Thoughts on RPR Protection and Topology Discovery

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Agenda

- **Protection Hierarchy**

- Wrapping vs Steering

- Topology Discovery

Hierarchy - Definition

- **Protection Hierarchy is a set of rules which define various protection request types and the actions which a ring should take when there are multiple requests simultaneously present in the ring**

- **Request types (from highest to lowest priority)**

    Forced Switch (FS) – operator originated

    Signal Fail (SF) – automatic (e.g. LOS, LOF, LAIS, EBER SF, keep-alive fail)

    Signal Degrade (SD) – automatic (e.g. EBER SD)

    Manual Switch (MS) – operator originated

    Wait to Restore (WTR) – automatic (waiting after SF/SD disappears)

    Idle (IDLE) – no other request present

Simplified Hierarchy Rules

- **The rules are based on standard SONET/SDH point-to-point and ring protection definitions (e.g. GR-253, GR-1230, ITU G.783, ANSI T1.105.01 etc.)**

- **Requests need to be signaled around the ring**

- **Requests >= SF can coexist**

- **Requests < SF can not coexist with any other requests**

- **A node shall execute highest priority local or from neighbor request unless the above rules prevent it**

Hierarchy Benefits/Use Scenarios

- **Operational consistence with SONET/SDH rings**

- **Ring does not get fragmented if there is a SF when there are wraps present due to a lower priority request (e.g. SD, MS, WTR)**

- **Operator can e.g. execute a MS to test wrap conditions knowing that a failure (SF) in a ring will not fragment it**

- **If there is a WTR (needed to prevent wrap flapping) operator can manually remove it before a timeout using MS/no MS on the wrapped span**

- **Different requests can be used as needed – e.g. if a span is to be brought down for repairs, using a FS results in smaller traffic loss comparing to just removing a fiber (SF)**

- **Any node is immediately aware of protection types present elsewhere in the ring**

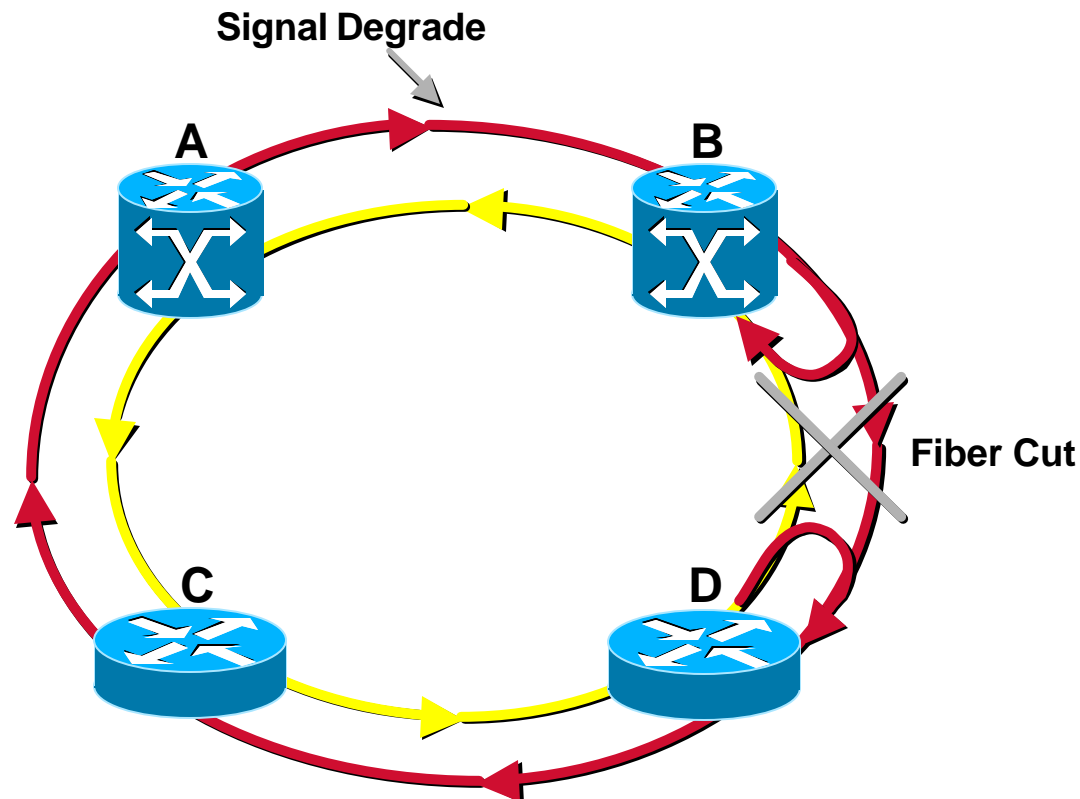- ***A more manageable ring with less traffic loss!***

Hierarchy Drawbacks

- **Additional system complexity**

   This has been standardized for years in SONET/SDH systems so the risk is low

Hierarchy Use Example

Signal Degrade

A

B

Fiber Cut

C

D

Signal Degrade (SD) and Fiber Failure (SF)

Agenda

- Protection Hierarchy

- **Wrapping vs Steering**

- Topology Discovery

Wrapping vs Steering

- **Wrapping – nodes adjacent to the failure immediately wrap traffic away from it. Subsequently as new ring topology is discovered, traffic paths may be re-optimized (nodes may steer on which ring they transmit traffic to a given destination).**

- **Steering – all nodes in the ring are notified about a ring span failure, they update ring topology view and if necessary, change on which ring they transmit traffic to a given destination.**

- **Protection Hierarchy can be implemented in both steering and wrapping scenarios.**

Wrap Operation

Wrapped

{SF,A,W,S}

A   B

Fiber Cut

{IDL,B,W,S}

{SF,A,W,L}

{SF,B,W,L}

Wrapped

C   D
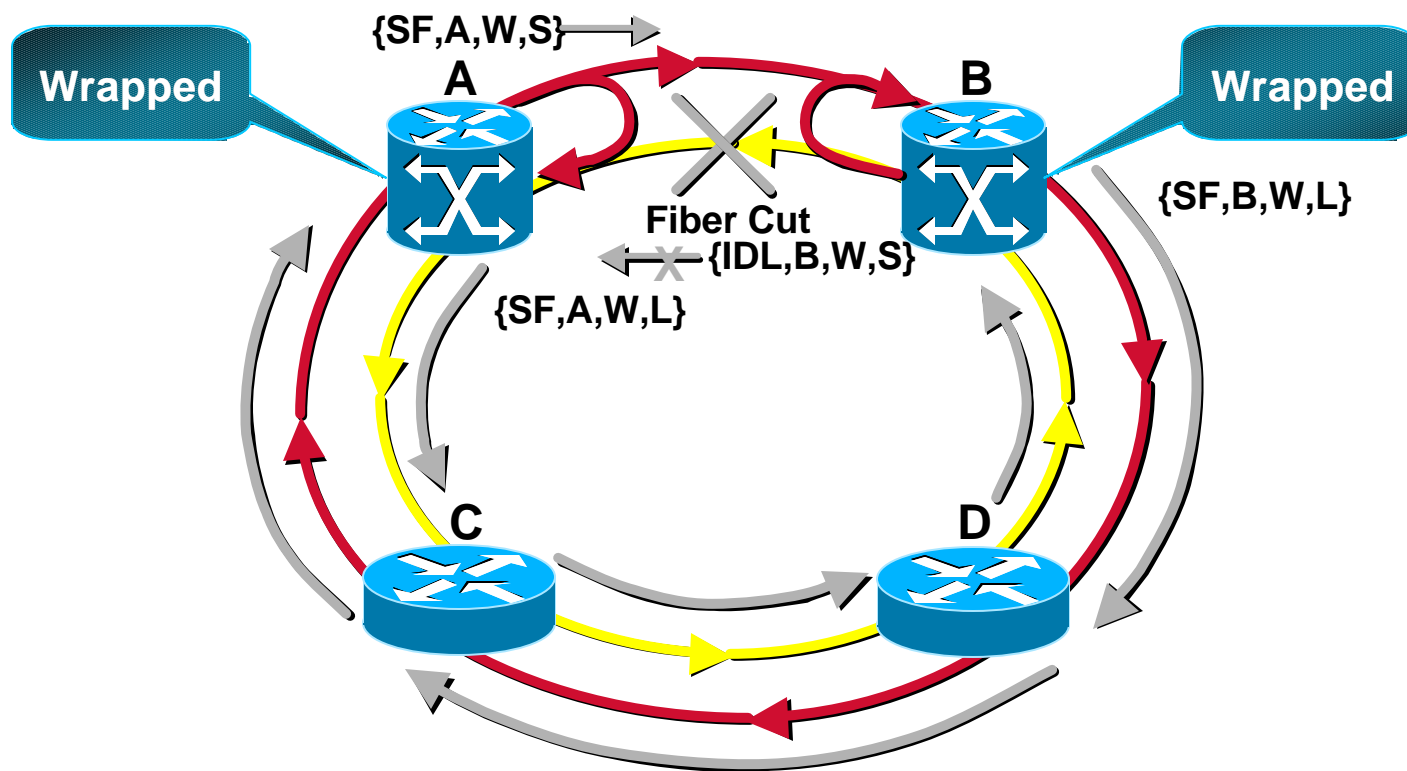
1 Fiber Failure

Wrapping

- ## Positives

  - ### Fast reaction time, minimal traffic loss

  - ### Well understood method with SONET and other precedence

  - ### To wrap at most 1 node needs to be informed of the failure

- ## Negatives

  - ### More complex hardware especially if MAC is split across 2 ASICs / cards

  - ### Non optimal use of ring BW

Steering

- **Positives**
  - Somewhat simpler hardware
  - Optimal usage of the ring during protection event

- **Negatives**
  - Slower than Wrapping
    - significant traffic loss on ring failures
      - time to signal failure to all nodes
        » lost notification cause nodes to continue black-holing
      - traffic already in transit can be lost
      - traffic already queued into Tx buffers destined past the failed span is lost

Combined Wrapping and Steering

- ## Positives

  - Very fast protection in combination with optimal use of the ring

    - minimal packet loss during protection events

  - Can be configured to do wrapping or steering or both

- ## Negatives

  - Most complex

Agenda

- Protection Hierarchy

- Wrapping vs Steering

- **Topology Discovery**

Topology Discovery Suggestions

- **Automatic and distributed** (no central control, note .17 motion #15)

- **Triggered by either connectivity changes or periodic timeouts**

- **Results in creation of a Topology Map**

- **Topology Map is used to steer packets (select a ring, based on optimal path)**

- **Topology Map is not necessary for wrapping**

- **Topology Map shows the actual reachable nodes (not a fault-free ring)**

- **The discovery needs to be fast for steering-only (few ms), can be slow for combined steering/wrapping (seconds)**

Topology Discovery Examples

- ## "Broadcast" Algorithm

  - Each node detects globally unique MAC addresses of neighbors and broadcasts them, together with potential other node info

  - Each node builds topology based on received broadcast addresses

- ## "Hop-by-hop" Algorithm

  - Each node sends a packet which goes around the ring before it's consumed by the originator

  - Transit nodes append their MAC addresses and other node info as they forward the topology packets

Hop-by-hop Details

- **If there is a wrap on the ring the wrapped node will indicate a wrap when appending its node information and will wrap a packet**

- **When a topology packet follows a wrap (travels on opposite ring), the node information is not appended to the packet**

- **The originator consumes the packet only if it is received on the same ring ID**

- **A new topology is built when two consecutive new topology packets are received**

Topology Map

- **The topology map includes information such as the MAC address and link/wrap status of each reachable node in the ring**

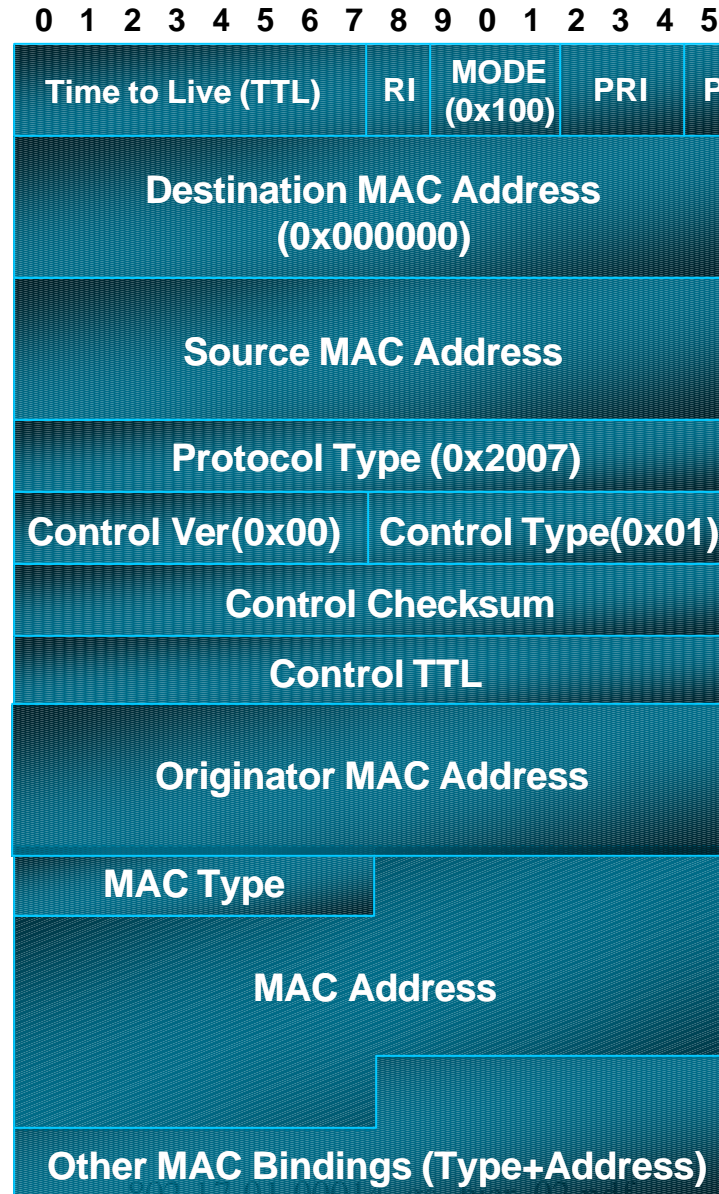- **It could contain other per node information as needed, e.g.:**

  Node name – aids in network debug

  Equipment type – helps in interoperability

  Link costs – for Optimal Path algorithms

Topology Packet Format Example

0 1 2 3 4 5 6 7	8 9	0 1	2 3 4	5
Time to Live (TTL)	RI	MODE (0x100)	PRI	P
Destination MAC Address (0x000000)				
Source MAC Address				
Protocol Type (0x2007)				
Control Ver(0x00)	Control Type(0x01)			
Control Checksum				
Control TTL				
Originator MAC Address				
MAC Type				
MAC Address				
Other MAC Bindings (Type+Address)				

MAC Type

MAC Type—8 Bits	
0	Reserved

1	Ring ID
	    0—Outer Ring
	    1—Inner Ring

2	Wrap Status
	    0—Node Unwrapped
	    1—Node Wrapped

3–7	Reserved

Recommendations

- **Protection design should include the following:**

  - **Protection Hierarchy**

  - **Support for both wrapping and steering**

    - **allow systems vendors to make final selection**

- **Automatic topology discovery should be supported**

- **Lets work together to discuss optimal solutions in the area of Protection and Topology design**