technische universität dortmund

computer science 12

Bachelor/Master Thesis

Timing Sensitive Synchronous Communication in Microcontroller Networks

Dr.-Ing. Christian Hakert
M.Sc. Kay Heider
Otto-Hahn Str. 16
Technische Universität Dortmund
Email: christian.hakert@tu-dortmund.de
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Building cyber-physical systems based on microcontrollers quickly leads to the construction of a distributed system, where many single instances have to communicate. Consider for instance the case of controlling a multitude of hardware instances, multiple microcontrollers have to be connected to the single instances and have to communicate among each other. This communication, despite functioning correctly, demands a list of criterions to be fulfilled. Some of these criterions could be bandwidth, latency and synchronization.

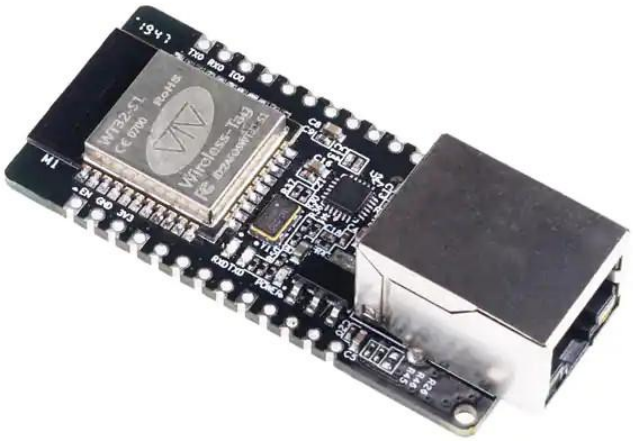

Figure 1: Ethernet Equipped Microcontroller (https://www.berrybase.de/seeed-serial-to-ethernet-module-esp32-basiert)

While latency and synchronization can be easily approached with simple communication standards, they usually don't serve for sufficiently high bandwidths. High bandwidth, on the other side, cannot easily guarantee low latencies and Synchronous communication. Consequently, this thesis aims to explore network communication of microcontrollers, which cam serve for high bandwidths, but can guarantee Synchronous communication at the same time. For this, a setup of microcontrollers equipped with Ethernet connections is considered in this thesis, where additional synchronization is to be developed.

While microcontrollers with Ethernet connections are commercially available and therefore form the basis for this thesis, synchronization means have to be implemented by the student and compared. The student should explore the synchronization of the clocking system of the microcontrollers, as well as self development of low level synchronization protocols. To complete the setup, the microcontroller network will be connected to a central controller node, which has to be involved in the synchronous Ethernet communication.

In this thesis, students should get familiar with the basic platform of microcontrollers with Ethernet connectors first. Students should be able to implement Ethernet communication with other microcontrollers, as well as other controller nodes. Afterwards, students should come up with and implement synchronization approaches, including clock synchronization and interrupt driven synchronization. Students should integrate the synchronization into the Ethernet communication process and achieve a synchronized Ethernet communication platform. Finally, students should implement a use case, where a high bandwidth transfer of data is done from the central controller node to the microcontrollers in the network. The bandwidth limitations under active synchronization should be explored.

Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment.

Required Skills:

- Knowledgeable of C and C++ programming
- Experience in microcontroller programming
- Knowledge about Ethernet communication