Algorithms for Radio Networks

Wireless Sensor Networks - Introduction
Wireless Sensor Networks (WSN)

- **Wireless sensor networks (WSN)**
  - Network embedded in an environment
    - measure and interact with the environment
  - Nodes collect, process and use this information
  - Wireless sensor & actuator networks (WSAN)

- **WSN Nodes**
  - Sensors
  - Actuators
  - Microprocessor
  - Transceiver
Example

- **Smoke detection network**
  - Sensors: smoke sensors
  - Actuators:
    - acoustic warning signal
    - Optical test signal
  - Transceiver and microprocessor
- **Alarms are activated at all connected smoke detectors**
Roles in Wireless Sensor Networks

- **Data Sources**
  - data collection and transmission
  - equipped with sensors

- **Data sinks**
  - collects all data
  - part of the WSN and external entity
    - e.g. PDA, gateway, PC, etc.

- **Actuator**
  - changes the environment
  - e.g. light source, speakers, engine
Architecture of a WSN Unit

- Main components of a WSN unit
  - controller
  - communications unit
  - sensor / actuator
  - memory
  - power
Technologies for WSN

› Mass production and price reduction
  • for wireless communications
  • Micro-controller
  • sensors
  • batteries

› Miniaturization
  • "Smart dust"

› Energy harvesting
  • power supply from the environment
  • e.g. Light, heat, motion, chemical
Controller

- Types
  - Microcontroller
    - microprocessor for embedded applications
    - low power consumption
    - inexpensive
  - FPGA (Field Programmable Gate Array)
    - too high power consumption
  - ASIC (Application Specific Integrated Circuit)
    - special circuit design
    - best but most expensive solution
Sample Configuration

- **Texas Instruments MSP430**
  - 16-bit RISC core
  - up to 4 MHz
  - 2-10 kbytes RAM
  - several analog-digital converters

- **Atmel ATmega 128L (z.B. Mica-2)**
  - 8-bit controller
  - 128 kB Flash program memory
  - 4-8 kB SRAM
  - 4-7.4 MHz
Energy efficiency

- **Standard**
  - Power supply from batteries

- **Long run times for**
  - Nodes and overall network

- **Necessary: energy-efficient protocols**
  - Multi-hop routes with low energy
  - Battery capacity as a parameter for algorithms
  - Energy and networking poses a conflict of interest
MANET versus WSN

- **Similarities**
  - Self-Organization
  - Energy efficiency is necessary
  - Wireless multi-hop networks
  - No centralized control or infrastructure
MANET versus WSN

differences

› MANETs
  • larger bandwidths
  • computationally stronger nodes
  • interconnect users (for example, to laptops, PDAs)

› WSN
  • highly application-oriented
  • interact with the environment
  • sometimes have more nodes
  • stronger requirements for energy efficiency and maintenance
  • longer life time
  • individual WSN nodes dispensable

› WSN
  • data centric

› MANET
  • ID-centric

 › mobility
  • sometimes in WSN much higher than in MANETs
  • e.g. If mobility is measured
WSN Applications

- **Disaster relief**
  - sensor nodes are dropped from planes over fires

- **Nodes measure temperature**
  - online collection of fires

- **Biology**
  - biodiversity acquisition
  - sensor nodes collect wildlife
    - e.g. rare animals in remote areas
  - detection of migration of animals
    - e.g. Zebras, cows, storks
WSN Applications

- **Intelligent buildings or bridges**
  - Reduction of energy wastage
    - by humidity, ventilation, cooling and heating control
  - Measurement of space usage, temperature, air currents ...
  - Measurement of the building load to earthquakes, earth movements

- **Environmental measurements**
  - e.g. measurement of the Gulf Stream, other water currents, weather balloons
WSN Application

› **Industrial control**
  • building control
    - Theft, access
  • leakage control in chemical plants
  • plant control

› **Machine condition monitoring and preventive control**
  • embedding of sensors and control units, where cables are not available
  • such as tire pressure monitoring
WSN Application

› **Automated agriculture**
  • fertilizer, pesticide and irrigation control
  • sensors monitor the soil chemistry and soil physics

› **Medicine and health care**
  • postoperative or intensive care
  • long-term monitoring of chronically ill or elderly
WSN Application

- **Logistics**
  - goods are equipped with sensors
  - localization and Quality Control

- **Telematics**
  - better traffic control through more accurate traffic monitoring

- **Intelligent roads**
  - cars as traffic sensors
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