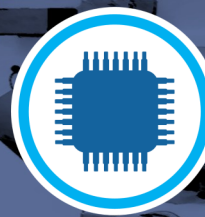




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Institut für verlässliche
Embedded Systems und
Kommunikationselektronik



Institute of reliable Embedded Systems and
Communication Electronics (ivESK)

The Institute of reliable Embedded Systems and Communication Electronics (ivESK) proposes a

Bachelor Thesis / Internship for the Implementation and Integration of TSN Translators and 5G UPF into TSN Switches

Time-Sensitive Networking (TSN) and 5G are key enablers for ultra-reliable and low-latency communication in future (industrial) networks. To unlock their full potential, seamless integration between both technologies is essential. Therefore, **ivESK** currently works on the **Integration of 5G and TSN into industrial networks**.

This project, focuses on **implementing and integrating TSN Translator functions and 5G User Plane Functions (UPF) into Linux-based TSN switches** provided by NXP. The NXP Layerscape LS1028 platform provides a Linux-based TSN-capable switch that offers advanced networking features and hardware acceleration for time-sensitive communication. The overall objective is to enable a seamless interaction between 5G networks and TSN domains by integrating key functional components directly into the switch. On the network side, this includes the integration of a 5G User Plane Function (UPF) that has direct access to the switch's hardware switching engine, enabling high-performance packet forwarding with deterministic latency. At the same time, TSN features such as traffic scheduling (e.g., Qbv) must be integrated and configured as part of the network-side translator (NW-TT).

On the device side, additional TSN translator functionalities (DS-TT) and high-precision timestamping may be explored to further enhance synchronization and timing accuracy. Together, these developments will contribute to a holistic 5G-TSN integration framework, where devices and networks can interact with guaranteed latency, reliability, and synchronization.

This project includes the following tasks:

- Set up and hands-on with NXP TSN switches.
- Get familiar with the hardware, Linux environment, and switch APIs.
- Integrate the 5G UPF and network-side translator (NW-TT) features.
- Implement device-side translator (DS-TT) functionalities with high-precision timestamping.
- Configure and integrate advanced TSN features such as Qbv (Time-Aware Shaper).

This task delivers and improves skills in programming, networking and software design and **requires**

- Solid knowledge of Embedded Linux.
- Strong background in networking (ideally including 5G and TSN networks).
- Programming experience (e.g., C/C++, Python, or similar).
- Familiarity with embedded devices and hardware-software integration.

References:

- https://en.wikipedia.org/wiki/Time-Sensitive_Networking
- <https://ieeexplore.ieee.org/document/10541017>
- <https://github.com/NXP/flexbuild>
- <https://www.nxp.com/design/design-center/software/embedded-software/linux-software-and-development-tools/nxp-debian-linux-sdk-distribution-for-i-mx-and-layerscape:NXPDEBIAN>

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