Multi-Partitioned Single Cores and Predictable Execution of Safety-Critical Tasks

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Project Overview and Description

- **Motivation**
  - Single partition/module on a core may not fully utilize core resources
  - Deploy multiple partitions on single core
- **Problem**
  - Deterministic execution of HSS tasks in presence of LSS ones is challenging when executed in multiple partitions on single core
- **Viable Solution**
  - Virtualization for isolation of HSS & LSS task sets on same core
- **Application** → Mechanism for Integrated modular avionics
- **Project Description**
  - Characterize interference between HSS and LSS tasks running under the same or different partitions on a single core
  - Develop dynamic partition scheduling algorithms → ensure HSS requirements and provide better Quality-of-Service for LSS tasks

Approach

- **Two-stage approach**
  - **Stage 1:** Explore interference between HSS and LSS tasks executing within one OS, with emphasis on determinism and responsiveness of HSS tasks and QoS of LSS tasks.
  - **Stage 2:** Explore interference between tasks executing in different OSs (e.g., a real-time and general purpose OS) running on a single core with hypervisor support and study the behavior of the OSs in each case.
- **Metrics for measuring success of partition scheduling algorithm**
  - HSS tasks: determinism of execution (satisfaction of timing and precedence constraints
  - LSS tasks: Quality-of-Service (QoS), measured by response time
- **Benefits to member companies**
  - Current schemes rely on static scheduling of partitions
  - Results could enable safe, yet dynamic partition scheduling

Project Tasks/ Deliverables

	Description	Date	Status
1	Exploration of existing research in the area of mixed-criticality systems and development/evaluation of new scheduling algorithms	Q1	Not yet started
2	Characterization of HSS and LSS tasks executing in multiple partitions on a single core with hypervisor support (XEN, KVM)	Q2	Not yet started
3	Characterization of HSS and LSS tasks executing in multiple partitions on a single core with hypervisor support (XEN, KVM)	Q3	Not yet started
4	Report writing and technology transfer	Q4	Not yet started

Technical Detail

QorIQ P4080 Communication Processor
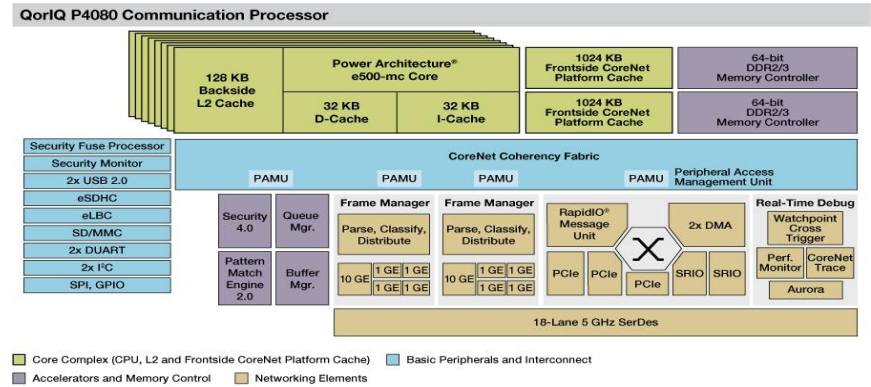
- **Freescale QorIQ P4080**

  - **Xen** based Virtualization

    - Can work in both para-virtualized and Fully-Virtualized (Hardware Virtual machine, HVM) mode

    - Offers high performance in para-virualized mode

  - **KVM** based Virtualization

    - Full virtualization solution for Linux

    - Designed as a loadable kernel module

  - High-bandwidth communication & coherence infrastructure
    - Support for prioritization, bandwidth allocation, packet-level queue management and QoS scheduling