

State-of-the-art & research objectives...

...concerning Programming Models and
Runtime/Operating Systems
For Embedded (Hard) Real-time Systems

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Embedded Real-time Systems

- Require high performance to increase
 - safety, comfort, number and quality of services, lower emissions and fuel demands of
 - automotive, aerospace, space, and construction machinery applications

 - Requirements for processor design
 - Hard real-time: predictable and analysable worst case execution time behaviour (WCET analysability)
 - less control units
 - low power
 - working under rough environmental conditions
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Embedded Multi-Cores

- Best solution to meet the demand of future high-performance embedded systems
 - High performance
 - Low power
 - Stable under harsh environmental conditions

 - However
 - Hard real-time requirements
 - How to prove timing correctness → new WCET analysis techniques and new architectural techniques
 - How to parallelize embedded applications, e.g. motor injection codes, ABS/ESP, steer-by-wire, driver assistance systems
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Objectives of EC FP-7 Project MERASA

- Develop embedded multi-core architectures
Partners: Barcelona Supercomputing Center, University of Augsburg

 - Develop WCET techniques and tools for multi-cores
Partners: University of Toulouse, Rapita Systems
 - Static WCET analysis
 - Weakly-hard WCET analysis

 - Develop system software for multi-cores
Partners: University of Augsburg, Honeywell
 - Real-time capable thread isolation
 - Hard real-time scheduling techniques
 - Dynamic run-time spreading of tasks within distributed systems
 - Fundament for adaptive systems
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Research Challenges for Embedded Multicore Operating Systems

- Preserve WCET analysability of the system routines
 - Real-time capable memory management for multi-cores
 - Integration of the thread management and an interface to the hardware thread scheduler
 - Integrated power management techniques
 - Safety / Security aspects
 - Target functionalities (e.g. resource management) to be compatible with a standard embedded OS as e.g. AUTOSAR/OSEK OS
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Research Challenges for Embedded Multicore Tools – WCET Analysis Tools

- Preserve WCET analysability of application runs including system software routines
 - Computed WCET close to the RETs (real-execution times)
 - Static WCET Analysis “strongly-hard” real-time systems
 - No deadline is allowed to be missed
 - “static” timing model of processor and programs
 - WCET Analysis for “weakly-hard” real-time systems
 - Occasional miss of some deadlines can be tolerated
 - Target: nearly all observed execution times are within a WCET boundary
 - Profiling combined with static WCET techniques
 - Allows more freedom in processor design
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