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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

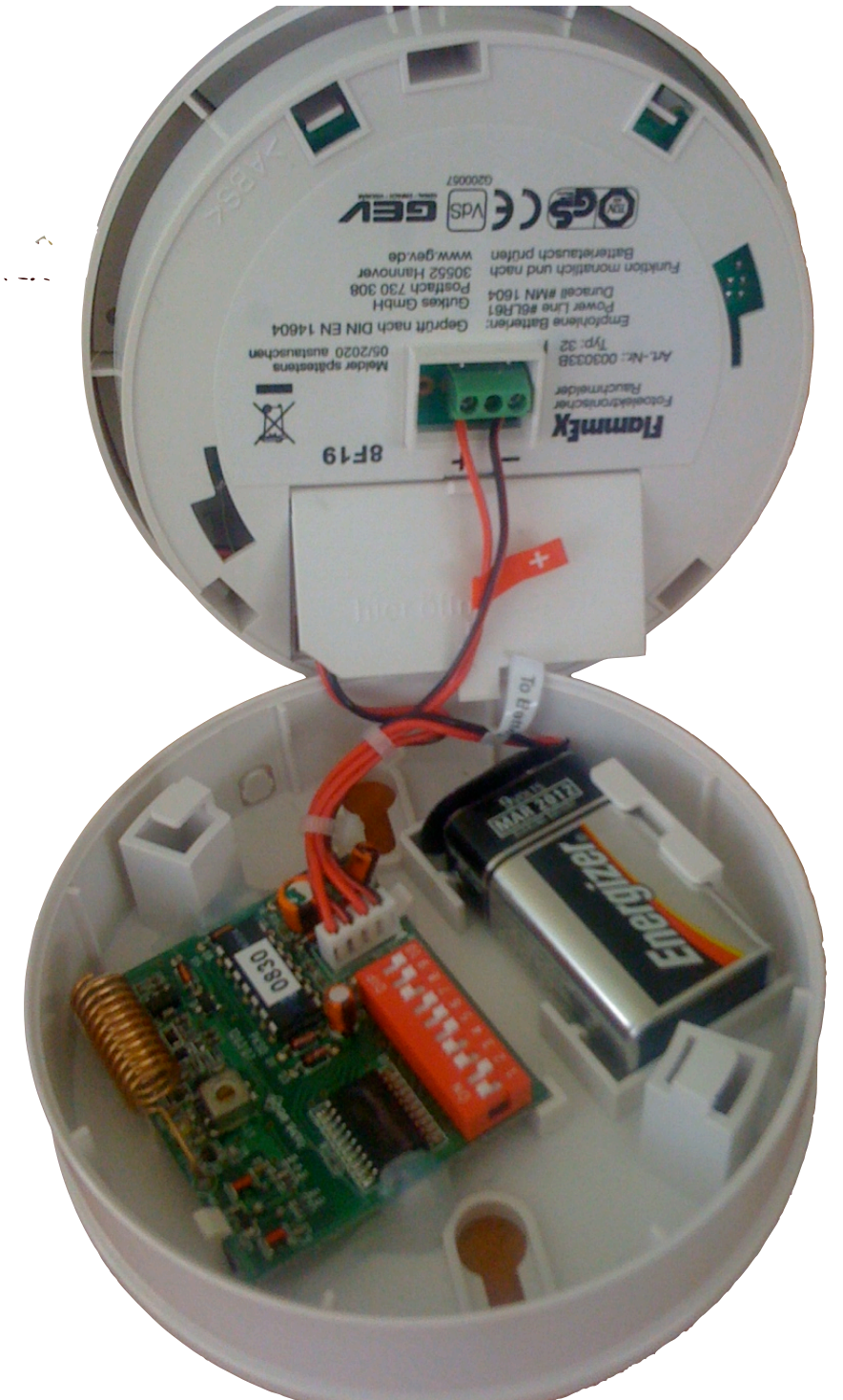- Wireless sensor & actuator networks (WSAN)

▸ **WSN Nodes**

- Sensors

- Actuators

- Microprocessor

- Transceiver

Algorithms for Radio   puter Networks and Telematics
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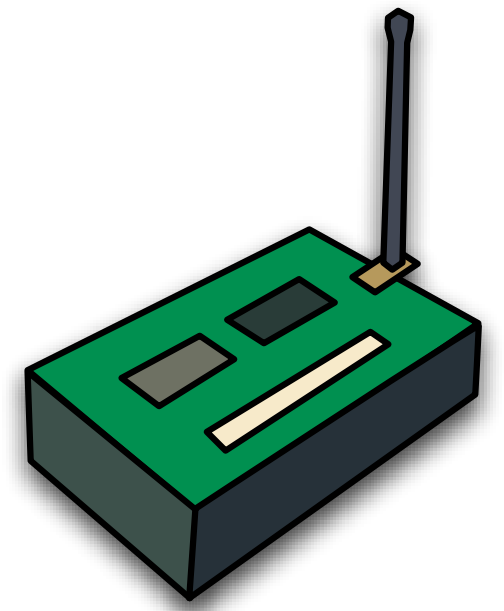
Example

▸ **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
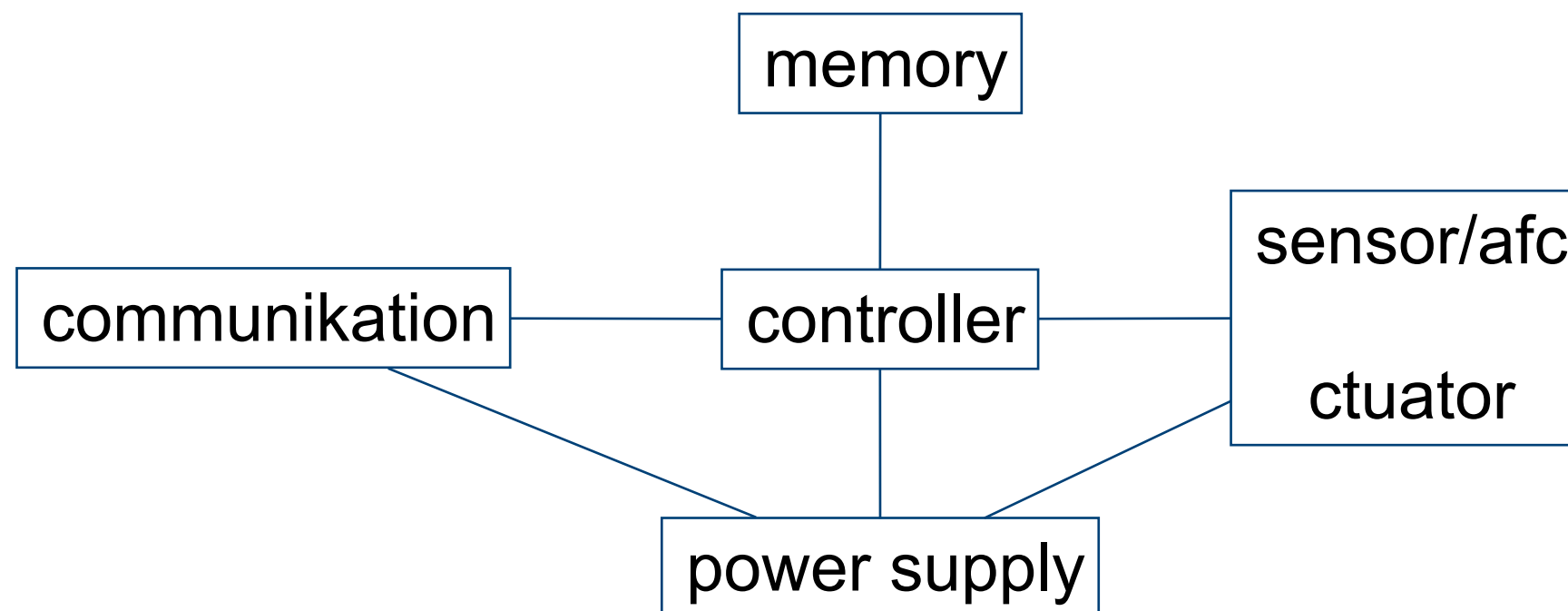
  - e.g. PDA, gateway, PC, etc.

▸ **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


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                    ┌──────────┐
                    │  memory  │
                    └────┬─────┘
                         │                    ┌──────────┐
                         │                    │sensor/afc│
┌───────────────┐   ┌────┴─────┐              │          │
│ communikation │───│controller│──────────────│  ctuator │
└───────┬───────┘   └────┬─────┘              └────┬─────┘
         \               │                    /
          \         ┌────┴────────┐          /
           \────────│ power supply│─────────/
                    └─────────────┘
```

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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