Scaling the Real-time Capabilities of Powertrain Controllers in Automotive Systems
PI: Aviral Shrivastava, Compiler Microarchitecture Lab, Arizona State University

Background
- The complexity and the size of automotive control systems are increasing.
- Such systems have hard real-time constraints, thus high-performance-yet-predictable control systems are needed.

Problem
- Current control system design in practice relies on testing, even though the correctness can only be guaranteed by static analysis at design time, not by testing.
- This is because of the unacceptable amount of pessimism in the analysis results.

Caches: The main culprit
- HW uncertainties are becoming more significant due to ever-increasing application sizes and system complexity.
- Caches are the main source that increases the uncertainties.

Solution: Using scratchpad memories (SPMs)
- Replace caches with scratchpad memories (SPMs)
- SPMs have the following benefits:
  - Tight WCET estimation thanks to explicit management
  - Better performance than caches
    - [DAC 2013] SSDM: Smart Stack Data Management for Software Managed Multicores (SMMs)

SPM Management Framework
- Using SPMs enables various optimizations in compiler and scheduler to improve real-time capabilities, tailored to each application (no hardwired logic).
- SPM space is partitioned for each task, and each type of data to privatize memory accesses.
- SPM space is allocated to minimize memory interference in the worst-case execution path.

Results with Code Management

Acknowledgement
This work was supported in part by the Center for Hybrid and Embedded Software Systems (CHESS) at UC Berkeley, Toyota Motors, and the National Science Foundation grant CNS 1525855.