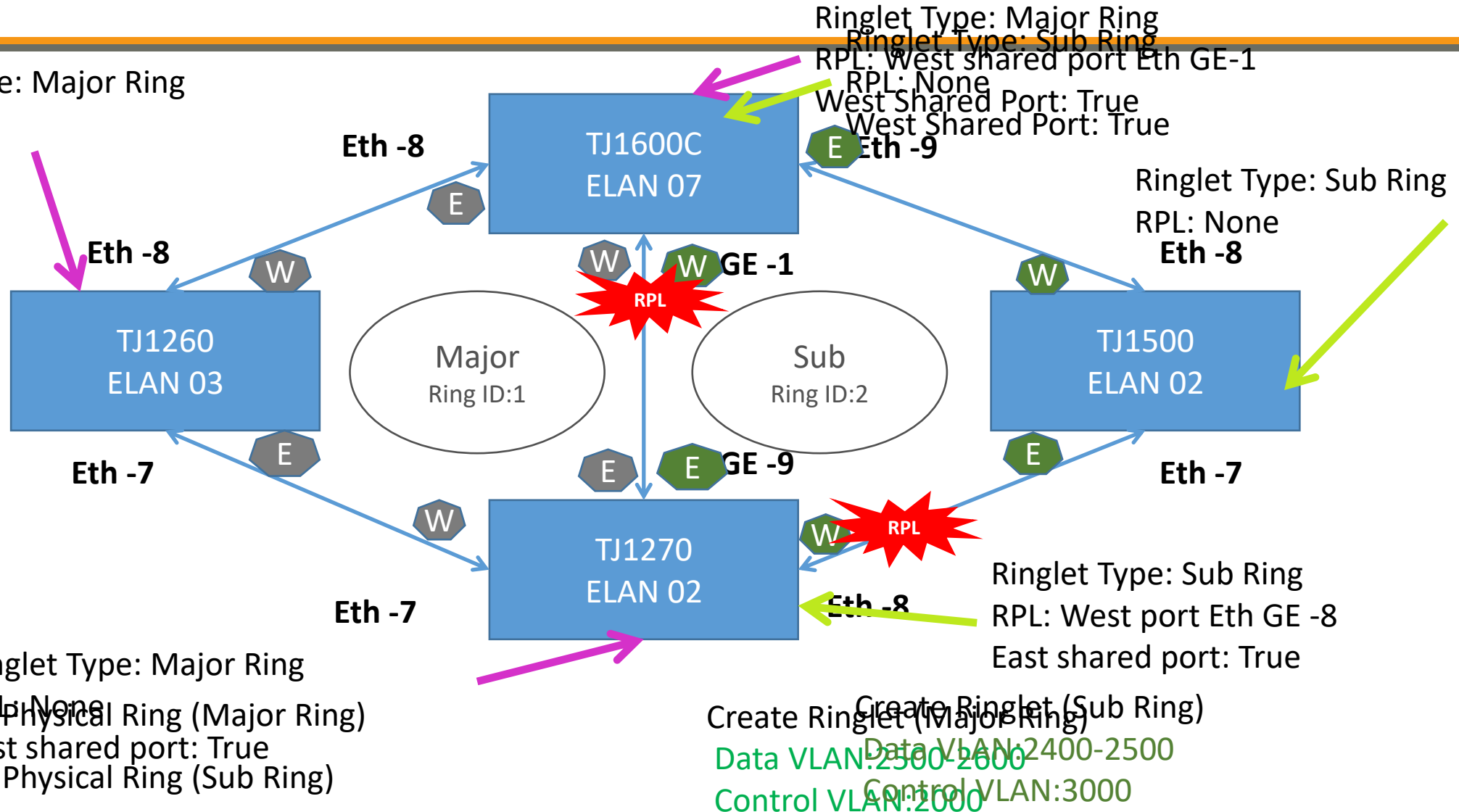
Interconnected Rings

- Sub-Ring does not control or directly transfer R-APS messages over the link between the Interconnection Nodes (this is under the control of the Major Ring)
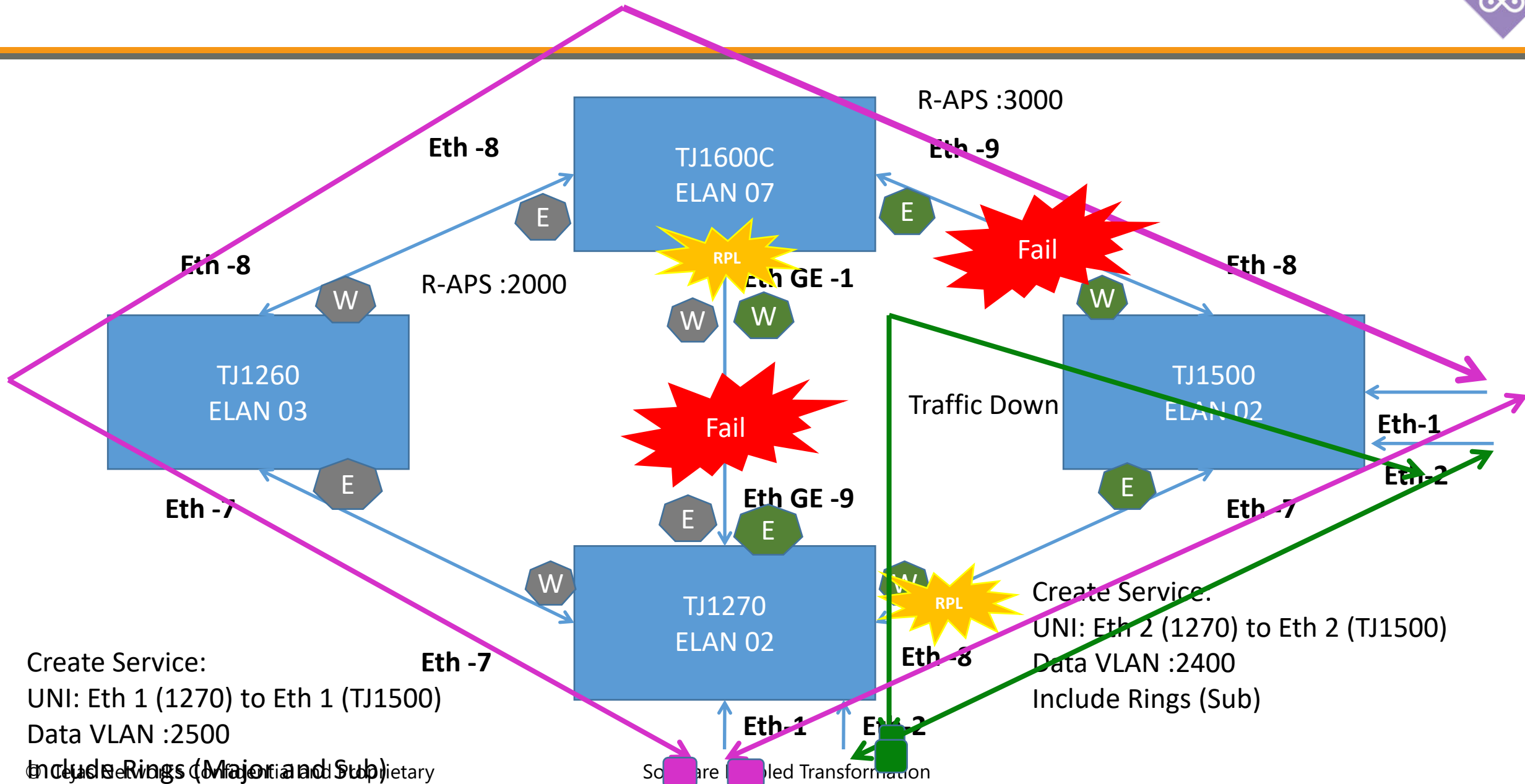
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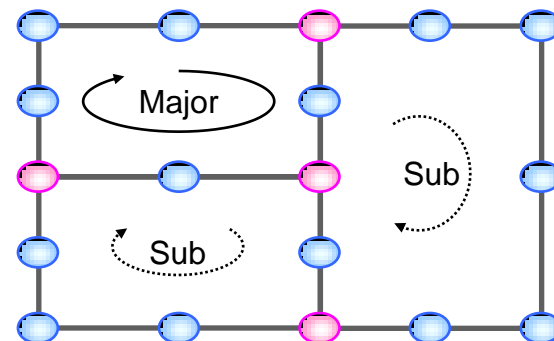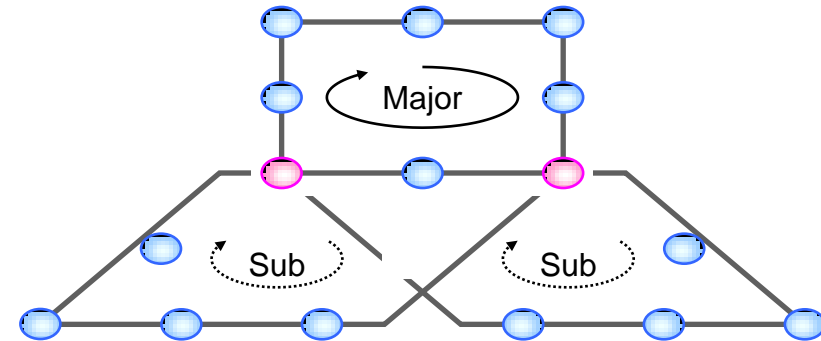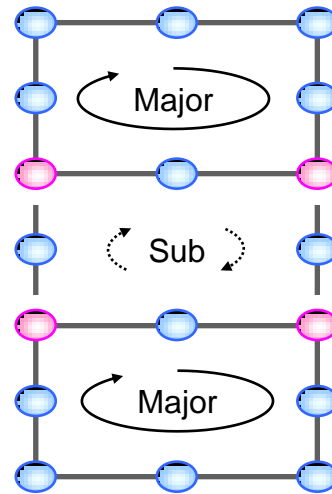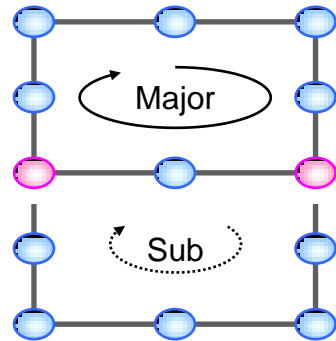
Major and Sub Ring

Ringlet Type: Major Ring
RPL: None

Ringlet Type: Major Ring
RPL: West shared port Eth GE-1
West Shared Port: True

Ringlet Type: Sub Ring
RPL: None
West Shared Port: True

Ringlet Type: Sub Ring
RPL: None

Eth -8

Eth -8

TJ1600C
ELAN 07

Eth -9

W GE -1

W   W

RPL

TJ1260
ELAN 03

Major
Ring ID:1

Sub
Ring ID:2

TJ1500
ELAN 02

Eth -8

Eth -7

E

E   E GE -9

E

Eth -7

W

RPL

TJ1270
ELAN 02

Eth -7

Eth -8

Ringlet Type: Sub Ring
RPL: West port Eth GE -8
East shared port: True

Ringlet Type: Major Ring
RPL: None
Create Physical Ring (Major Ring)
East shared port: True
Create Physical Ring (Sub Ring)

Create Ringlet (Major Ring)
Data VLAN:2500-2600
Control VLAN:2000

Create Ringlet (Sub Ring)
Data VLAN:2400-2500
Control VLAN:3000

Major and Sub Ring

R-APS :3000

Eth -8   TJ1600C   Eth -9
          ELAN 07

Eth -8   RPL   Eth GE -1

R-APS :2000   W   W

                    Fail

TJ1260   TJ1500
ELAN 03   ELAN 02
                                          Eth-1
          Fail
                   Traffic Down   Eth-2

Eth -7   E   E   Eth -7

          Eth GE -9

          TJ1270
          ELAN 02   RPL

Eth -7   Eth -8

Create Service: Create Service:
UNI: Eth 1 (1270) to Eth 1 (TJ1500)   UNI: Eth 2 (1270) to Eth 2 (TJ1500)
Data VLAN :2500   Data VLAN :2400
Include Rings (Major and Sub)   Include Rings (Sub)

          Eth -1   Eth -2

Major and Major Ring

Ringlet Type: Major Ring
RPL: None

Ringlet Type: Major Ring
RPL: West shared port Eth GE-1
West Shared Port: True

Ringlet Type: Major Ring
RPL: None
West Shared Port: True

Ringlet Type: Major Ring
RPL: None

Eth -8

TJ1600C
ELAN 07

E Eth -9

Eth -8

W GE -1

RPL

Eth -8

W

W

E

TJ1260
ELAN 03

Major
Ring ID:1

Major
Ring ID:2

TJ1500
ELAN 02

Eth -7

W

E

E GE -9

W

E

Eth -7

TJ1270
ELAN 02

W

RPL

Eth -7

Eth -8

Ringlet Type: Major Ring
RPL: West port Eth GE -8
East shared port: True

Ringlet Type: Major Ring
RPL: None
East shared port: True
Create Physical Ring (Major Ring 1)
Create Physical Ring (Major Ring 2)

Create Ringlet (Major Ring 1)
Data VLAN:2500-2600
Control VLAN:2000

Create Ringlet (Major Ring 2)
Data VLAN:2400-2500
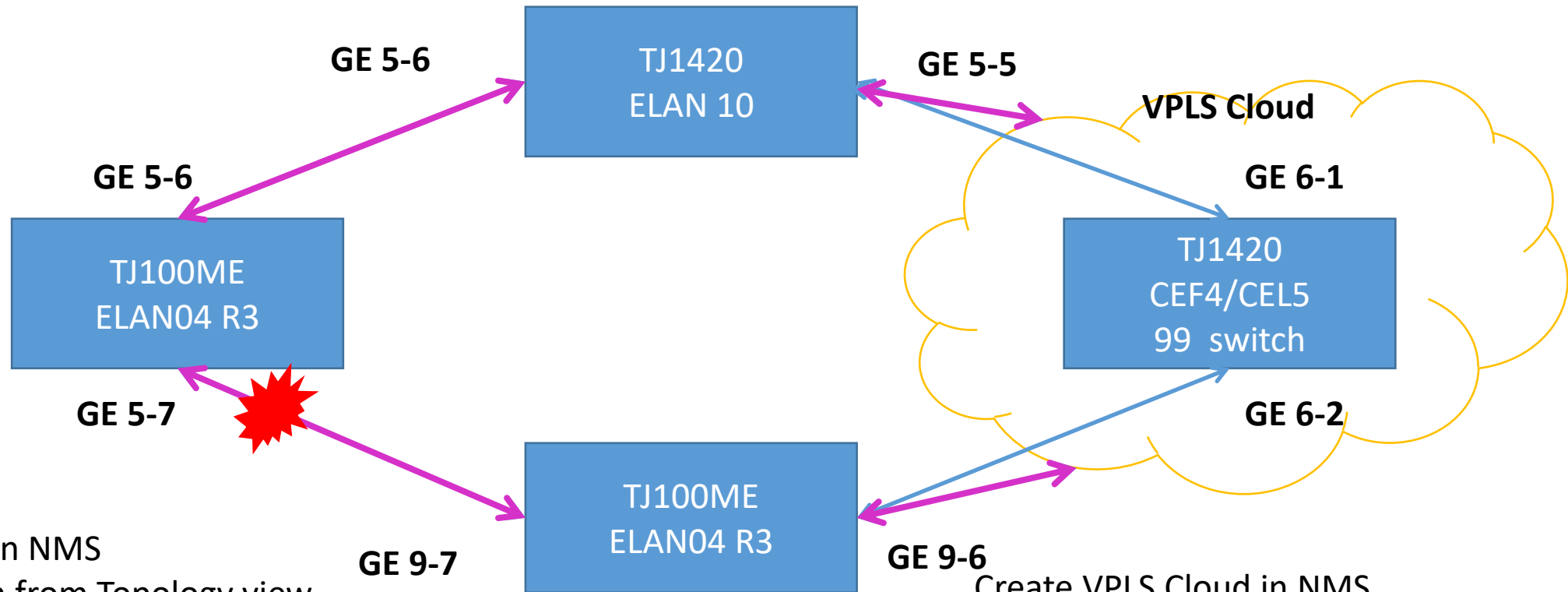Control VLAN:3000

Major and Major Ring
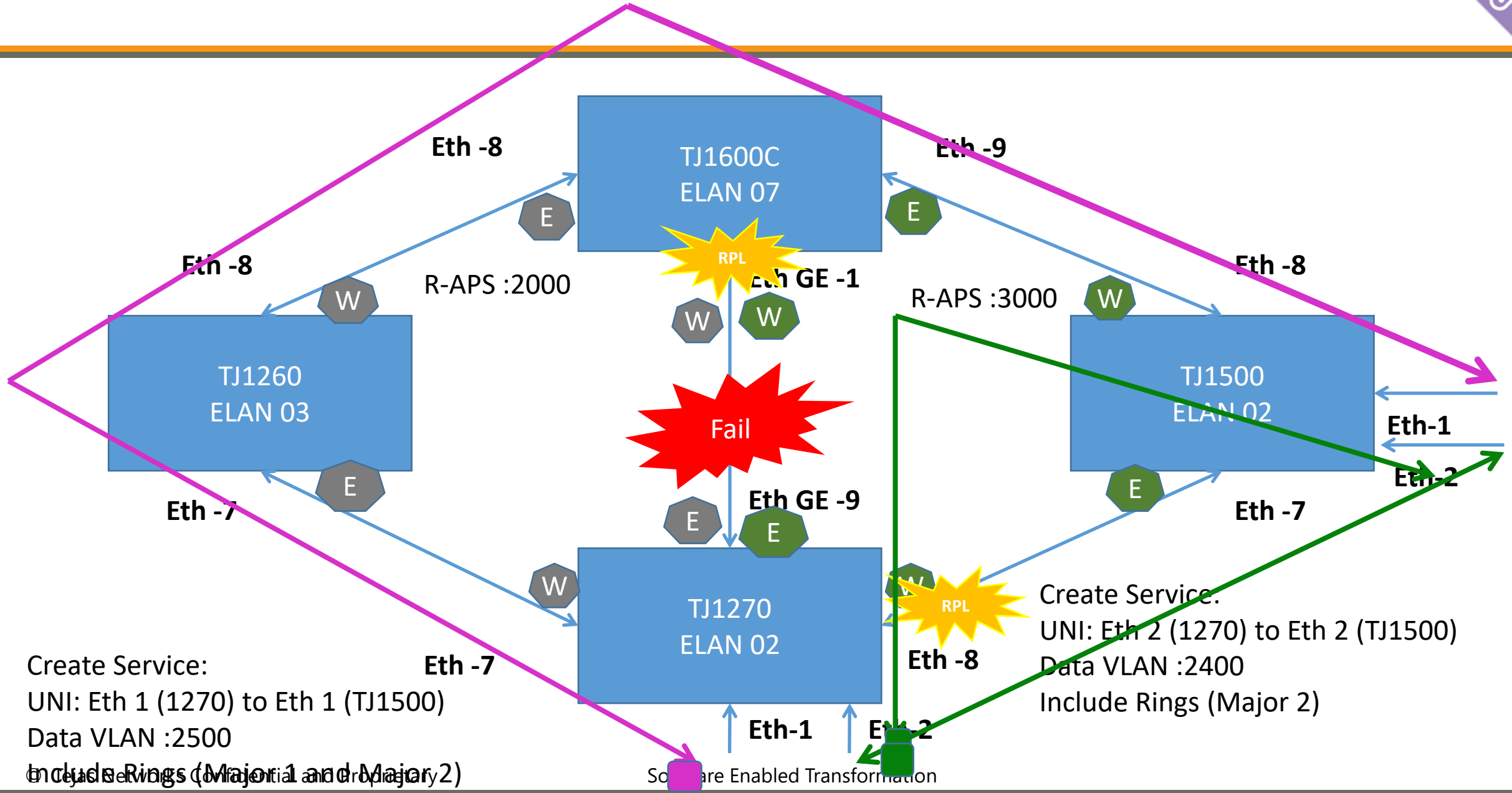
Open Ring

- ERPS can be interconnected with VPLS cloud.

- This could be a rather standard configuration where a redundant access network running ERPS could be interconnected to gateway or aggregation router (VPLS cloud).

- Mostly the gateway or aggregation router is configured in a redundant topology. The traffic from the aggregation network can reach both the active and standby router, and in case of a failure, all the traffic needs to be switching to the standby router.

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Open ring

GE 5-6

TJ1420
ELAN 10

GE 5-5

VPLS Cloud

GE 6-1

GE 5-6

TJ100ME
ELAN04 R3

TJ1420
CEF4/CEL5
99 switch

GE 5-7

GE 6-2

GE 9-7

TJ100ME
ELAN04 R3

GE 9-6

Create Ring in NMS
1.Select path from Topology view
2.Add Ringlet
   Control VID:1500
   Data VLAN:100-200
   Open port VLAN list:100-200
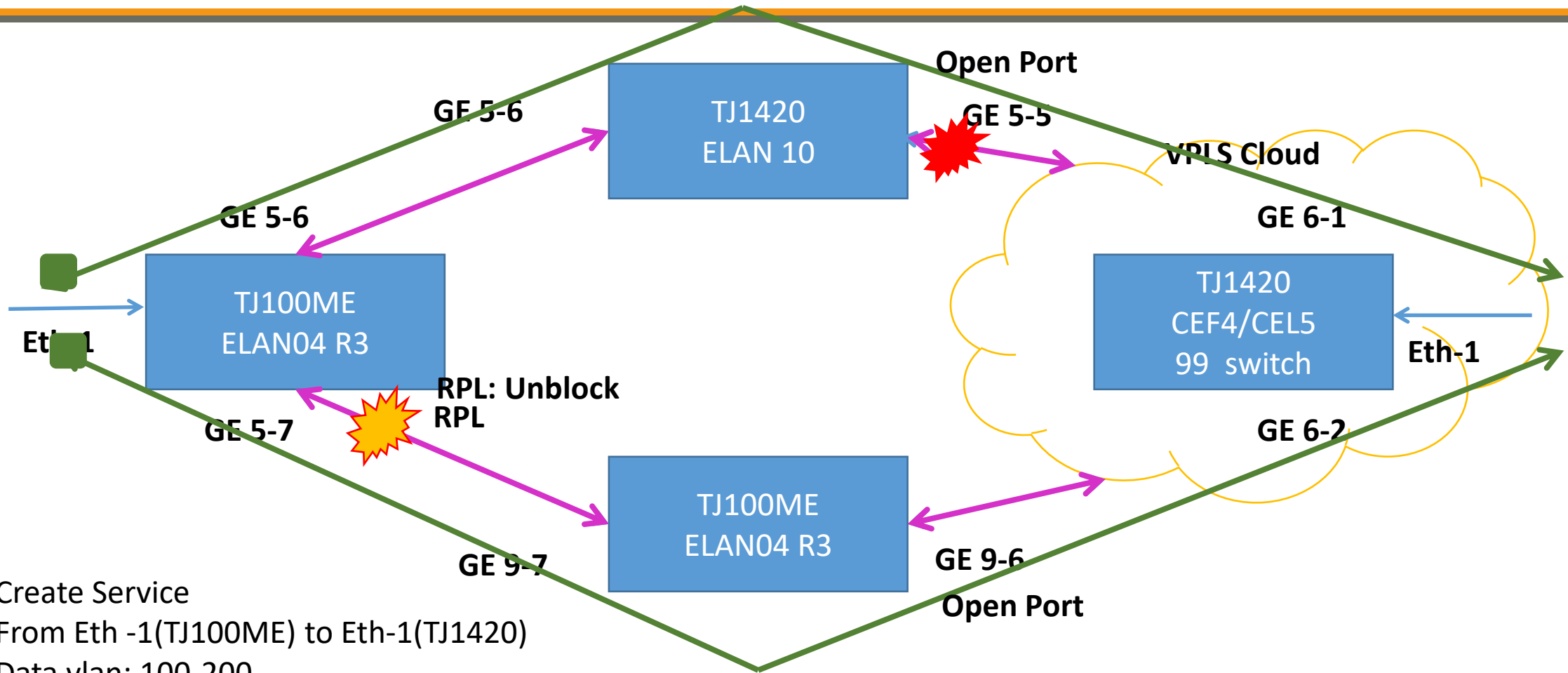   RPL Port: GE 5-7 (TJ100ME)

Create VPLS Cloud in NMS
Source port :GE 5-5(TJ1420)
Destination port: GE 9-6 (TJ100ME)

Open ring

ERPS v2

- Support for interconnected rings with/without R-APS Virtual Channel

- Support for administrative commands (Forced and Manual Switch)

- Revertive and non-revertive behavior upon recovery

- Switching based on Signal Degrade.

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Administrative commands

New revision supports basic operator administrative commands

Forced Switch (FS) – Allows operator to block a particular ring-port Effective even if there is existing SF condition

Multiple FS commands for ring supported

May be used to allow immediate maintenance operations

Manual Switch (MS) – Allows operator to block particular ring-port Not effective if existing FS or SF condition,

Overridden by new FS or SF conditions

Multiple MS commands will cancel all MS commands

Clear – cancels an existing FS or MS command on the ring-port May be used [at RPL Owner] to clear non-revertive mode

Updated R-APS frame

Specific information (32octets) defined by G.8032

- **Request/Status** (4bits) – Indicates the APS message that is being transmitted
- **Sub-code** (4bits) – Used when Request/Status = 1110, otherwise should be all zeros
- **Status – RB** (1bit) – Set when RPL is blocked (used by RPL Owner in NR)
- **Status – DNF** (1bit) – Set when FDB Flush is not necessary (Future)
- **Status – BPR** (1bit) – Identifies the port that is initiating the R-APS message, used by the Flush logic
- **NodeID** (6octets) – MAC address of message source node. Informational
- **Status Reserved** (5bits), **Reserved2** (24octets) - Future development

1								2								3								4							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
Request /State				Sub-code				Status								Node ID (6 octets)															
								RB	DNF	BPR	Status Reserved																				
(Node ID)																															
Reserved 2 (24 octets)																															

Updated State machine

Additional states defined for the State Machine –

Idle (A) – when node is in normal working state

Protecting (B) – when protection switching triggered by SF condition

Forced Switch (C) – when protection switching triggered by FS operator command

Manual Switch (D) – when protection switching triggered by MS operator command

Pending (E) – during recovery, waiting for delay timers

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Thank you

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