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Algorithms for Radio Networks

Wireless Sensor Networks - Introduction

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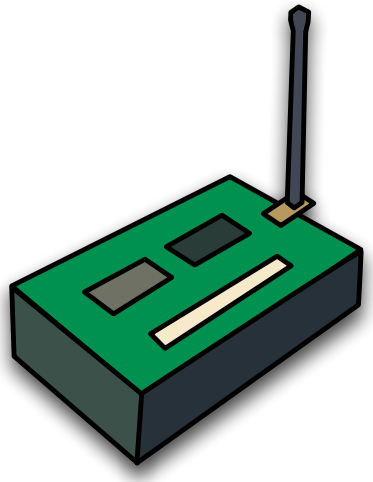
Wireless Sensor Networks (WSN)

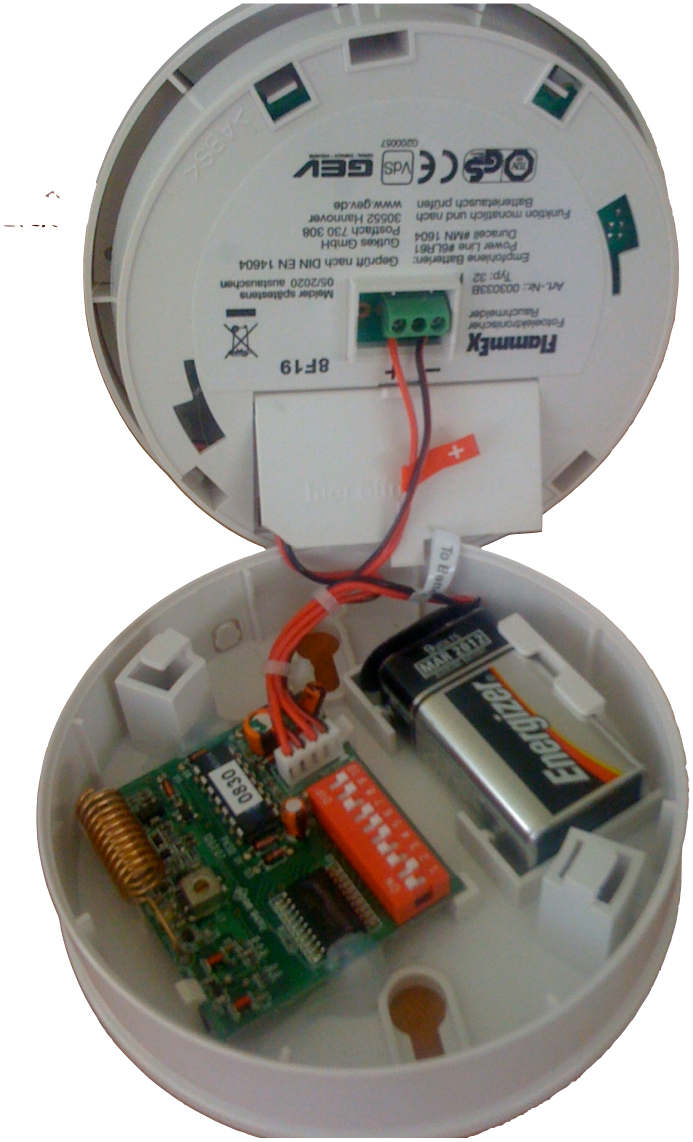
- **Wireless sensor networks (WSN)**
  - Network embedded in an environment
    - measure and interact with the environment
  - Nodes collect, process and use this information
  - Wireless sensor & actuator networks (WSAN)
- **WSN Nodes**
  - Sensors
  - Actuators
  - Microprocessor
  - Transceiver




TmoteTelos

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**

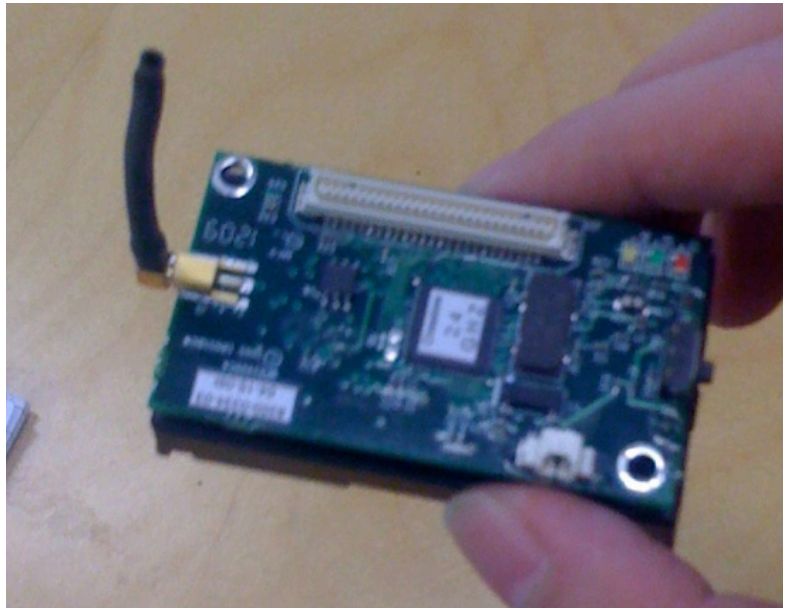


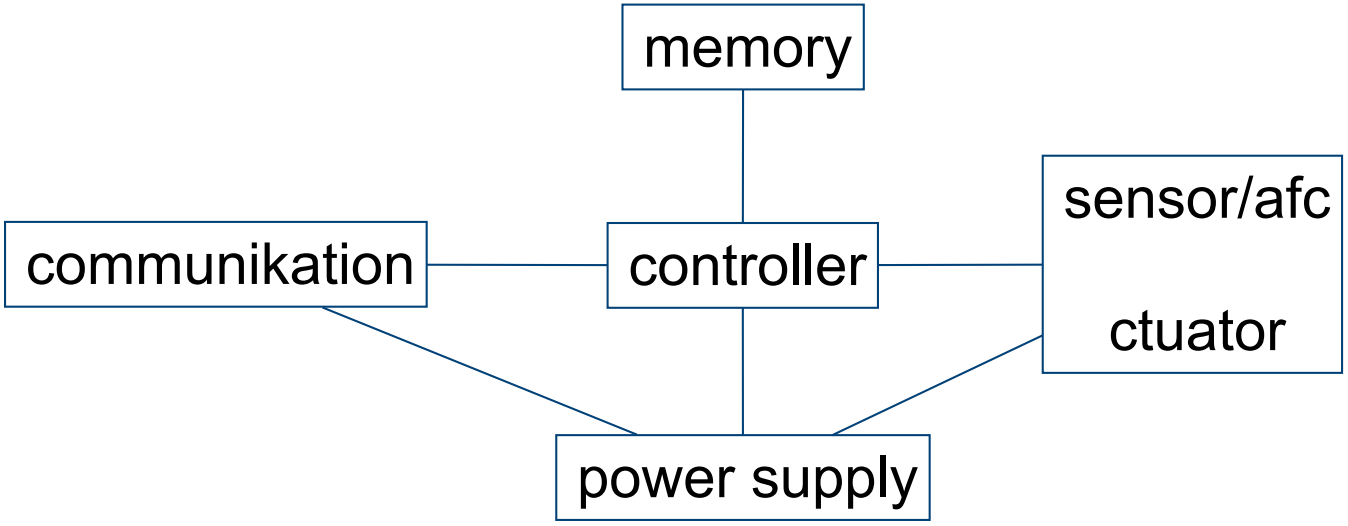
Roles in Wireless Sensor Networks

- **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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