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Task description:

Bachelor thesis

Lab test of Time-Sensitive Networking for avionics systems

Currently, the Institute of Aircraft System is developing a self-configuring avionics platform called Plug&Fly Avionics (PAFA). The PAFA platform has been demonstrated to detect and configure the flight controls of an octocopter and to establish normal operation in the lab autonomously. Currently, the platform uses Ethernet as a backbone network. However, the PAFA concept is independent of the underlying bus technology and shall benefit from advanced capabilities like time-synchronized communication if available, as for instance with Time-Sensitive Networking (TSN).

TSN is an extension of the Ethernet technology and is described throughout the IEEE 802.1Q Standard. The main focus of TSN is the transmission of data with low latency and high availability. TSN provides extension profiles for Ethernet, e.g. time synchronization, scheduling, traffic shaping as well as a common rule-based decision principle for reservation and choice of bandwidth and communication paths. Some extensions of TSN are favorable for future avionics systems. Exemplary, Figure 1 shows how TSN could ensure hard-real time requirements. It introduces protection of communication through prioritized time slices and guard bands. Using this profile needs a common time base, specific switches and drivers.

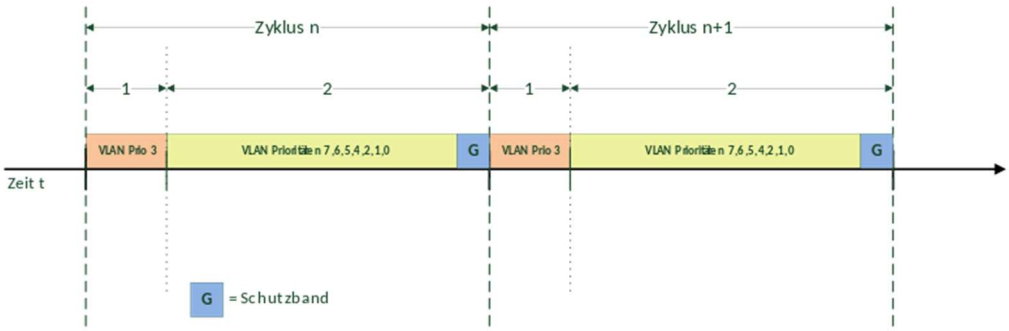

Figure 2: TSN-Schedule with guard bands https://de.wikipedia.org/wiki/Time-Sensitive_Networking

Task
The goal of this thesis is to evaluate TSN practically. The thesis shall start with the definition of the TSN profile, hardware and software to use, as well as the definition of evaluation criteria. From this, a small network architecture shall be derived, which can be built in the lab. The hardware shall be setup and installed as a lab test bed. Once the laboratory is setup, testing and validation of TSN functionality should take place. At the end, TSN should be evaluated in terms of its suitability for an avionics system. Therefore, the evaluation criteria shall be analyzed, and results shall be compared

to State of the Art Ethernet and Avionics Full Duplex Switched Ethernet (AFDX). From a practical point of view, the technology readiness should be judged in terms of available software, hardware and support, as well as the difficulty of setting up the test bed.

Work items:

- Familiarization
  - Ethernet and bus communication technology
  - TSN functionality
  - TSN - Switches Hard – and Software
- Concept development
  - Definition of simple representative architecture
  - Determination if available soft- and hardware is sufficient
- Assembly and setup of the test-bed
  - Assembly of the defined architecture
  - Implementation of determined missing software
- Validation and Testing
  - Carry out tests to validate and possibly quantify the TSN functionalities
  - Evaluation of the results
- Evaluation of the applicability of TSN for avionics systems considering certification, safety, security and technology readiness
- Documentation of the results
- Final presentation

Begin:	01.12.2023
End:	01.04.2023
Supervisor:	Mario Werthwein
Examiner:	Prof. Björn Annighöfer

Date, signature student:_____