Bachelor Thesis
Preparation and validation of a custom Linux kernel for Time-Sensitive Networking experiments

Topic Description

The recently developed Environment for Generic In-vehicular Networking Experiments [1], otherwise called EnGINE, provides a flexible environment for repeatable, reproducible, and autonomous Ethernet-based Time-Sensitive Networking (TSN), and In-Vehicle Networking (IVN) experiments. The framework uses open-source solutions and commercial off-the-shelf hardware. Solutions used include Linux and OpenVSwitch, as well as the Intel I210 NICs. The experiments performed within the framework heavily rely on methods introduced with the IEEE 802.1Q standard [2].

Linux has its challenges when it comes to real-time operation and time-sensitive tasks. EnGINE currently includes some optimizations and a low-latency kernel to improve the deterministic behavior of Linux, however there is still room for improvement. The goal of the thesis is to find, evaluate, and implement/integrate additional options that enable further optimization of the Linux kernel towards real-time and deterministic operation for TSN. One of the further optimizations could include the inclusion of a real-time Linux kernel [3].

The outcomes of the thesis should include a custom Linux kernel image that is optimised towards real-time and deterministic optimisation and has minimal modules relevant for the EnGINE use-case and support of experiments. The custom kernel can be provided as a self-standing outcome, however a framework for its generation and compilation would be desirable. Furthermore, the created optimized kernel should be evaluated and compared against the currently used generic and low-latency variants that only include some optimisations. This evaluation should be done using the EnGINE network and include networking experiments looking at delay and jitter over a few hops in the network.

Your tasks

1. Familiarize with the EnGINE framework, its functionality and use-cases
2. Define and investigate methods for kernel optimization towards deterministic operation
3. Prepare a framework for generation of the kernel with desired optimizations
4. Generate and evaluate the optimized kernel against the currently used variants

Required Experience

- General knowledge of computer networking
- Some experience with and understanding of the Linux kernel and its configuration
- Knowledge of IEEE 802.1Q TSN standards is a plus

Additional Information

- Offered as a Bachelor Thesis, IDP could be considered

(See next page for more details)

References

[1] Filip Rezabek, Marcin Bosk, Thomas Paul, Kilian Holzinger, Sebastian Gallenmüller, Angela Gonzalez, Abdoul Kane et al. "EnGINE: Developing a Flexible Research Infrastructure for Reliable and Scalable Intra-Vehicular TSN Networks."

[2] *"IEEE Standard for Local and Metropolitan Area Network--Bridges and Bridged Networks,"* in IEEE Std 802.1Q-2018 (Revision of IEEE Std 802.1Q-2014) , vol., no., pp.1-1993, 6 July 2018, doi: 10.1109/IEEESTD.2018.8403927.

[3] https://wiki.linuxfoundation.org/realtime/start

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