SoC*e* for Railway

Ver. 200304

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- Challenges and Use-cases
  - On-track Electronic Signaling
  - Rolling Stock
- SoCe Solutions
- R&D and References

On-track Electronic Signaling

- Demand for a network infrastructure:
  - Optimized in terms of:
    - Data throughput
    - Life cycle costs
    - Scalability
  - Featuring:
    - Highest levels of availability
    - Easy integration into existing infrastructures
    - Security
    - Safety

On-track Electronic Signaling

Solutions based on **High-Availability Ethernet (HSR/PRP):**

- **Redundancy** with Zero-delay recovery time
- **Switch-less** Ring Network topologies (HSR)
- **Latency worst case known** Ring Network topologies (HSR)
- **Full compatibility** with standard Ethernet (PRP)
- Seamless **HSR-PRP merging**
- **Redundant PTP**

On-track Electronic Signaling

Solutions based on **Time-Sensitive Networking (TSN):**

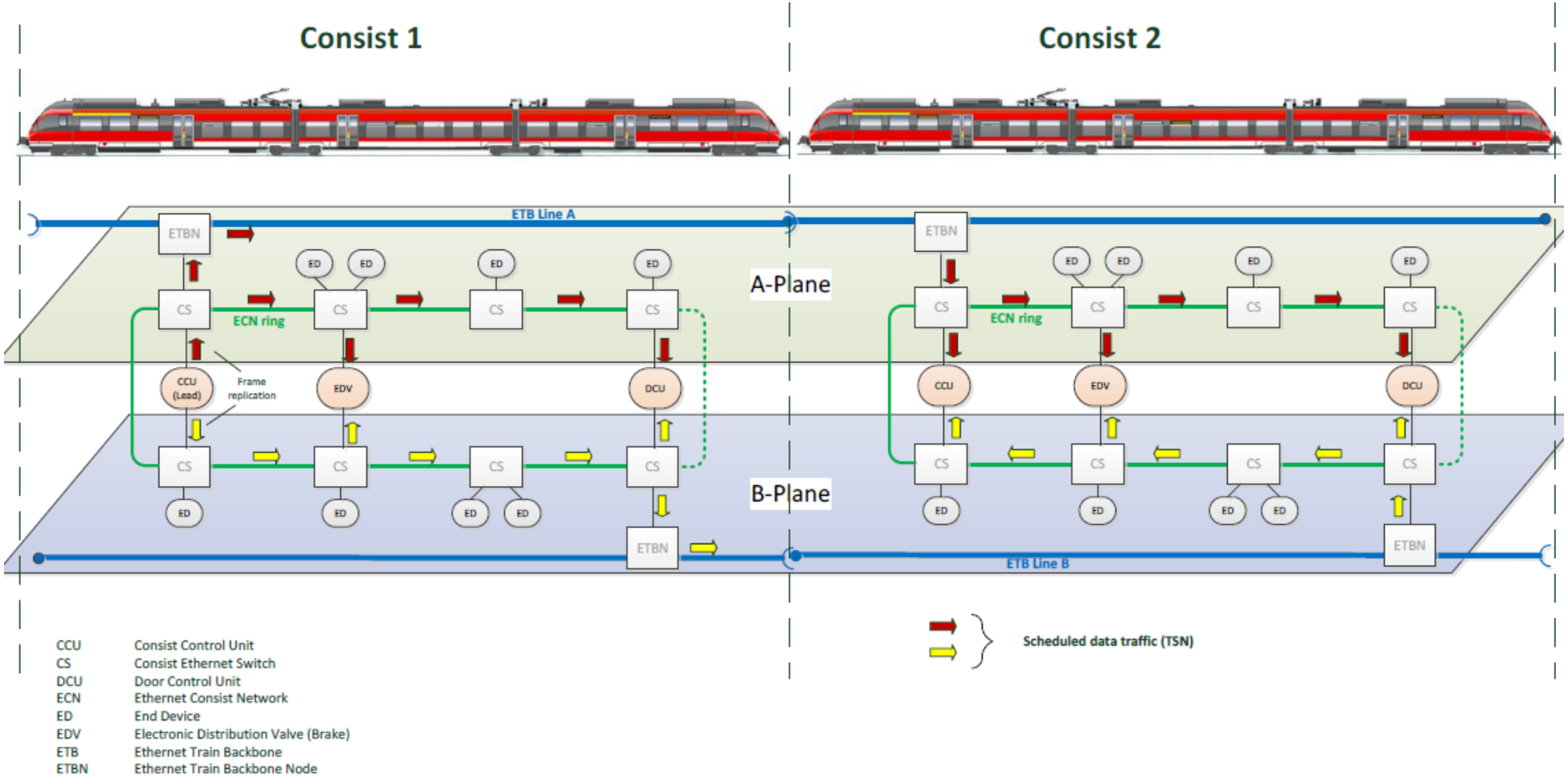
- **Redundancy** with Zero-delay recovery time (802.1CB)
- Network topology **simplification**:
  - Deterministic Ethernet
  - Advanced QoS for Real Time traffic: ***Scheduled, Reserved, Best Effort***
  - OT/IT traffic integration in the same network

Rolling Stock

- Evolving TCN-Train Communication Networks with Time-Sensitive Networking (TSN):
  - **Simpler** Network Infrastructure
  - Simplified integration due **Interoperability**
  - Support for :
    - Controlled network latency (**Deterministic Ethernet**)
    - **Zero-delay** recovery time Redundancy

Rolling Stock

- Ethernet Train Backbone (ETB)
- Ethernet Consist Network (ECN)

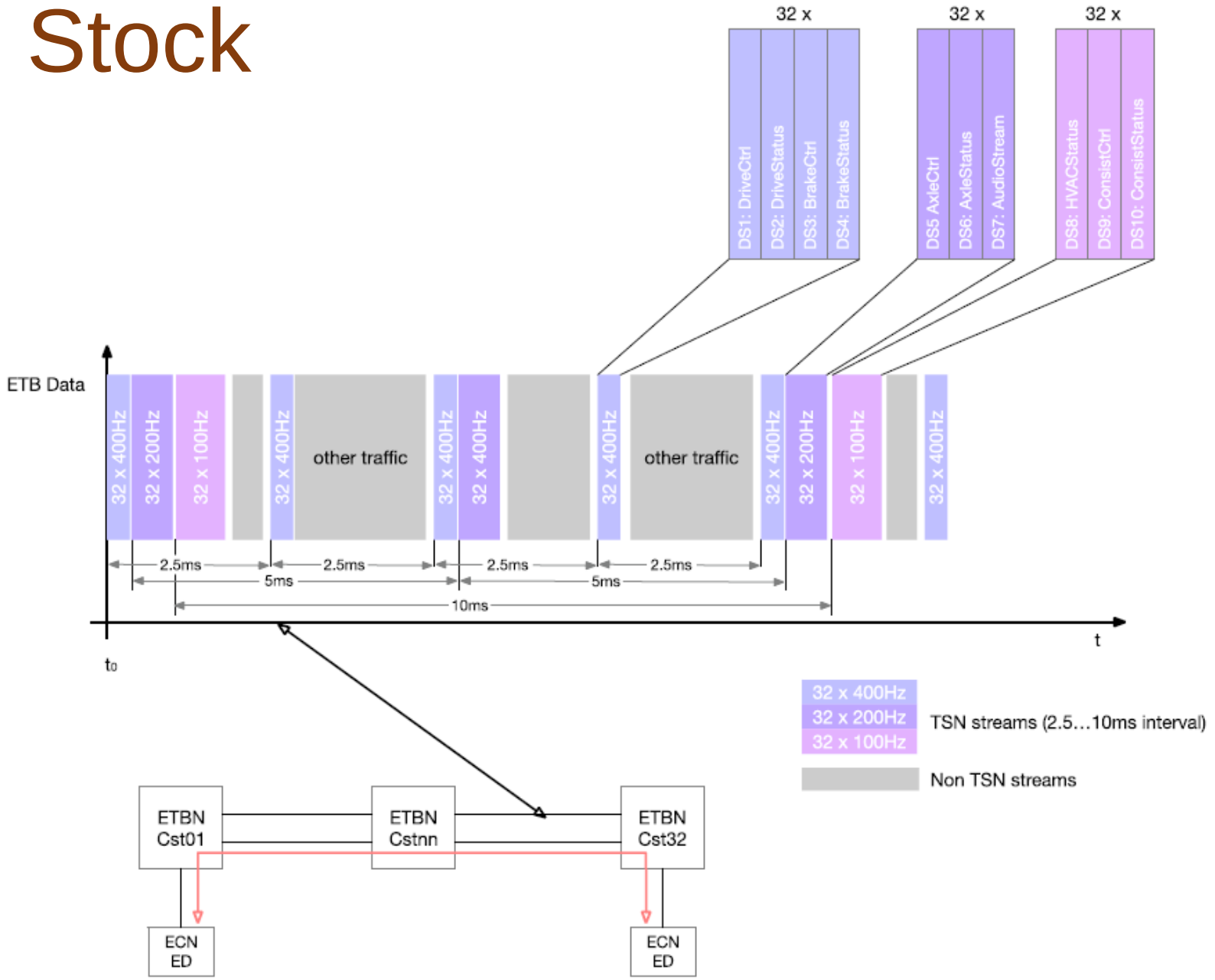


ETB/ECN Layout proposed by CTA (Source SAFE4RAIL D1.9)

SoC*e*

- TSN Streams over ETB (Source SAFE4RAIL D1.9)

Rolling Stock



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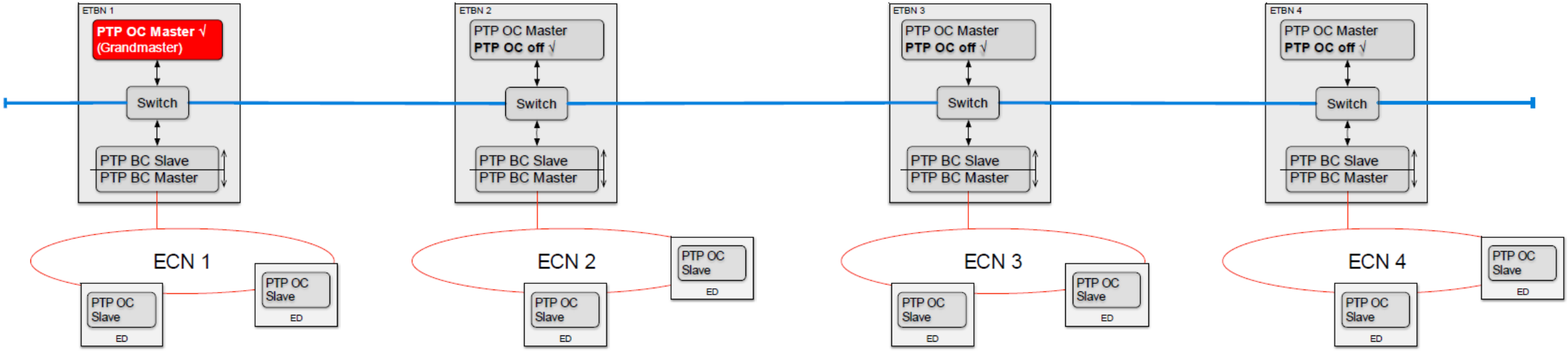
Rolling Stock

- IEEE 1588 based accurate synchronization distribution



PTP: Trains after coupling and inauguration (Source SAFE4RAIL D1.9)

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  - 1G/10G Managed Ethernet Switch IP
  - Time-Sensitive Networking TSN IP
  - Synchronization IPs
  - Wire-speed security for Ethernet
  - SoMs and Boards
- R&D and References

1G/10G Managed Ethernet Switch IP

- **Designed for Critical Systems:**
  - Scalable up-to 32 ports
  - No-frames lost at full-speed
  - Distributed memory for low-latency
  - IEEE 1588 Synchronization
  - Redundancy: (MR)STP, DLR, MRP, HSR/PRP

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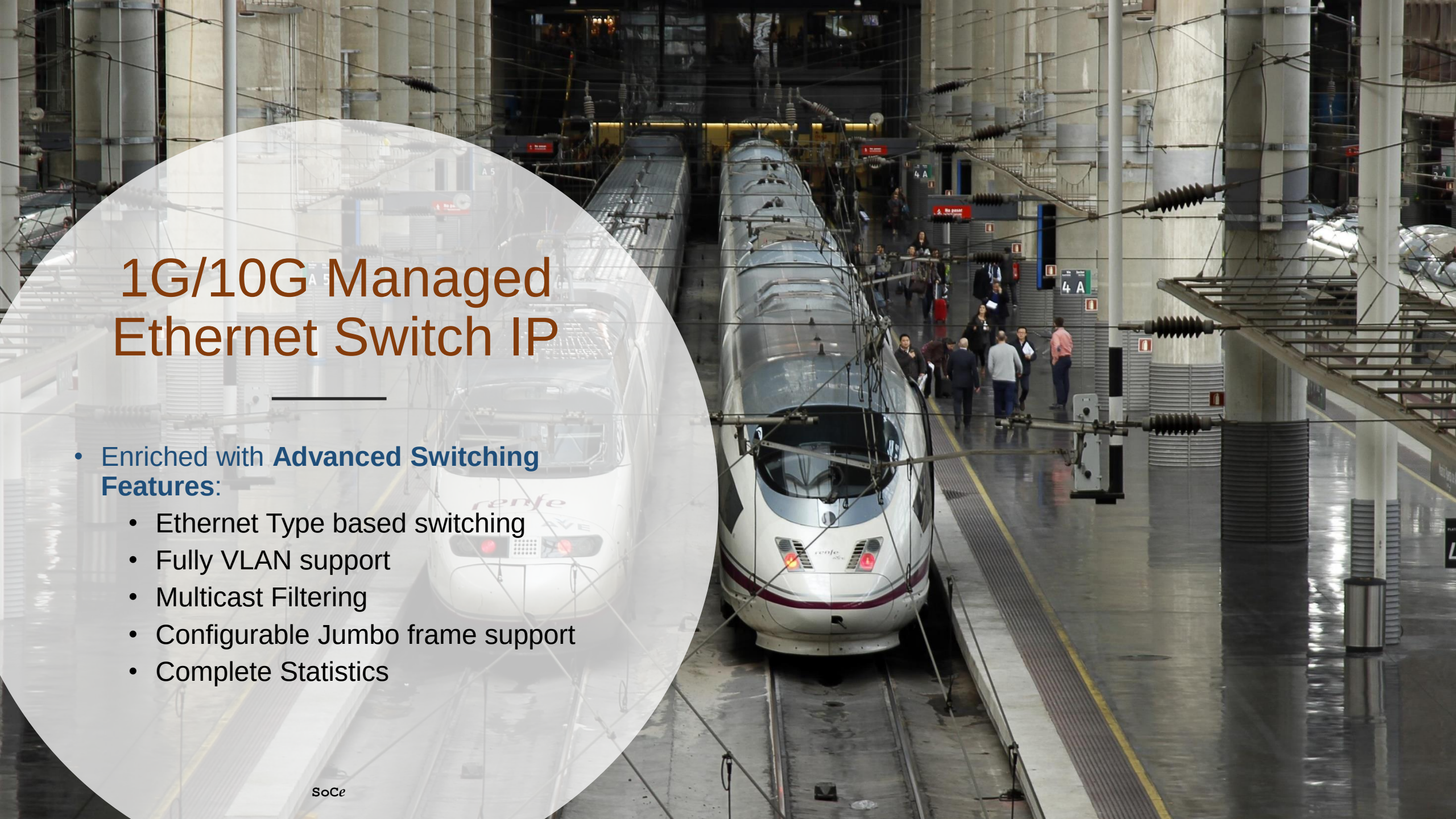
1G/10G Managed Ethernet Switch IP

- Enriched with **Advanced Switching Features**:
  - Ethernet Type based switching
  - Fully VLAN support
  - Multicast Filtering
  - Configurable Jumbo frame support
  - Complete Statistics



1G/10G Managed Ethernet Switch IP

- **Cybersecurity Support**:
  - Hardware filtering for IEEE 802.1X
  - Frame Rate Limiting
  - Broadcast Storm Protection
  - Embedded Port Mirroring capability
  - Optional Wire-speed security

1G/10G Managed Ethernet Switch IP

- **Easing the integration** for the designer:
  - Fully parametrizable in Vivado IPI
  - Software support: APIs and GUI
  - Reference Designs
  - SoMs and Development Platforms

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10G Managed Ethernet Switch IP

- **Head-of-Line blocking free architecture** to support:
  - Full-speed switching at 10G
  - Switching availability even in congestion in output ports
  - Low-latency thanks to MAC queries parallelization
  - All features included in 1G Managed Ethernet Switch IP

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Time-Sensitive Networking IP

- **All-in-one flexible** solution for TSN:
  - Fully parametrizable in Vivado IPI
  - Number of ports
  - Desired TSN features
  - Software stacks supported
  - Reference Designs and Development Kits

Time-Sensitive Networking IP

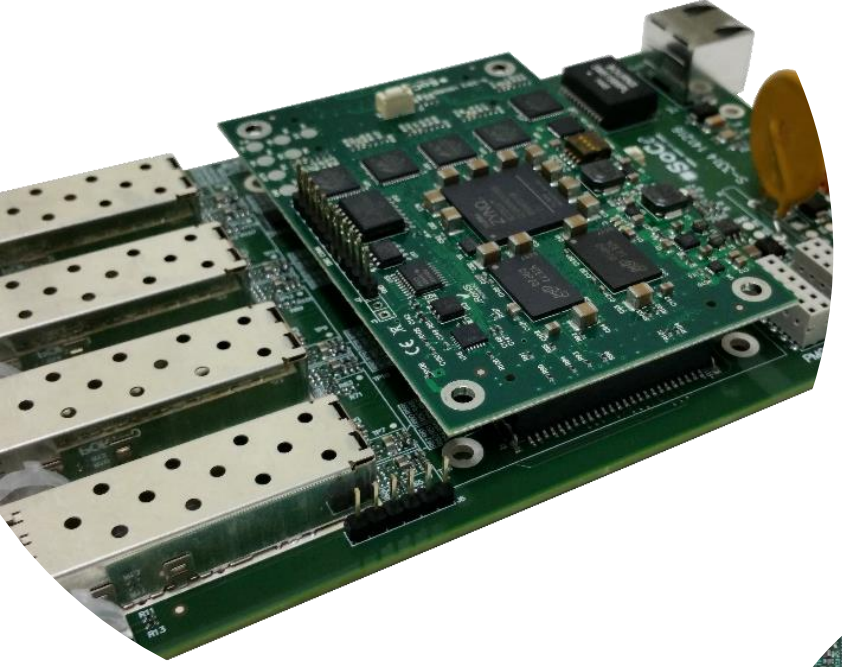
- **Complete TSN features** to build a node according to your Profile:
  - Time-aware Shaping
  - Credit-based Shaping
  - Redundancy
  - Pre-emption
  - Interoperable Configuration

Synchronization IPs

- **Full solution** for IEEE 1588v2 (OC, BC, TC): IPs & SW
- IEEE 1588v2 Slave-only **CPU-less** IP (hardware only implementation)
- **IRIG-B Master, Slave** and IEEE 1588v2 combined IPs

Wire-speed security for Ethernet

- Facing the challenge of **securing real-time traffic:**
  - AES-GCM based wire-speed cryptography
  - Automatic Ethernet traffic type identification
  - Fixed and small latency depending on Secure Frame Format
  - Single core to support up to 16Gbps of data bandwidth
  - Multiple parallel Security Keys management



SoMs and Boards

- Focused on Networking applications:
  - Xilinx Zynq-7000, Ultrascale+ MPSoC, Artix-7
  - Evaluation, Reference and Production

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  - Interoperability Events
  - Some References in Railway

Interoperability Events

- IEEE ISPCS 2011: Munich (Germany). Product qualified: Precise Time Basic on S6
- UCA Pre-testing for CIGRE 2012: Winterthur (Switzerland). Product qualified: HSR/PRP on S6
- CIGRÉ 2012: Paris (France). Product qualified: HSR/PRP on S6 in customer product
- IEEE ISPCS 2012: San Francisco (USA). Product qualified: 1588Tiny IP S6
- UCA Pre-testing for CIGRE 2014: Bilbao (Spain) Coordinated and hosted by SoCe 1GE HSR and IEEE 1588 test passed
- CIGRÉ 2014: Paris (France). Coordination Demo
- IEEE ISPCS 2014: Austin (USA) Products qualified: 1GE HSR/PRP with IEEE1588 running Power and Utility Profile
- IEEE ISPCS 2015: Beijing (China):PRP/HSR<-> HSR new BC. Secure 1588
- IEEE ISPCS 2016: Stockholm (Sweden): IEEE 1588 AS profile (AVB and TSN)
- IIC TSN TESTBED 2018: Erbach, Stuttgart, Hannover (Germany): QbV, AS profile, modules
- IIC TSN TESTBED 2019: Hannover, Stuttgart (Germany). Beasain (Spain): CB, YANG
- IIC TSN TESTBED 2020: Stuttgart (Germany): Network

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R&D

Time Sensitive Networking - Flexible Manufacturing

Industrial Internet Consortium Testbed Showcase Winner Q1 2017

Time Sensitive Networking (TSN) is key for industrial applications such as process and machine control where low communication latency and minimal jitter are critical to meeting closed loop control requirements. TSN is the first fully open, standard and interoperable way to fulfill these requirements.

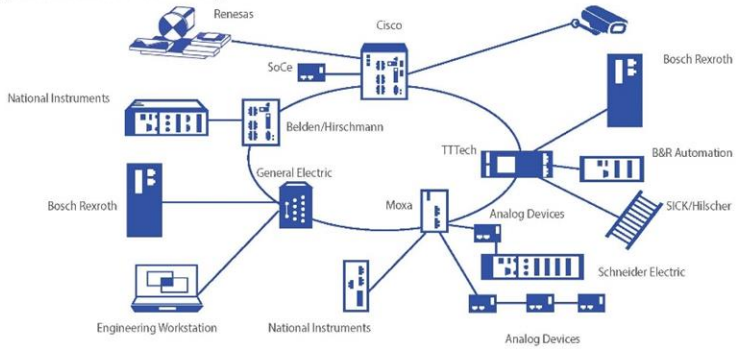
CHALLENGE

Manufacturing operations requires tight coordination of sensing and actuation to safely and efficiently perform closed loop control. Typically, these systems have been deployed using non-standard network infrastructure or air-gapped (unconnected) standard networks. This approach makes devices and data much harder to access and creates a technical barrier to IIoT which is predicated on the ability to consume data anywhere throughout the infrastructure.

To address these needs of IIoT all the way to the control system, the IEEE organization has been working to update the standards for Ethernet and wireless (IEEE 802) to support time sensitive networking.

SOLUTION

TSN enables a single, open network infrastructure supporting multi-vendor interoperability through standardization and IT and OT convergence through guarantee of service. The technology will be used to support real-time control and synchronization of high performance machines over a single, standard Ethernet network. This testbed showcases an early implementation of TSN. As such, it will show the value of the technology as well as some of the challenges in implementations from a number vendors. This testbed will not only document the value of TSN, but will provide feedback to the relevant standards organizations on areas of further clarification or improvement.



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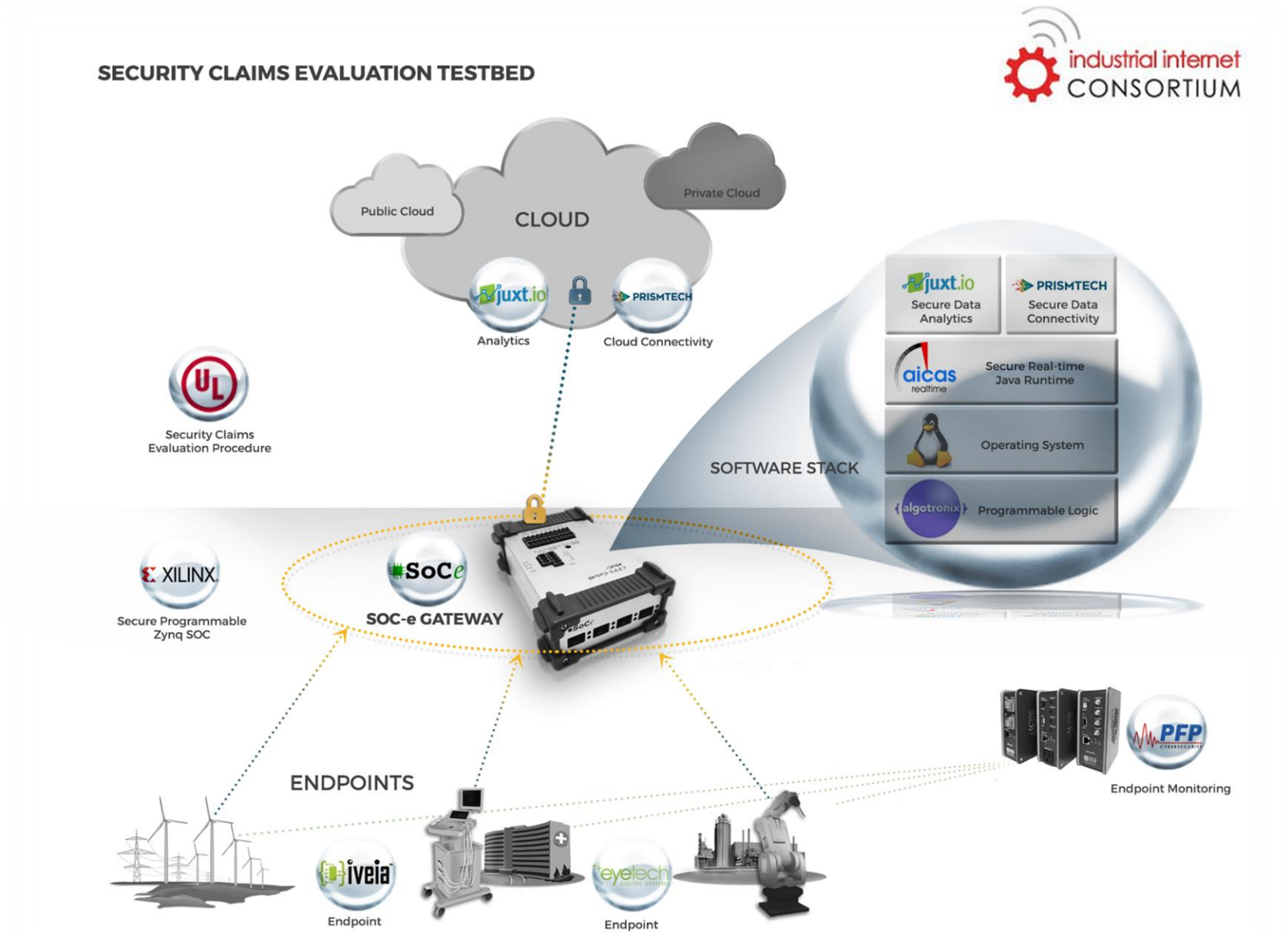
R&D

CONNECTA-2 & Safe4RAIL-2 joint TSN interoperability tests
14 June 2019
https://projects.shift2rail.org/s2r_ip1_n.aspx?p=CONNECTA-2

CONNECTA-2 project and its complementary action Safe4Rail-2 met in Beasain on 27th, 28th and 29th May 2019 for the first TSN interoperability tests. Within these joint tests two different TSN IP cores to be used in Urban and Regional demonstrator of CONNECTA-2 project have been tested. These tests have validated the full interoperability of IP core deployed by TTTech, to be used in consist and train switches of the demonstrators, and the IP core from SoC-e to be used in the TSN controller deployed by CAF.

R&D


SECURITY CLAIMS EVALUATION TESTBED
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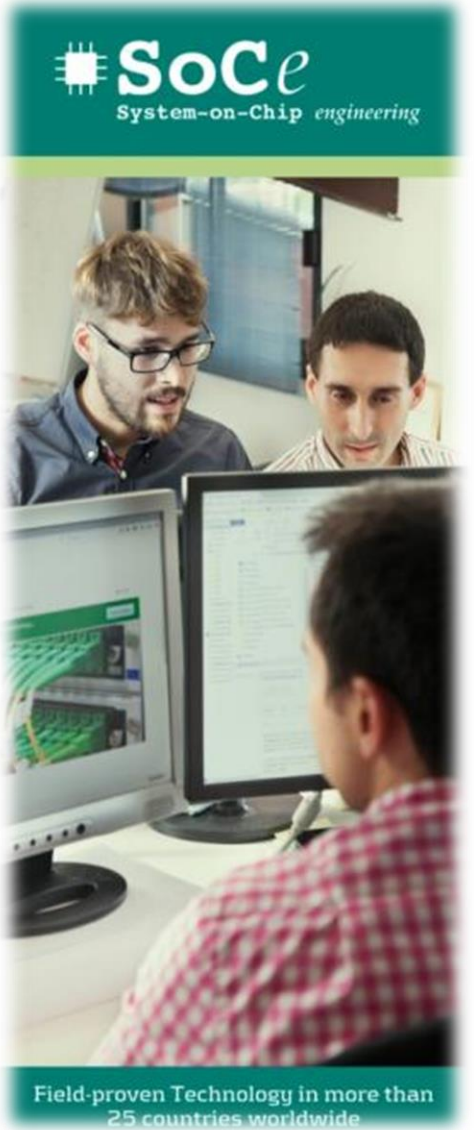
Secure Real-time Java Runtime
Operating System
algotronix
Programmable Logic
XILINX
Secure Programmable Zynq SOC
SoCe
SOC-e GATEWAY
ENDPOINTS
iveia
Endpoint
eyetech
Endpoint
PFP
Endpoint Monitoring

About SoC-e

- Provides IP cores, modules and end-equipment for
  - Networking:
    - Deterministic Ethernet:
      - MTSN, D-HSR
    - High-availability Ethernet:
      - HSR/PRP, MRP, S-HSR
    - Time-aware Ethernet:
      - MES, UES, Field-buses
  - Synchronization:
    - IEEE1588, Irigb
  - Real-time Cyber-security



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