

Interoperability in High Speed Seamless Redundancy (HSR) Communications Networks



What is HSR?

- A “new” Ethernet based high reliability networking protocol
- Designed to address industrial process control requirements and the weaknesses of regular Ethernet
 - Redundancy / Failover
 - Latency
 - Predictability
 - Cost

Standards: Promoting Interoperability!

- IEC 62439 “Highly Available Automation Networks”, ratified May 2008
- Describes several protocols with different characteristics: MRP, PRP, CRP, BRP, ...
 - Each vendor/country wants their own!
 - No interoperability and performance varies
- HSR approved in 2010 Q1
 - RSTP also being included

Where does HSR fit in the standards?

[IEC 61850 Edition 2](#)

[IEEE 1588 Version 2](#)

Power Profile

[IEC 62439-3 Highly Available Automation Networks](#)

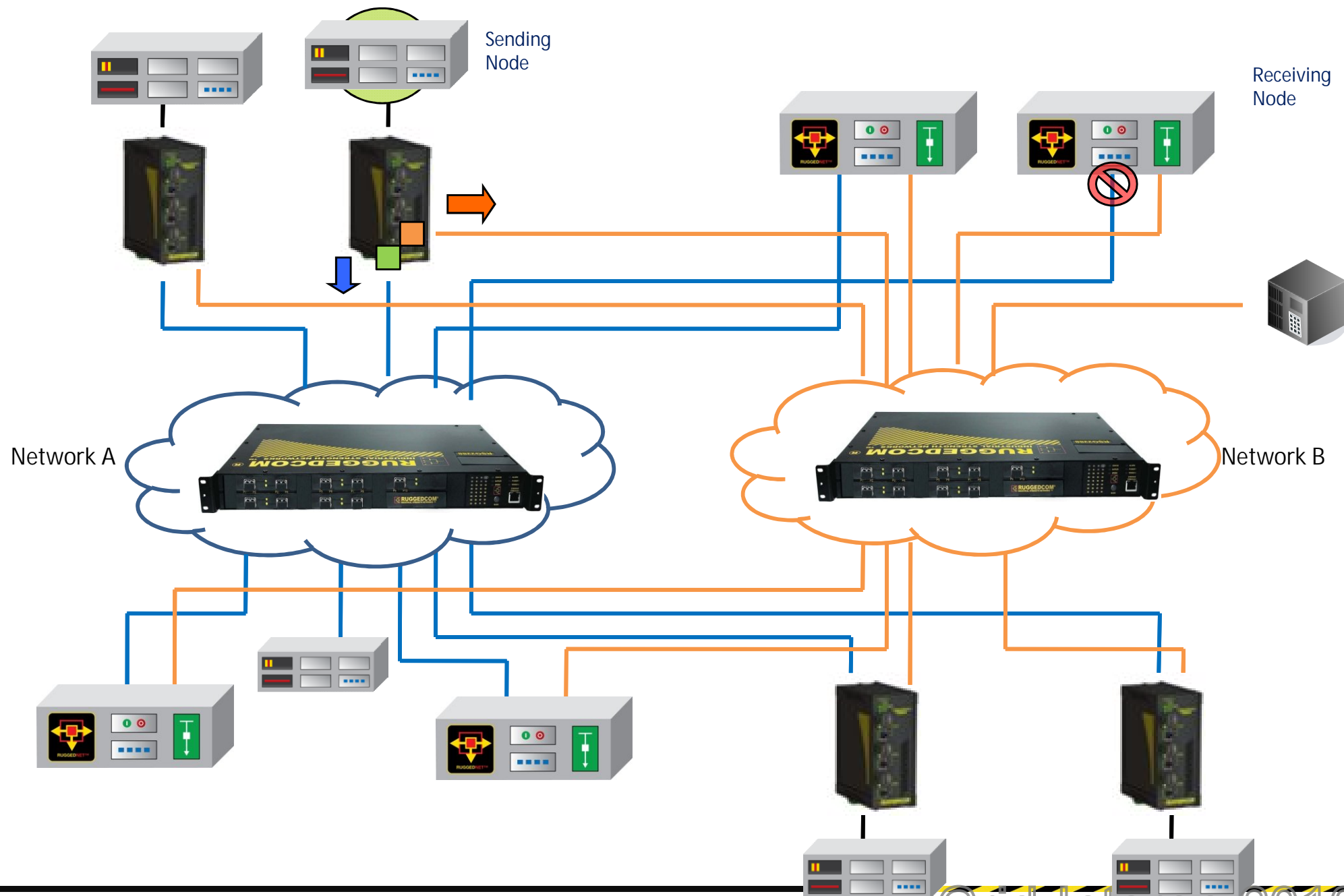
RSTP – Rapid Spanning Tree Protocol

PRP – Parallel Redundancy Protocol

HSR – High Availability Seamless Redundancy

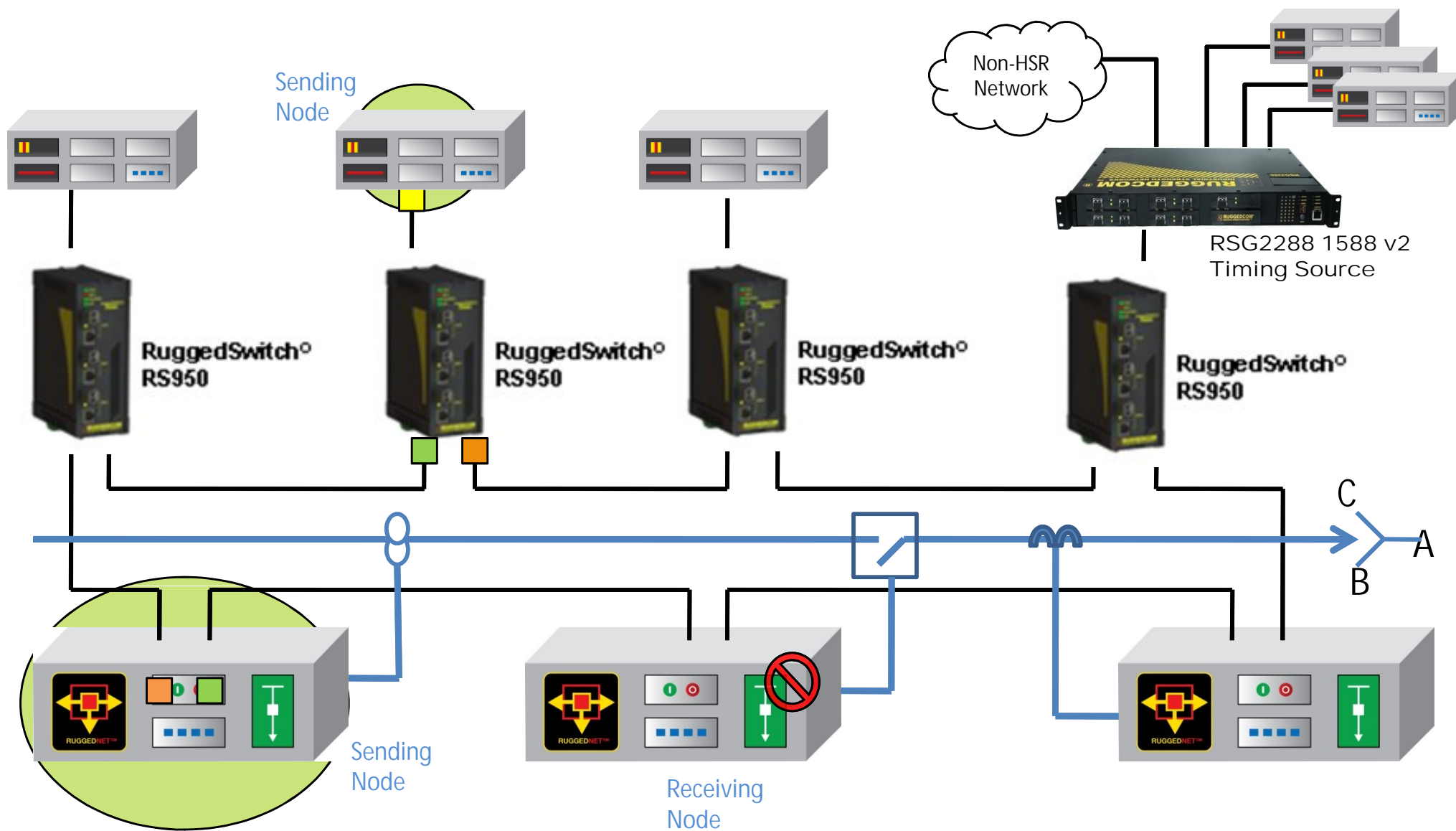
PRP = Parallel Redundancy Protocol

- Guaranteed 'ZPL' (Zero Packet Loss) for any single point of failure
- Supports any topology (ring, mesh, star etc)
- Chosen by IEC 61850 for mission critical substation networks
- Essential for future 'process bus' networks
- Future IEDs may include HSR and / or PRP built in



HSR = High Availability Seamless Ring

- Built on concept of PRP
- Guaranteed 'ZPL' (Zero Packet Loss) for any single point of failure, essential for 'process bus' networks
- Ring topology and interconnected rings
- Chosen by IEC 61850 for mission critical substation networks
- RedBox connects legacy Ethernet IEDs to HSR ring
- QuadBox interconnects rings
- Future IEDs may include HSR built in

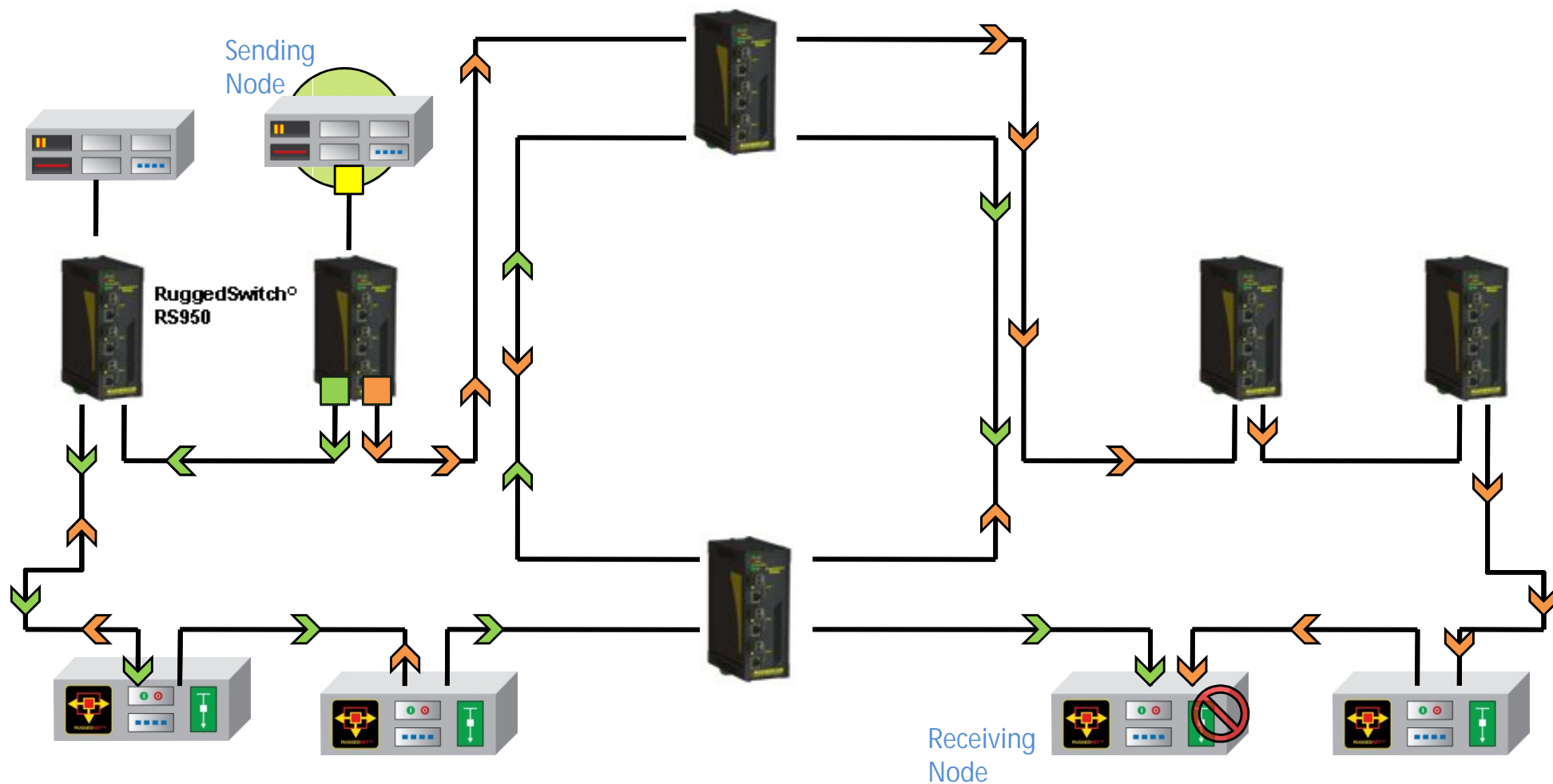


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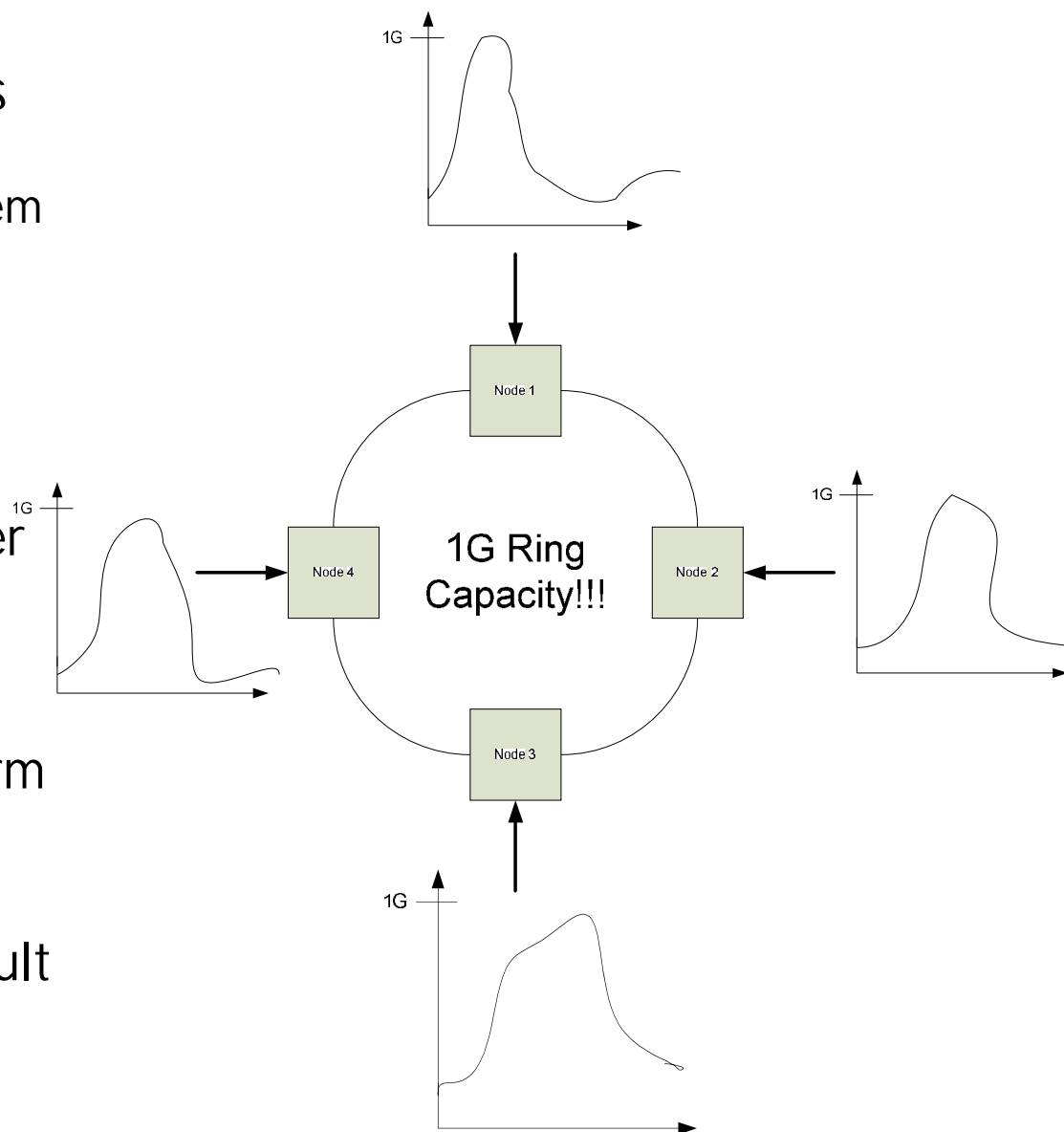
IED with RuggedNet™ OEM Module

HSR – Scaling up, linking rings with a Quad-box

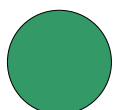
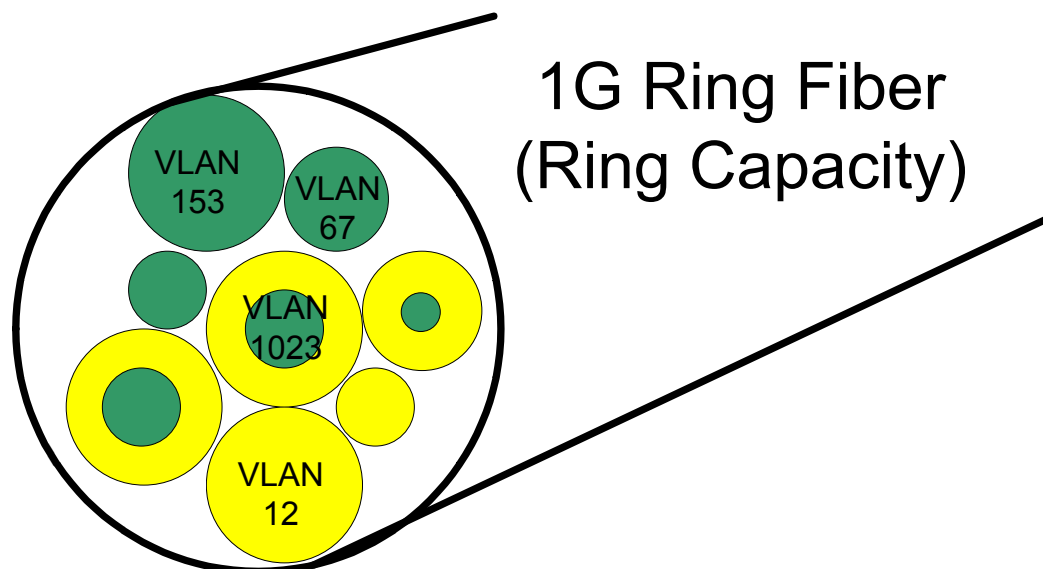


'Seamless' Failover Does Not Guarantee Delivery

- GOOSE traffic from multiple IEDs is quasi synchronized
 - IEDs all see and react to power system events at same time
 - 9-2 traffic is synchronized via IEEE 1588
 - Merging units send traffic at exact same instant in time
 - "Instantaneous bandwidth" is greater than bandwidth of network
 - Phenomenon same for HSR and 802.3
 - Up to 4G Traffic Injection in short term
 - 1G Ring Capacity!!!
- ⇒ Even Short term congestion can result in dropped packets

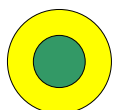


VLAN Tunelling: VLANs define tunnels around the ring



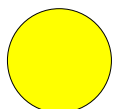
Guaranteed Bandwidth: Guaranteed Bandwidth around the ring. **The bandwidth is always available.** If not used it can be reused by other lower traffic class.

- No packet drop.
- Low delay and jitter (if bandwidth is reused by lower traffic class, current packet is aborted and re transmitted later)



CIR/PIR Bandwidth: Mix of guarantee and shared bandwidth around the ring. A portion of the bandwidth is guaranteed and another portion of the bandwidth is shared among other traffic class. The CIR (green) portion is always available and the PIR (yellow) portion may or may not be available. If the CIR portion is not used it can be reused by other lower traffic class.

- Packet drop will occur (service must tolerate packet drop, all TCP applications are packet drop tolerant).
- Higher delay and jitter (if bandwidth is reused by lower traffic class, current packet is aborted and re transmitted later)

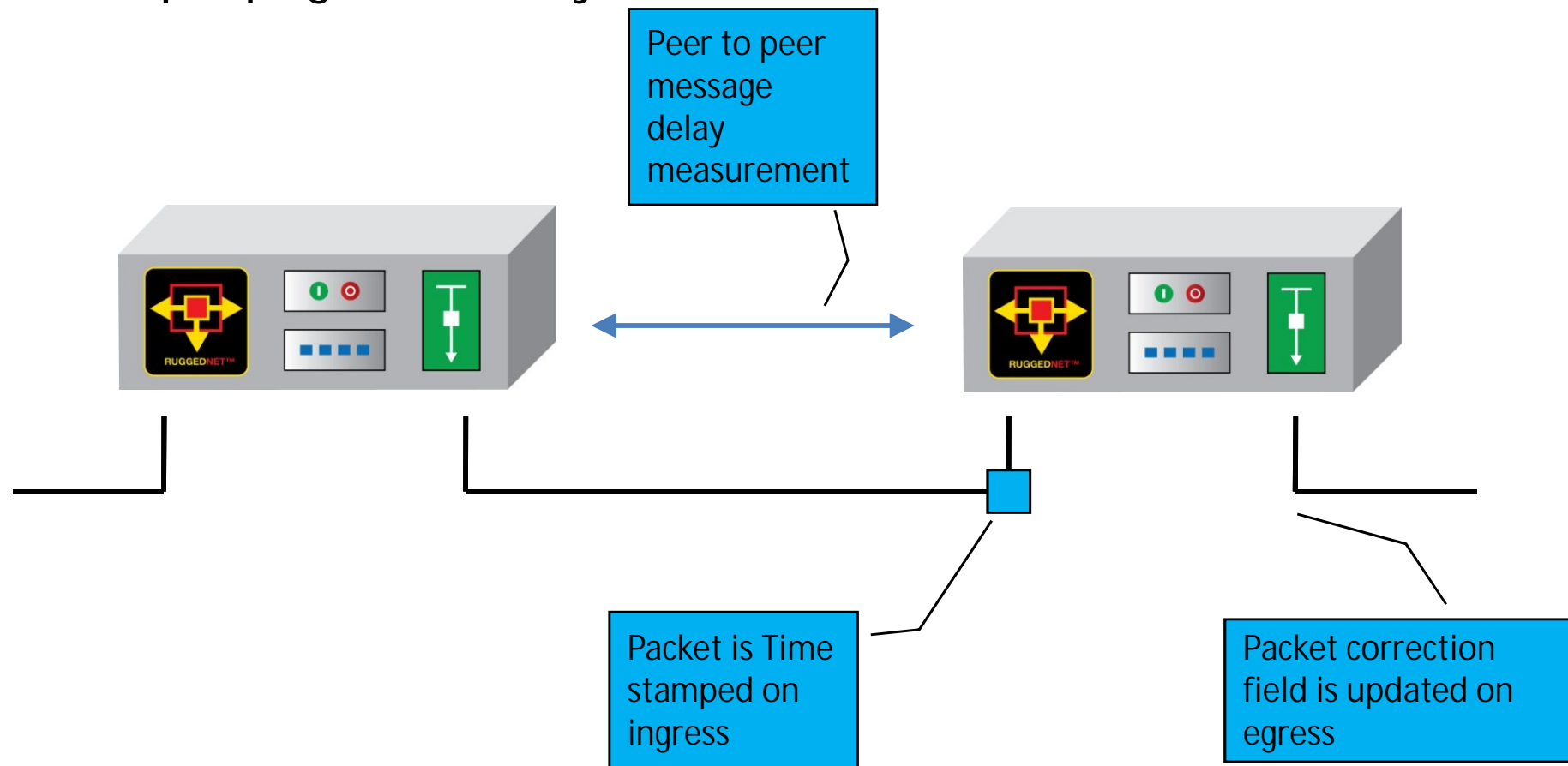


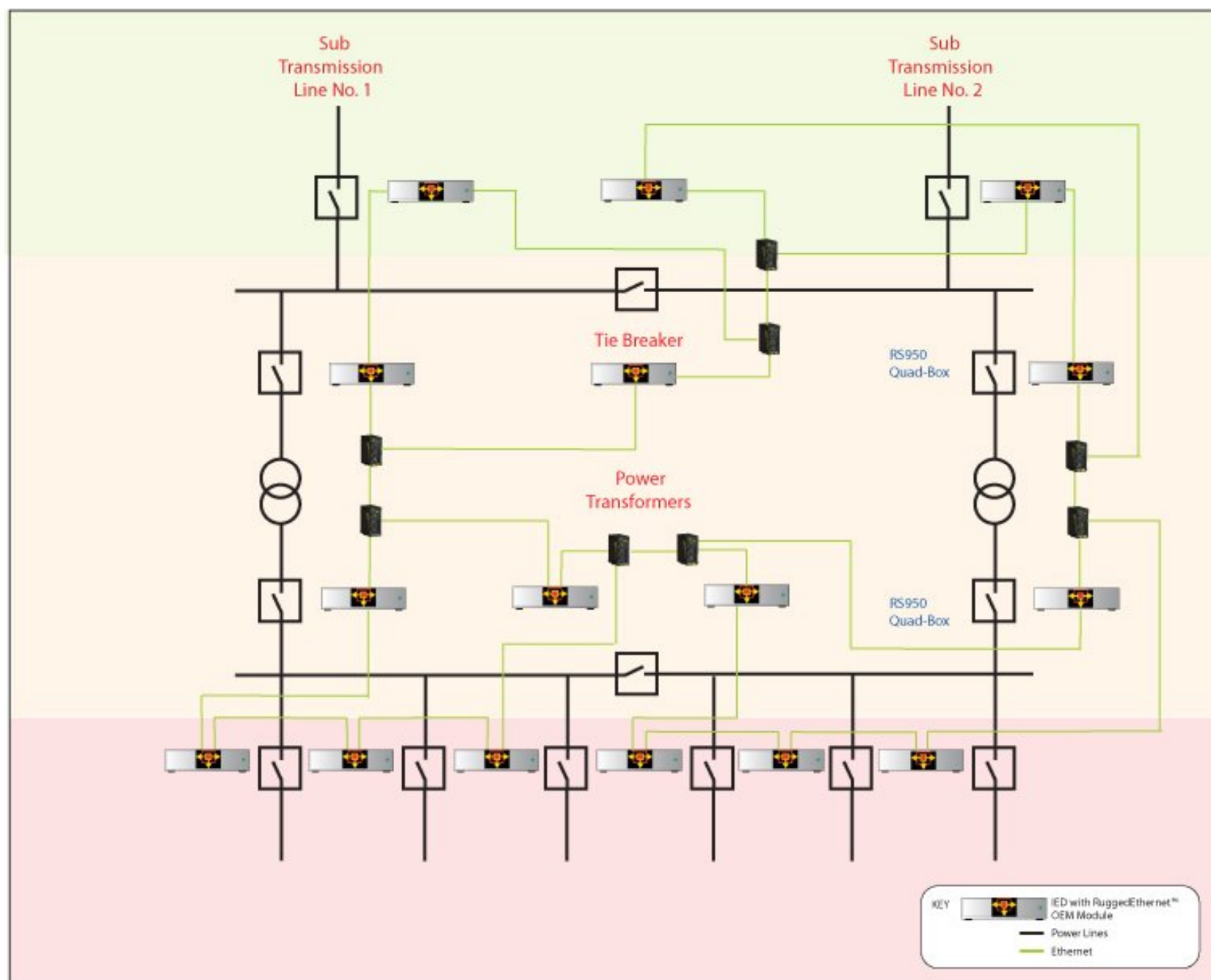
Best Effort Bandwidth: Shared Bandwidth around the ring. No Guaranty

- Starvation may occur.
- Unbound delay and jitter

1588 Features:

- Support real time Ingress and Egress time stamping
- Support 1-Step Peer to Peer Delay measurement
- Packet correction field accounts for switch processing time and propagation delay





HSR Interoperability Considerations

HSR has no intermediary network switch, it is a peer to peer network architecture requiring interoperability between IED vendors.

- ✓ IEC 62439 Standard
- ✓ Supports compatible QoS / CoS (not defined in 62439)
- ✓ Compatible IEEE 1588v2 profile (not defined in 62439)

	RSTP	PRP	HSR
Standard	Well known and accepted	Standard	New standard
Impact on End Nodes	None	Dual Attached Interface	Dual Attached Interface
"Seamless" failover	No	Yes	Yes
Reduced Loss Rate	No	Yes	Yes
Cost	Mid	Double Infrastructure + DANs	DANs but less switches
Bandwidth	No Impact	No Impact	Half
Application Independent	Yes	Yes	Yes

Thank you.

