INSTITUTE OF COMMUNICATION, INFORMATION AND PERCEPTION TECHNOLOGIES

Scuola Superiore Sant'Anna

Energy Saving Exploiting the Limited Preemption Task Model

M. Bambagini, G. Buttazzo, M. Bertogna, M. Marinoni

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Retis
Real-Time Systems Laboratory

Outline

Introduction - Energy saving

The energy saving techniques are divided in:

- DVFS, Dynamic Voltage and Frequency Scaling
  - Pillai (2001), Aydin (2004), Bini [1] (2005), Gong (2007)
- DPM, Dynamic Power Management
  - Huang [2] (2009), Rowe [4] (2010), Awan and Petters [3] (2011)

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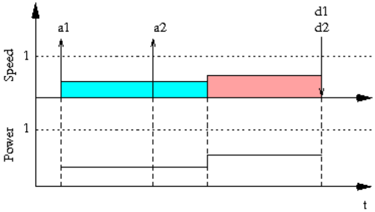
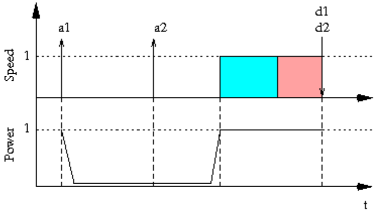


DVFS



DPM

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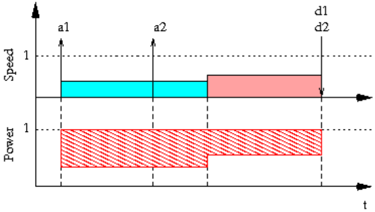
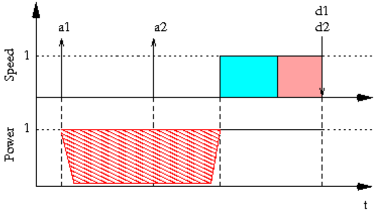


DVFS



DPM

The technique usefulness depends on the HW's power function

Introduction - Deferred-Preemption model

Originally introduced by Burns in 1994 (Cooperative scheduling of Fixed Preemption Point model)

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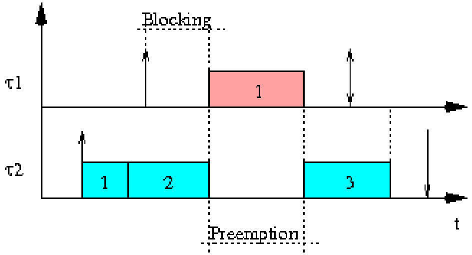
Tasks are divided into a set of non-preemptive chunks

Preemptions can happen only after the end of a chunk and before the starting of the next one



Introduction - Deferred-Preemption model

Deferred-Preemption benefits (with Fixed Priority scheduler):

1. a reduced number of preemptions → lower overhead
2. limited preemptive increases schedulability with respect to fully preemptive and non-preemptive, even with negligible preemption costs (Bertogna et al. [5])

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- if Γ feasible under Limited-P $\not\Longrightarrow$ Γ feasible under Fully-P

Motivational example

Consider a system with two speeds ($s_1 = 0.5$ and $s_2 = 1$) and a task set Γ, scheduled using RM:

- τ_1: high priority, $C_1 = 30$ (at $s = 1$) and $T_1 = D_1 = 80$
- τ_2: low priority, $C_2 = 25$ (at $s = 1$) and $T_2 = D_2 = 200$

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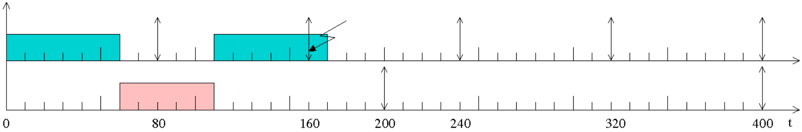
At $s = s_2 = 1$ ($U = 0.5$), the task set is feasible with the models:

- Non-Preemptive
- Fully-Preemptive
- Limited-Preemptive

Motivational example

At $s = s_1 = 0.5$ ($\tau_1 : 60/80, \tau_2 : 50/200,\ U = 1$):



Non-Preemptive model

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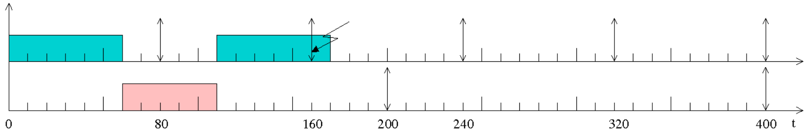
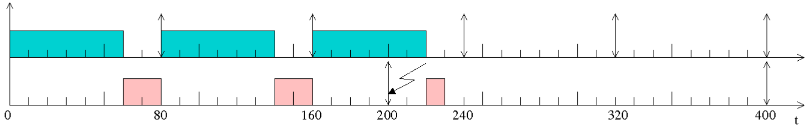


Non-Preemptive model



Fully-Preemptive model

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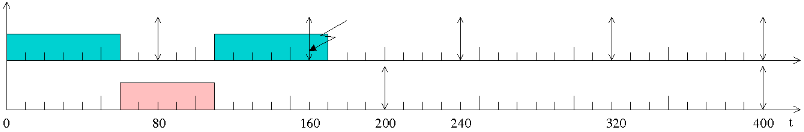
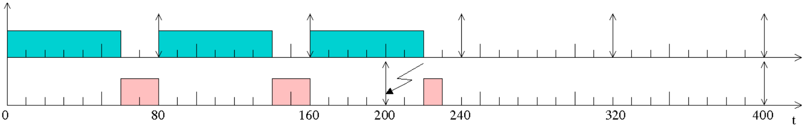


Non-Preemptive model



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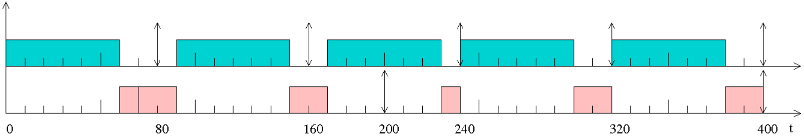

Limited-Preemptive model

Open problem

The deferred preemption model optimizes the tasks execution, giving us extra slack time that is useful to save further energy

But, how can it be effectively exploited for reducing the overall energy consumption?

Possible approaches: DVFS and DPM

Open problem - DVFS approaches

Off-line: how can the speed be computed efficiently during PPP?

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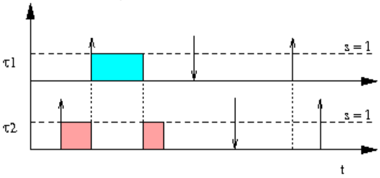

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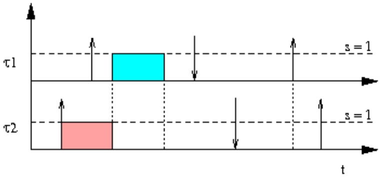

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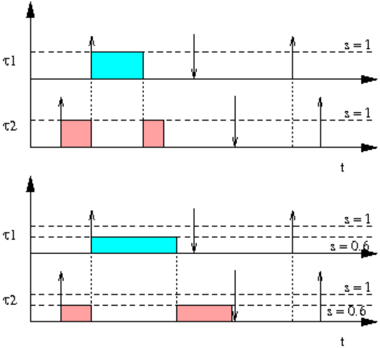

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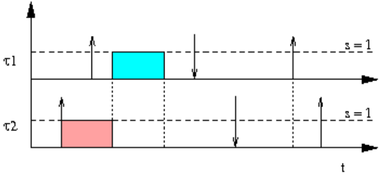

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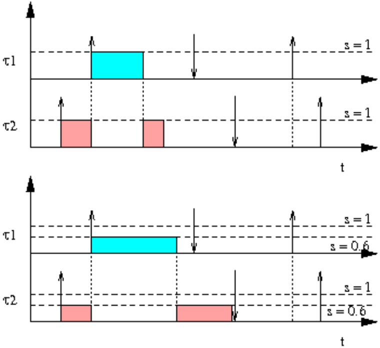

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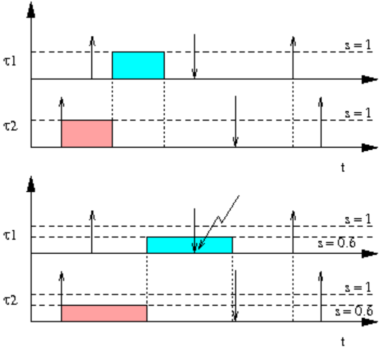
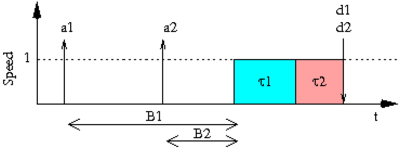


Open problem - DPM approaches

Task procrastination algorithms: forcing inactivity period blocks the execution of the tasks and so, reduces their blocking tolerance



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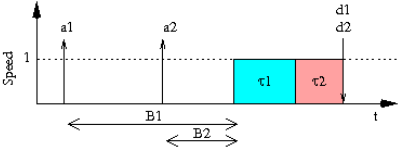

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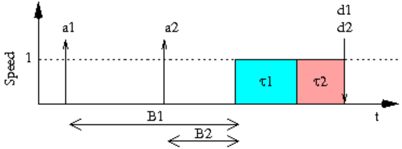

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How is it possible to exploit Limited-Preemptive characteristics for further collecting idle intervals and compacting task executions?

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thank you

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