

Prototyping Next-Generation In-Car Backbones Using System-Level Network Simulation

Motivation & Challenges

- Early design of Ethernet based in-car networks
- Analysis of network and gateway configurations
- Hardware requirement prediction
- Development and evaluation of protocols and shaping strategies

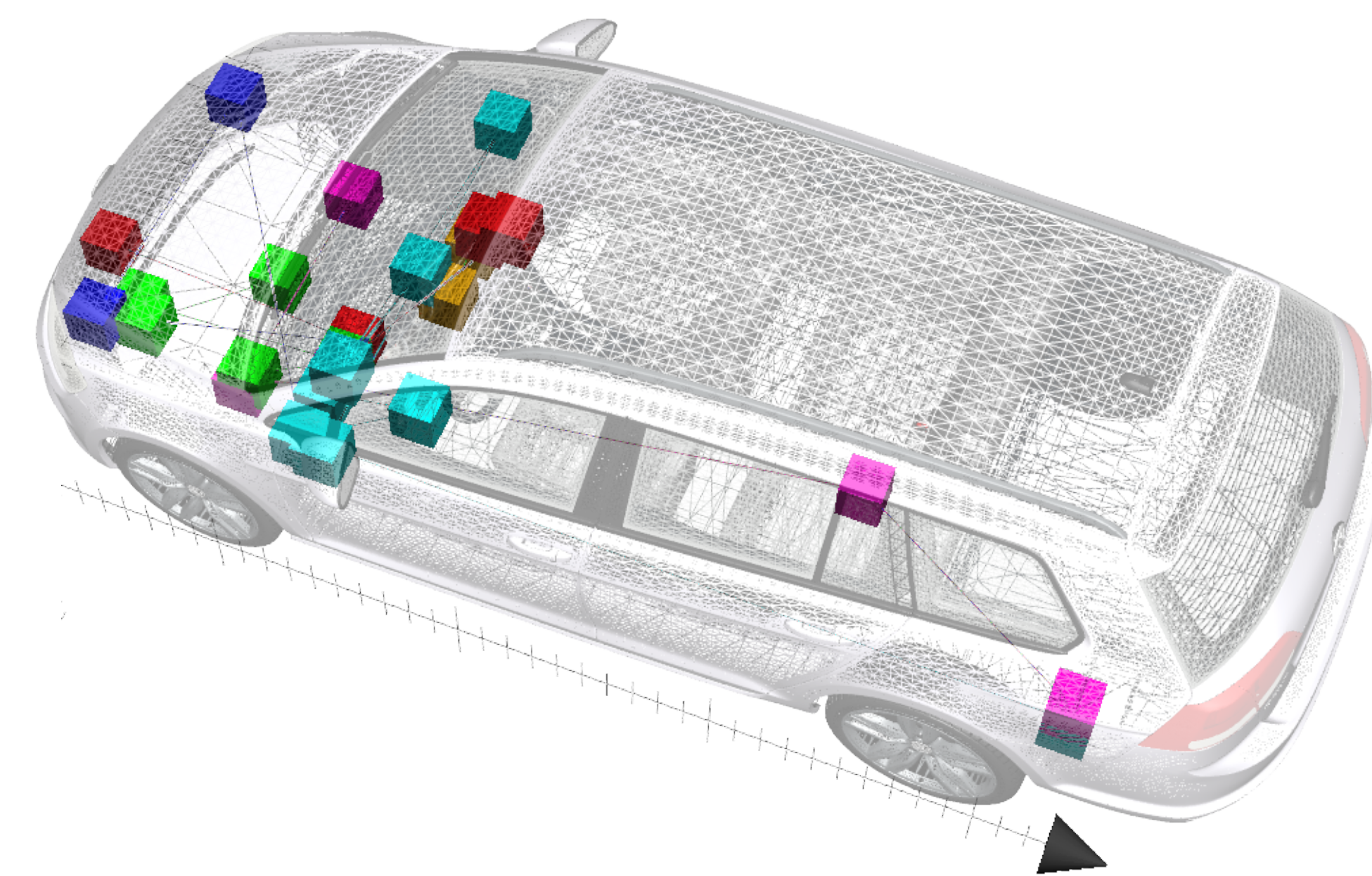
Background

- Discrete event based simulation
Based on OMNeT++ [1]
- Real-time Ethernet models [2]
AS6802, AFDX, AVB, 802.1Q
- Fieldbus models [3]
CAN, FlexRay
- Gateway models:
Interconnecting fieldbusses and Ethernet backbone

References

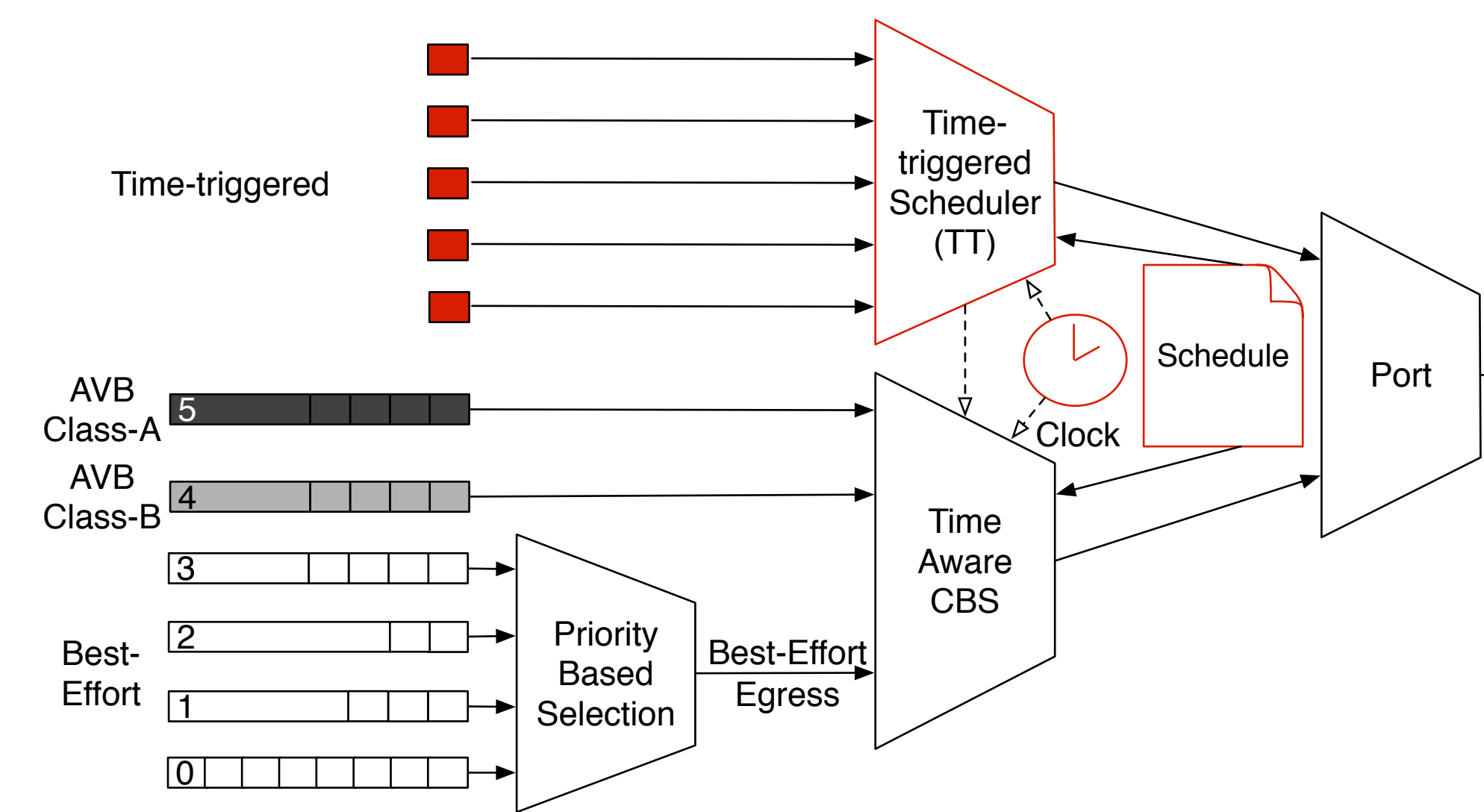
- [1] A. Varga and R. Hornig, "An overview of the OMNeT++ simulation environment," in *Proceedings of the 1st International Conference on Simulation Tools and Techniques for Communications, networks and systems & workshops*. New York: ACM-DL, Mar. 2008, pp. 60:1–60:10.
- [2] T. Steinbach, H. Dieumo Kenfack, F. Korf, and T. C. Schmidt, "An Extension of the OMNeT++ INET Framework for Simulating Real-time Ethernet with High Accuracy," in *Proceedings of the 4th International ICST Conference on Simulation Tools and Techniques*. New York: ACM-DL, Mar. 2011, pp. 375–382.
- [3] S. Buschmann, T. Steinbach, F. Korf, and T. C. Schmidt, "Simulation based Timing Analysis of FlexRay Communication at System Level," in *Proceedings of the 6th International ICST Conference on Simulation Tools and Techniques*. pp. 285–290, New York, Mar. 2013, ACM-DL.

In-Car Backbone Design



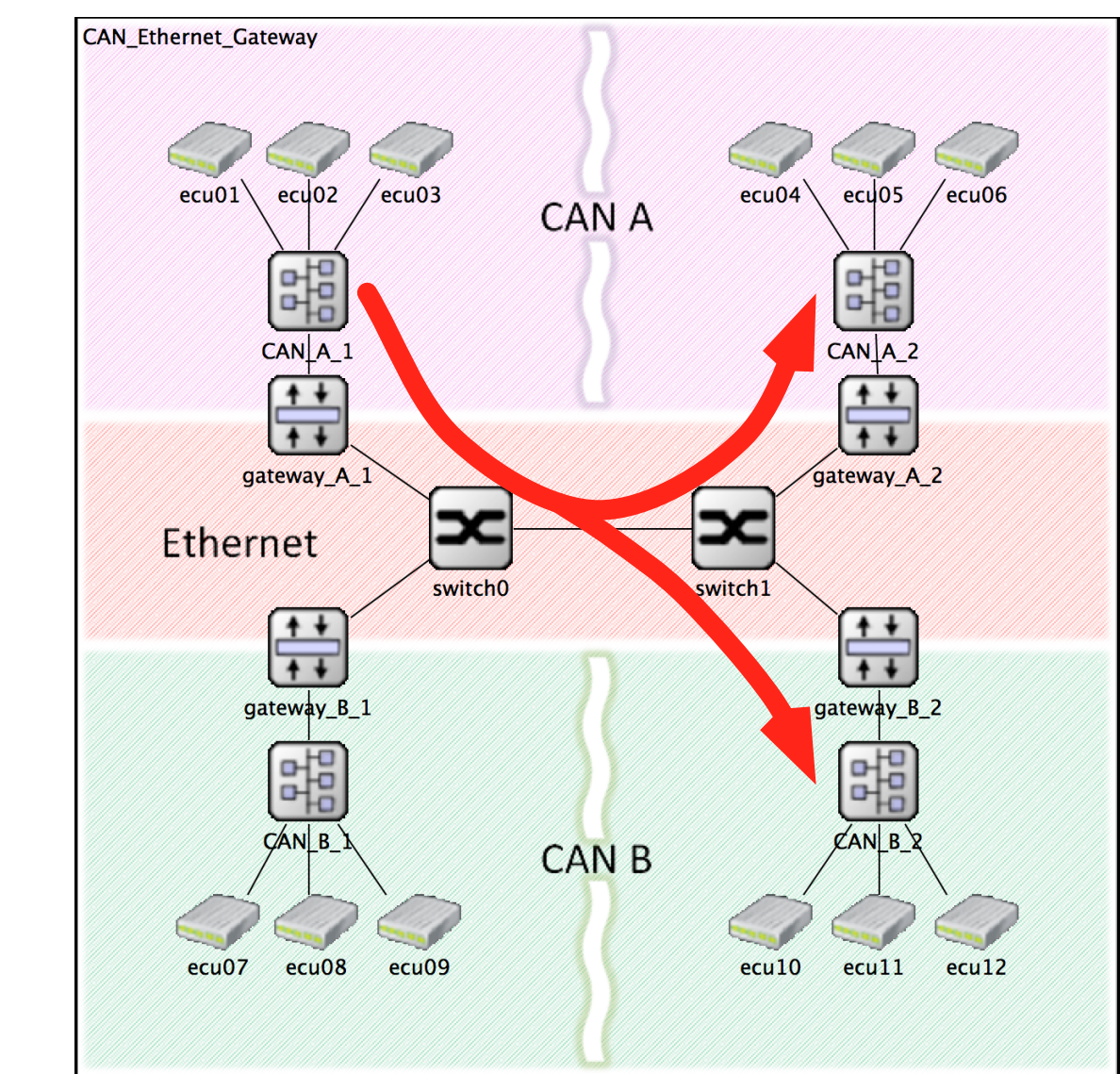
- Simulate real-world prototypes
- Assess large parameter sets
- Reduce bring-up time
- Sufficiently scale hardware
- Debug configuration and schedule problems

Traffic Shaper Concepts



- Design and evaluate shapers
- Merge credit based shaping with time-triggered scheduler into a new time-aware shaper
- Analyze influence of schedule on asynchronous streams

Gateway Strategies



- Connect legacy fieldbusses with real-time Ethernet backbone
- Tunnel messages through (real-time) Ethernet transparently
- Assess aggregation strategies that preserve bandwidth

Workflow of In-Car Network Simulation

