Bringing the Multicore Revolution to Safety-Critical Cyber-Physical Systems

The Challenge

Multicore platforms have the potential of revolutionizing the capabilities of embedded cyber-physical systems. Unfortunately, when such systems have safety-critical components, multicore platforms are rarely used. The reason is a lack of predictability associated with hardware components such as caches, memory controllers, etc., that are shared among cores. Safety-critical systems require certification; with current technology, very conservative estimates concerning the usage of these shared resources must be made, to certify that overuse violations do not occur at runtime. The resulting over-provisioning can be significant, easily negating the processing power of any additional cores.

The Approach

In this project, research will be conducted to resolve this multicore "predictability problem." A key focus of the project will be the development of methods that enable shared hardware resources to be allocated in a predictable way. Additionally, implementations of these methods will be produced within real-time operating systems (RTOSs) or middleware, and associated tools will be produced for provisioning and analyzing systems. The devised methods will be evaluated through experimental research involving synthetic micro-benchmarks and through work on a difficult challenge problem: the development of a real-time resource allocation framework for next-generation unmanned air vehicles (UAVs). In comparison to current UAVs, these future UAVs will have far greater autonomous capabilities and will be significantly better equipped to adapt to changing environmental conditions.

The Significance

Addressing the "predictability problem" associated with multicore platforms would be a breakthrough result for safety-critical, cyber-physical systems in domains such as avionics and automobiles. When using multicore platforms to host highly-critical workloads in these domains, the current state of the art is to obviate the predictability problem by turning off all but one core. Unless a more intelligent solution can be found, such domains will not benefit from savings in size, weight, and power (SWaP) and gains in functionality that multicore platforms afford.

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