

Performance Optimization for Real-Time System Software

Real-time systems require the efficient and timely execution of periodic tasks to preserve system stability, responsiveness to time-sensitive events, and predictable behavior in the applications they serve. Numerous studies have been conducted on scheduling algorithms and corresponding analyses, but there are some unrepresented components in the real-time operating systems, deserving research efforts for systematical optimizations.

For instance, the task dispatcher plays a crucial role in initiating task execution and maintaining task periodicity. In our previous study¹, we showcase that different data structures and corresponding implementations, featuring various merits and drawbacks. Apparently, the story is not ended here. Inspired by Verstraaten et al.², constructing the most efficient dispatcher for given task sets, (e.g., by switching between implementations on the fly) could be of interest here. A general problem is how to derive performance modelling for such system software and fully exploit the scarce resource on embedded systems.

Students are encouraged to explore the following directions:

- Performance modeling for periodic task dispatchers, resource sharing protocols, etc.
 - Runtime adaption for online admission. Suppose tasks may release/suspend on from time to time. How to make an adaptive dispatching design by construction? What is the key info and parameters needed for the adaption?
- Exploitation of external hardware such as real-time cores, e.g., ARM Cortex-R5, for light-weight task dispatching. A similar work has been done, based on hardware timers:

https://www4.cs.fau.de/Research/Sloth/time_triggered_scheduling.shtml

Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment with the following supervisors:

dr.ing. K.H. Chen (Kuan) <k.h.chen@utwente.nl>

prof.dr.ir. A.L. Varbanescu (Ana-Lucia) <a.l.varbanescu@utwente.nl>

¹ Florian Hagens and Kuan-Hsun Chen, "Assessment of Efficient Dispatching in FreeRTOS", 2023, Workshop on Operating Systems Platforms for Embedded Real-Time applications (OSPRT)

² M. Verstraaten, A. L. Varbanescu and C. de Laat, "Mix-and-Match: A Model-Driven Runtime Optimisation Strategy for BFS on GPUs," 2018 IEEE/ACM 8th Workshop on Irregular Applications: Architectures and Algorithms (IA3), Dallas, TX, USA, 2018, pp. 53-60, doi: 10.1109/IA3.2018.00014.