Suzeck at a Glance

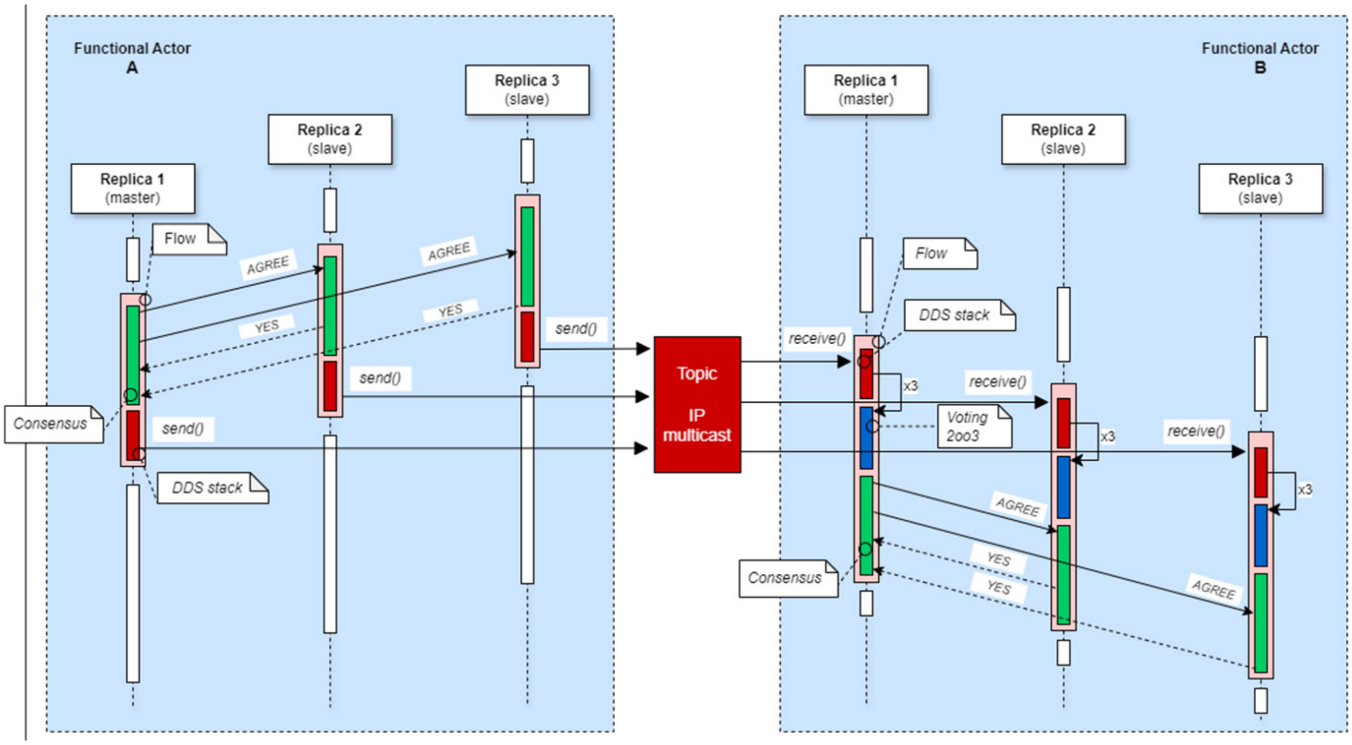


Figure 1: OCORA PI initial approach

Suzeck builds a distributed system architecture for replica management for Railway trackside infrastructure, implementing the OCORA PI API. It delivers an open-source reference implementation as well as building blocks for a commercial implementation for Safety-critical systems.

The OCORA PI compatible architecture for transparent repeated (multi-replica) communication for Cloud/Edge networks, is depicted in Figure 1 as one initial approach.

SYSGO implemented and ported a fully functional version of gPTP over PikeOS, required for TSN (Time Sensitive Networks), as a fully-funded Master's thesis (2025) in collaboration with the University of Rostock. The outcome of the thesis will be directly used for the communication over TSN between the SCP and the Field Element Concentrator (FEC), described next.

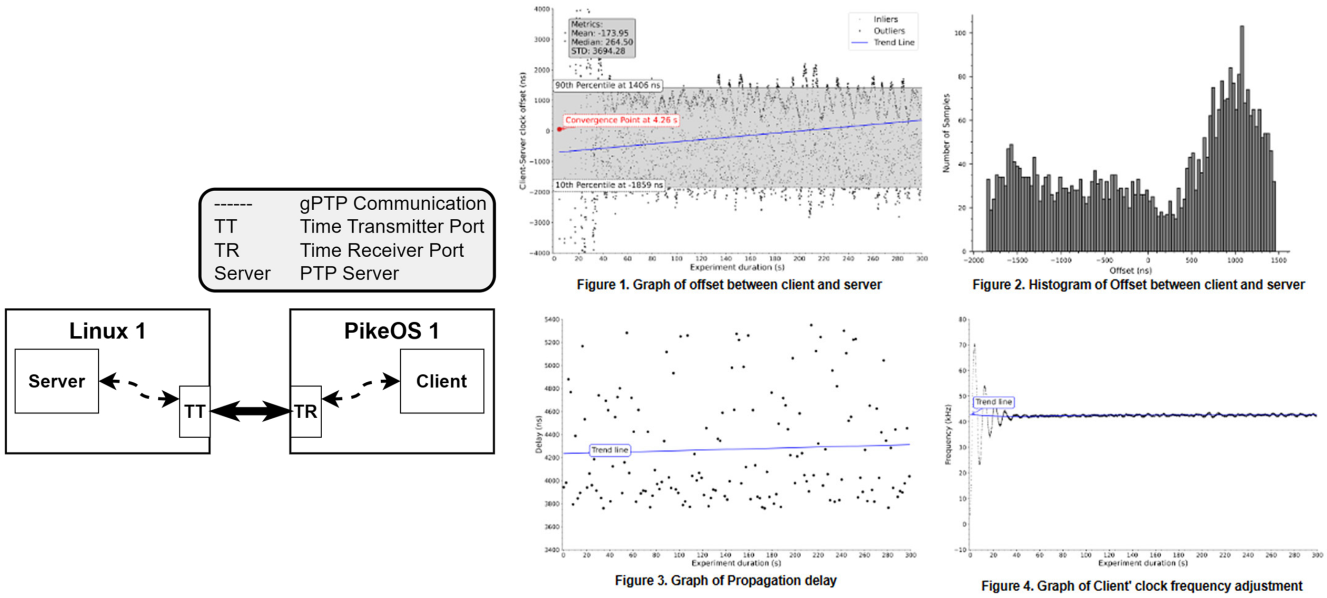


Figure 2: Implementation of gPTP protocol for TSN, from the master thesis co-supervised with the University of Rostock on March 2025

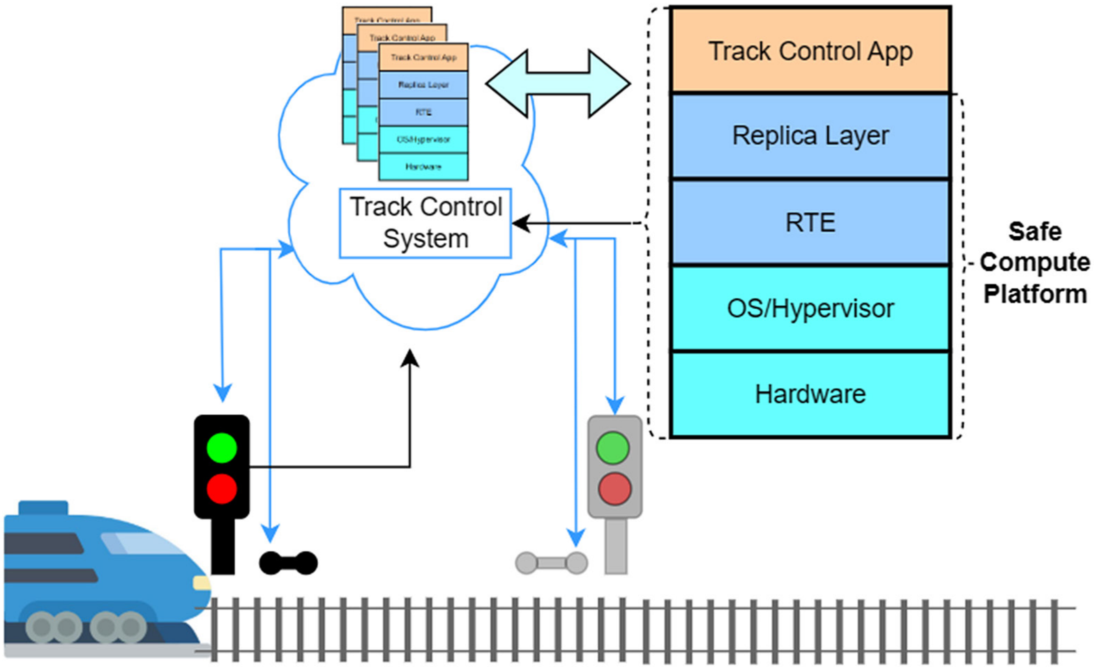


Figure 3: Targeted System as a Safe Compute Platform (SCP)

SYSGO is working based on a simple use case, where an axle counter is sent to three CCS (Control Command and Signalling) systems, and then this data is retrieved by a signal. The use case has been selected because it is intuitively understandable (although notably modern Railway technology has developed beyond such approaches, the synchronization challenges remain comparable).

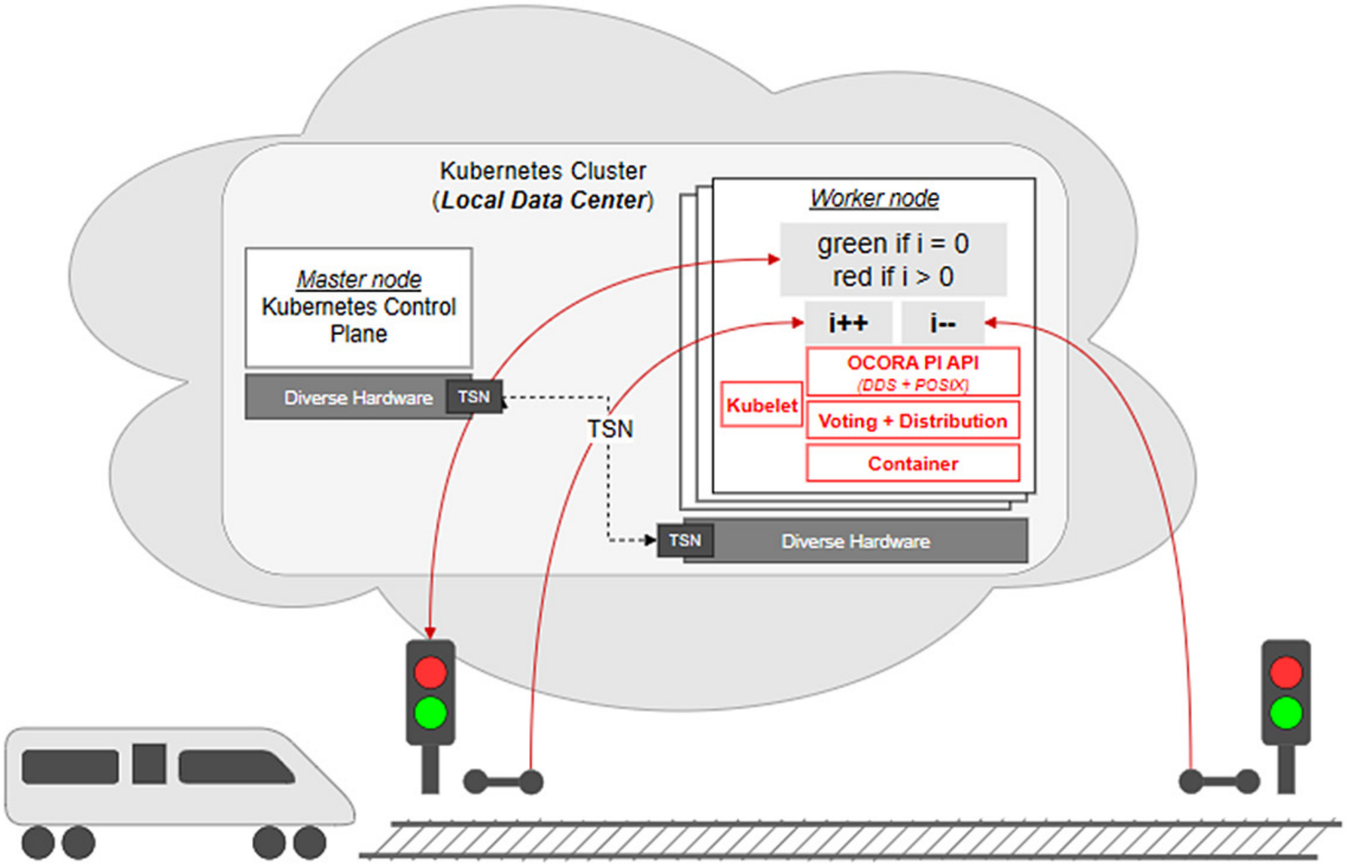
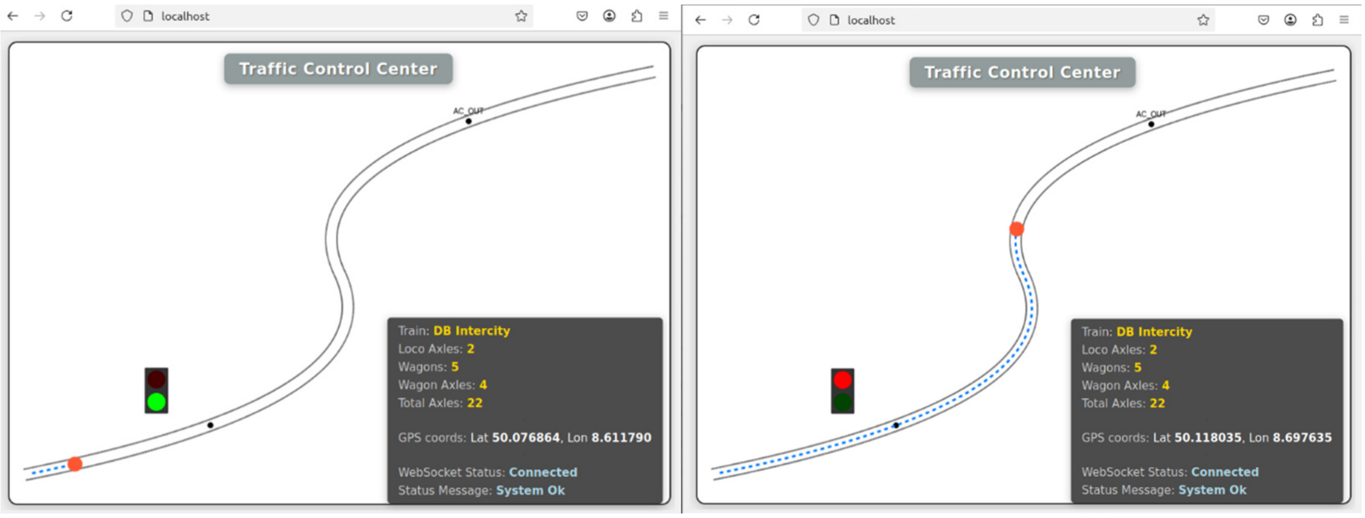


Figure 4: Ttarget SCP System, with multiple copies (e.g., Kubernetes) cluster implementation, diverse redundant hardware with voting mechanisms over TSN communication protocol, based on OCORA PI implementation

SYSGO constructed a complete train simulation of the use case described in Figure 1, described as one train track segment with one incoming-train axle counter and an outgoing axle counter at the end of the segment. At the segment start (entry point), there is a traffic light, which is red when the track segment is occupied by a train (when the incoming axle counter is >0), or green otherwise.

The basic logic of the simulation is identical to the one agreed with DB at the beginning of the project, as follows:

The train can enter the segment when the traffic light is green. As soon as the axle_counter_in senses one wheel, the system has to turn the traffic light red. The system counts the total incoming axles (increase variable, ++) and keeps the traffic light red. The axle_counter_out sensor advertises the axle number out (decrease variable--), when the train passes by. The system will turn the traffic light green only if the variable axle counter is zero (++ == --).



Train: **DB Intercity**
Loco Axles: **2**
Wagons: **5**
Wagon Axles: **4**
Total Axles: **22**

GPS coords: Lat **50.076864**, Lon **8.611790**

WebSocket Status: **Connected**
Status Message: **System Ok**

Train: **DB Intercity**
Loco Axles: **2**
Wagons: **5**
Wagon Axles: **4**
Total Axles: **22**

GPS coords: Lat **50.118035**, Lon **8.697635**

WebSocket Status: **Connected**
Status Message: **System Ok**

Figure 5: LEFT: The track segment is unoccupied, the axle_sensor_in has not detected any wheels.
RIGHT: The axle_sensor_in detected the 1st wheel and the system turned the traffic light to red.

The simulation also implements the “remote data concentrator”, emulating the same-name hardware entity on a train track infrastructure (outside of the scope of the emulation), as the device connected via cabling with the “field elements” (axle sensors, traffic lights) southbound, and via Data Distribution Service (DDS) protocol, with the cloud-based “Secure State Platform” (SCP) northbound. The SCP is receiving the axle counter signals (++, or – – respectively), and signals the traffic light change accordingly. In future versions, the SCP could initiate a series of Safety alarms (sound and optical signals, message sending, etc.) in cases of Safety violations, as if the number of axles in is different from the number of axles out, or if the axle_sensor_out is idle for more than a given time elapsed limit.

Next Steps of Suzeck

- Fully functional hardware implementation over three compute devices with full redundancy, operating over Time Sensitive Network (TSN) protocols, and DDS (Data Distribution Service) communication.
- Fully functional workload containerization (e.g., Kubernetes cluster) over the above hardware, with failover and state-of-the-art voting mechanisms, to accommodate MooN (Majority of N) connected logical or physical machines.
- Full deployment of the OCORA PI API and exhibition of its capabilities over the demo infrastructure, and full documentation and GitHub distribution.

Founded in 1991, SYSGO became a trusted advisor for Embedded Operating Systems and is the European leader in hypervisor-based OS technology offering worldwide product life cycle support. We are well positioned to meet customer needs in all industries and offer tailor-made solutions with highest expectations in Safety & Security.

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