

Motivation

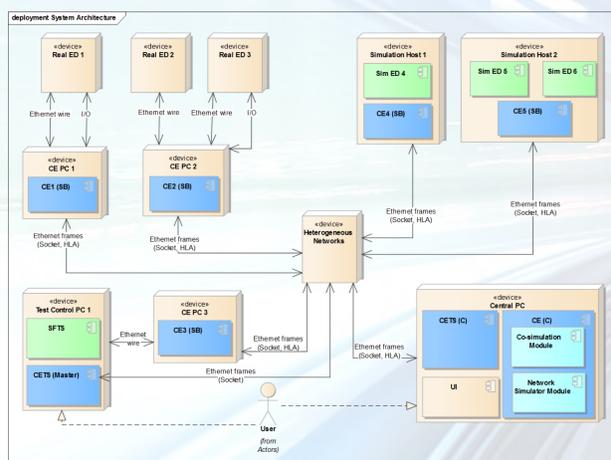
In the development process of today's railway systems, the integration and testing of components are crucial steps. They can be improved by using a distributed simulation and validation framework which provides the following features:

- Time-accurate simulation of in-train communication networks with co-simulated end-systems
- Early validation of functionality, timing, reliability and safety
- Software- and Hardware-in-the-loop testing of the communication behaviour on network level
- Distributed co-simulation of components located at manufacturer's sites being connected via heterogeneous communication networks such as the Internet
- Generic interface to support various simulation tools and devices

Safe4RAIL

Distributed Simulation and Validation Framework for Virtual Placement in the Market

Overall architecture of the framework



The main components in the distributed simulation and validation framework are multiple simulation bridges, one central PC as well as one test control PC. These components are interconnected using heterogeneous communication networks such as the Internet or corporate internal LANs.

Central PC

- Contains subsystems to configure the framework and to monitor data
- Provides an interface to interact with the framework

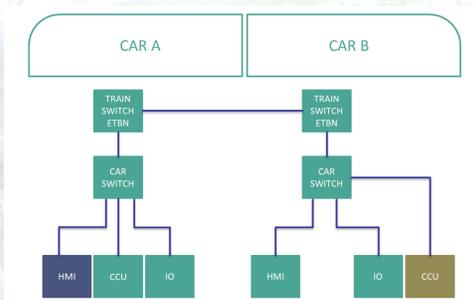
Test Control PC

- Controls the simulation execution
- Configures the devices attached to the framework
- Collects and provides monitoring data to the operator

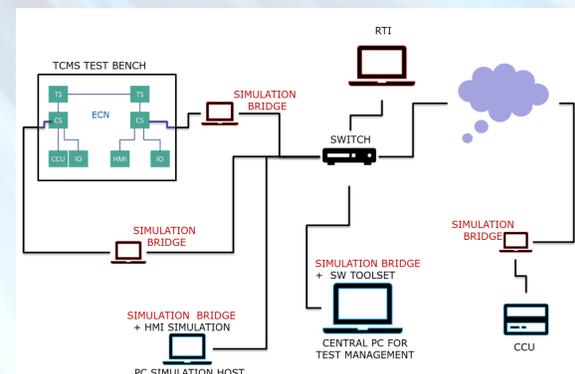
Simulation Bridges:

- Connection of network devices or end-systems available as SIL/HIL
- Synchronization and data exchange between systems under test
- Management of indeterministic delays introduced by the heterogeneous communication network used (when the traffic schedule is known and the application supports state estimation)
- Injection of faults to validate functionality and reliability

Framework instantiation



The framework instantiation shows one example for using the distributed simulation framework during tests. The example consists of two cars connected by ETBN switches. In the cars, Car Switches connect the end devices. Those end devices are Human Machine Interfaces (HMI), Control Units (CCU) and Input/Output Modules (I/O). One HMI device is simulated (blue) while the brown CCU is connected from a remote site via a heterogeneous communication network.



The TCMS test bench hosts all devices except the simulated HMI and the real CCU as devices under test. They are logically connected to the test bench using the Simulation Bridges. Those realize the physical communication between all components.

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