Project Profile: HARPA

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The Challenge: dependable performance
- Critical for embedded applications timing correctness
- Paramount for HPC load balancing and fast execution

The Vision: a synergistic approach
- Exploit synergies in the EC or the HPC domains
- Merging concepts, assessing key applications

The Goal: HARnessing Performance vARIability
- Variable performance confronts new EC/HPC systems
- Dependable performance, slack identification, timing
Cost-Conscious Performance Variability Mitigation
- Reduce the energy, area or delay overheads

Observe and Control the Platform
- Cross-layer, minimally intrusive knobs and monitors

Performance Dependability both for EC and HPC
- Different connotations for each, for example:
  - HW monitors cost relatively less in HPC than in EC

A Space of Conflicting Figures of Merit
- Formal treatment of trade-off space; Pareto Optimality

Customized HW-SW interfaces
- To communicate knob/monitor information across the stack
Dependable Performance **Guarantees**
- Engine={ HARPA OS + HARPA RTE + Knobs & Monitors }
- Enable reusability, based on the monitor and knob availability of each platform

**System Architectural Design Principles**
- Guidelines for the performance dependability of heterogeneous MPSoCs
- Performance guarantees facilitated across many layers
- Hints towards a low cost knobs and monitors

**Demonstrators**
- Case studies representing both the EC and HPC worlds
- Explore the HARPA capabilities using monitors and knobs available in existing and future heterogeneous MPSoCs
Introduction

HARPA components at a glance

- **User Requirements**
  - Quality & Quality Cost
- **HARPA Operating System**
  - ~1s responsiveness
- **HARPA Run Time Engine**
  - ~1ms responsiveness
- **Monitors and Knobs**
  - Cross-Layer Placement
- **Hardware System**
  - EC or HPC Platform
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The Consortium
Involvement :: POLIMI

- HARPA Operating System
- Leveraging knowhow on resource management
- High level decisions (process/thread granularity) aiming at performance variability mitigation
- Bridging the gap between the applications and the hardware
- Hooks into the HARPA RTE
- ~1s responsiveness
Knobs and Monitors

Cross-Layer solution

- PLATFORM SPECIFIC
  - Temperature Sensing
  - DVFS Knobs

- GENERIC
  - OS Utilities
  - Kernel Modules / Schedulers

Platform observability & controllability enabled with minimal overhead
HARPA Run Time Engine
- Implemented as a middleware/firmware routine
- Focused on high responsiveness (~1ms)
- Has to communicate information of low level monitors to the OS, regarding the availability of resources
Provider of Performance Variability Model

Leveraging expertise on deca-nanometer reliability and TCAD modeling

The model captures impact at the device level (e.g. Vth fluctuations)

Projected to the system level

Performance Variability Modeling: CPU intensive
Spectrum Sensing Application

- Explore the frequency spectrum
- Information on unused frequency bands
  - Samples for a large frequency band; filtering; splitting the signal in frequency bands
  - For each frequency band, provision of statistical information is given, with view of signals carriers and spectral footprint
  - The computations can be thoroughly parallelized

The goal is to perform radio-frequencies allocation
FLOREON (FLOoods REcognition On the Net)

- Modular web-based system for environmental risk modelling and simulation in Moravian-Silesian region
- Used to simplify the process of disaster management and increase its operability and effectiveness
Wireless Wearable Human Motion Acquisition
- Rehabilitation assessment capable of real-time processing
- Wireless wearable human motion acquisition system composed by up to 5 wireless tri-axial accelerometers (slave modules) and one receiver (master module)

Target application: Reliable Holter-like Device
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Different metrics are continuously monitored

The HARPA engine:
  - Actuates the knobs to bias the execution flow as desired
  - Implements control strategies

Manage different slack manifestations to enforce timing guarantees & lifetime

Combine performance dependability techniques from both the ES and HPC

Heterogeneous multicore architecture, fitting to emerging computational paradigm
Scenarios are groups of similar platform behavior, under the effects of performance variability.

We pre-characterize at design time and exploit during the run time of the system.
In case the phenomenon is very stochastic, we can build an inventory of scenarios as the platform is operating.

Thus, each instance of the platform creates its own scenario inventory.
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Goal: **mitigate performance variability**

- **Downscaled technologies & Large Scale Computing** feature different variability effects

- We employ a **cross-layer approach** to control the time-zero and time-dependent variability, aiming at **dependable performance with reduced overhead** (avoiding worst case designs)

- HARPA leverages a pool of skills and target applications, equally addressing EC and HPC

- These two domains will exchange concepts, thus enabling **EC-HPC cross-fertilization**
Conclusion

Project Homepage
http://www.harpa-project.eu/

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