



Issues and Solutions in Wireless Sensor Networks



2nd Semester in Master's
Name
Hyo Jung Yun



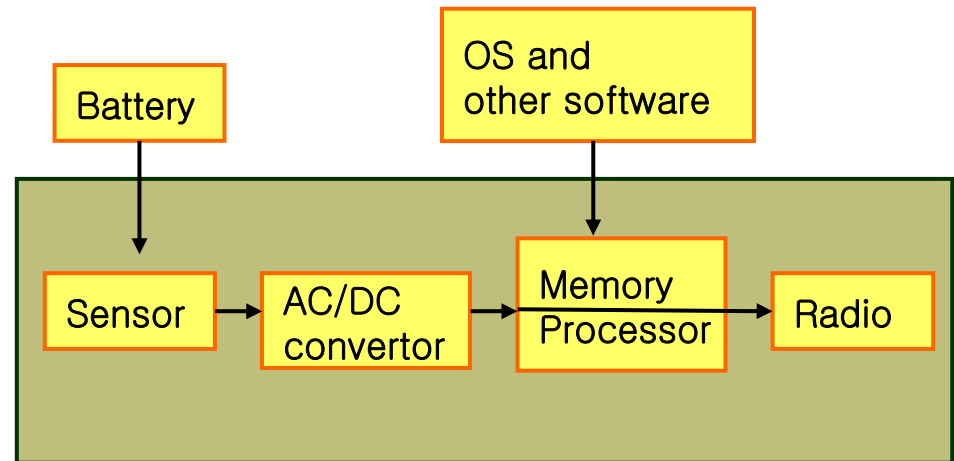
- Introduction
- Sensor Networks versus Mobile ad hoc Networks
- System Models
- Design Issues in Sensor Networks
- MAC Layer Protocols
- Routing
- Other Important Issues

■ Sensor Network

- + Hundreds of sensor nodes
- + Transmission sensing data
- + Numerous applications

■ Node

- + Sensors
- + Processor
- + Memory
- + Radio
- + Limited power battery
- + Software components
 - Operating system
 - Protocols





■ Mode of communication

+ MANETS

- Any node can send data to any other node.

+ Sensor Networks

- Base station : Broadcasting commands to all sensor nodes
- Sensor nodes : Sending sensed data to base station

■ Node mobility

+ MANETS

- Every node can move.

+ Sensor Networks

- Both static, Sensor node moving, Both moving

■ Energy

+ MANETS

- Rechargeable source of energy

+ Sensor Networks

- Energy conservation is very important in Sensor networks.



■ Various system models

- + Mobility of base stations
- + Number of base stations
- + Method of organization (hierarchical/flat)
- + And so on.....

■ Operational Model

+ Active

- Periodic
- Event driven

+ Passive

- Energized on query
 - Only when a query is generated for the data, the sensor node would switch on its sensor and record the data to be forwarded.
- Always sensing
 - Running all the time
 - As soon as there is a query for data from it, a sensor node would generate the data packet based on the observations until now and forward the packet.



- Energy
 - + Sensor nodes spend more energy in communication than local computations.
- Bandwidth
 - + Using ISM band.
 - + Requirement to use the available bandwidth optimally.
- Limited computation power and memory
- Unpredictable reliability, failure models
- Scalability
- Timeliness of action (latency)
 - + Applications such as security and surveillance.



■ Channel allocation

- + Energy-efficient function
 - Avoidance : Collisions, Overhearing, Idle Listening, Control packet
- + Existing solution in MANET
 - Contention-based method
 - Contention-Free method
- + Organized methods in sensor networks
 - Determining the network topology first and then assigning the channels
 - Distributed protocol

■ Self-organizing MAC (SMAC)

- + Each node allocates channels to links between itself and neighbors within a TDMA frame referred to as super frame.
- + In a given time slot, every node communicates with only one neighbor to avoid interference.
- + Super frame
 - First period : nodes try to discover neighbors, and rebuild severed links.
 - Second period : communication between nodes.

■ Eavesdrop and Register (EAR)

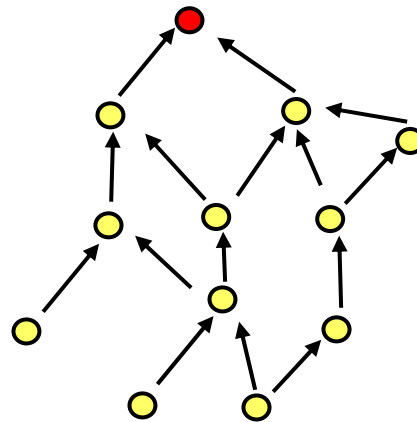
- + Handling channel allocation with moving base stations

■ Piconet

- + Using periodic sleep cycle to save energy

■ Flat Routing Protocols

- + Sequential Assignment Routing (SAR)
 - Considering the energy and QoS
- + Directed Diffusion
 - Using attribute-based naming query
- + Sensor Protocols for Information via Negotiation (SPIN)
 - Using negotiation and information descriptors



[Flat Routing]

○ sensor node
● sink node

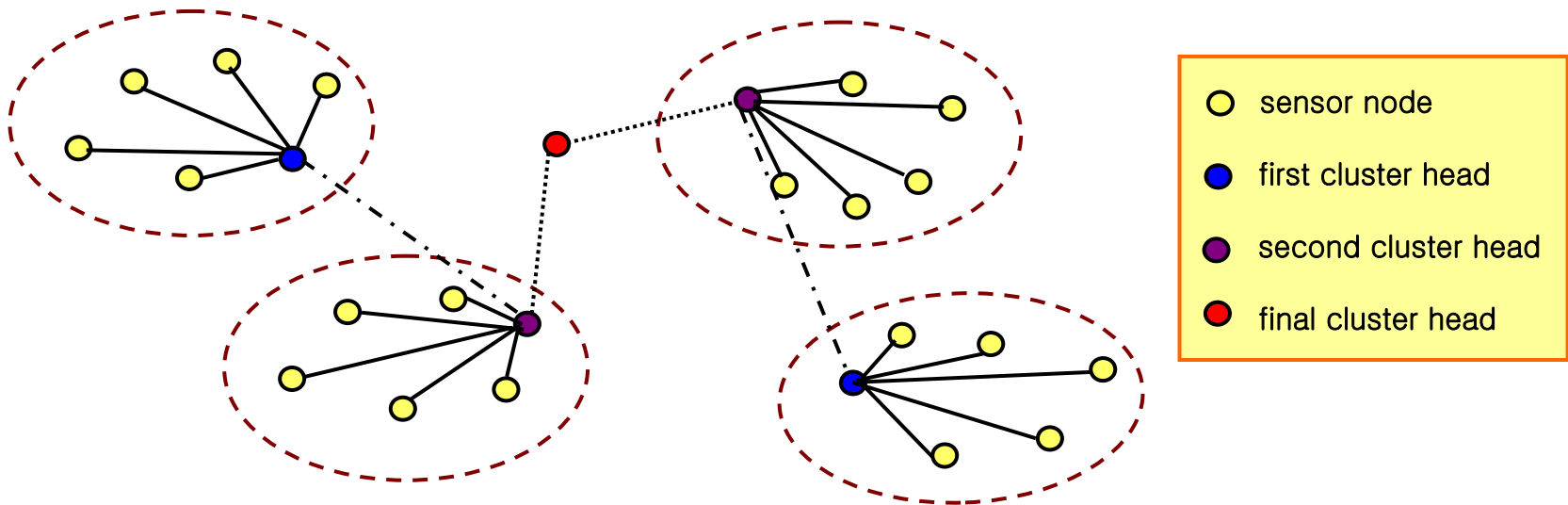
■ Cluster-Based Routing Protocols

+ Low Energy Adaptive Clustering Hierarchy (LEACH)

- The proactive networks
- Self-elected cluster heads collect and aggregate data

+ Threshold sensitive Energy-Efficient sensor Network (TEEN)

- The reactive networks



[Cluster-Based Routing]



■ Security

+ Issues

- Node power (ex. Symmetric Key encryption)
- Mode of communication
- Node mobility
- Key distribution

+ SPINS (Security Protocols for Sensor Networks)

- Secure Network Encryption Protocol (SNEP)
 - Data integrity
 - RC5 algorithm
 - Shared key and an incremental message count, maintained at both sensor node and base station
- Micro-Timed Efficient Streaming Loss-tolerant Authentication Protocol (μ TESLA)
 - MD5 algorithm
 - Using key chain and key disclosure schedule



■ Location Determination

+ GPS

- Expensive
- Reflection and multi-path fading

+ Proximity-based solutions

- Using the special nodes whose locations are known
 - Cricket
 - RADAR
 - SpotON

■ Lifetime Analysis

+ Lifetime

- Refers to the time period for which a sensor network is capable of sensing and transmitting the sensed data to the base station.
- Hybrid Automata modeling
 - Mathematical method
 - Analyzing the systems with both discrete and continuous behaviors



■ Power management

+ Dynamic Power Management (DPM)

- Shutdown the devices when not needed.
- Lesser the power consumption, more the latency

+ Dynamic Voltage Scheduling (DVS)

- Changing the power supply to match the workload

■ Clock Synchronization

+ Cryptographic schemes

+ Data aggregation algorithms



■ Sensor Placement and Organization for Coverage and Connectivity

+ Coverage area

- Some applications may require preferential coverage of critical points
 - Surveillance/monitoring applications

+ Placement

- Good placement strategy can minimize the cost and the energy consumption.

+ Organization

- The number of active and passive (sleep) node
- CCP, OGDC
 - Maintains coverage and connectivity by keeping the minimum number of sensors in the active mode

■ Topology Control

- + A sparse topology can increase the chances of network partitioning due to node failures and can increase the delay.
- + A dense topology can limit the capacity due to limited spatial reuse and can increase the interference and the energy consumption
- + Cone-Based Topology Control algorithm (CBTC)
- + Local Minimum Spanning Tree (LMST)

THANK YOU