Efficient RMS schedulability tests

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28 May, 2010

1 Introduction

Priority-based scheduling branches into static and dynamic priority scheduling. The optimal static priority algorithm is Rate-Monotonic Scheduling (RMS, for the case of implicit deadlines). In the dynamic priority case where priorities are no longer attached to an entire task, Earliest-Deadline First (EDF) and Least-Laxity First (LLF) are optimal algorithms. While an exact schedulability test both for EDF and LLF is very simple ($u_{total} \leq 1$), exact tests for RMS are much more complex. Time-Demand Analysis (TDA) [7] is, besides simulation along the entire hyperperiod, a solution, but one with pseudo-polynomial complexity.[1] Thus, several only *sufficient* tests with linear, log-linear, quadratic or cubic complexity have been suggested.

In [8], we have recommended the increased use of the sufficient RMS schedulability tests *Distance-Constrained Tasks* (DCT) and *Specialization with respect to r* (Sr), first given by Han and Tyan [2][3]. Related to their medium computational complexity of $\mathcal{O}(n^2)$ and $\mathcal{O}(n \log n)$, their performance is very good. They outperform established ones of comparable computational complexity and both are based on the concept of *accelerated simply periodic task sets*. This crystal-clear principle plays a central role in the field of RMS schedulability tests [8].

2 Open Problem 1: DCT/Sr for MP Scheduling

The two tests DCT and Sr serve as good uniprocessor schedulability tests in partitioned multiprocessor scheduling, see [8]. Thus, a further application to multicore scheduling algorithms - especially global ones - shall be investigated. Preliminary work using task splits can be found in [5] and [4] where *simply periodic task sets* up to 100% utilization are scheduled on multiprocessors, first with a minor dynamic element in [5] and then statically in [4]. The step to include in the approach is the *acceleration*.

[1] This means that TDA requires a polynomial number of operations in terms of the number of tasks which is exponential in the length of the input when coding in a non-trivial, i.e., not in unary, denominational number system.

3 Open Problem 2: Parallelization Potential of DCT/Sr

Compared to some linear complexity algorithms like RBound [6] and Burchard criterion [1], DCT and Sr completely exclude expensive operations like logarithms or powers. They are perfectly suited for parallelization since it is a minimization problem with a moving pivot. Thus, even in this meta perspective, state-of-the-art hardware with multicores should be considered. Because of that, a closer investigation of run-time behavior seems to be promising. Minimzing the run-time of the test is a key factor for its application not only offline but also online.

4 Open Problem 3: DCT/Sr for E-efficient Scheduling

For the emerging field of energy-efficient scheduling, the application of DCT and Sr to Dynamic Voltage Scaling (DVS) as done with the Pillai/Shin (PS) test [9] shall be tried. Although DCT and Sr seem to be superior to PS since they provide guarantees, it is not yet clear whether they are suited for DVS. What makes them attractive is the same (DCT) or even better (Sr) computational complexity compared to the Pillai/Shin test. Quick scheduling is of key importance in online scheduling and in DVS since a too long overhead could easily eat up some of the gain.

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