Fast Feasibility Tests and Event Dependency Graphs for the Design-Space Exploration of Distributed Real-Time Systems

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This presentation provides an introduction to fast analysis techniques for real-time scheduling in embedded systems. Real-Time Analysis has an exponential run-time complexity depending not only on the number of system tasks, but also on the ratios of the periods of the systems input events [4][6]. Large smallest common multiples of the periods can easily lead to excessive time required for the analysis. Moreover, during system synthesis this part of the real-time analysis has to be performed in every iteration within the optimization. This is why approximation algorithms are key to a fast system-level design space exploration of embedded systems. We will discuss several approximation techniques for the real-time analysis of different scheduling algorithms such as fixed priority scheduling and earliest deadline first scheduling [2][3][6][7][9].

The classical real-time analysis model abstracts from the internal behavior of tasks and considers only their worst-case execution time [4][8]. This also leads to the assumption that all tasks first perform all their computations and, when they are done, send all signals and events to their successor task. This assumption does not hold true for many real-time systems. In fact many tasks generate events during their execution. By analyzing the internal timing behavior of a task, the timing relationship of all events generated during execution can be efficiently described using the event stream model. With a new technique, called event dependency analysis it is possible to calculate a tasks communication response behavior [5]. This information can be used for a streamlined task-level real-time analysis of entire distributed systems. Based on this technique the algorithm and task-level of embedded systems can be linked in a mathematically sound way.

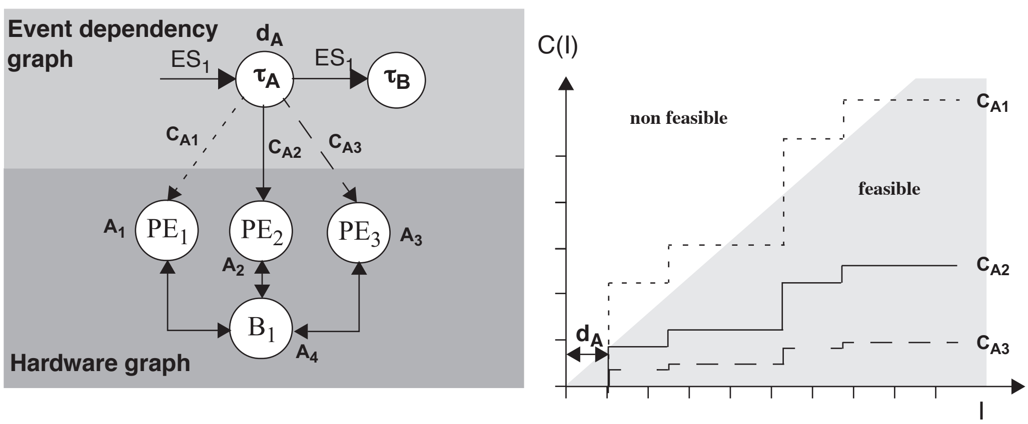

Figure 1: : Synthesis and analysis model

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However a case study has shown that this method led to in-acceptably complex event streams when signals were generated within nested loops. To overcome this problem an improved event model for inter-task communication is introduced, the hierarchical event stream. This model efficiently describes the behavior of bursty event streams. As the event streams released within loops are bursty by nature this model allows for an efficient description of distributed systems [1].

After introducing the hierarchical event streams it will be shown how this model, in combination with the approximative analysis algorithms, can perform a fast real-time analysis of distributed systems [10].
After presenting this new approach for embedded real-time analysis open questions and unsolved problems are pointed out as a starting point for workshop discussions.

1. References

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