

# Complexity Analysis for MILP-based or SMT-based Schedule Synthesis

Research Internship / Forschungspraxis

## Abstract:

MILP-based and SMT-based formulation is a popular method for synthesizing schedules for time-triggered systems (e.g., FlexRay and Time-Triggered Ethernet). Here the whole scheduling problem is formulated as either a MILP (Mixed Integer Linear Programming) or a SMT (Satisfiability Modulo Theories) model, where the platform characteristics are formulated as constraints. A solver software (e.g., Gurobi, CPLEX, Z3) can be employed to solve the problem and thus delivering the schedules. However, a major problem with these approaches is the scalability. As the size of the system grows, the synthesis time increases drastically and at some point the problem becomes intractable. However, the size of the system might not be the only factor influencing the complexity and thus the synthesis time of such problems. It could also be observed from the experiments that the synthesis time of different system configurations (e.g., task and message mapping, network topology) of the same size also varies considerably. The reason behind this observation is yet to be identified.

In this research internship, the student will try to analysis different system configurations for both the FlexRay and Time-Triggered Ethernet scheduling, and identify the parameters in the system configuration that strongly influence the complexity of the problem. In addition, the influence of the identified parameters on the complexity should be quantified.

## Tasks:

- Familiarization to the FlexRay and Time-triggered Ethernet scheduling problem
- Familiarization to the MILP and SMT model formulation and solvers
- Analysis of test cases
- Identification of the parameters influencing the complexity of the problem
- Quantification of the influence on complexity of the identified parameters

## Knowledge Required:

- Good knowledge on realtime and embedded systems topics like scheduling and timing
- Basic knowledge on mathematical programming and optimization problems
- Very good knowledge on Matlab/C++
- Knowledge on FlexRay, Ethernet preferred, but not required

## Contact:

If you are interested in this topic as research internship,

Please Contact: Debayan Roy ([debayan.roy@tum.de](mailto:debayan.roy@tum.de)), Licong Zhang ([licong.zhang@rscs.ei.tum.de](mailto:licong.zhang@rscs.ei.tum.de))