Title
Smart Object Architecture for Energy-Efficient Wireless Sensors

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Introduction: Smart Object—The Future of the Sensor World

Applications

- Focus on new class of wireless sensor applications with demands for high performance computing and networking that requires low duty cycle sensor operations
- Architecture matches high performance computing capability to the sensing task
- Wide dynamic range power control

A New Architecture

- Combines a hardware and software object-oriented architecture for wide dynamic range and fine granularity energy management
- Software architecture permits autonomous scheduling and isolates developers from complex energy management detail
- Enables systematic design approach for multitasking energy-aware wireless sensor systems that must adapt to environment and events

The Platform

- Standard processor platforms
- Standard operating systems
- Language-independent interfaces
- Support for diverse sensors
- Energy and resource aware scheduling

Problem Description: Limitations of the Current Sensors

Background

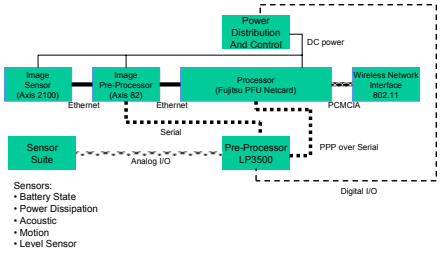
- Wireless networked sensor deployments are now planned for a wide range of critical applications
- Energy limitations have always constrained unattended wireless sensors
- Early systems focused on simple monitoring methods
- Now, new applications require powerful sensing (including vision sensors) and high performance computing (for image processing and security services) and low energy
- Energy demands exceed available energy by many orders of magnitude—new approach required

Prior Architectures

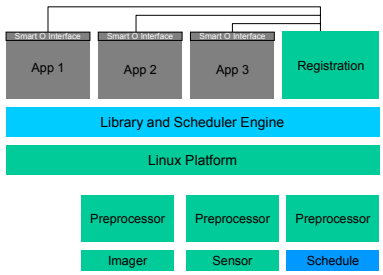
- Microcontroller-based wireless sensors do not satisfactorily support computation intensive applications
- Low computational power efficiency
- Limited support for energy efficient wide-bandwidth wireless
- Past methods for energy-aware platform scheduling presented complex demands to developer with regards to energy-management

Proposed Solution: Smart Object Architecture Approach

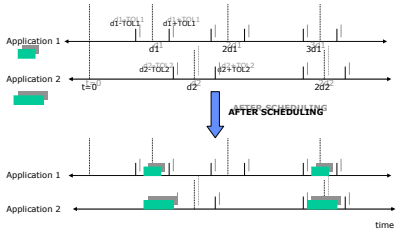
Hardware Architecture



Software Architecture



Resource Scheduling Example



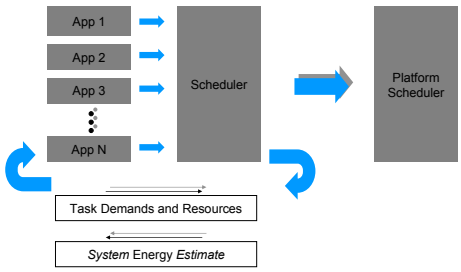
Operations

- Scheduler observes application duty cycle and deadline demands and tolerance
- Scheduler computes energy-efficient operation schedule meeting task and resource requirements at minimum energy
- Micropower preprocessor manages power and platform operation episodes according to scheduler
- Automated admission and scheduling of applications

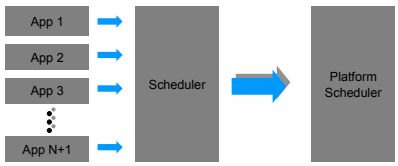
Scheduler

- Developers:
  - Specify operating duty cycle, execute time estimates, and allowable tolerances
- Scheduler:
  - Resource aware
  - Dependency aware
  - Energy aware
- Computes estimated optimal schedule
  - May seed schedule search with pre-computed solutions
  - Variational approach for scheduling of admitted new applications

Development Pathway: Design



Runtime Application Admission



Prototype System