Demonstration of The Low Power Energy Aware Processing (LEAP) Embedded Networked Sensor System

Dustin McIntire, Kei Ho, Bernie Yip, Amarjeet Singh, Winston Wu, and William J. Kaiser
Electrical Engineering Department
University of California, Los Angeles
Los Angeles, California

Many important new applications of embedded networked sensor (ENS) systems requires advances in computing performance, improved communication bandwidth, and support for complex sensors and instruments. While these new demands have appeared, the strict requirements for low energy operation remains. Prior development of ENS platforms has resulted in low power systems well matched to the requirements for supporting low power sensor devices (for example, thermistor transducers for temperature sensing or photodiode sensors for light level sensing). The computing demands for such systems were matched to these low data rate and low complexity sensor devices. However, these prior platforms designed to support micropower sensor devices are not adapted to system level energy minimization for the new expanded set of ENS applications.

This demonstration will highlight operation of a new platform, the LEAP (Low Power Energy Aware Processing) ENS system. The LEAP architecture has been developed to achieve low energy operation for sensing tasks by harnessing the use of properly scheduled, energy efficient multiprocessor components. It is partitioned such that high efficiency, high power components (used only on demand) are assigned to a LEAP processor partition (based on an Intel PXA-255 processor) while continuously vigilant micropower components (based on a TI MSP-430 microcontroller) are assigned to a LEAP preprocessor partition. The Energy Management and Accounting Preprocessor (EMAP) provides fine-grained monitoring and control of energy dissipation in all ENS subsystems. The EMAP enables the entire LEAP system to operate at micropower vigilance and also provides event detection and triggering capability. This allows event-triggered transition to states where sensors and computing systems are available on-demand according to schedules that match application sampling requirements.

The LEAP hardware architecture is combined with a software architecture providing developer access to system energy monitoring and management along with subsystem operation scheduling. The LEAP system processor supports an embedded Linux operating system. Experimental results verify that this enables convenient developer access and promotes development of energy aware systems. It also provides an advance for in network programmability and remote debugging of all the components.

The LEAP system also includes the LEAP Emulator, providing a complete development and verification environment that mirrors all operations of embedded LEAP platforms with virtual LEAP nodes. Each feature of platform management of all power modes, sensing inputs and operating mode transition times and actual component power dissipation are reproduced with high fidelity. This permits developers to compose, test, and verify applications with accurate reproduction of performance and system energy usage. The LEAP Emulator along with event generation testbed systems has provided many users with a development environment for energy-efficient and high performance sensing.

This demonstration will include the LEAP platform equipped with a high performance imager, and a low energy sensors as well. This will demonstrate a sensing system that adaptively schedules image capture from the imaging sensor based upon micropower sampling of the external light environment. Autonomously adaptive duty cycle operation will be shown with a set of user interfaces that display energy dissipation of each primary component including sensing, computing, and wireless networking. The multimode LEAP Emulator will also be demonstrated. Finally, remote access to a LEAP testbed will also be demonstrated providing visitors to the demonstration with hands-on access to local, remote, and virtual systems.

Facility Needs

- Standard facility needs of 1 table, 1 easel and a 8'x8' space
- 110V AC power and Internet connectivity in the form of wireless or wireline links
- Setup time required: two hours
- No requirements for sensor nodes to be placed in remote locations
- Radio frequencies and protocols to be used: 2.4 GHz ISM Band and IEEE 802.11b protocol