G.8032 v2 Ethernet Ring Protection Overview

November, 2009

Agenda

- G.8032 Objectives and Principles
- Revision notes – what has changed
- Interconnected Rings
- Administrative Commands
- Multiple Instances
- Updated R-APS format
- Updated State Machine
- Future enhancements

G.8032 Objectives and Principles

- Use of standard Ethernet and OAM frames around the ring. Ring should support normal Ethernet forwarding behavior, i.e. learning, flooding. STP is not supported on ring ports.
- Prevents loops within the ring by blocking a one of the links (either a pre-determined link or a failed link)
- Monitoring of the ETH layer for discovery and identification of signal failure (SF) conditions
- Protection and recovery switching within 50 ms for typical rings
- Switching due to administrative commands within 50 ms
- Total communication for the protection mechanism should consume a very small percentage of total available bandwidth
- Support for multi-ring/ladder network of conjoined Ethernet Rings by one or more Interconnection Nodes

G.8032 Revision Notes

April 2008 – first revision approved, basic functionality supported

- Loop prevention by use of Ring Protection Link (RPL)
- Support of single ring protection
- Protection against Signal Failure (SF) condition at link or node
- Automatic Protection Switching (APS) protocol for coordination of FDB flushing and switching of blocked link.
- Support of revertive operation upon recovery

January 2009 – Addendum 1 approved, added functionality

- Support for interconnected rings with R-APS Virtual Channel

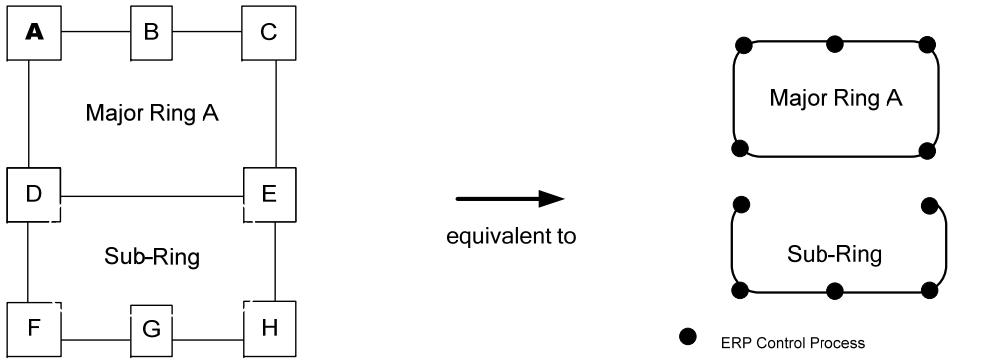
October 2009 – second revision consented, new features

- Support for interconnected rings with/without R-APS Virtual Channel
- Support for administrative commands (Forced and Manual Switch)
- Support for multiple Ring Protection Instances
- Ability to block RPL at both ends of link
- Revertive and non-revertive behavior upon recovery

Interconnected Rings

G.8032 specifies support for a network of interconnected rings. The recommendation defines basic terminology for 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.

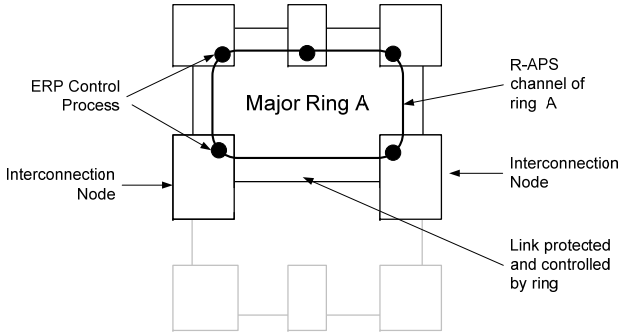


a) Physical Topology

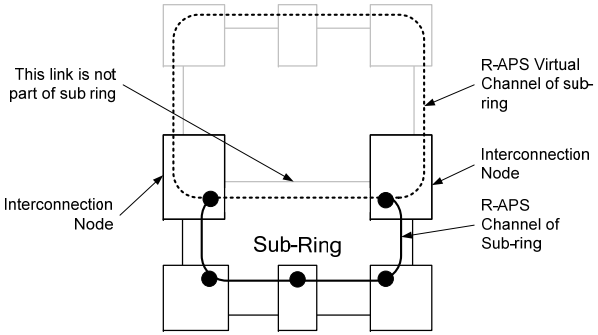
b) Major-Ring and sub-ring

Sub-Rings with R-APS Virtual Channel

- 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)
- One solution supported by the Recommendation is to define that R-APS messages are encapsulated and transmitted over a Virtual Channel on the Major Ring.
- Allows the Sub-Ring to use identical protection mechanism for single ring
- Easily reconfigure Major-Ring into a Sub-Ring when connecting a new ring to the network.



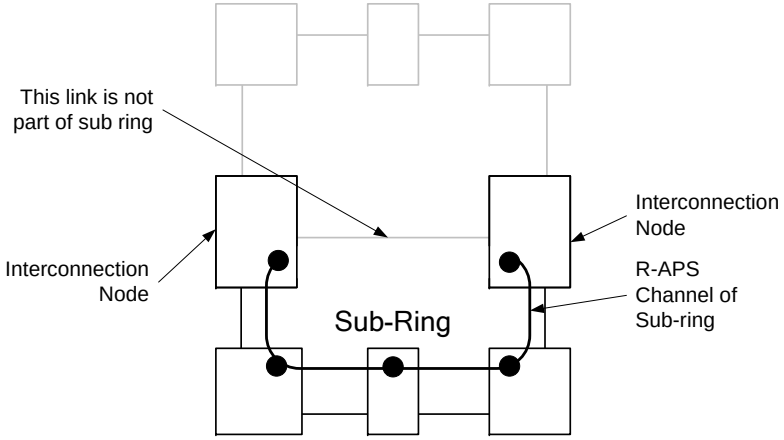
c) Major Ring A entities



d) Sub-ring entity with R-APS virtual channel

Sub-Ring without R-APS Virtual Channel

- Second option for protection of Sub-Ring
  - No side-effects on the interconnected ring or network
  - R-APS messages of the Sub-Ring not affected by Major Ring characteristics
- Sub-Ring R-APS channel is terminated at the Interconnection Nodes
  - To prevent segmentation of the R-APS channel – blocked ports (e.g. RPL) will only block data channel, not the R-APS channel.



e) Sub-ring entity without R-APS virtual channel

Flush Propagation for interconnected rings

- A basic principle of the interconnection mechanism is that switching triggered on the Sub-Ring should be protected by the ERP process of the Sub-Ring and those of the Major Ring should only affect the Major Ring ERP process
- It has been shown through different use cases that there are situations where a protection switching operation on the Sub-Ring may require propagation of FDB Flushing to a subset of the Major Ring nodes.
  - G.8032 specifies propagation of special “Event” R-APS messages to the Major Ring
  - The Interconnection Nodes are responsible to decide, based on Management Information and Status flags, when to propagate these R-APS messages

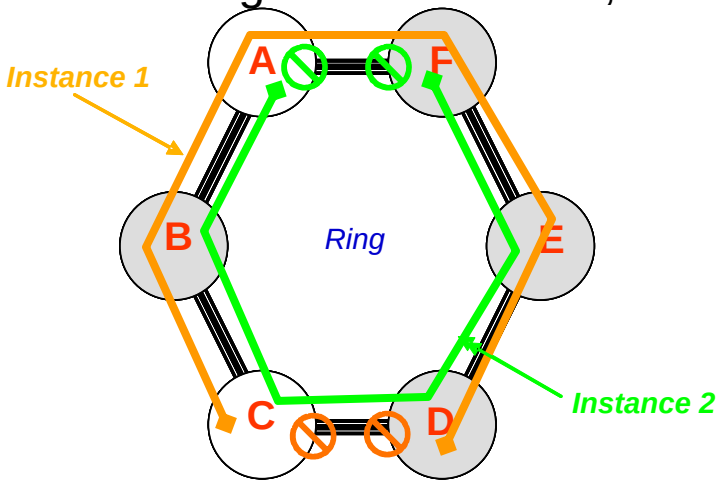
Administrative commands

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

Support of multiple ERP Instances on single ring

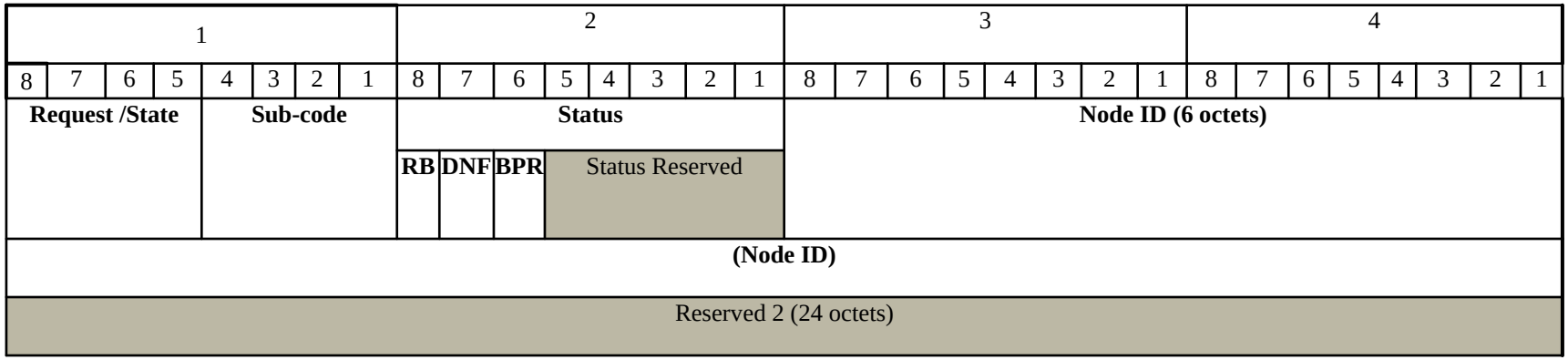
- An Ethernet Ring may support multiple traffic channels that may be grouped into different sets of VLANs.
- It is possible to define an *ERP instance* as an entity that is responsible for the protection of a subset of the VLANs that transport traffic over the physical ring.
- Each Ring instance is independent of other ring instances that may be configured on the physical Ethernet Ring.
- When multiple protection ring instances are configured for an Ethernet Ring, each ring instance should configure its own RPL, RPL Owner Node, and RPL Neighbour Node



Updated R-APS Specific information

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



Updated State Machine

To accommodate the new functionality, the ERP Control Process and State Machine have been updated:

- Additional logical components to ERP Control Process
- 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
- Activation of different timers
- Backward compatibility checking of Administrative commands

G.8032 Timers

G.8032 specifies the use of different timers to avoid race conditions and unnecessary switching operations

- 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
  - After FS/MS command – Wait-to-Block timer used to verify that no background condition exists
  - 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

Future Enhancements

G.8032 will continue to be enhanced. The following topics may be addressed in future versions of the recommendation:

- Enhancements for addressing schemes to allow greater scalability
- Support for Signal Degrade scenarios – SD situations need special consideration for any protection mechanism
- In-depth analysis of different optimizations – e.g. FDB flushing
- Ring topology discovery mechanism
- Dual-homed client access to the ring

Thank You