



System-on-Chip *engineering*



Introduction to HSR/PRP/ IEEE 1588(PTP)

V:140626-UCA STICK



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Index:



Introduction:

- PRP (IEC 62439-3 Clause 4)
- HSR (IEC 62439-3 Clause 5)
- IEEE 1588 – IEC61588 (PTP)

HPS IP:

- **SoCe Industrial: Solutions**
- **HSR/PRP Switch** IP Scalability and Regular Ethernet Ports
Introduction

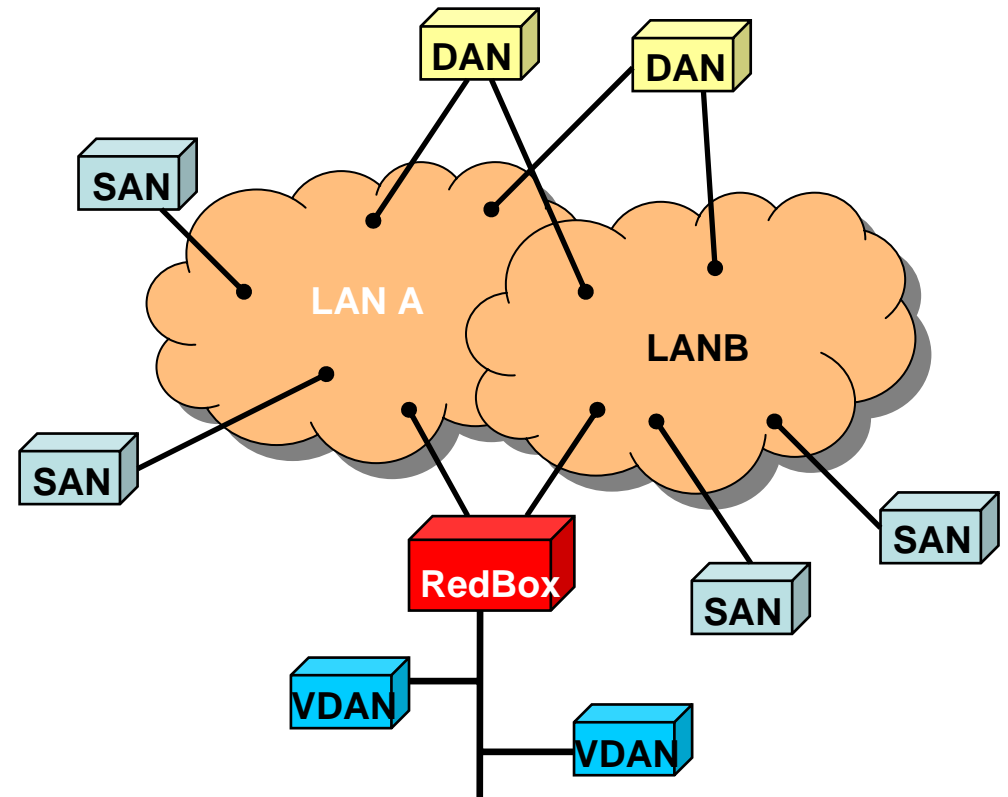


SoCe Portable Tools

Cases –of-Use

Introduction: Parallel Redundancy Protocol (PRP)

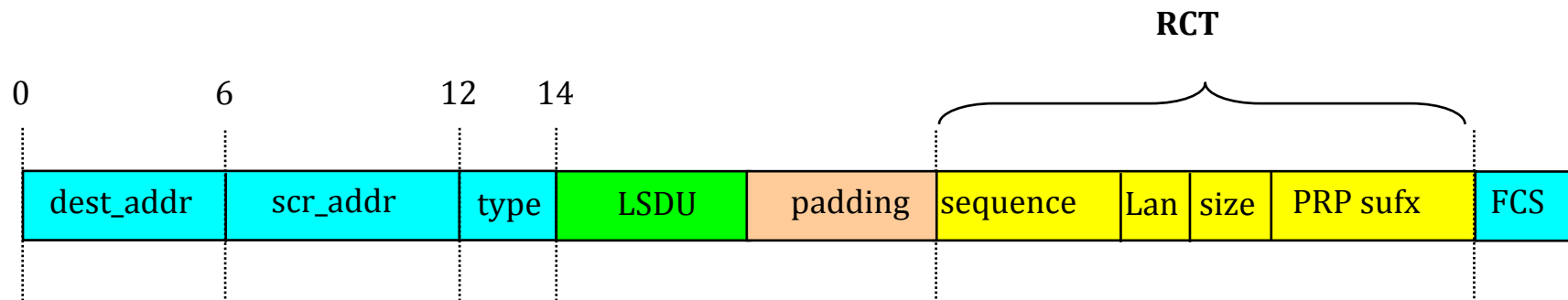
- **PRP nodes (Dual Attached Nodes-DANs), are connected to two independent Ethernet networks (LAN A and LAN B)**
- **DAN nodes send the same frames over both networks**
- **Fault-free state: Destination nodes consume the first received frame and discard the duplicates**
- **Fault state: the frames will still be transmitted and received through the other**
- **Non-PRP nodes can be attached to a single Network**



Introduction: PRP

PRP Frame Format

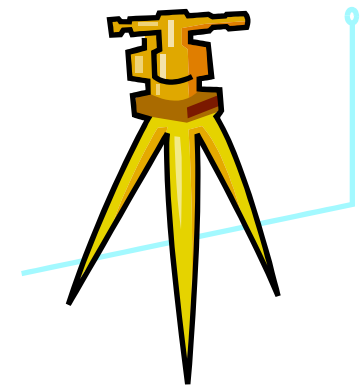
- Redundancy Control Trailer (RCT):
 - 16bit sequence number
 - 4bit LAN identifier
 - 12bit Frame Size (additional check)
 - 16 bit PRP suffix 0x88FB (new in Ed. 2)
- Duplicate Discard Algorithm
 - Open to different implementations
 - Occasional acceptance of a duplicate is tolerated



Introduction: PRP

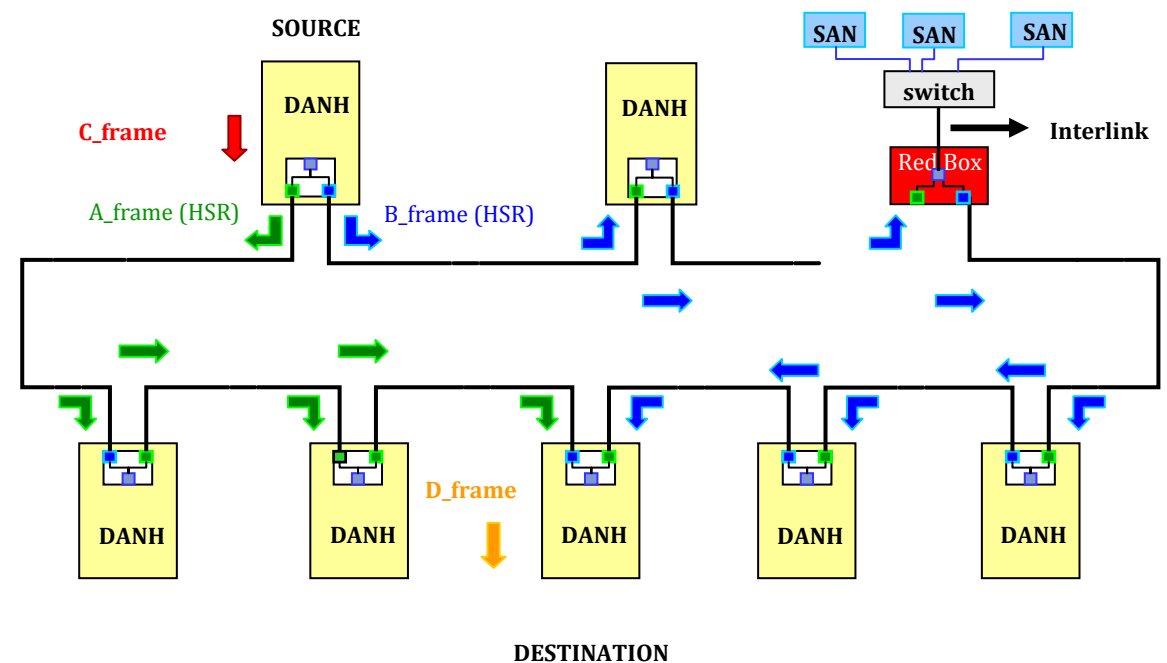
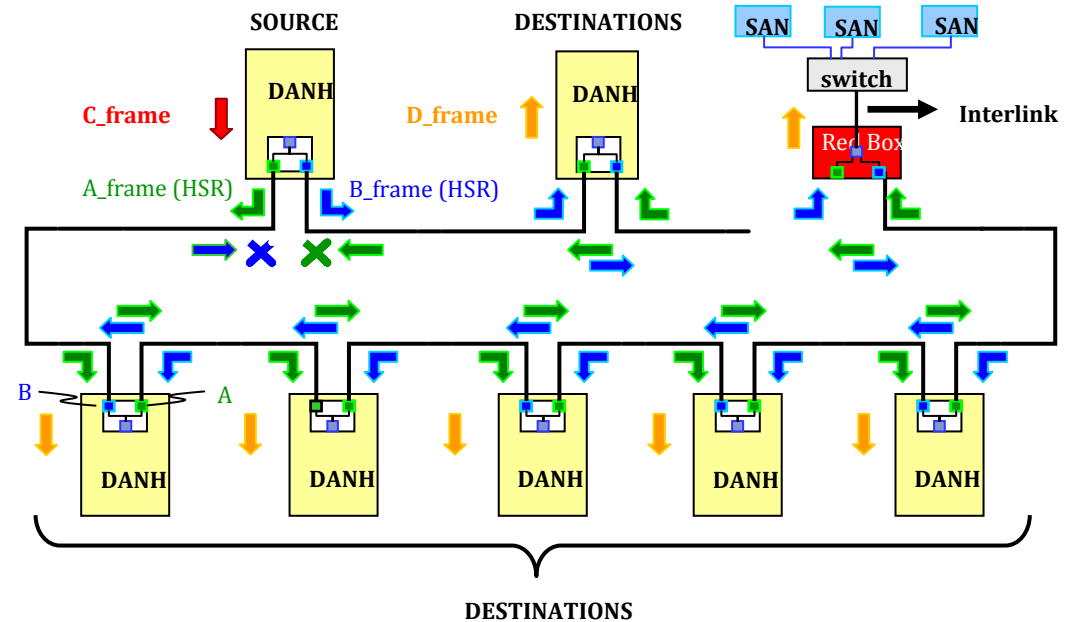
Network Supervision

- Monitor **the status of each node and LANs** Each DAN sends periodically a Supervision Frame
- **Supervision Frame Format:**
 - Multicast by each DANP over both ports every LifeCheckInterval
 - VLAN tag optional
 - MAC addresses
 - Protocol version
 - Mode of operation supported
 - Supervision frames sequence number



Introduction: High-availability Seamless Redundancy (HSR)

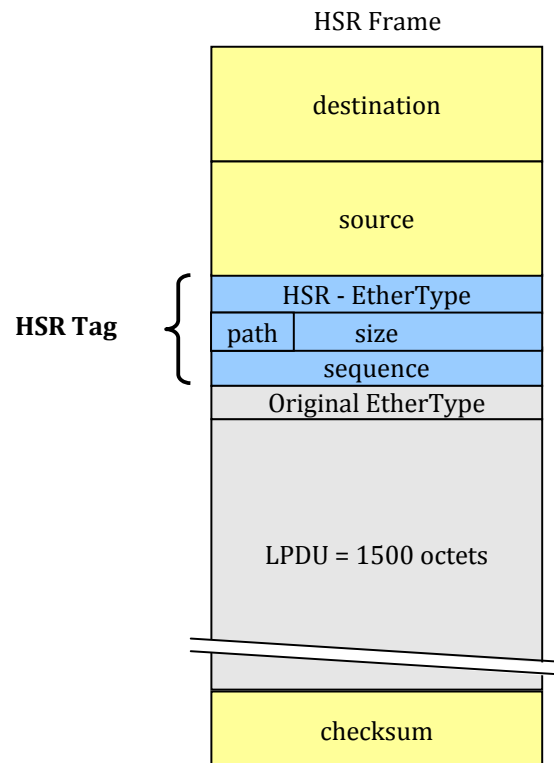
- HSR nodes (Dual Attached Nodes with HSR protocol - DANHs), are provided with two Ethernet ports
- Provide redundancy by sending duplicate packets in both directions
- Multicast and Unicast operation
- Typical configuration: rings and ring of rings
- SANs must be connected through a RedBox
- Deterministic (Worst Case Scenario)



Introduction: HSR

- HSR tag:

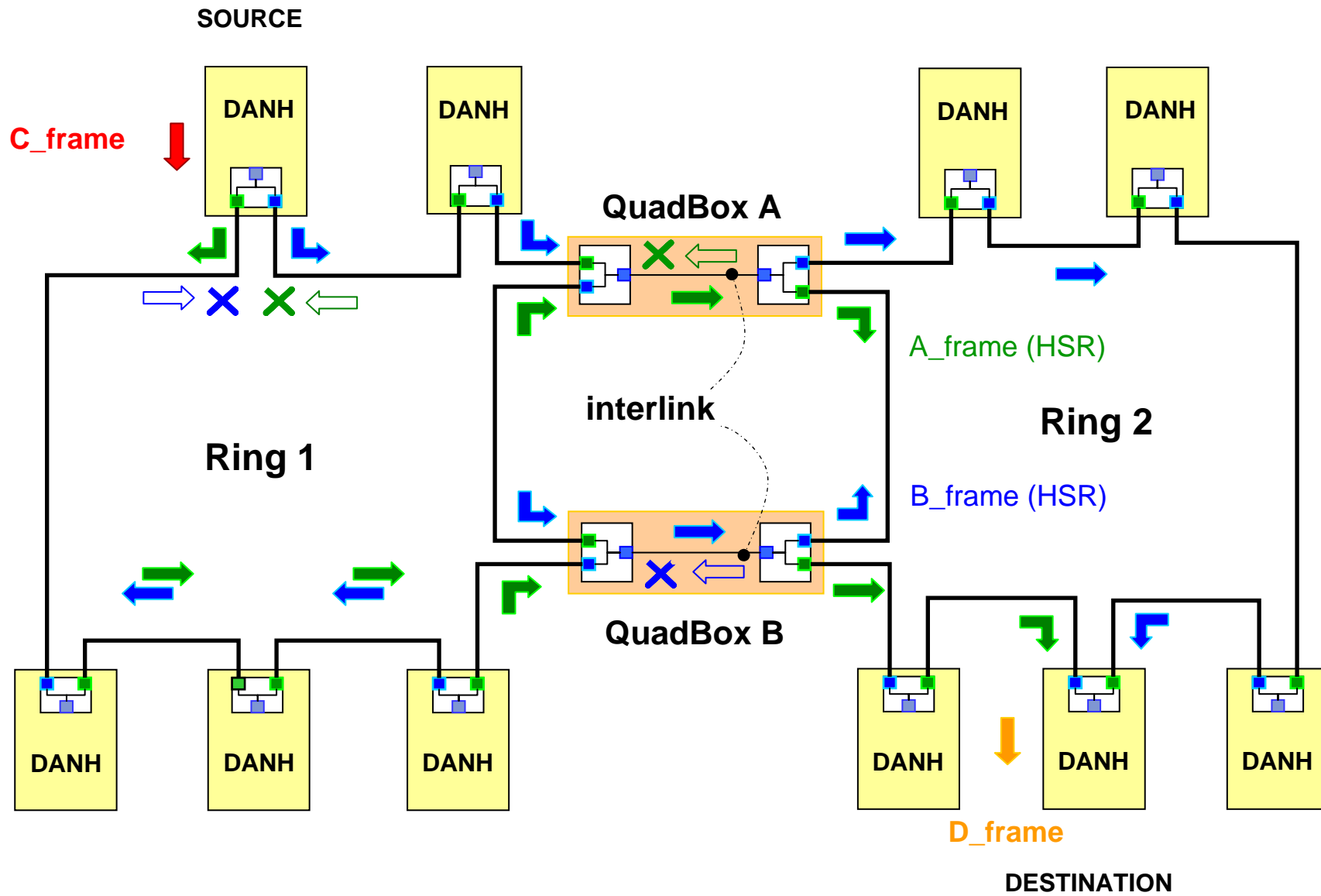
- 16 bit EtherType = 0x892F
- 4bit path identifier
- 12bit frame size
- 16bit sequence number



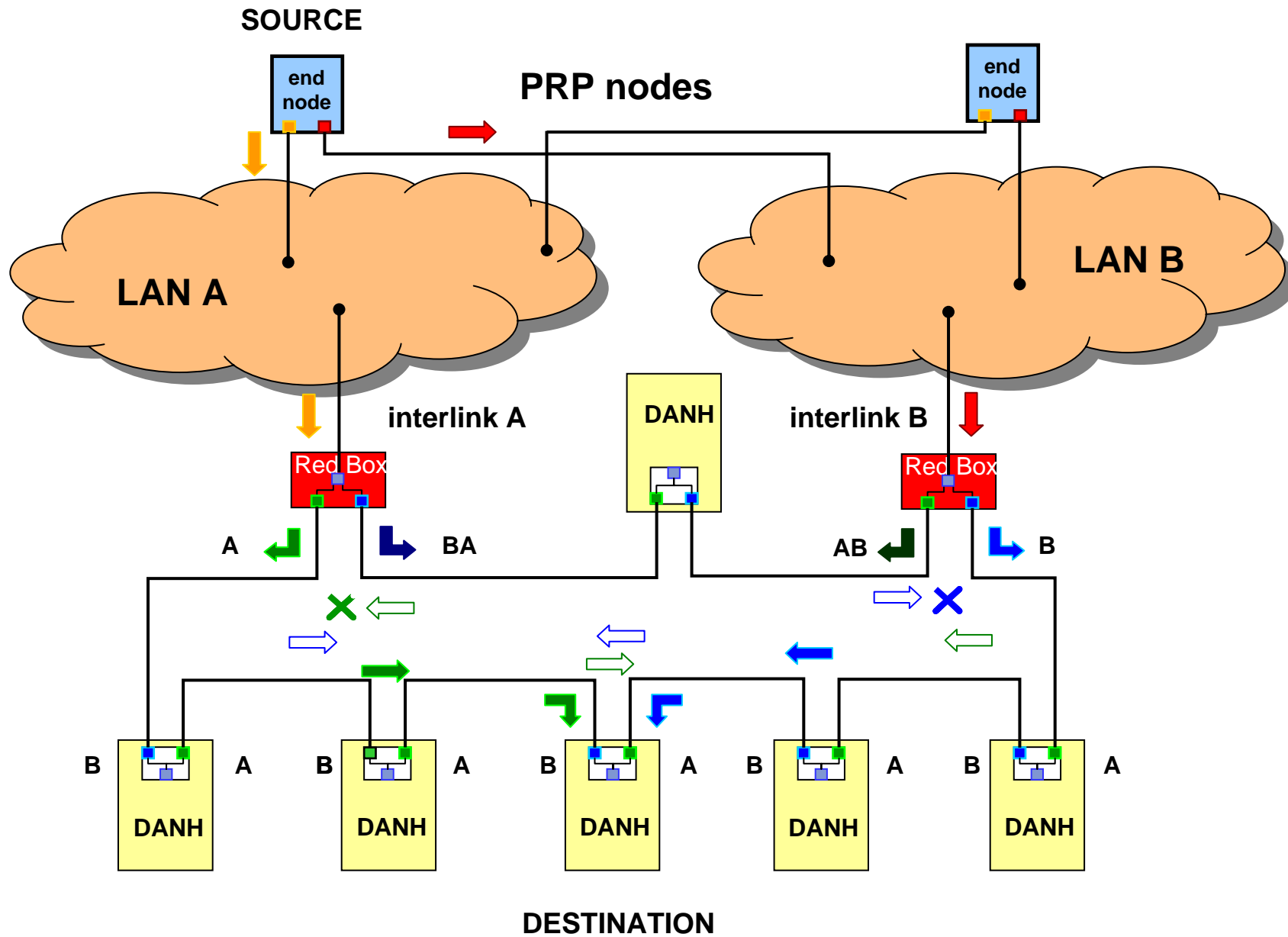
- Supervision Frame Format:

- Multicast by each DANH over both ports
VLAN tag optional
- Ethernet subtype for supervision frames
type
- MAC addresses
- Protocol version
- Mode of operation supported
- Supervision frames sequence number

Introduction: HSR



Introduction: HSR & PRP

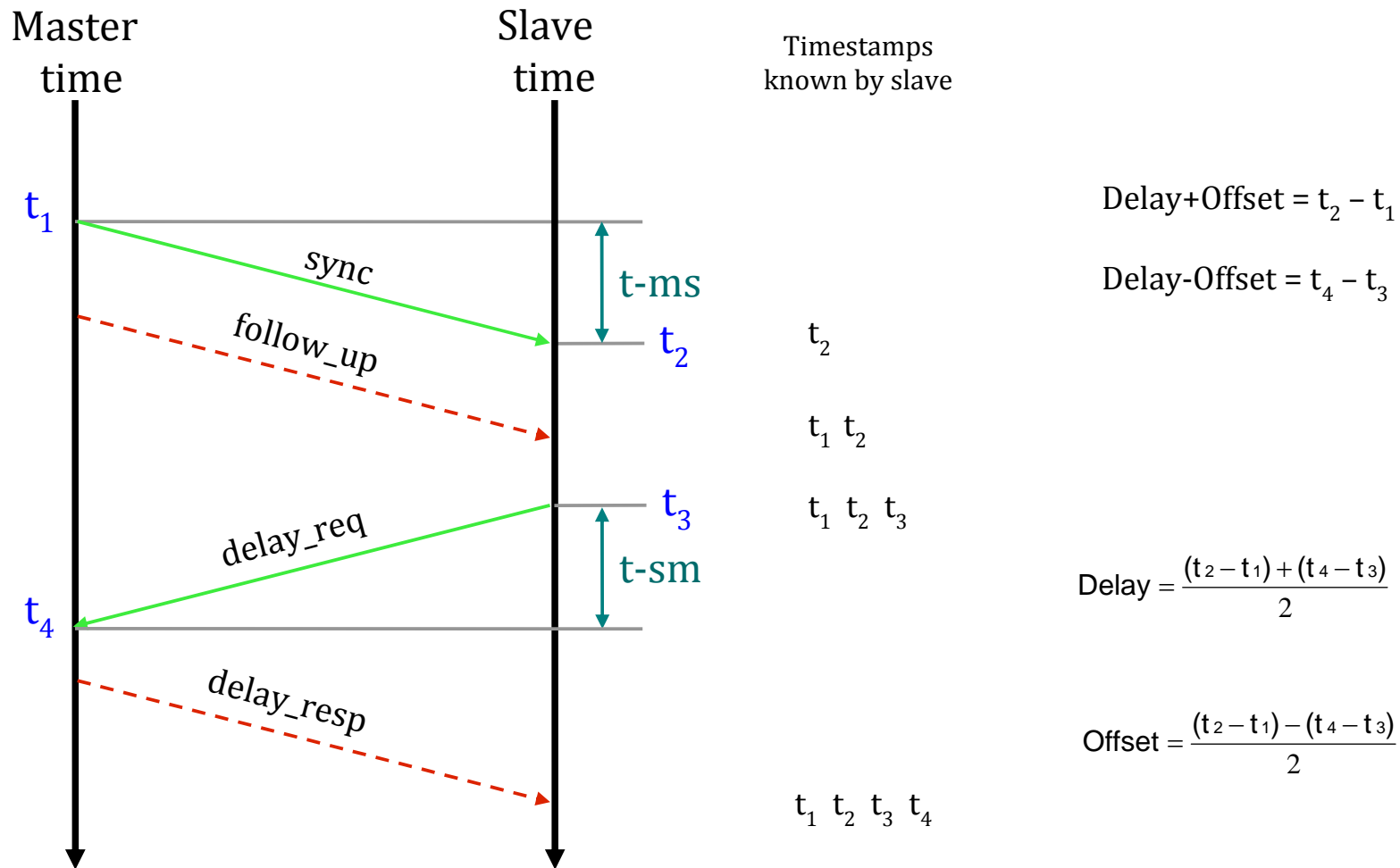


Introduction: IEEE 1588 V2 (Precise Time Protocol -PTP-)

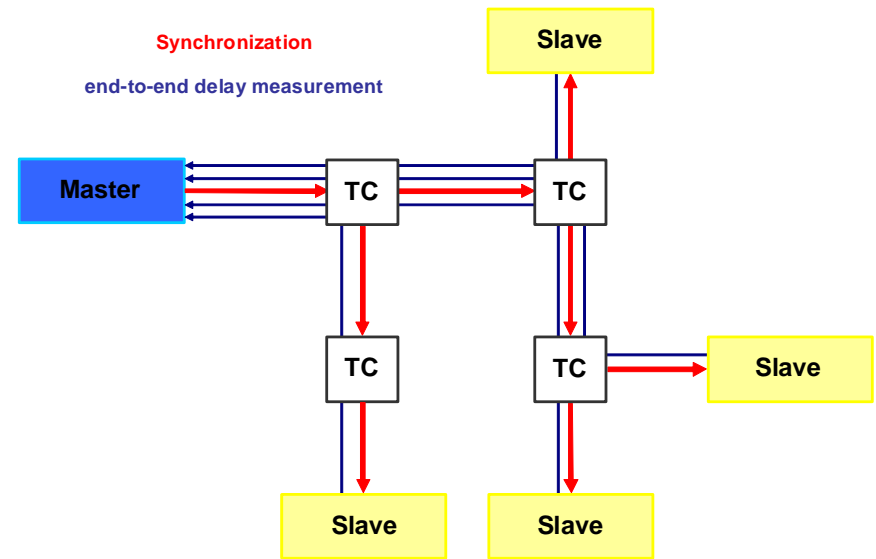
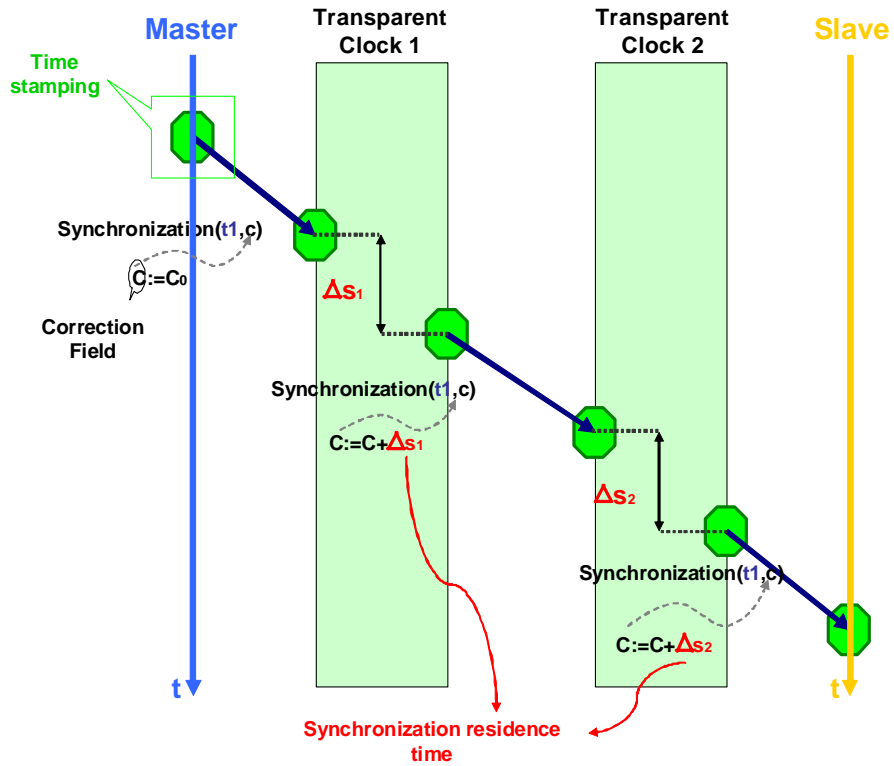
- Synchronize Networked Clocks in **nano-second range**
- Precision with **easy installation**
- Systems Synchronization and Data Transfer in the same standard version
- **Packet Looped Loop** (approach) for *syntonization* using a PID algorithm
- Main Drawback: It assumes that the packets will arrive at the destination reliably and with no delays



Introduction: IEEE 1588 V2 (Precise Time Protocol -PTP-)

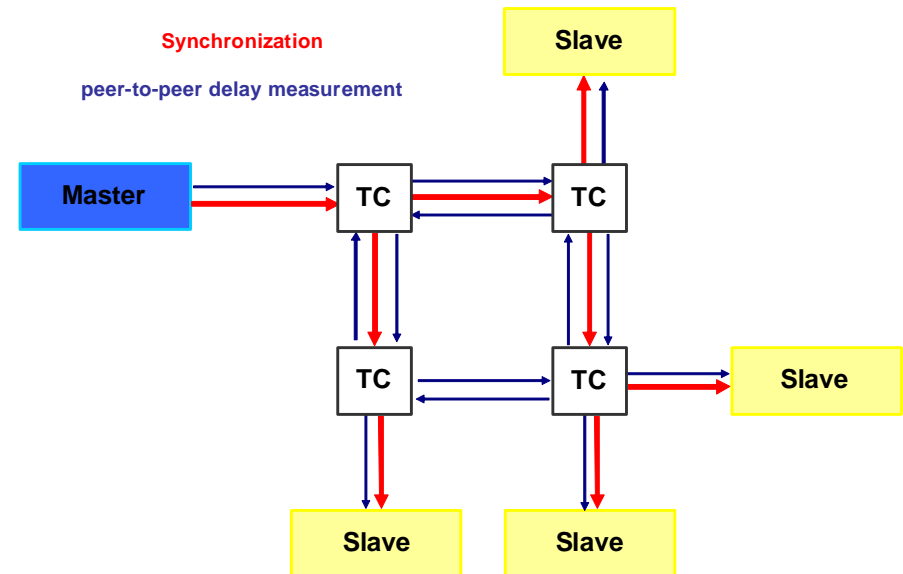
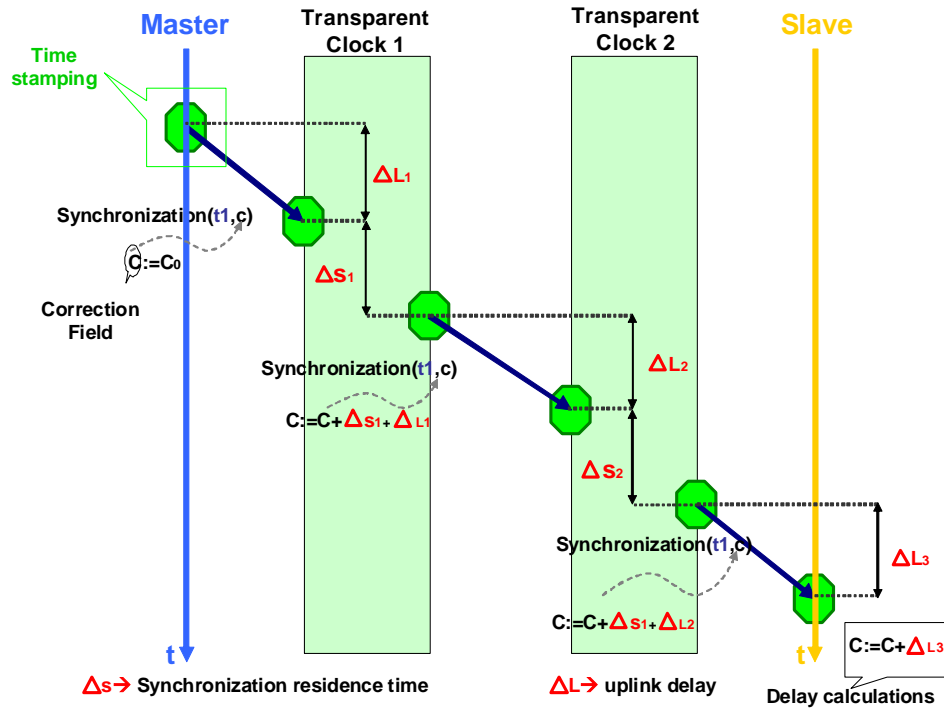


Introduction: IEEE 1588 V2 (Precise Time Protocol -PTP-)



End-to-End

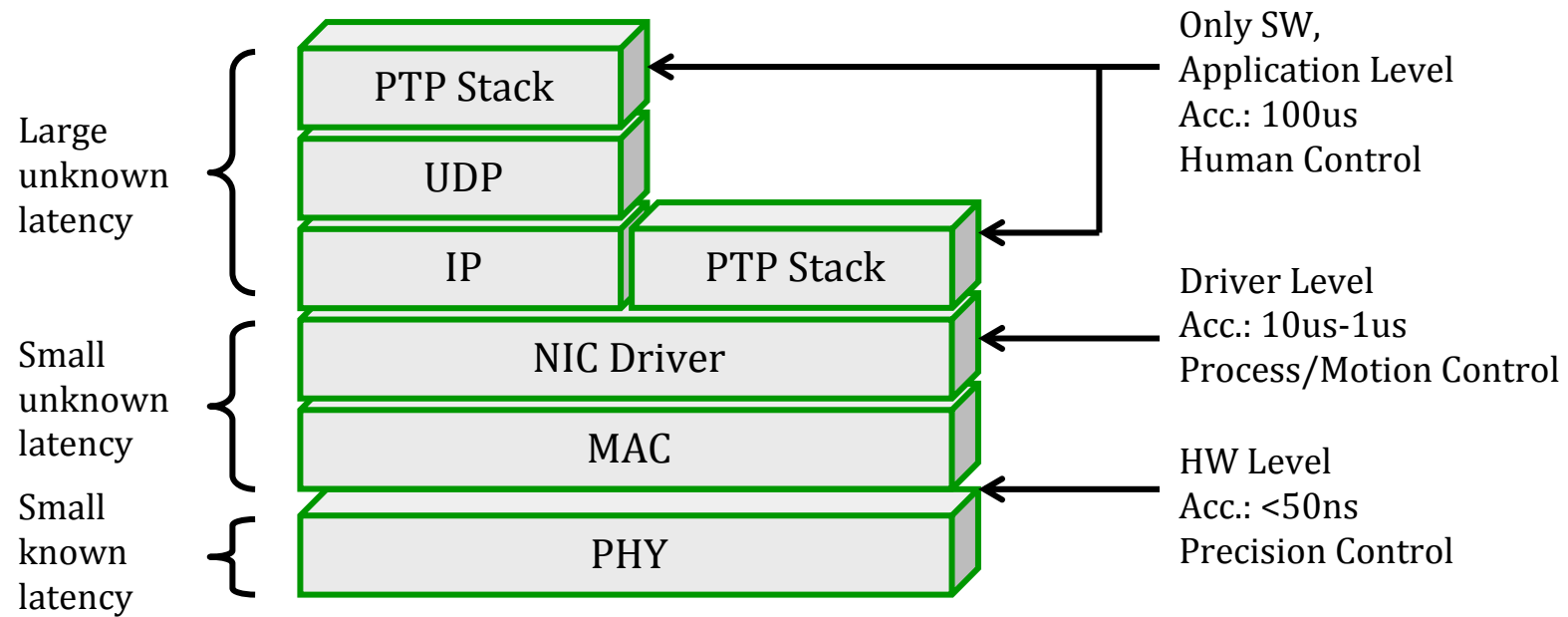
Introduction: IEEE 1588 V2 (Precise Time Protocol -PTP-)



Peer-to-Peer

Introduction: IEEE 1588 V2(Precise Time Protocol -PTP-)

- The precision of the results depends on the timestamps

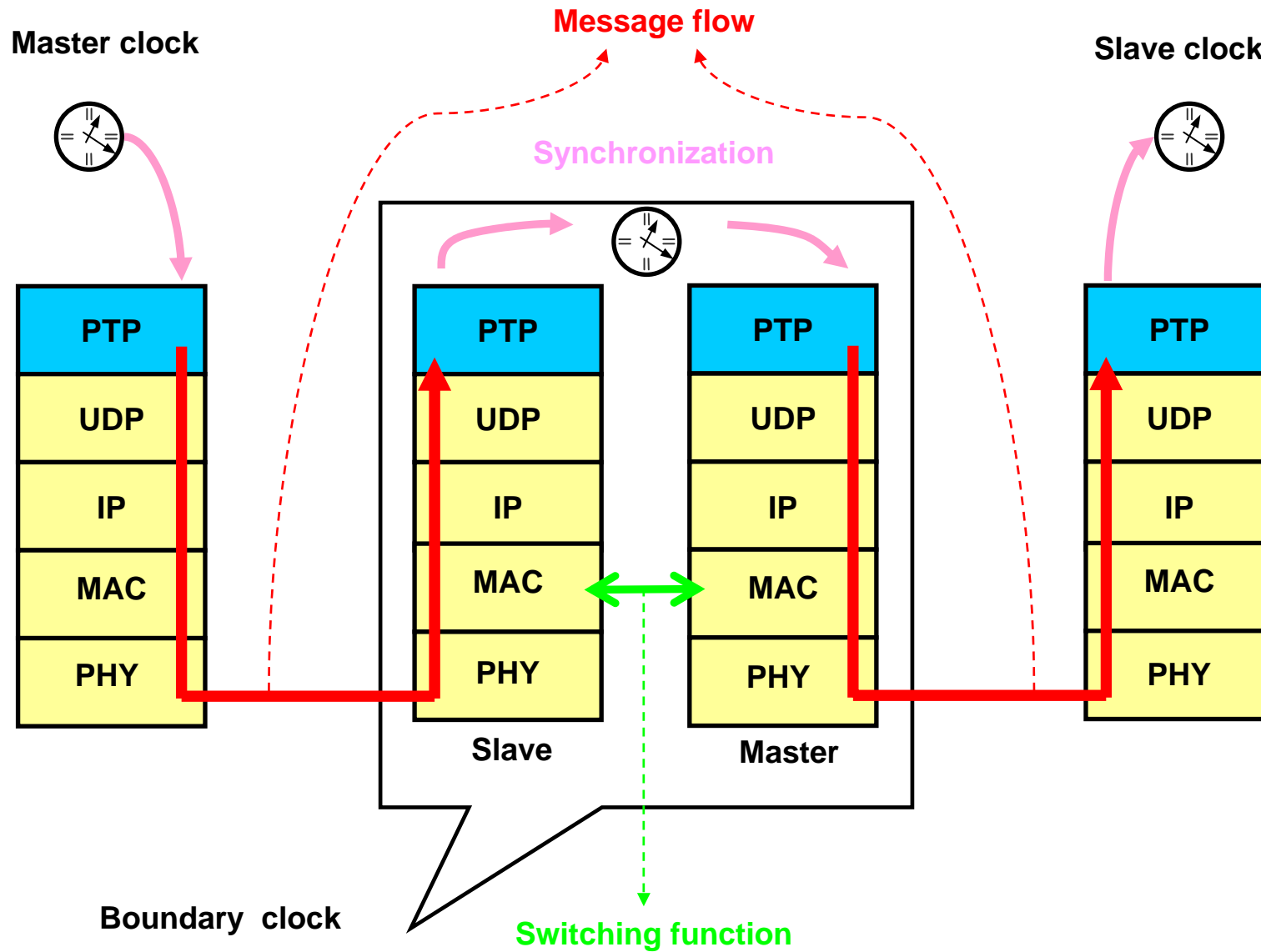


Introduction: IEEE 1588 V2(Precise Time Protocol -PTP-)

- **IEEE 1588 Transparent Clock:** Switches
- **IEEE 1588 Ordinary Clock:** End- equipment
- **IEEE 1588 Master Clock:** Clock Reference Equipments (GPS)
- **IEEE 1588 Boundary Clock:** Gateways/Different Clock Domains
- **IEEE 1588 E2E:** Mode of operation between Master and Slave
- **IEEE 1588 P2P:** Mode of operation between peers
- **IEEE 1588 1-step:** No need for follow-up messages
- **IEEE 1588 2-step:** Need for follow-up messages



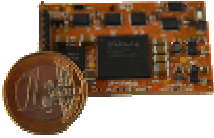


Introduction: IEEE 1588 V2 (Precise Time Protocol -PTP-)



IP Cores

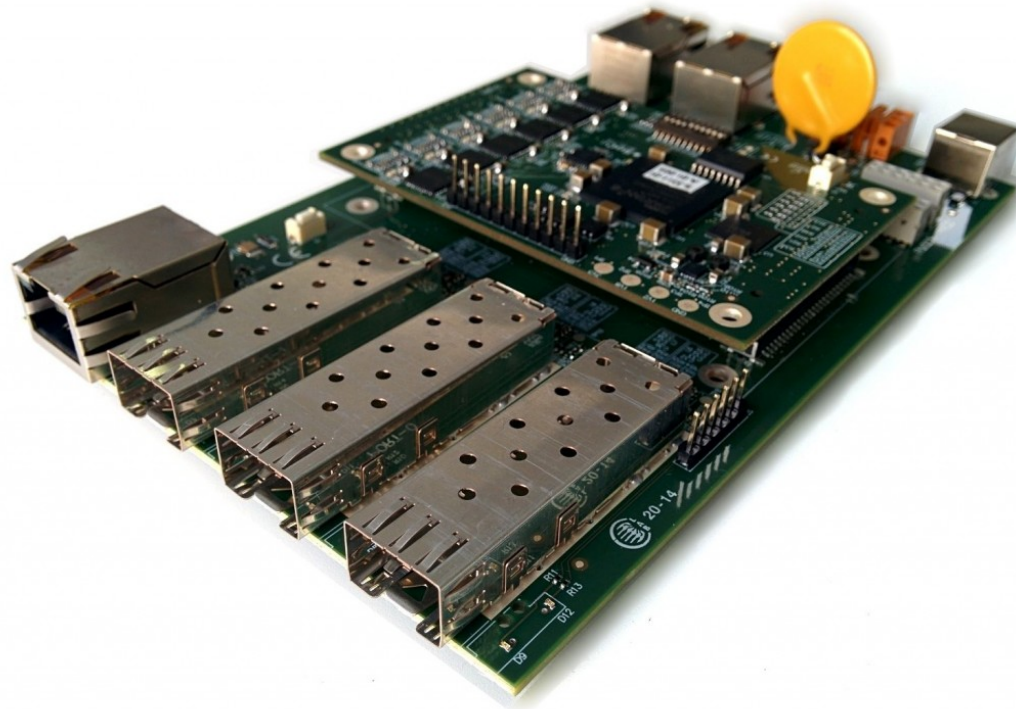
Name	Dev.	Description	Sectors
HSR/PRP Switch	S6, Zynq-7S	Redundant Ethernet with IEEE1588	Energy, Transportation, Automation, Aerospace
Unmanaged Ethernet Switch (UES)	S6, Zynq-7S	Multiport Ethernet Switch with IEEE1588 Transparent Clock. Combinable with HSR/PRP Switch	ISM, Industrial Ethernet, Aerospace
Managed Ethernet Switch (MES)	S6, Zynq-7S	Multiport Ethernet Switch with 1588 Transparent Clock, managed (VLAN, manual access to MAC table) Combinable with HSR/PRP Switch	ISM, Industrial Ethernet, , Aerospace
Industrial Ethernet IPs	S6, Zynq-7S	Profinet IP, Ethernet IP	Energy, ISM, Wireless
Irigb and IEEE 1588-2008 v2 IPs	S6, Zynq-7S	Sub-microsecond synchronization using Ethernet. Three IPs for different IEEE 1588 modes	Energy, ISM, Wireless
Full IEEE 1588 solution for Zynq	Zynq	IP an software. Seamless integration with UES for 1588-aware solution on Zynq	Energy, ISM, Wireless

Modules and Development Platforms

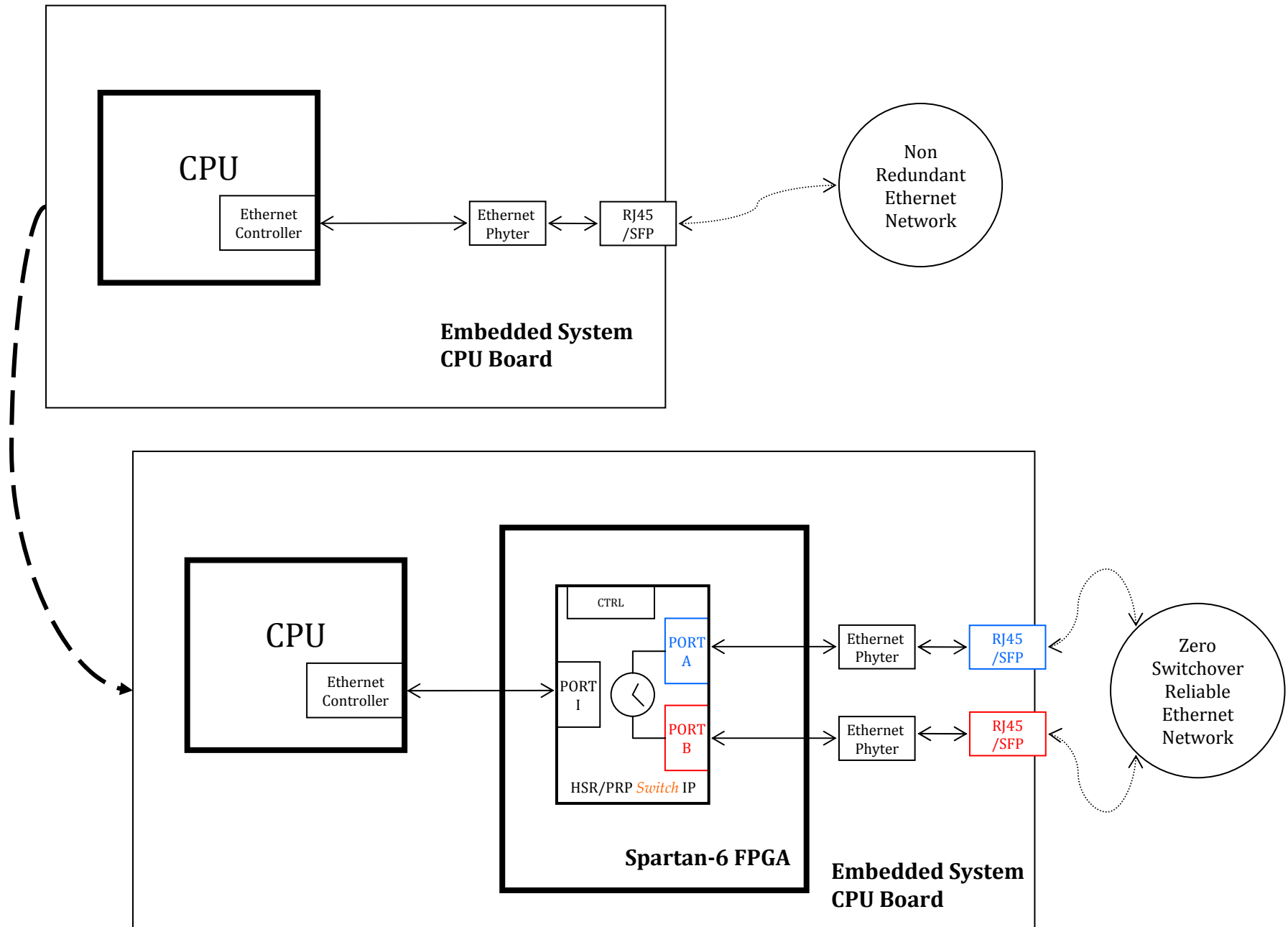
Name		Description	Key features
NET <i>oem</i>	 A small, rectangular printed circuit board (PCB) with a central integrated circuit (IC) and several surface-mount components. A coin is placed next to it for scale.	Ready to use HSR/PRP/1588 solution for Fast Ethernet copper	<ul style="list-style-type: none">• 4 integrated Ethernet Phyters• Industrial grade
SMART <i>oem</i> family	 A larger, green PCB with a complex layout of components, including a large central IC, various capacitors, and connectors. It has a more industrial or server-like appearance.	Ready to use HSR/PRP/1588 solution for Fast Ethernet copper/fiber	<ul style="list-style-type: none">• Up to 6 integrated Ethernet Combo Phyters• Industrial grade• Compatible (size, pins) with other modules• Design open to customer
NET <i>Box</i>	 A development kit consisting of a PCB mounted inside a blue and red plastic enclosure. The enclosure has a transparent top and a front panel with ports.	Development-kit and ready to use HSR/PRP RedBox	<ul style="list-style-type: none">• JTAG, PMODs,• Graphic Display• Industrial grade

Modules and Development Platforms

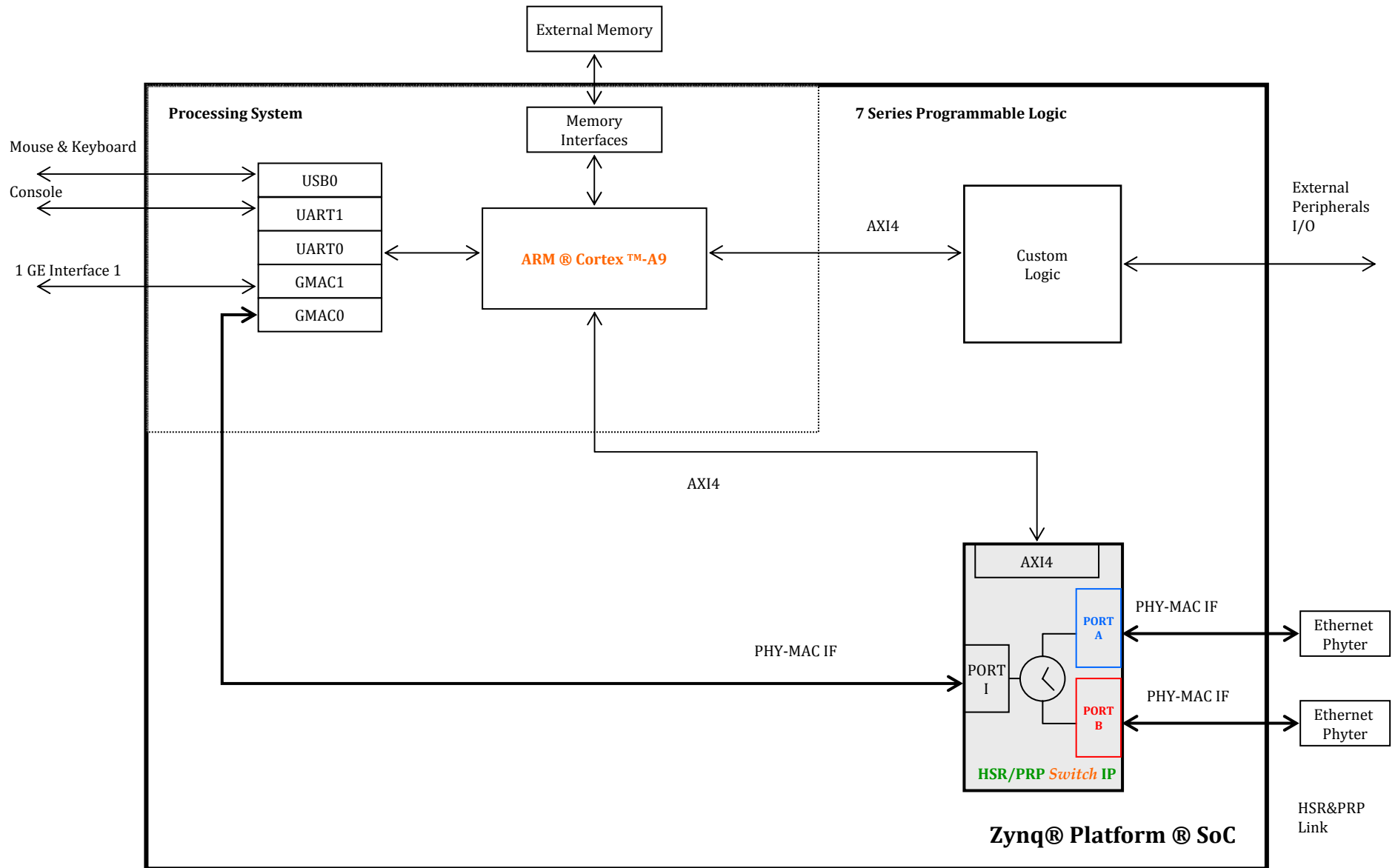
SMART^{oem} family



HSR/PRP *Switch IP* Simplest Solution (fully scalable in Port Numbers)



HSR/PRP Switch IP : Simplest Solution (fully scalable in Port Numbers)

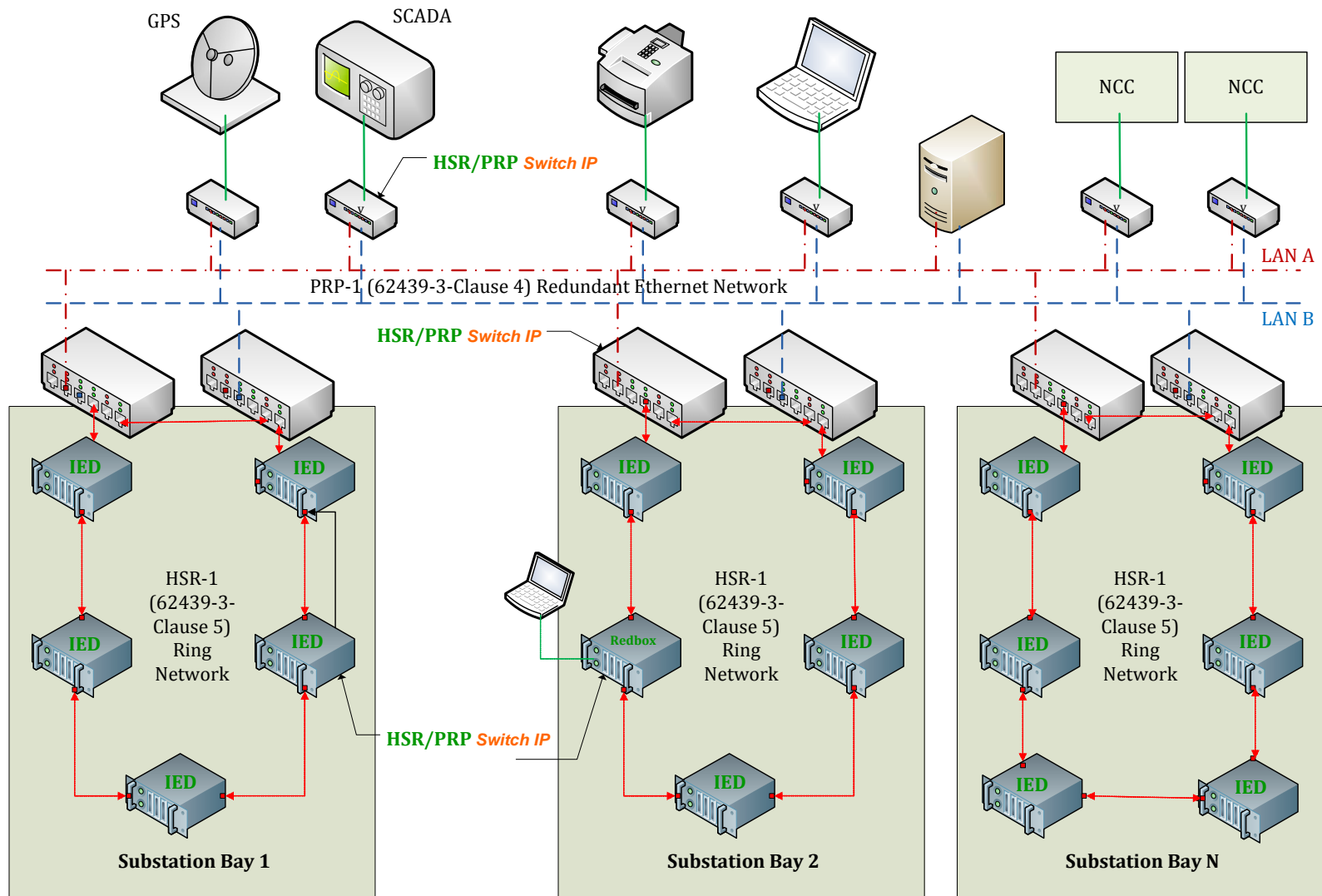


SoC Portable Tools

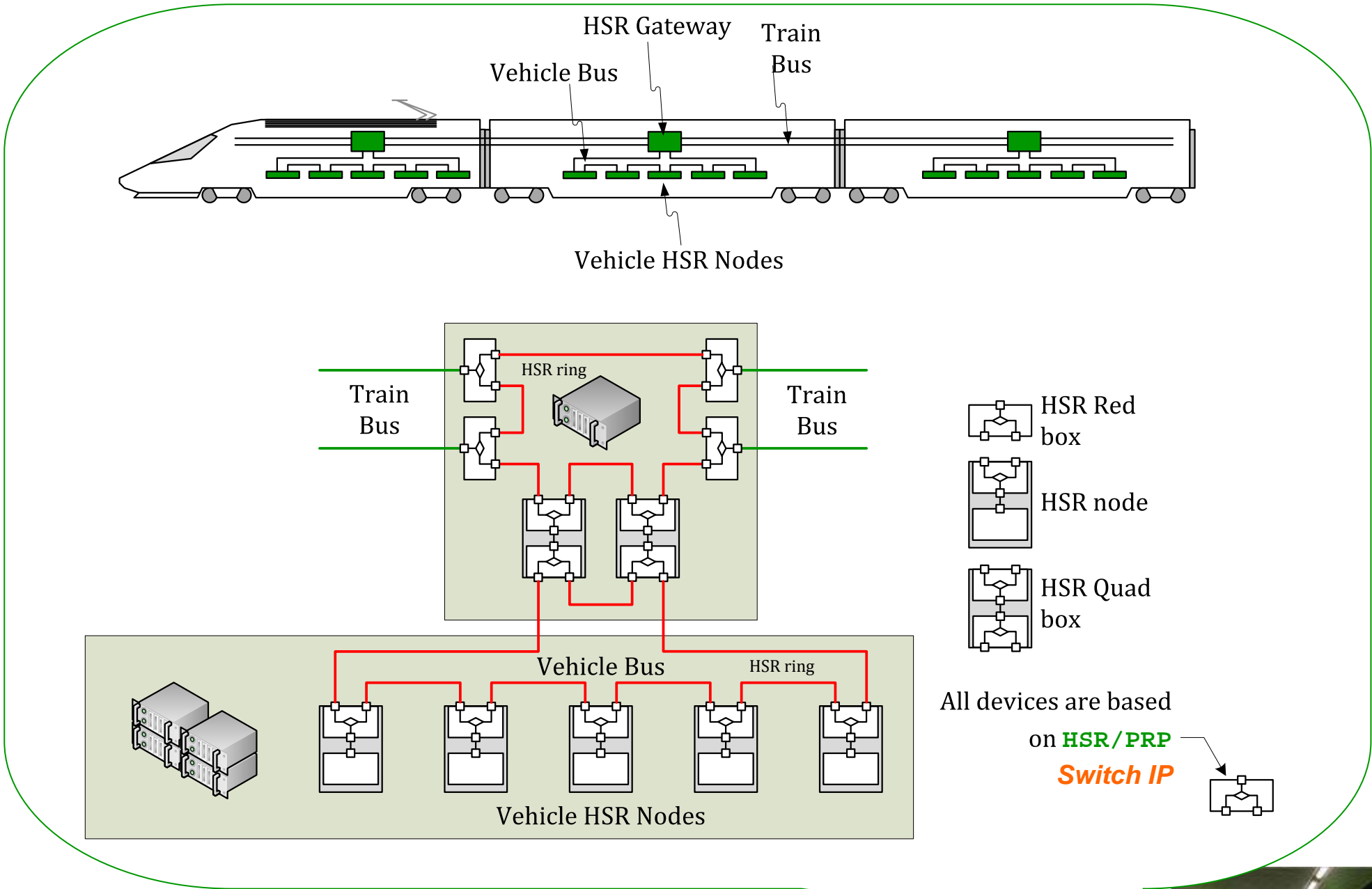
- Configuration and Management APIs
- Supervision Frames Management Tools
- RSTP Stacks
- Application Software Examples



SoCe Industrial : (case of use 1)



Case of use 1.: ELECTRIC SUBSTATION AUTOMATION: Process-Bus implemented using HSR and Station and Inter-bay Buses using PRP



CASE OF USE 2: **TRANSPORTATION:** Train Bus and Vehicle Bus implemented using HSR





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