Energy-efficient Management of Heterogeneous Wireless Sensor Networks

Gerald Wagenknecht
Universität Bern
Agenda

> Introduction
> Key issues
> Key concepts
> WSN scenario
> Working packages
> First steps & ideas
> Discussion
Introduction

> Wireless sensor nodes with limited resources
  — energy / battery
  — processing power, RAM
  — network bandwidth

> Characteristics of WSNs
  — long-term deployment cycles
  — heterogeneous nodes’ hardware base

> Node maintenance tasks
  — (re)configuration
  — (re)programming
  — monitoring
  — planning of physical maintenance tasks
Key issues

> WSN management framework
  — support individual node management
  — distribute OS / application level code
  — exchange management information

> Efficient & reliable communication mechanisms
  — unicast
  — multicast
  — broadcast

> Challenging problems
  — wireless transmission is unreliable
  — sensor nodes are unreliable
  — topology might change frequently
Key concepts

- Packet caching
- Local repair
- Efficient flow & congestion control mechanisms
- Compression schemes
- Acknowledgement suppression
WSN scenario

Typical WSN scenario
- management station
- base station
- management nodes
- sensor nodes
Working Packages – WP1 (1)

> Management and Code Distribution for Wireless Sensor Nodes

— Defines overall wireless sensor network management and code distribution framework.

— Include following tasks:
  – WSN Management Framework (Apr’07)
  – WSN Management Architecture Implementation (Jun’07)
Working Packages – WP1 (2)

> WSN Management Framework

— Support of following management operations:
  – dissemination of management information to all sensor nodes (using broadcast)
  – installation and run-time modifications to a group of nodes (using multicast)
  – configuration and management individual sensor node parameters (using unicast)

— Specification of:
  – management / code distribution operations
  – supporting protocols
Working Packages – WP1 (3)

> WSN Management Architecture Implementation

— Identification of:
  - appropriate sensor node platforms
  - appropriate operating system and middleware components

— Design & implementation of:
  - basic management station
  - management node middleware
  - sensor node middleware
Working Packages – WP2 (1)

> Reliable Communication Mechanisms for Wireless Sensor Networks

— Developing the required reliable unicast, multicast, and broadcast mechanisms

— Include the following sub packages:
  - Reliable Point-to-Point Transport (Aug’07)
  - Reliable Multicast Transport (Mar’08)
  - Reliable Broadcast (Mar’08)
Working Packages – WP2 (2)

> Reliable Point-to-Point Transport

— TCP Support for Sensor Networks (TSS)

— Includes special functionality:
  - caching
  - local retransmission
  - congestion control
  - compression schemes
  - acknowledgement suppression

— Potential improvements:
  - delayed acknowledgement
  - reducing transmission by combining TCP data & TCP ack
  - header compression
Working Packages – WP2 (3)

> Reliable Multicast Transport

— Development of a reliable multicast communication mechanism
  – use multicast routing protocol for wireless sensor networks
  – add reliability mechanisms (e.g. Scalable Reliable Multicast)

— Development of a reliable overlay multicast scheme
  – application level multicast
  – based on partially meshed overlay network
  – might use TCP connections between nodes of a group

— Multicast routing schemes vs application level multicast
  – evaluation and comparison of schemes
Reliable Broadcast

- Development of a reliable broadcast communication mechanism

- Use Dynamic Delayed Broadcast (DDB)
  - improves delivery ratio of broadcasts

- Need of additional transport mechanisms on the top of the broadcast routing protocol
  - to support WSN management scenario

- Evaluation and optimization
Working Packages – WP3 (1)

> Implementation and Integration

— Integration of the protocol mechanisms with the implementation of the WSN management framework

— Development of a demonstrator

— Include following tasks:
  – Implementation of management and code distribution operations (Oct’08)
  – Implementation of reliable unicast, multicast, and broadcast protocols (Oct’08)
  – Integration of management and code distribution operations, reliable unicast, multicast, and broadcast protocols as well as selected sensor node platform and middleware (Dec’08)
First steps & ideas

> Sensor nodes bought
   — TmoteSky nodes & TmoteConnect

> Brainstorming “Schlagworte”
   — Thought about the management architecture
   — Dynamic change of sensor nodes to management nodes
   — Combining mesh networks with sensor networks
   — …
Discussion

> Questions and ideas are welcome …