Mixed-Criticality Systems with Partial Lockdown and Cache Reclamation Upon Mode Change

K. Bletsas*, M. A. Awan*, P. F. Souto‡, B. Åkesson† and E. Tovar†

* CISTER/INESC-TEC Research Centre, Porto, Portugal
† ISEP, Polytechnic Institute of Porto, Portugal
‡ University of Porto, Faculty of Engineering, Portugal
The classic Vestal model with mode changes

- In each mode, only asks of a respective criticality or higher execute.
- Different WCET estimates for the same task in different modes.
  - By techniques with corresponding confidence levels.
- When a task overruns its WCET estimate for that mode, a mode change occurs (e.g., L → H, with two modes).
- Essentially, the processor resources originally for L-tasks are repurposed for the H-tasks upon mode change.
Idea: Reclaim more kinds of resources at mode change!

• Explored in our paper at the main track
• Resource targeted: the shared last-level cache of a multicore.
• The cache is partitioned to the tasks
• At mode change the cache partitions of the L-tasks are reclaimed and given to the H-tasks as additional resources.
  • The cache partitions can either be used to lock the hottest pages of the respective task in place (e.g., using Colored Lockdown);
  • Or they can be used dynamically by the task (e.g., under LRU policy).
• This WiP paper considers a more refined arrangement.
Partial Lockdown

• H-tasks:
  • Part of their cache partition is used for locked hot pages.
  • The rest of an H-task’s cache partition is used dynamically.

• L-tasks:
  • Their partitions are only used dynamically.

• At mode change:
  • The cache reclaimed from the L-tasks is used to enlarge the H-tasks’ dynamically used partitions.
Illustration of the arrangement
Tradeoffs and challenges

• WCET estimates depend on the mode and cache resources assigned.
  • Tractable and accurate parametric WCET estimation needed.

• How much cache per task to use for locking hot pages and how much to use dynamically?
  • Interesting and complex tradeoffs in terms of derivable WCET estimates, that extend to schedulability analysis.

• Reclaiming only dynamically used cache limits mode change overheads.
  • No unlocking, bringing in new page and locking anew needed.