Joint IEEE-SA and ITU Workshop on Ethernet

IEEE 802.1 Frame Replication and Elimination for Reliability

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Draft PAR (P802.1 CB) title & scope

- Scope:
  - *The scope of this project is to specify procedures, managed objects and protocols for bridges and end stations that provide:*
    - Identification and replication of frames, for redundant transmission
    - Identification of duplicate frames
    - Elimination of duplicate frames

Abstract

Redundant topologies are common in many industrial networks such as Industrial Automation, Energy Automation, Rail Systems. Growth rate of redundant systems is much higher than the growth of communication in general.

Redundant topologies are also used in automotive in-vehicle networks for safety critical control applications and ring topologies are proposed for automotive backbone applications. These applications would significantly benefit from frame replication and duplicate frame elimination in order to support seamless availability with network segment protection.

Professional AV requires error protection as well. This is accomplished today by duplicating the complete network infrastructure which is costly and sometimes not as robust as required. Additionally every AV application which needs audio/video transmissions with seamless availability will benefit.

Overview Redundancy

- IEEE802 RSTP- Rapid Spanning Tree
- ITU G.8032 coupled rings
- ISO-1/Flexray dual channel redundancy
- Professional AV proprietary solutions
- IEC 62439 various protocols with
  - PRP (Parallel Red. Protocol) duplicate Network
  - HSR (Highly available Seamless Ring) Ring Protocol

➔ All areas have their specific solution

3 distinct classes

Pros

RSTP/G.8032/...

- Minimized wiring effort
- Software only

PRP/Dual Channel

- No switchover time
- Standard networks
- Various error types

HSR

- Minimized wiring effort
- No switchover time
- Various error types

Cons

RSTP/G.8032/...

- Recovery time needed
- Transient errors

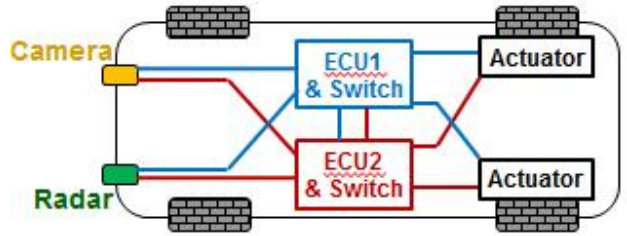
PRP/Dual Channel

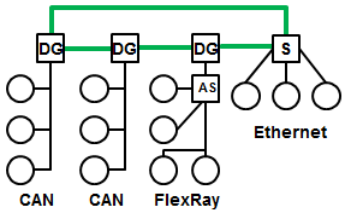
- High cost
- Integration of Std Devices
- Overload Problems

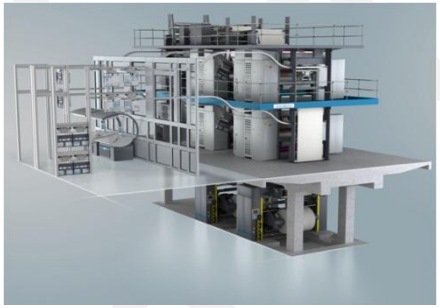
HSR

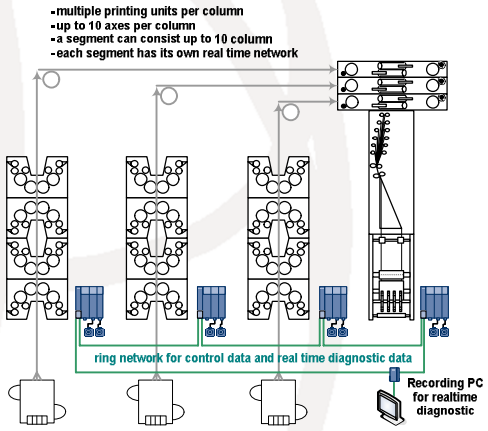
- Special bridges needed
- Setup required
- Overload Problems

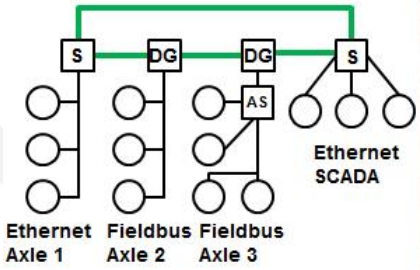
Seamless Failover for Automotive, Power and Industrial

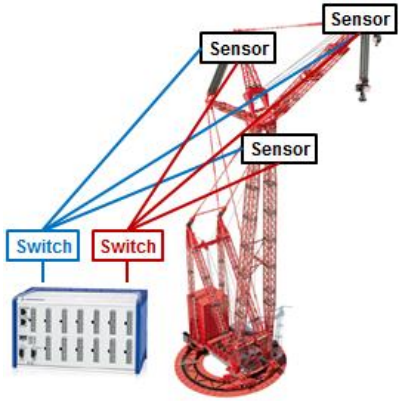








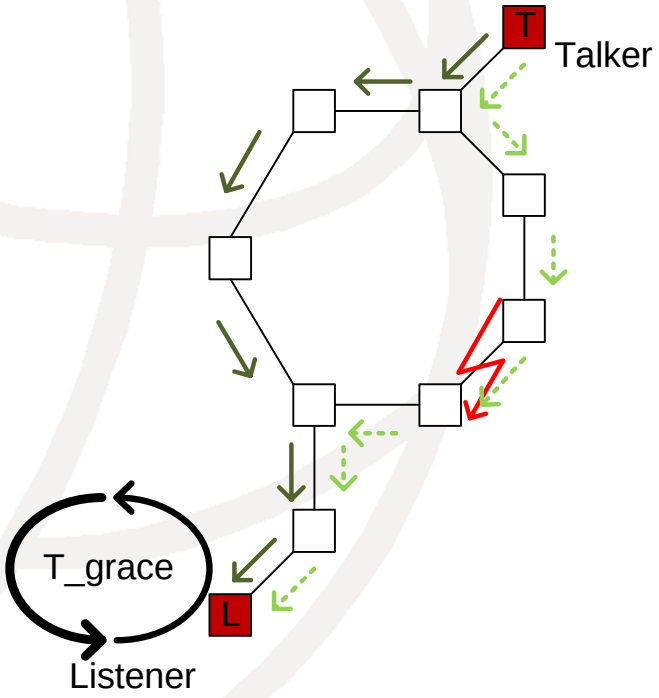




Why Seamless Failover @ Industry?

- T_grace: Max. time an application can sustain a loss in network connectivity
- T_rec: Time a redundancy control protocol (e.g. RSTP) needs to reconfigure network paths

=> Usually T_rec !< T_grace for the application not to notice network failure



Seamless Failover for Control Data and Audio/Video Traffic

- *For automotive and industrial applications seamless failover is not required for Best Effort Traffic*
- The proposed mechanism for seamless failover supports reserved layer 2 traffic:
  - Audi/Video Traffic (AV-Streams)
  - Control Data Traffic (CD-Streams)
  - *Stream characteristic*
    - Unique stream destination MAC address (per VLAN)
    - Reserved stream priority (e.g. prio 3) within a domain
    - Periodic transmission
    - Known max frame size

    => predictable max latency

Proposal

- The communication path for AV-Streams and CD-Streams is given
- Elimination requires the ability to identify duplicates

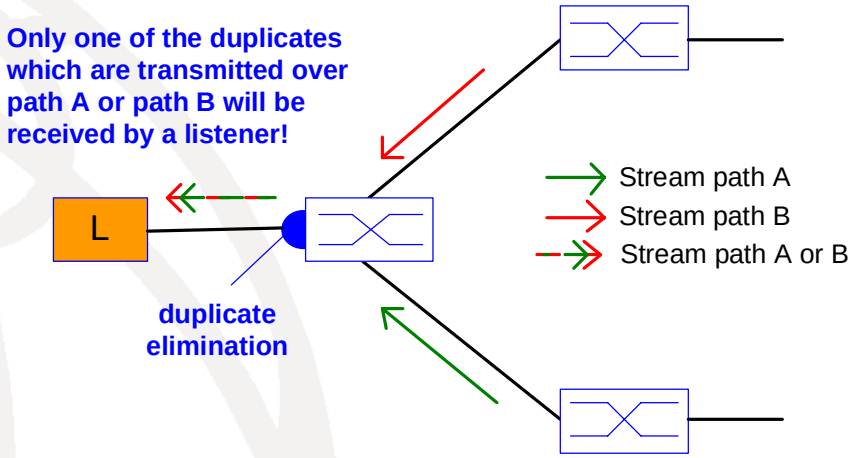
The table gives a high level overview about the information used to identify duplicates:

Information	Purpose
VLAN ID	• Duplicates are transmitted on independent paths on different VLANs. • VLAN ID‘s are used to mark redundant path (Path A, Path B, …)
MAC Address	• If duplicates have the same MAC Address, they belong to the same stream. • A stream MAC address (destination) is unique for VLAN ID‘s used to mark the redundant path (A, B, …).
Sequence Number	• A Sequence Number in the frame will enable to identify individual frames within a stream. • An elimination unit is looking for two frames with the same MAC address and the same sequence number that are transmitted on different VLANs.

Example (1) for Elimination of Duplicates

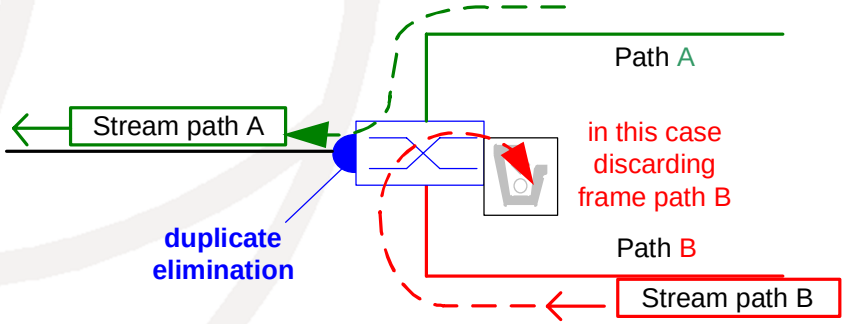
Use Cases:

- For simple End Stations e.g. sensors with limited computing power and low power consumption (automotive)
- Avoid bandwidth bottleneck on edge port
- Simplify integration of legacy devices



Frame path A received before frame path B

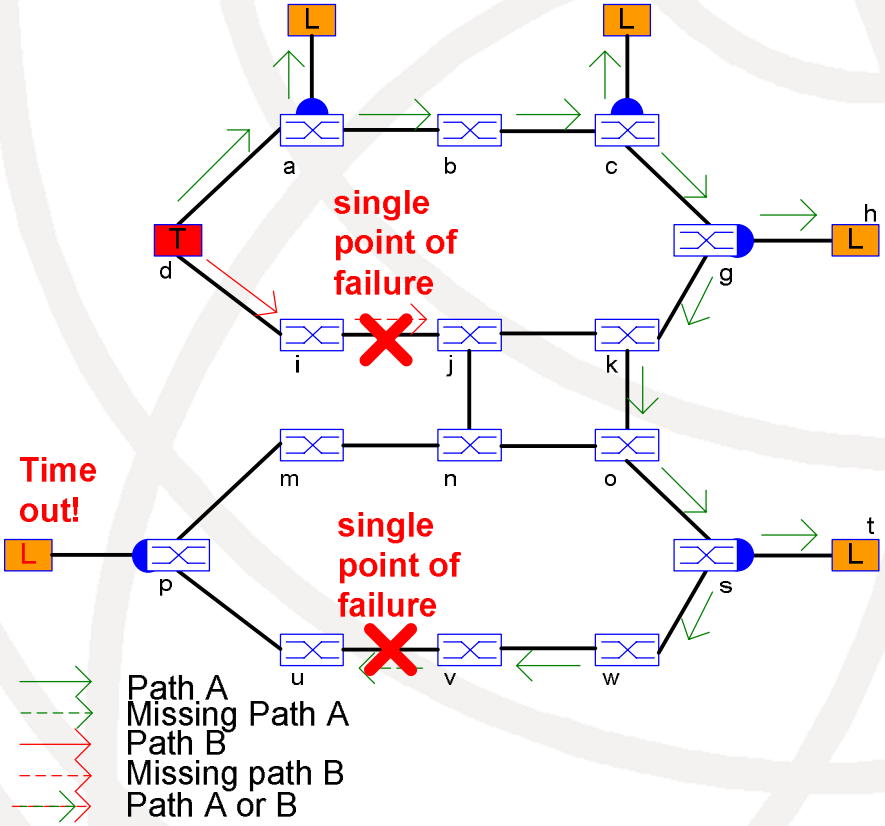
When frame path A is correct
-> Forwarding frame path A (no waiting for frame path B)
-> Frame path B will be discarded

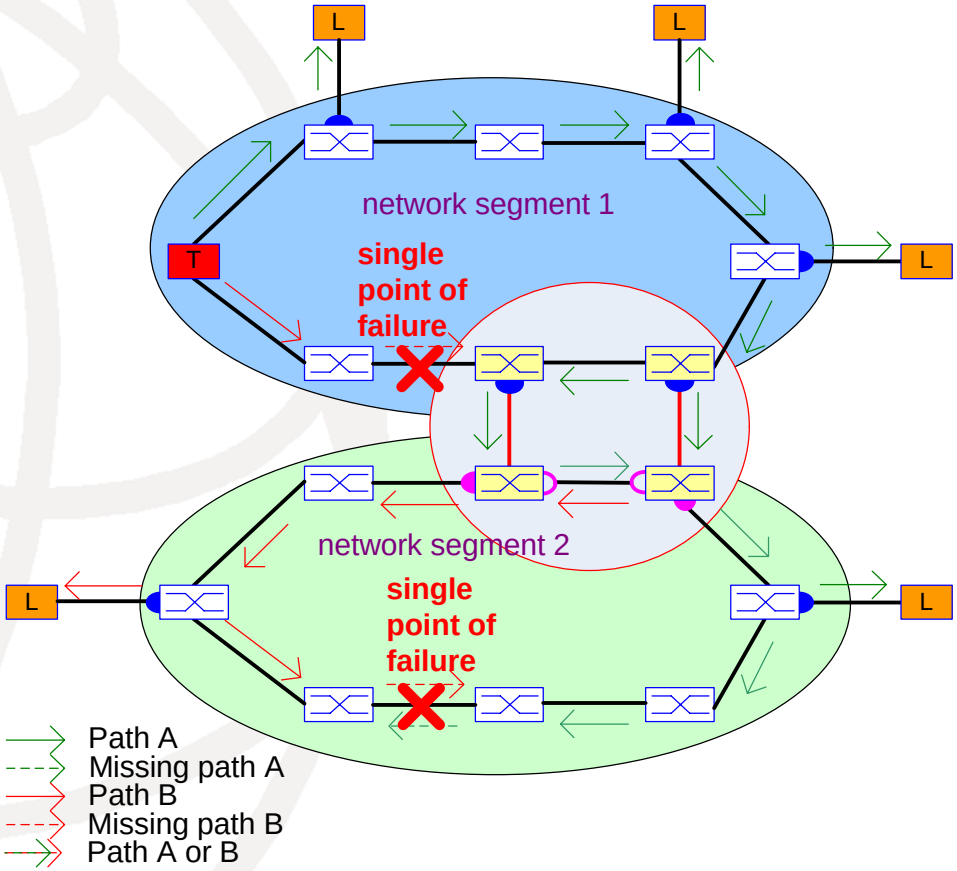


Example (2)

Use Cases:

Guaranteed connectivity by single point of failure in each ring (network segment)





THANK YOU
for your attention

Questions?