Universität Rostock

Traditio et Innovatio

FAKULTÄT FÜR
INFORMATIK UND
ELEKTROTECHNIK

Thesis Topic: Time-Sensitive Networking Routing and Scheduling

In todays smart factories and vehicles (cars, airplanes), the communication network has become an essential infrastructure to connect distributed systems. In factories and vehicles, several of the distributed systems have to transmit critical messages over the communication network, i.e., the respective message must be transmitted with high reliability and within a certain time span. If the deadline of a critical message is violated, this may cause damage to the whole system (i.e., vehicle or production facility). With Time-Sensitive Networking (TSN), which refers to the latest extensions of the IEEE 802.1 standard, Ethernet

technology allows the reliable and timely message delivery by the application of a time-triggered communication principle. Here, critical messages are transmitted over the different links in the network according to a given schedule, which is computed before the system is taken into operation (so-called offline scheduling). For example, consider the network of 6 switches and 6 end devices, given in the figure above, and two critical messages $a0\_f0$ and $a0\_f1$ which have to be transmitted every 100 µs and 200 µs, respectively, from a predefined source node src to one or more destinations given as dst. A possible transmission schedule is shown below. The computation of such schedules is an NP-hard mathematical problem and the TSN standards do not suggest any solution to this problem. Therefore, the development of efficient routing and scheduling algorithms has become an important research question.
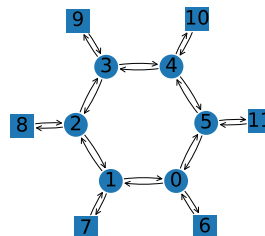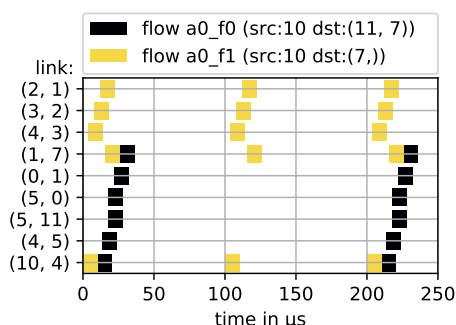
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Task: Development and evaluation of new routing and scheduling algorithms

In recent years, an Integer Linear Programming (ILP)-based routing and scheduling mechanism for TSN has been developed at the Institute of Applied Microelectronics and Computer Engineering, as well as an elaborate test environment for routing and scheduling. Nevertheless, few comparisons to the routing and scheduling approaches of other research groups could be conducted, mainly due to the lack of freely available implementations of the other approaches. Moreover, there are several possibilities to further improve the ILP-based routing and scheduling approach, e.g., by combining it with an iterative heuristic.

Therefore, this topic, appropriate for **Bachelor Thesis**, **Master Thesis** and **Specialization Module**, includes the following tasks:

- Literature study about existing routing and scheduling approaches
- Implementation of at least one routing and scheduling approach from the literature
- *(Optional)* Development and implementation of a new routing and scheduling approach either based on the existing ILP-based approach or as a standalone mechanism
- Comparison of the implemented appraoches with the existing ILP-based approach regarding runtimes, schedulability and schedule quality
- Documentation of concept and evaluation

Prerequisites:

- Must Have
  - Basic programming skills (any language)
  - Ability for self-sufficient and independent working
  - Basic understanding of Ethernet technology and network protocols
- Should Have
  - Advanced programming skills and basic Python skills
  - Basic knowledge in graph theory, routing algorithms and scheduling algorithms

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