

Enhancing Reliability in Private 5G Communication via TSN FRER Vector Recovery

Project topic adaptable for Oberseminar, Student Thesis, Bachelor, or Master/Diploma-Thesis



Objective of Work

Reliable and deterministic communication is essential for applications such as industrial automation, robotics, and real-time control. The IEEE 802.1CB Frame Replication and Elimination for Reliability (FRER) protocol addresses this need by transmitting replicated frames across multiple network paths and eliminating duplicates at the receiver to ensure continuous operation even during packet loss or link failure. Its core mechanism, the Vector Recovery Algorithm (VRA), enables precise sequence tracking for effective loss recovery and duplicate suppression.

With the convergence of TSN and 5G networks, new challenges arise from wireless delay, jitter, and packet reordering. This work aims to study, implement, and evaluate the VRA within the INET simulation framework and validate its performance using data from a 5G-TSN testbed. The goal is to assess VRA's reliability under hybrid wired-wireless conditions and explore optimizations to improve its robustness and efficiency.

Focus of Work

In the thesis, the following tasks should be addressed:

- Study existing research on FRER and the Vector Recovery Algorithm to understand their operation and relevance in TSN and 5G, and define the project scope.
- Implement the VRA in the INET framework and verify its correctness in a dual-path TSN simulation.
- Analyze VRA performance under different network settings in terms of reliability, latency, and jitter.
- Integrate a 5G model with TSN simulation to assess VRA behavior under wireless delay and jitter.
- Validate simulation results using a 5G-TSN testbed and refine the model for accuracy.
- Develop and test improvements to the VRA and compare them with the baseline implementation.

Material for Further Reading

- IEEE Std 802.1CB-2017: *Frame Replication and Elimination for Reliability*. IEEE Standards Association, 2017.
- [A. Aijaz, 5G Replicates TSN: Extending IEEE 802.1CB Capabilities to Integrated 5G/TSN Systems](#)
- [Frame Replication and Elimination for Reliability in Time-Sensitive Networks](#)
- INET Framework Documentation: *TSN and FRER Modules in OMNeT++ INET Framework*,
<https://inet.omnetpp.org/docs/showcases/tsn/framereplication/index.html>

Keywords

Time-Sensitive Networking (TSN), Frame Replication and Elimination for Reliability (FRER), Vector Recovery Algorithm (VRA), Simulation and Testbed Validation

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