Poster Abstract: Energy-aware Task Allocation onto Unrelated Heterogeneous Multicore Platform for Mixed Criticality Systems

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I. Motivation and challenges

A recent trend in real-time embedded system domain to integrate functionalities belonging to different criticality levels on a single hardware platform has paved a way towards mixed criticality systems. Modern multicore platforms provides sufficient computing capabilities to deploy mixed criticality systems. Among different kinds of multicore architectures, heterogeneous multicore platforms — composed of more than one heterogeneous processing units (cores) — has gained popularity to perform specific tasks well and cheap. Various components (applications) in mixed criticality system have diverse computing requirements that makes heterogeneous multicore platforms an attractive choice to opt.

Despite all benefits, efficient mapping of mixed criticality applications on heterogeneous multicore platform is one of the major challenges faced by system designers. The problem is acerbated with an additional limitation of energy supply. This is particularly relevant in battery powered embedded systems. The energy consumption of a heterogeneous multicore platform can be reduced in two different ways. Firstly, a task should be mapped to a core where it dissipates minimum dynamic power. Secondly, energy-aware scheduling mechanism can be employed to further reduce the energy consumption on each core. This work only explores the former technique.

We use partitioned scheduling to map the given functionalities (tasks) belonging to different criticality levels on a heterogeneous multicore platform such that available computational capacity of the hardware platform is efficiently exploited and energy consumption is minimised while ensuring the timeliness properties of the system. This is an NP-hard problem and hence, heuristics are the way forward. The state-of-the-art on the energy minimisation of mixed criticality systems is very limited and based on simplistic assumptions. This work considers a realistic power model.

II. Proposed approach

We assume a mixed criticality model proposed by Steve Vestal [1] in which a system starts its execution in low criticality mode and transitions into a high criticality when any task misbehaves. The feasibility of the task-to-core mapping on each individual core is checked through Ekberg and Yi's schedulability analysis [2]. We optimise the energy consumption for the low criticality mode as system mostly stays in this mode and occasionally transitions into high criticality mode.

In our proposed approach, we compute a set of feasible allocations and select the one that minimises the overall energy consumption of the system. The following method is used to collect the feasible allocations. A suffrage based task-to-core allocation scheme ILLED [3] ranks the tasks based on a metric called density difference while performing allocation to their preferred core. The density difference of a task shows how much a system will lose in term of given criteria (utilisation or energy) if a task is not allocated to its preferred core. The ILLED algorithm ranks the tasks based on density difference metric and performs the allocation to optimise the given criteria (utilisation or energy). This ranking plays an important role in the allocation process. The tasks ranked higher have the higher probability of getting mapped to their preferred core. In our proposed algorithm, we manipulate the ranking of the tasks to optimise the energy in low criticality mode while respecting the timeliness property. Initially, we rank the task-set with respect to density difference computed based on the energy consumption in the low criticality mode and perform the allocation with the ILLED algroithm. If the system is schedule with such ranking, we have achieved the minimum energy consumption allocation. Otherwise, we rank the task-set with respect to density difference computed based on utilisation in the low criticality mode and perform the allocation. We gradually upgrade the high criticality tasks in the ranking to get a set of feasible allocations and select the one that gives us the minimum energy consumption.

References

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