Integrated FDF and DbD Demo
Converged Communication and Computation

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Safe4RAIL – SAFE architecture for Robust distributed Application Integration in roLling stock (730830)

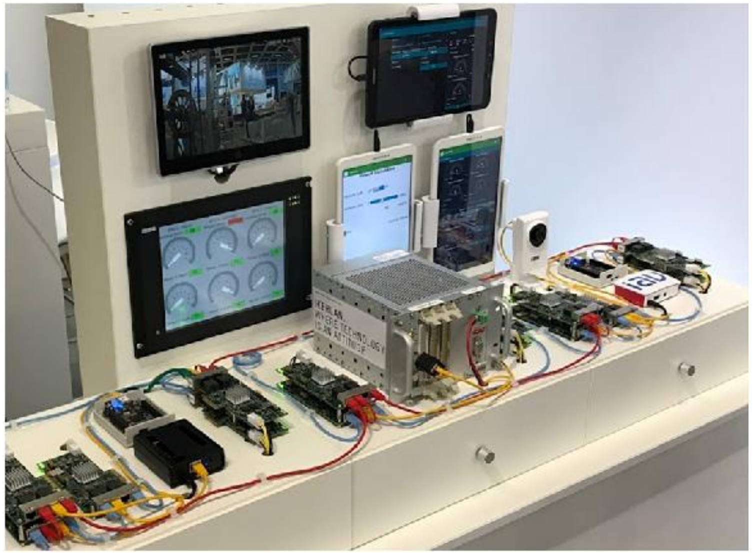
CONNECTA – CONtributing to Shift2Rail's NExt generation of high Capable and safe TCMS and brAkes (730539)

Demonstrator Overview

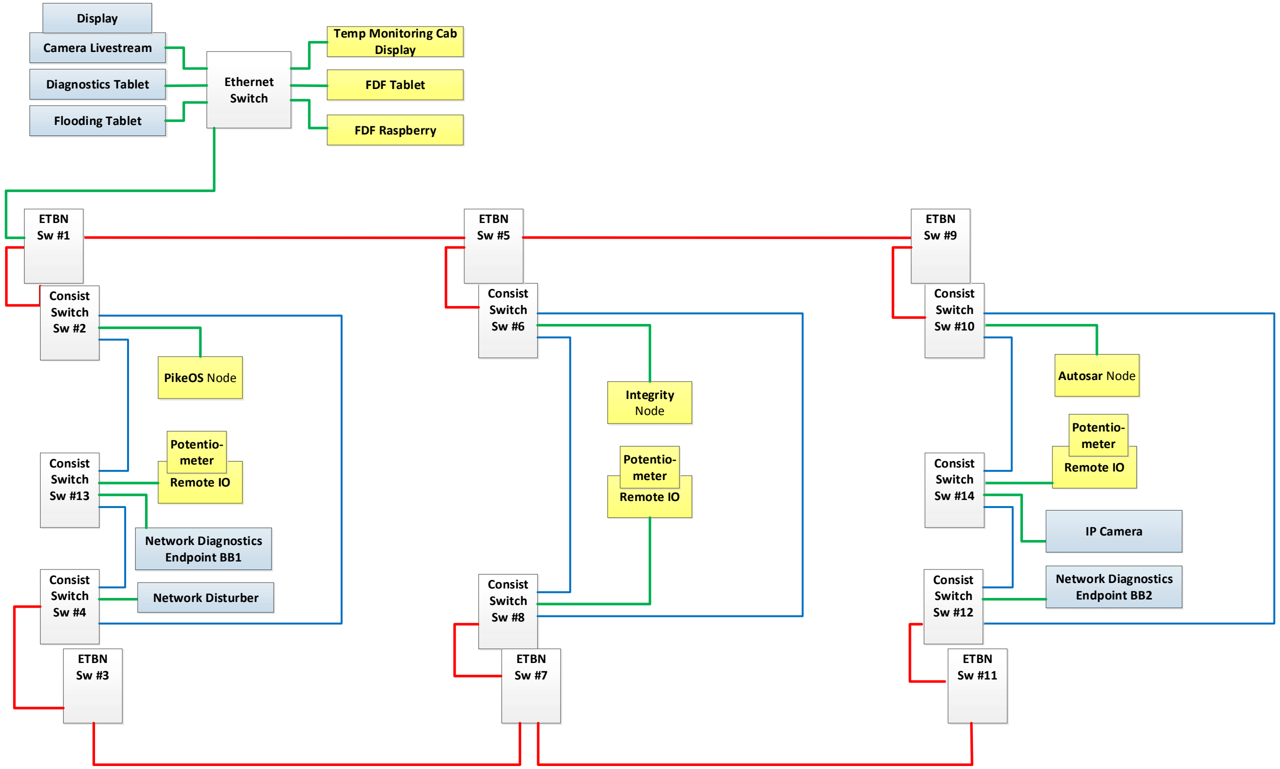
- Converged Communication (DbD)
  - Deterministic Communication
  - Full Network Isolation
  - Robust Topology
- Converged Computation (FDF)
  - Deterministic Computation
  - Full Partition Isolation
  - Spatial Separation
  - Access control for shared memory
  - Monitoring and error-prevention

Demonstrator Contents

- Network
  - Three consist networks + Backbone network
  - IP Camera
  - Network Diagnostics Application
  - Network Disturbance Control
- Computation platform
  - Three instantiations
  - Bogie Monitoring (BMS) Display
  - BMS Diagnostics and Control Terminal

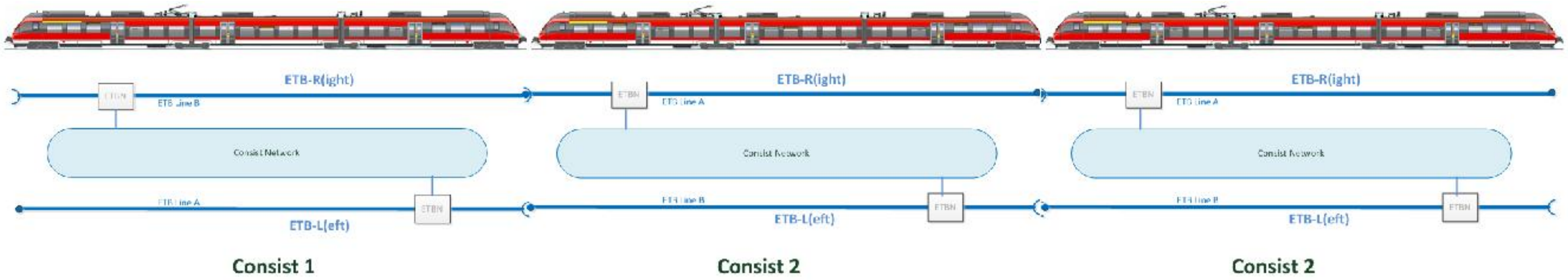


Demonstrator Layout



Robust Redundancy

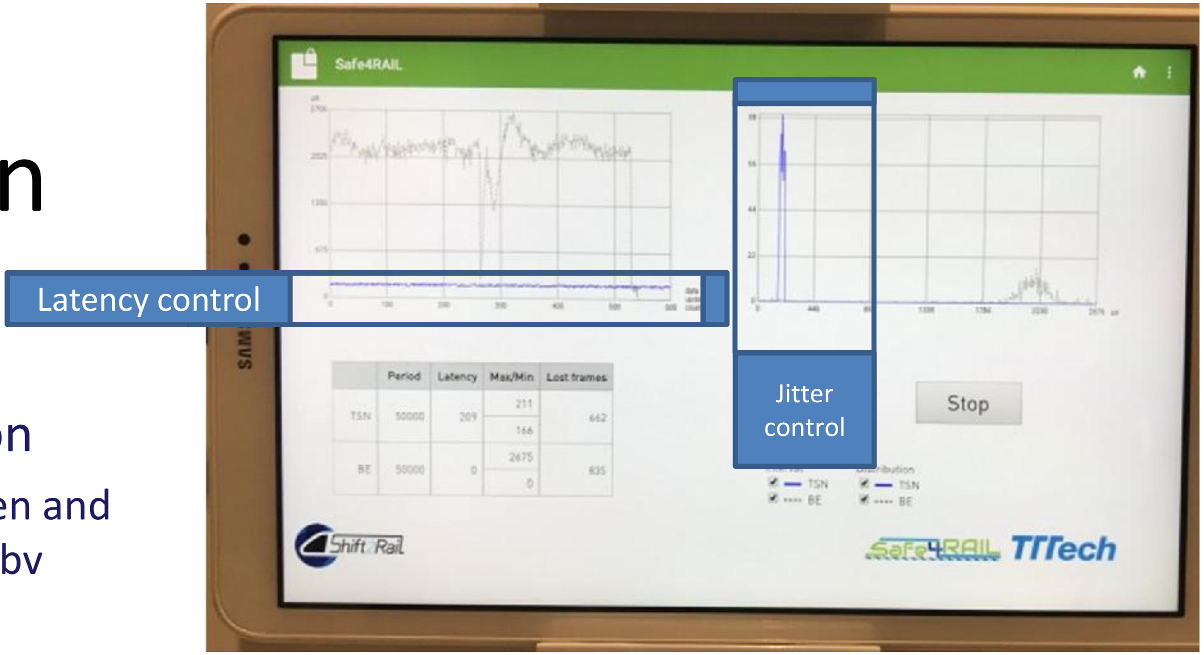
- Use two separated Ethernet lines along the train: ETB-L(eft) and ETB-R(ight).
- ECN ring topology
- Three consists connected



Converged Communication

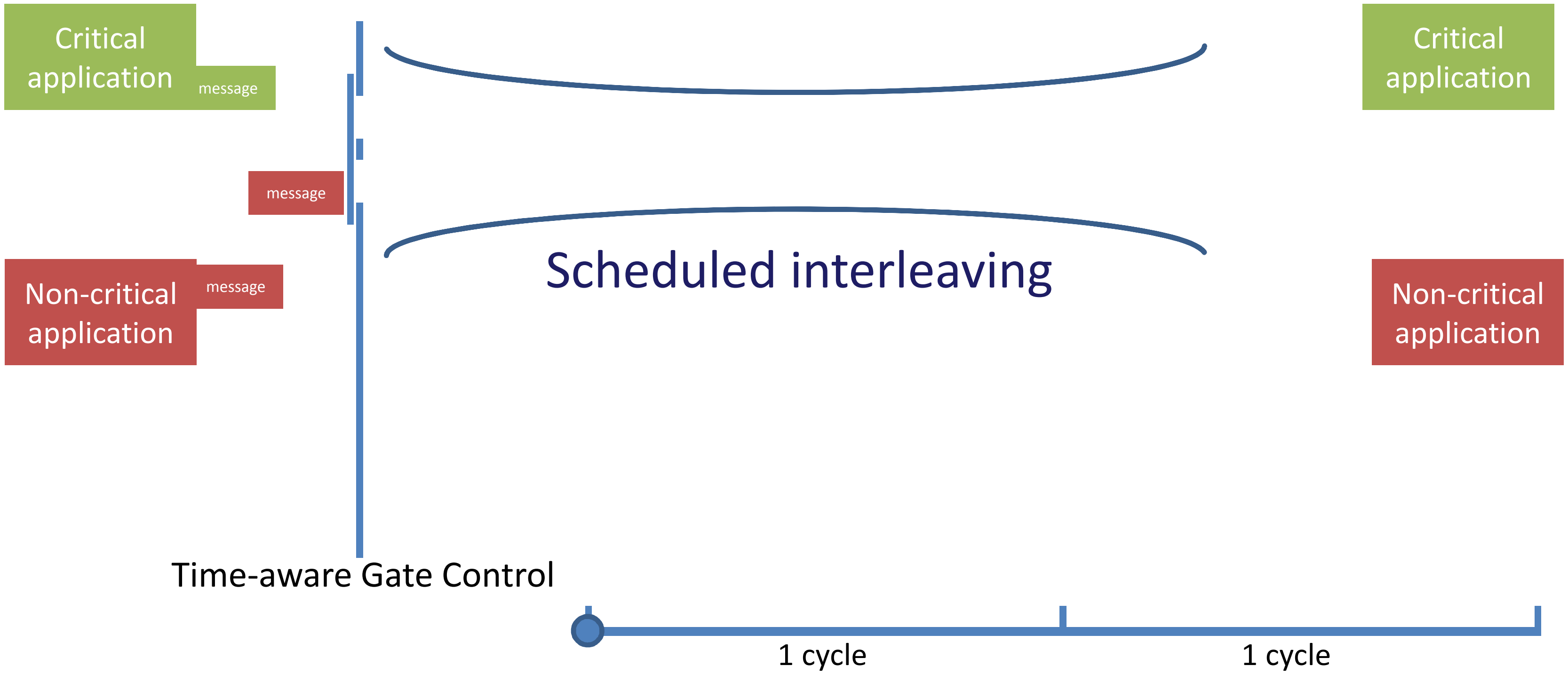
Deterministic Communication

- Synchronized clocks
  - according to 802.1AS-rev
- Scheduled Communication
  - Priority queue gates are open and closed according to 802.1Qbv

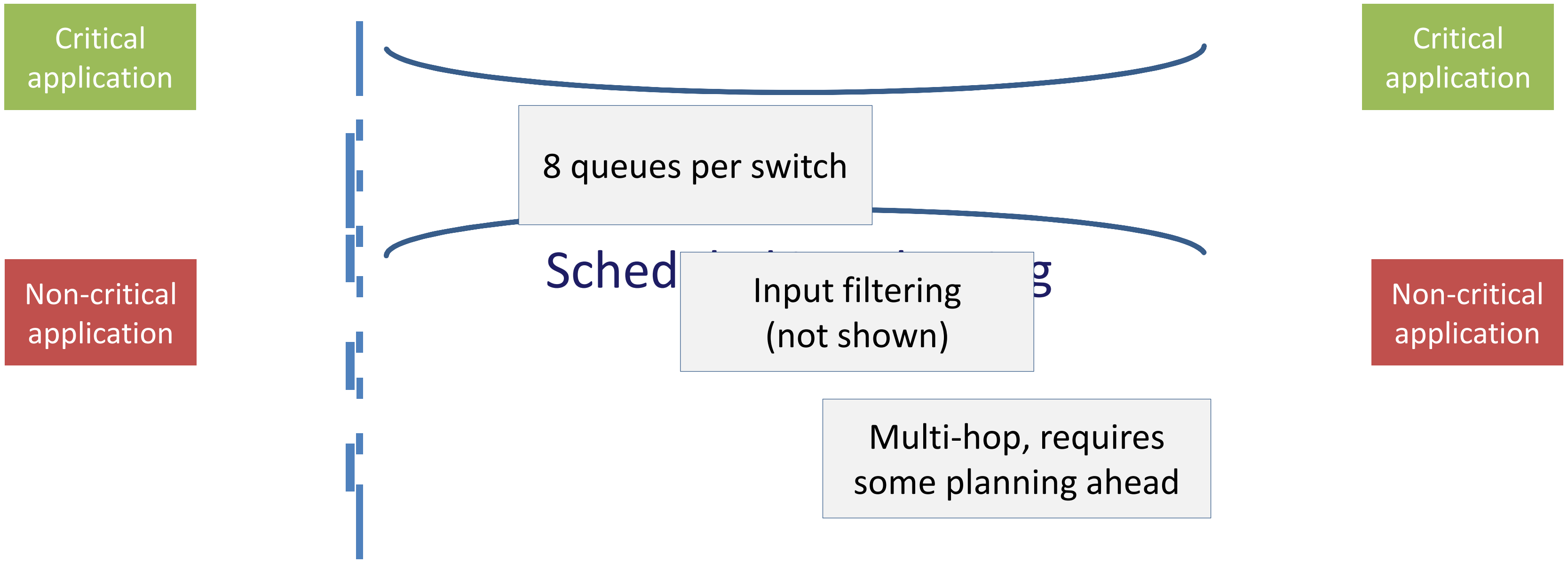


	Period	Latency	Max/Min	Lost frames
TSN	50000	209	211 166	642
BE	50000	0	2675 0	835

Gate Schedule



Gate Schedule



8 queues per switch

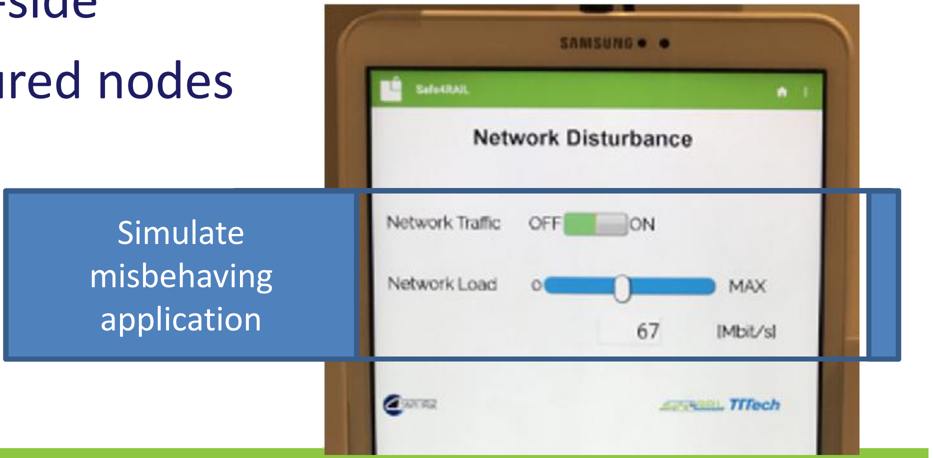
Input filtering (not shown)

Multi-hop, requires some planning ahead

Converged Communication

Full Network Isolation

- Full network virtualization
- Safety and non-safety streams side-by-side
- Misbehaving nodes or wrongly configured nodes can do no harm
- Incoming traffic controlled through 802.1Qci ingress policing
- Not affected by high traffic load



Network Disturbance

Network Traffic OFF ON

Network Load 0 MAX

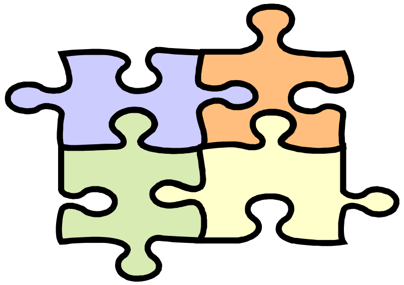
67 [Mbit/s]

Simulate misbehaving application

Live view

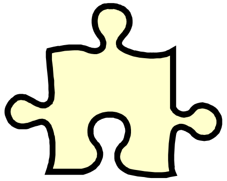
- Follow the camera!

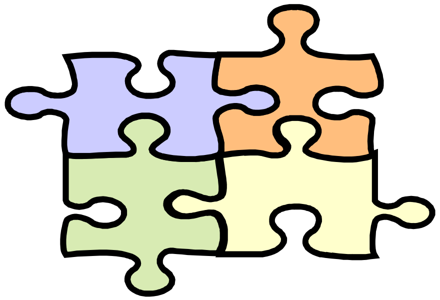
Modular integration concept



AUTOSAR FDF

HW A





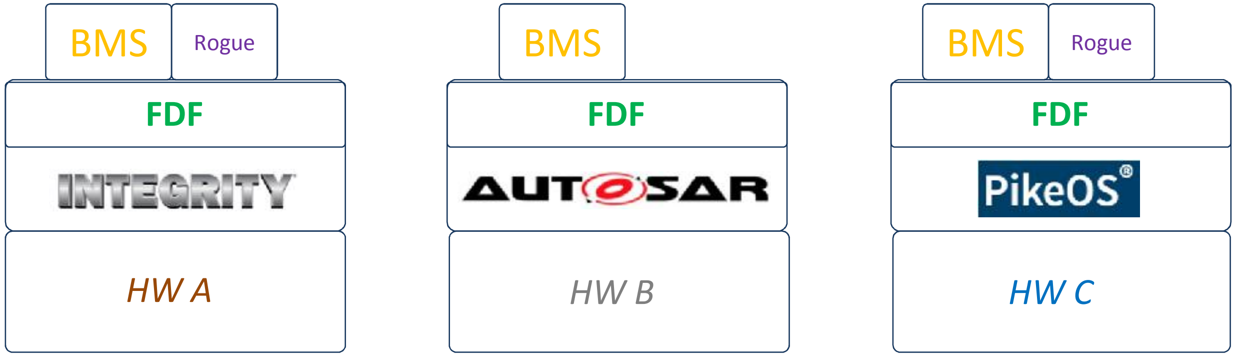
Integrity FDF

HW B

Safety-critical and non-critical application side-by-side on the same platform =>

- Non-interference guaranteed
- HW and communication abstraction

Interoperability



BMS | Rogue

FDF

INTEGRITY

HW A

BMS

FDF

AUTOSAR

HW B

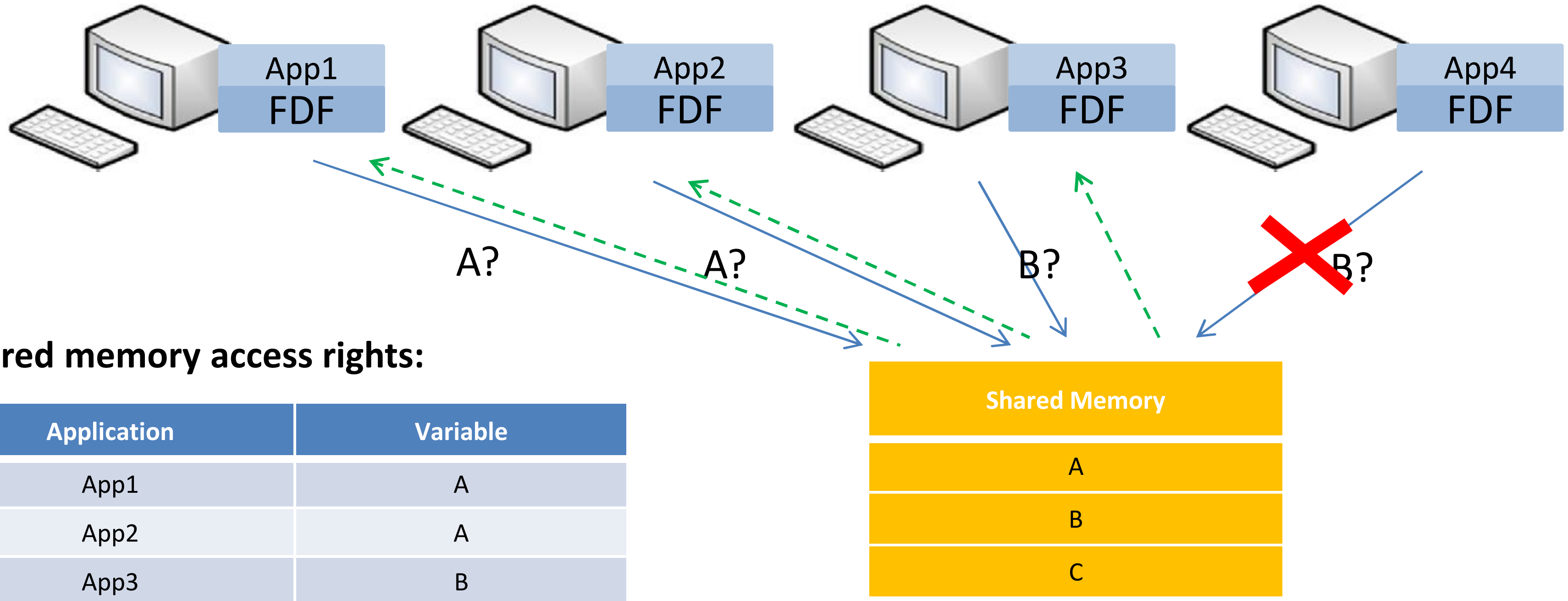
BMS | Rogue

FDF

PikeOS®

HW C

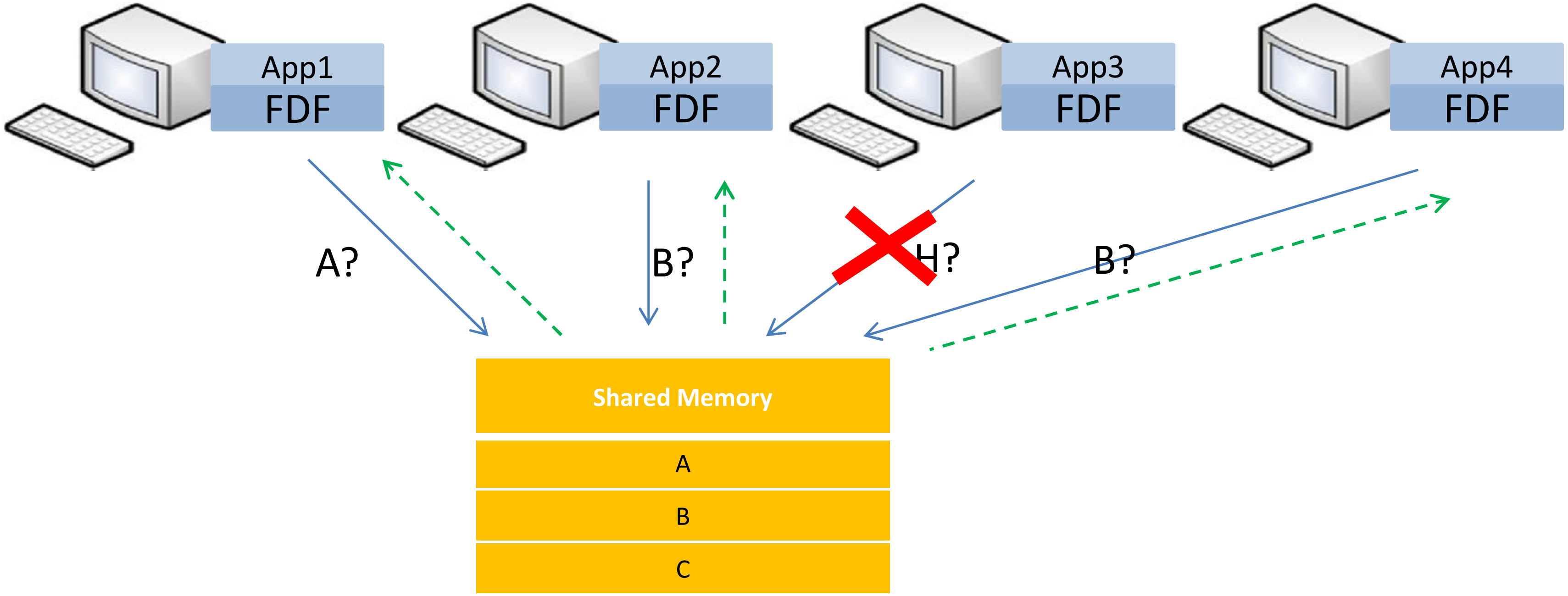
Spatial separation



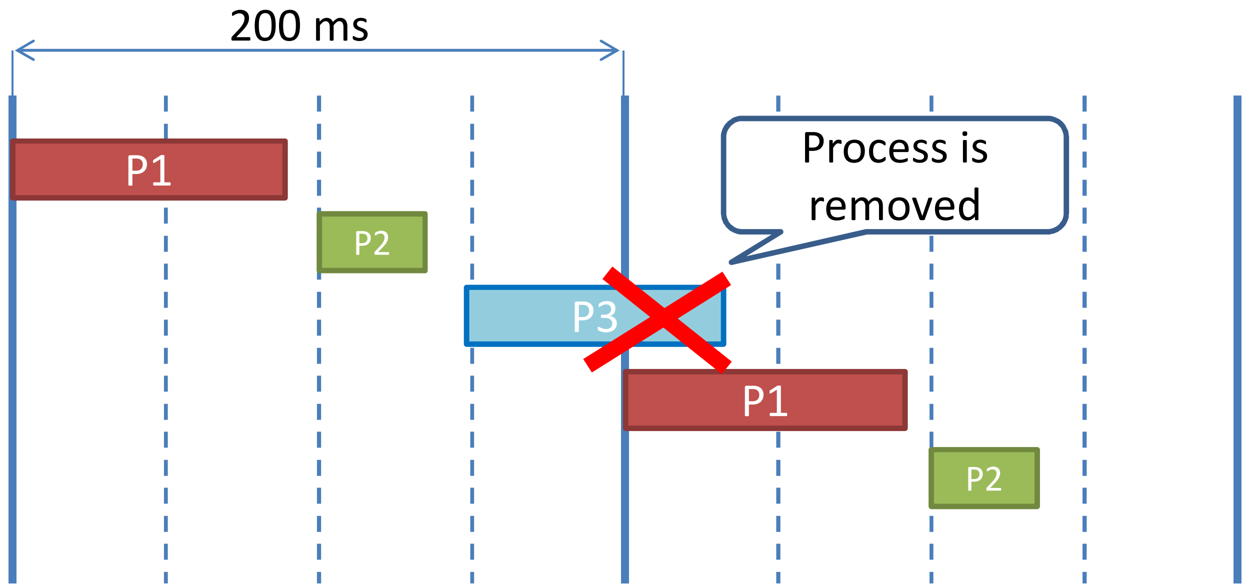
Shared memory access rights:

Application	Variable
App1	A
App2	A
App3	B

Protection & Isolation



Temporal separation



P1: SIL (Safety Integrity Level) 4

P2: SIL 2

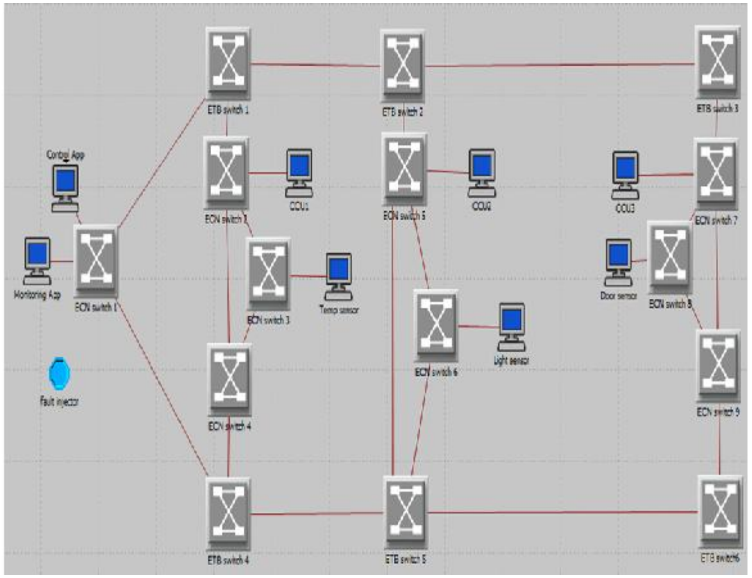
P3: SIL 0 tries to use more than the assigned slot!

Live view

- Follow the camera!

DbD Simulation Framework

- Evaluate and validate the applicability of TSN solutions for DbD concepts
  - The V/V processes of train components compliant to TSN protocols are expensive and timely
  - The simulation tools are time and cost efficient alternative for analyzing the temporal and non-temporal attributes of TSN-capable components
- DbD simulation components
  - Configuration Manager
    - Heuristic TT scheduler
    - Network Generator
  - TSN-capable Switches and End-system
    - Time-Aware Shaper (IEEE 802.1Qbv)
    - Ingress Time-based Filtering (IEEE 802.1Qci)
    - Frame Replication and Elimination for Reliability (IEEE 802.1CB)



Configuring the DbD Simulator

- Set up the example TCN layout taken from the proof-of-concept implementation of the demonstrator with minor adaptations
  - Run the heuristic TT scheduler to compute the global TT transmission schedule
  - Run configuration management to generate device-specific GCLs and the network layout XML file
  - Import the network topology XML file and create the demonstrator network
  - Set up statistics parameters of end-systems and switches
  - Run the simulation and examine the simulation results
  - Set the fault injector to inject different faults into the simulation network
  - Evaluate the impact of every faults on different streams in the simulated network