technische universität dortmund

computer science 12

Bachelor/Master Thesis

Evaluating and optimizing mechanisms to prevent timing anomalies

Lars Willemsen
Prof. Dr. Jian-Jia Chen

Otto-Hahn Str. 16
Technische Universität Dortmund
Email: lars.willemsen@tu-dortmund.de
October 4, 2024

In Real Time Systems timing guarantees are of critical importance. Determining whether a given task set is schedulable under a specific algorithm is clasically done through *schedulability tests*. However, such tests tend to be overly pessimistic. An alternative approach is to try and construct a reference schedule under the worst possible input parameters, such as imposing the Worst Case Execution Time (WCET) for individual jobs and the maximum amount of suspension time between job segments. Unfortunately it turns out that constructing such a reference schedule does not necessarily coincide with the global worst case, and less favorable outcomes might occur under *more relaxed* parameters. This is referred to as a **timing anomaly**.

In Figure 1 a timing anomaly is demonstrated: by reducing the the suspension time between the two job segments in τ_0 the makespan of the schedule is increased from 8 to 10 (ω_0 is the reference schedule, and ω the actual, or *online* schedule).

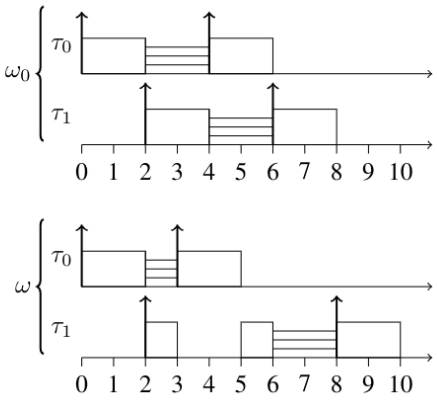

Figure 1: An example of a timing anomaly

In the literature many treatments to prevent such anomalies exist. Some of which might prove sufficient for allowing **transfer schedulability**. Transfer schedulability refers to the phenomenon of being able to *transfer* the schedulability of one schedule to another. If we could transfer the schedulability from our reference schedule we can also guarantee the absence of timing anomalies.

As this concept is new there is unfortunately no data available on how these transfering mechanisms compare, and they might not be optimized to a convincing degree. Reasoning about such mechanisms is important. Perhaps we can optimize them and demonstrate the results in a relevant environment.

In this thesis,[1] the student will need to familiarize themselves with the concepts of timing anomalies and transfer schedulability. Several mechanisms will be provided that are designed to treat timing anomalies. The student is expected to implement, optimize and reason about them, and then evaluate the results of their adjustments. Both the evaluation and implementation of the mechanism may be implemented in the environment of the student's choosing, as long as an agreement can be reached about the relevance of the experimental setup. Determining this setup will be a substantial part of the thesis. Potential evaluation contexts include but are not limted to a ROS2 executor [1], RTSim [2], LitmusRT [3] or a framework provided by our group written in Python3.

Required Skills:

- Recommended intermediate/skilled level experience with Python3
- Good debugging skills
- Proactivity and creativity, capable of reasoning about sensible solutions

Acquired Skills after the thesis:

- Learned how to generate and present relevant data in a convincing way
- Learned about optimizing algorithms in different dimensions

References:

[1] ROS2 github page
[2] RTSim homepage
[3] LitmusRT homepage

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