Center for Embedded Systems

An NSF Industry/University Cooperative Research Center

Towards Predictable Execution of Safety-Critical Tasks on Mixed-Criticality Multi-Core Platforms

PIs:

Harini Ramaprasad

Dimitri Kagaris

Southern Illinois University Carbondale

SIU Southern Illinois University Carbondale

National Science Foundation

ASU Ira A. Fulton Schools of Engineering Arizona State University

Project Overview and Description

- **Project Description**
  - Conduct trade-off study of determinism vs. performance of mixed-criticality tasks on Freescale P4080 multi-core platform.
  - Develop policies to maintain responsiveness of HSS applications under regular and overload conditions.
- **Problem**
  - Deterministic execution of HSS tasks in presence of LSS ones on multi-core architectures is challenging.

Approach

Two stage approach:

- Stage 1: a) Use cache locking and partitioning to improve predictability of HSS tasks; b) Identify/develop suitable policies to apply to end-user scenarios.
- Stage 2: Explore the use of manager partition to dynamically control resource usage of LSS tasks under overload or unexpected situations.

Novelty:

- No study/research on applying cache locking and partitioning mechanisms to mixed-critical workloads executing in virtualized environments.

Potential member company benefits:

- Integration on Multicore -> save space and cost
- Use of hypervisor -> Safe execution of mixed-criticality workloads.
- Allowance of migration of certified HSS tasks to the multi-core platform.

Things needed from IAB:

Sanitized / anonymized workload characteristics for benchmarks.

Project Status

Year 1:

- Explored partitioning of cores among multiple partitions.
- Studied cache behavior under no shared cache (Corenet Platform Cache or L3 cache) partitioning.
- Explored partitioning of CPC among multiple OS partitions and the Physical Memory Area (PMA1) , which is a shared memory region that all partitions access, presumably for system/hypervisor related data storage.
- Results revealed that the real time performance improves with increased CPC assignment to RT partition.

Year 2 progress:

- Research on Cache locking mechanism for the Freescale P4080 platform.
- Developed a kernel module to enable cache locking from the user space.
- Implementing features in the kernel module to load and lock data in the cache lines from user space.

Project Tasks/ Deliverables

	Description	Date	Status
1	Exploration of existing research in the area of cache locking and partitioning.	Q1	In progress
2	Workload characterization and end-use scenario analysis under cache locking and partitioning schemes.	Q2	In progress
3	Exploration of mechanisms to create and configure manager partitions;	Q3	Not yet started
4	Development of strategies for dynamic resource management using manager partitions	Q3	Not yet started
5	Report writing and technology transfer	Q4	Not yet started

Executive Summary

Problem

- Deterministic execution of HSS tasks in mixed-criticality multi-core environment and develop policies to maintain responsiveness of HSS tasks under regular and overload conditions.

Viable solution

- Virtualization (hypervisor) for isolation of HSS & LSS task sets and applying the cache-locking and cache partitioning techniques.
- Hypervisors allow configuring one partition as a manager partition, giving this partition rights to pause and resume other partitions.

State-of-the-art

- Comprehensive trade-off study of *determinism* vs. *performance* of mixed-criticality tasks executing in the Freescale P4080 multi-core platform.

Goals of proposed project

- Conduct trade-off study of determinism versus performance HSS-LSS & HSS-HSS interactions with cache-locking and cache partitioning techniques.
- Explore the use of a manager partition to dynamically control the resource usage of LSS tasks under overload or unexpected situations in an effort to maintain deterministic execution of HSS tasks.