

**Kyland Technology Co., Ltd.**

# **White Paper**

High-Available Seamless Redundancy(HSR)

# Kyland HSR Ring

**Keywords:** IEC62439-3, HSR

**Acronyms:**

Acronym	Full Spelling
HSR	High-Availability Seamless Redundancy
MN	Multiplexer Node
RPR	Resilient Packet Ring
STP	Spanning Tree Protocol

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# Kyland HSR Ring

## 1 Background

With widely used in different application field, more time-critical service and applications are carried in Ethernet, and different techniques are explored to guarantee high availabilities of the network, such as, link aggregation, spanning tree, fast Ethernet Ring Protocol, to optimize the availability of the network under different conditions, The fail-over time had been minimized from several seconds to hundred milli-seconds, and then within 50milli-seconds. And for some kind of topology, the fail-over time of Industrial Ethernet Ring can be optimized to 20ms and less. The performance of different mechanisms are shown as follows:

HA features	Performance	Comments
Link Aggregation	< 50ms	Just for link failure protection
Spanning Tree	Several Seconds	Depends on the number of the nodes, and can be optimized to sub seconds with some particular scenario
RPR	<50ms	Expensive and need dedicated hardware support
Fast Ethernet Ring	<50ms	Only Ring topology supported, most of them are private protocols

Though the fail-over performance had been significantly optimized, the requirement of time-critical applications can not be met yet, such as smart grid, manufacturing automation, etc. For example, in substation automation system, the performance of typical 4ms transfer time is required for fast and important messages like GOOSE and 'Trip' message for control and protection purpose, which is beyond the scope of performance can be achieved using traditional STP and Ring protocols. So, a seamless redundancy with zero fail-over time is to be introduced and deployed in the industrial communication network to meet critical requirements of industrial applications.

## 2 Introduction of IEC62439-3 HSR

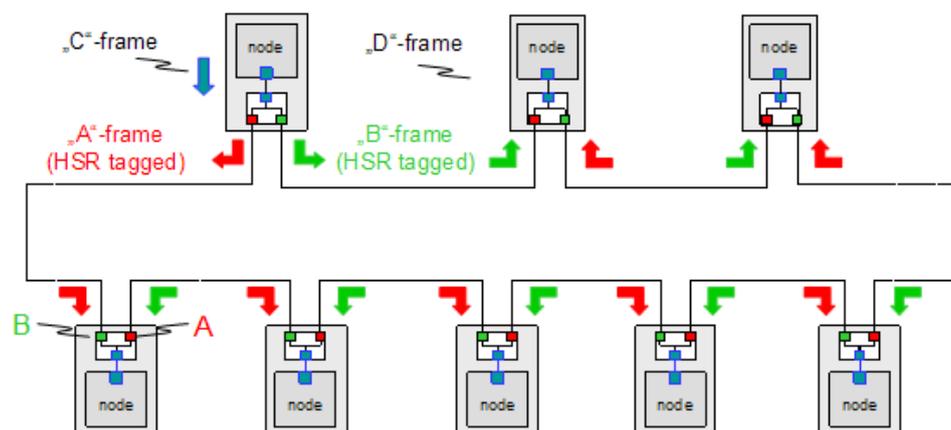
### 2.1 General Description of HSR

IEC62439-3 was developed in IEC SC65C WG15 (highly available automation networks) and was started to fulfill the dependability and real-time requirements of applications such as substation automation and automation control.

The essence of HSR is to use bi-directional packet transmission and selection of the first arrival and discard of duplicated packet in another direction to guarantee the seamless fail-over time in ring topology.

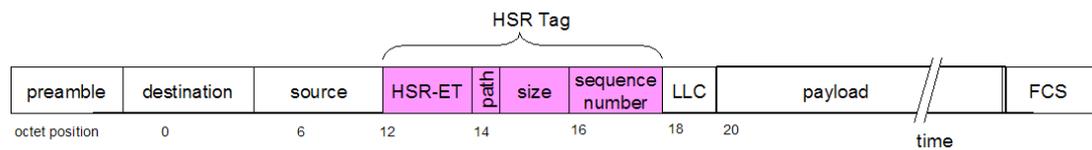
In a HSR ring network, each node has two identical interfaces, port A and port B. For each frame to send ( "C" -frame), the source node sends two copies over port A and B separately. Each node forwards the copy of frame it receives from port A to port B, and vice-versa, except if already forwarded. The destination nodes use the first arrived copy of frame ( "D-frame" ) and discards the duplicate.

When link failure occurs, one copy is dropped due to link failure, while another copy still arrive over the uninterrupted path in another direction. No impact of application make it a seamless resolution for link failure in ring topology .



### 2.2 Packets with HSR header

When the packets tagged with a HSR header, the packets are uniquely identified, and can be distinguished by the session. A HSR header should include such information:



- each frame has an HSR Ether-type, a path indicator, a size field and a sequence number, inserted as an HSR tag in the same way a VLAN tag is inserted.
- the sender inserts the same sequence number in the pair of frame copies, and increments the sequence counter one by one for each frame sending out this node.
- the receiver keeps track of the sequence counter for each source MAC address it receives. Frames with the same source and sequence number value coming from another direction are discarded.

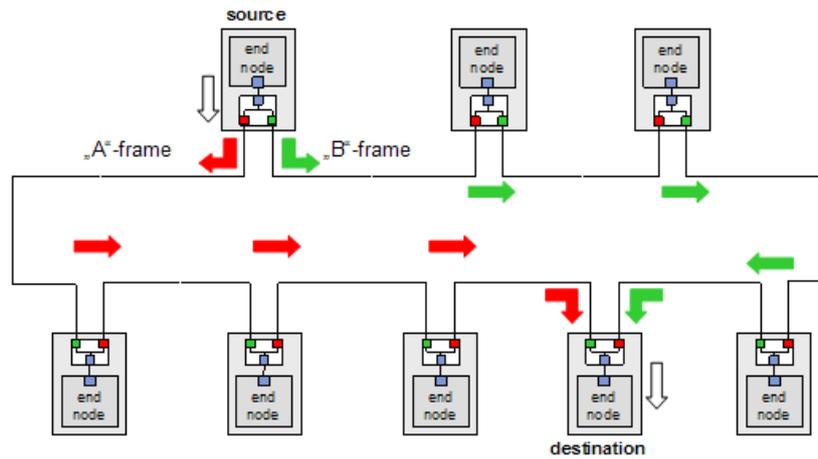
Since the HSR tag is only inserted to the packet in the ring, and will be removed by the destination node, so the HSR is a protocol independent high-availability mechanism and is transparent to other applications.

## 2.3 HSR Networks Traffic Model

With the bi-directional sending mechanism, the HSR nodes replicate the inner packets to the two directions of ring ports, and transmit them along the HSR ring ports.

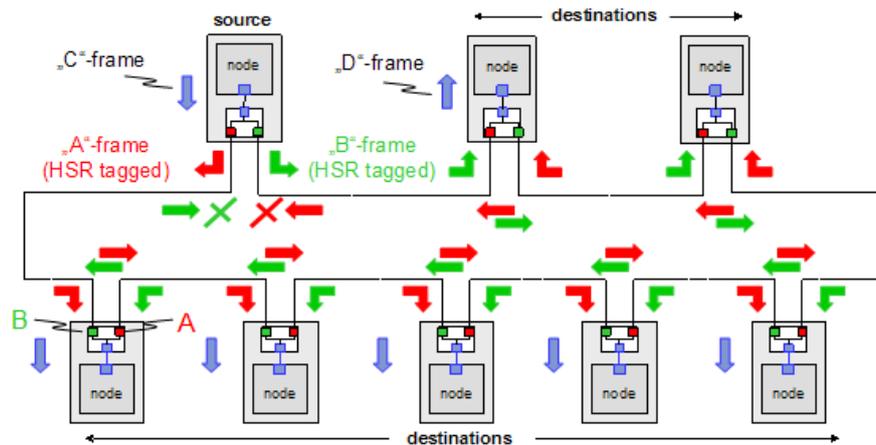
For unicast packets:

- The source node will insert a HSR tag in the packet and then forward to two direction along the ring,
- The other nodes in the ring will check the destination MAC address, if the DA is a local address then the node will check the HSR header to get the sequence ID to see if is packet processed already, if no, then remove the HSR tag and forward the packet to the destination host, otherwise, drop the packet since it is a duplicated one and no longer needed by the host.



For multicast and broadcast packets:

- The source node will insert a HSR tag in the packet and then forward the packets to two directions along the ring,
- The other nodes in the ring will check HSR header to see if this packet has been sent by itself, if so, the packet will be dropped, otherwise, it will be forwarded along the ring.



### 3 Kyland HSR Implementation

Kyland Technology implemented a module with 2 Giga HSR interfaces compliant with IEC62439-3 , which can be used in 19 inch rack mounted switch SICOM3028GPT .

### 3.1 SICOM3028GPT



SICOM3028GPT is a 19 inch 1U rack mounted modular switch with different module support, including: 4 cooper GE/FE, 4 fiber GE/FE, 2 cooper + 2 fiber GE/FE, 4 RS232/485 serial modules and can support up to 28Giga ports;

SICOM3028GPT also support precise time synchronization with IEEE1588v2 and ITU-T.G.8261/G.8262 (Sync-E) support;

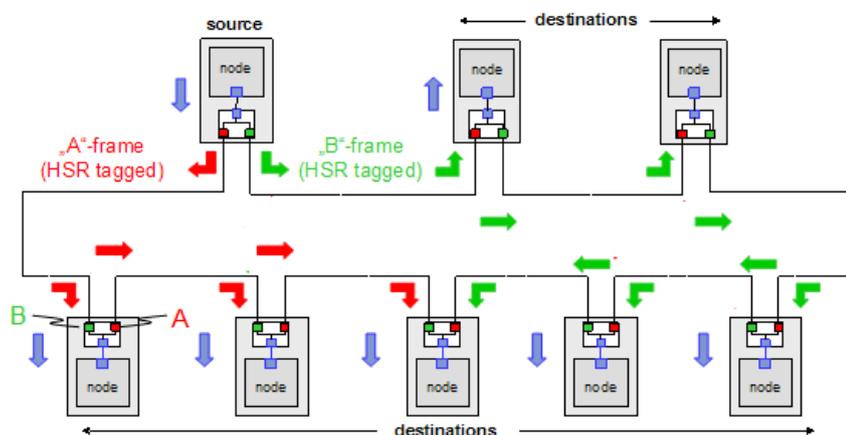
With the HSR module, SICOM3028GPT can provide HSR based Redundancy Ring via 2 Giga HSR ports.

### 3.2 Kyland HSR Extensions

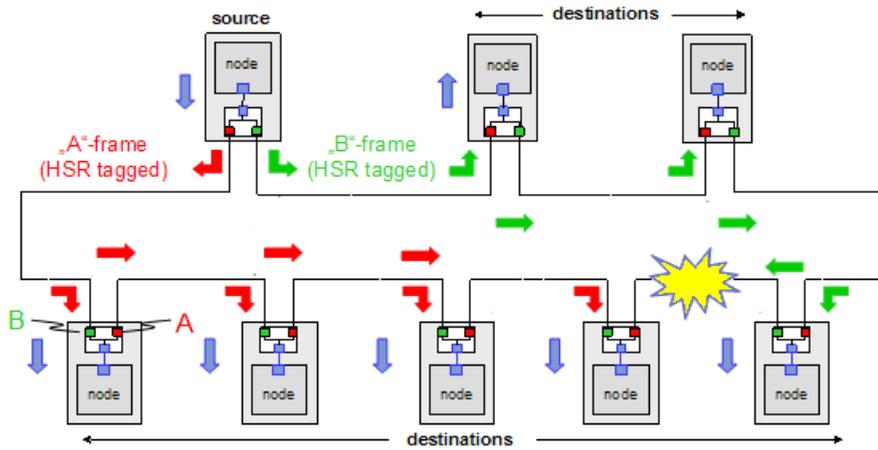
Kyland HSR follows the same Header with HSR protocol, but with an extension of the processing, Kyland HSR optimized the processing of multicast and broadcast packets, and a configurable of control for the multiple ring topology is developed to have a better bandwidth usage and support for multiple rings topology.

#### 1, HSR muticast processing

In Kyland HSR processing, the multicast packets will be terminated in the node which receives both copies: A-frame and B-frame, that means, the total band width only be half of HSR ring, as the figure shows below:



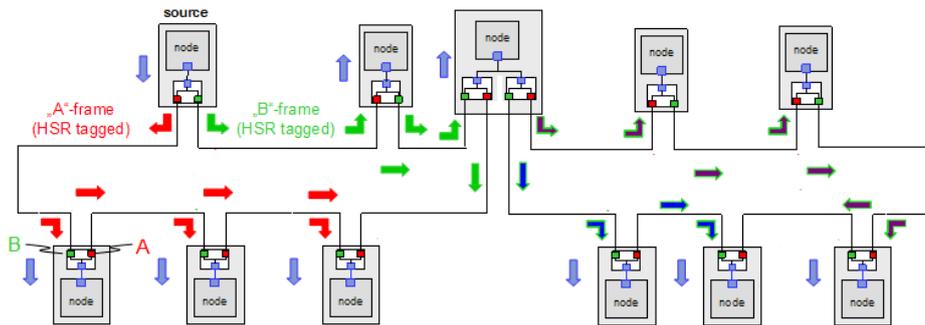
When a link failure occurs, no node will receive both two copies in dual directions, so the packets will be transmitted as below with no packet loss:



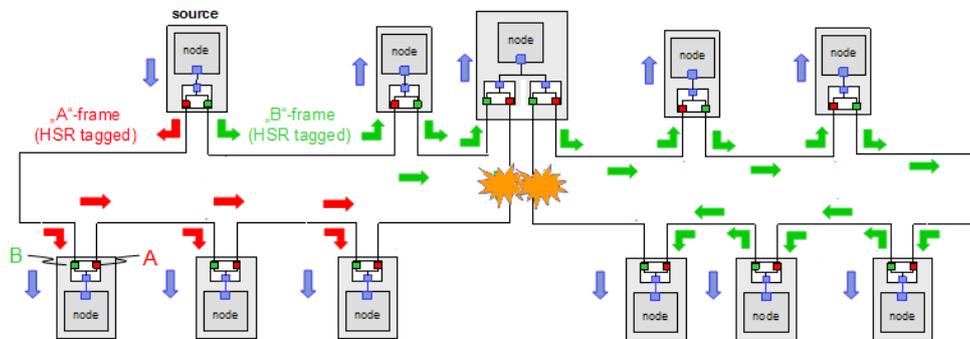
### 2, HSR multiple ring processing

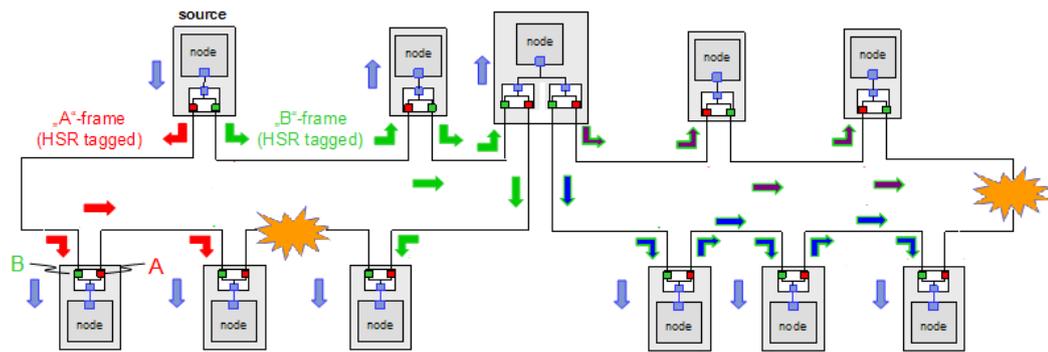
Another node called Multiplexer Node is introduced in Kyland HSR to provide more flexibility for more ring topologies.

A Multiplexer Node support more than two redundancy ports, and the redundancy ports can be configured to different redundancy rings, and the connectivity of different rings is also configurable to make flexible ring coupling topology.



If the MN nodes encountered two link failures, then the MN will forward the HSR frames to the other port and the packets can be forwarded in the second ring.





## 4 Summary

With the implementation of SICOM3028GPT HSR technology, Kyland can provide a high performance, fully redundant, universal, flexible and scalable redundancy solution.

- **High Performance**

SICOM3028GPT's HSR module support two Gigabyte HSR ports to provide a high bandwidth Ring, also HSR can reduce the band width requirement while the multicast/broadcast forwarding.

- **Universal**

SICOM3028GPT support GPS /IEEE 1588 time synchronization and multiple serial ports accessing, so the HSR ring solution will provide a universal multiple service to support different application scenario;

- **Fully Redundant**

HSR can support multiple ring topology and can provide real zero packet loss ring redundancy, then be the best solution for mission-critical application.

- **Flexible and Scalable**

Modulized SICOM3028GPT support field replaceable modules to provide enough scalability for seamless future extension, various of interface type also helps to meet the physical interface requirements of various application.