Provided through the gracious contribution of Dr. Dakai Zhu

Project Summary

The ultimate objective of this project is to develop **an integrated scheduling framework for multicore based real-time embedded systems**. Such an initiative is crucial as multicore processors will be the computing engines for the next-generation real-time embedded systems, where increasing functional requirements create ever-increasing demands for high performance, energy efficiency and high reliability. With a strong research background in real-time scheduling, energy management and fault tolerance, the PI has great confidence to tackle the **scheduling** issues (i.e., *what* applications/tasks are executed *where*, *when* and *how*) for exploiting multicore processors in high performance, low power and highly reliable real-time embedded systems.

The major barrier deterring the exploitation of multicore processors in real-time embedded systems is the performance non-predictability of tasks due to interferences in accessing shared resources (e.g., L2 cache). Moreover, recent studies show that there is an intriguing interplay between energy management and system reliability. Therefore, an integrated scheduling framework is necessary to address the often conflicting requirements on performance, energy efficiency and reliability. Towards this end, the PI will study the component-based system models and, for different kinds of real-time workloads, develop a set of multicore-aware real-time scheduling algorithms, which will incorporate the flexible performance/power characteristics and inherent redundancy of multicore processors. These new models and algorithms will be validated and evaluated through both extensive simulations and real implementation on physical platforms equipped with multicore processors.

Intellectual Merit: The development of this proposed scheduling framework will advance the state-of-the-art in the research of real-time embedded systems in the following aspects:

- **Novel component-based execution and resource models** will be studied to capture the essential features of multicore based embedded systems and to facilitate the development of **efficient multicore-aware real-time scheduling algorithms**, which will guarantee various hard and soft timing constraints of periodic, sporadic and aperiodic real-time tasks;
- **Flexible reliability- and energy-aware real-time scheduling algorithms** will be developed, which will incorporate the inherent redundancy in multicore processors and all power consuming components (e.g., memory and I/O devices) in embedded systems;

Broader Impacts: The development of the proposed scheduling framework will lay a solid foundation for the design of multicore based real-time embedded systems, which will proliferate in the foreseeable future. Furthermore, this project will provide abundant topics and learning opportunities for both undergraduate and graduate students, especially those from the under-represented groups. The PI will bring the latest research trends to classrooms and expose students to cutting-edge knowledge. Specifically, the educational efforts in this career development plan include:

- developing a new course on **Multicore and Real-Time Systems** for graduate students to inspire their research interests and to motivate research activities in this area;
- enhancing the existing courses on **Operating Systems** and **Embedded Systems** (for graduate and undergraduate students, respectively) with advanced topics on multicore based systems (such as the related scheduling techniques and energy/reliability management schemes).

As an officially recognized *minority institution*, about 58% of UTSA students are from minorities. To expose them to prevalent research topics and promote their participation to scientific activities, the PI will continue to participate in the annual ExxonMobile Texas Science and Engineering Fair and the San Antonio BEST (Boosting Engineering, Science, and Technology) robot competition.