Reconfigurable Sensor Networks with SOS

Chih-Chieh Han, Ram Kumar Rengaswamy, Roy Shea and Mani Srivastava
UCLA Networked and Embedded Systems Laboratory

Introduction: Remote Reconfiguration in Wireless Sensor Networks

- **Remote and Inaccessible Deployments**
  - **Deploy and Leave**: Sensor networks observe the otherwise unobservable. Deployments locations are often **hazardous, remote, or fragile**.
  - **Quotation From the Field**
    “Sitting here in the middle of nowhere and getting motes to work... I have to walk for 5 minutes on a mine field (they swear they have removed all the mines but who knows?) just because we forgot to initialize some variable!”
  - **Remote Operation**
    Operation from afar is essential to the continued success of sensor networks.

Proposed Solution: Sensor Network System Support for Loadable Modules

- **Need a Minimal System Kernel**
  - System Core Implements Basic Services
    Message passing scheduler for messages between parts of the system.
  - Low layer **hardware abstractions** for a given system platform.
  - Fixed-partition **dynamic memory** mechanism to provide constant time dynamic memory allocation to the SOS kernel and modules.

- **Need Loadable Binary Modules**
  - **Modules Implement Most Functionality**
    Everything from sensor drivers to user programs are implemented as modules.
  - Modules can be added, modified, and removed at run time. This creates a **dynamic system** that can change over time to meet new challenges.
  - Modifications to modules does not interrupt system operation.

Solution Analysis: Examining the SOS Operating System

- **Inter-Module Communications**
  - Priority-based asynchronous messaging for inter-node module communication.
  - Type-safe synchronous function call for intra-node module communication.

- **System Communications**
  - Static kernel interface for access system resources such as timers, memory, sensors, and actuators.

Sample Application

- Testing a sensing application written in SOS. Uses **One Phase Pull** to gather sensor data from a network.
- Application is composed of five modules that can be customized **individually** post deployment.

Competitive Performance of SOS

- **SOS Combines**: 
  - **Performance** of traditional wireless sensor network operating systems.
  - **Flexibility** of virtual machines.
- The combination creates a system that supports larger sensor networks that are able to evolve after they have been deployed.