Wireless Sensor Networks

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Control of Artificial Irrigation and Early Detection of Bushfires

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What is a Wireless Sensor Network?

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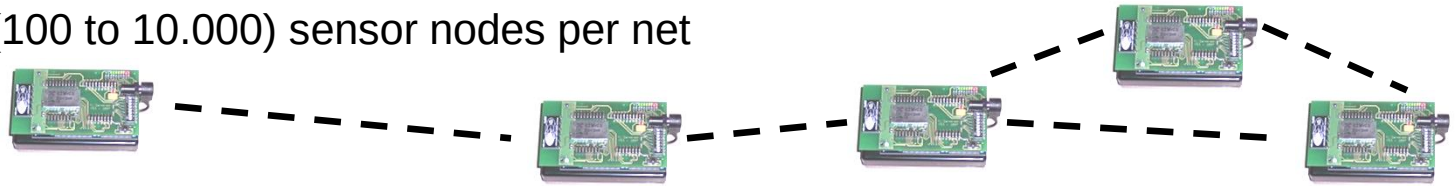
- Self-organizing networks formed by many autonomous sensor nodes
  - Each node comprises its own power supply, processing unit, radio and sensors
  - Typically peer-to-peer communication (no central server)
  - Many (100 to 10.000) sensor nodes per net



- Various Applications: Industrial Automation, Building Control, Health Care, Military, Farming, Traffic Control, Home Automation, ...

- Visions: „Smart Dust“, „Ambient Intelligence“, …

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What are the requirements for a Wireless Sensor Network?

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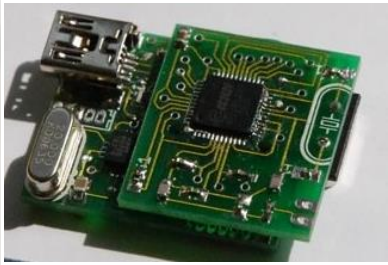
- Must be kept cheap
  because large quantities are required
- Must be robust
  to be deployable in rough environments
- **Must not be power-hungry**
  - To be deployable in remote areas without any infrastructure
  - To keep working for several years without changing of batteries
- Basic functionalities:
  - Sensing
  - Transferring data to a base station where it will be processed

FhG IIS S3-TAG



Porcupine v2.5

Crossbow Telos

Our own (-:

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TU Darmstadt´s Contribution: Reconfigurable Hardware

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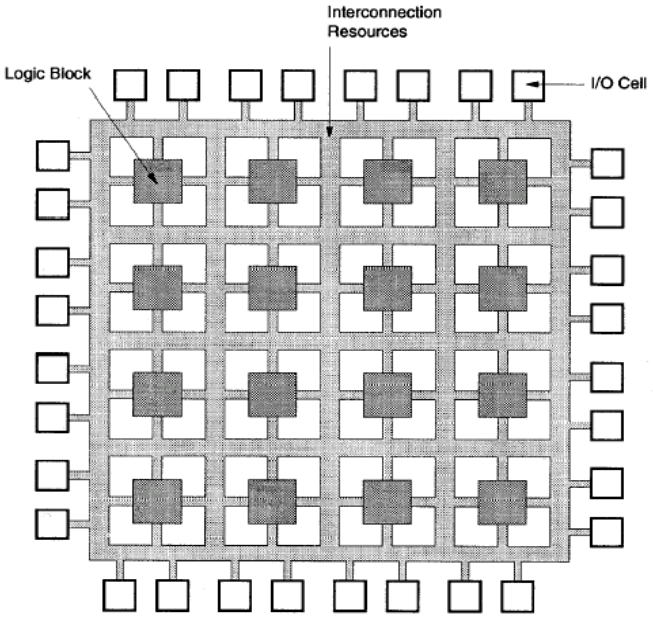
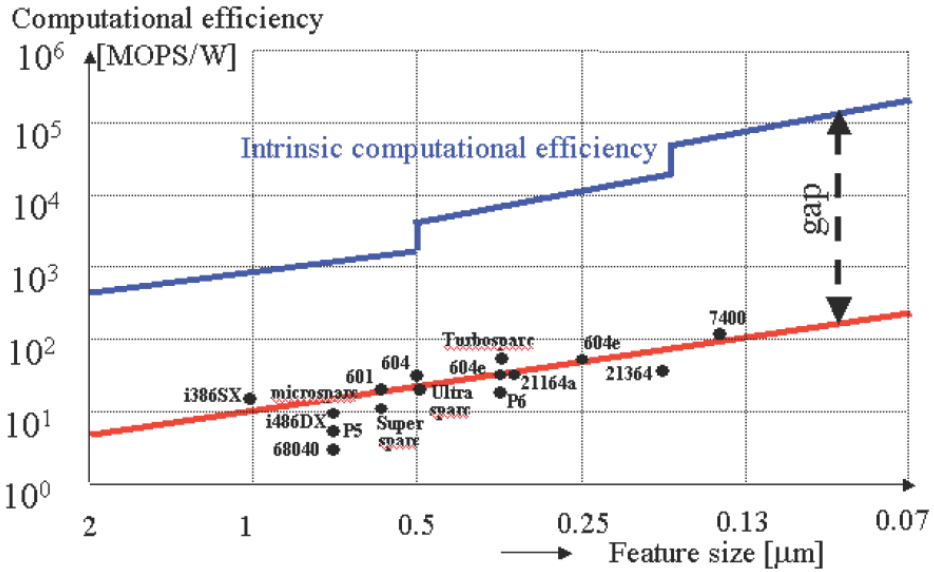
- Dedicated circuits are orders of magnitudes more energy-efficient than software running on general-purpose chips
- Software can be easily changed, hardware cannot





- Programmable Logic Devices (Reconfigurable Hardware)
  - Are flexible, yet more efficient than software
  - Are composed of programmable function blocks and programmable interconnects

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TU Darmstadt´s Contribution: Domain-Specific Reconfigurability

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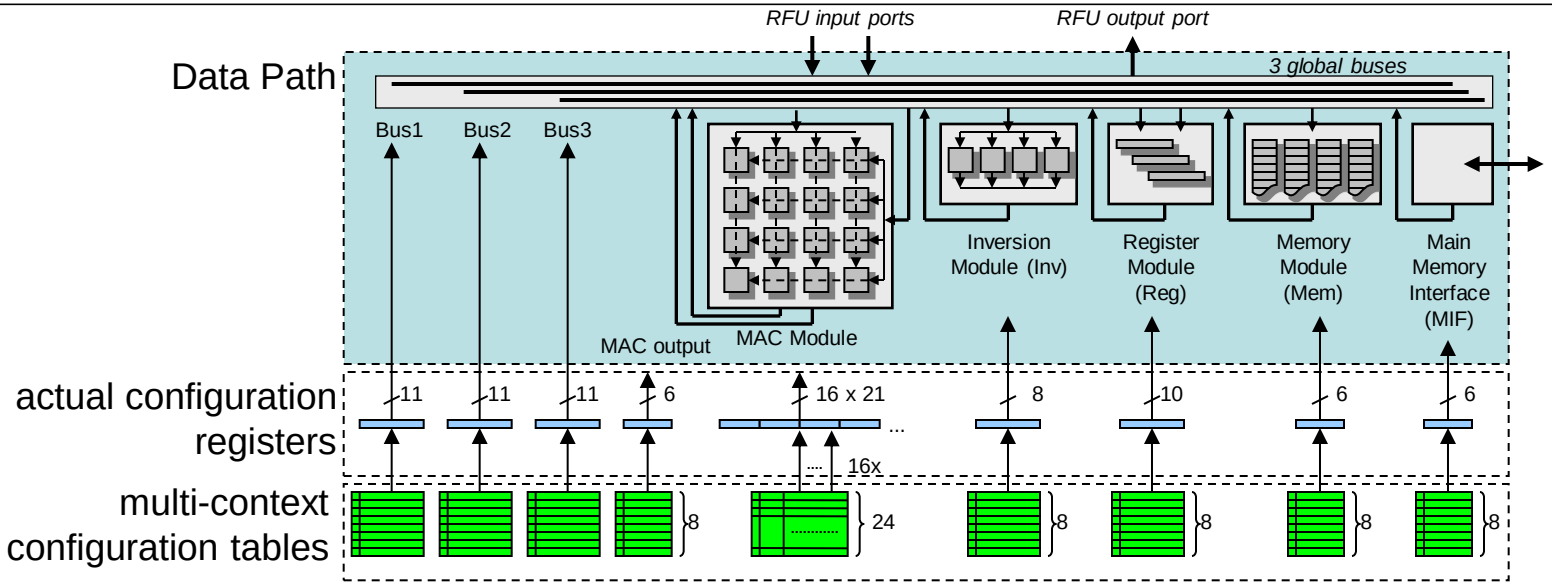

- Commercial programmable logic devices are fine-grain reconfigurable
  - This offers maximum flexibility at the cost of efficiency
  - The configuration vectors become very large
- Often, limited flexibility is sufficient
  - Coarse-grain or domain-specific reconfigurability
  - Trade-Off between flexibility and efficiency
  - Weakly-reconfigurable devices can even outperform dedicated logic

University of Melbourne´s Contribution: Sensor Scheduling and Multi-Hop Routing

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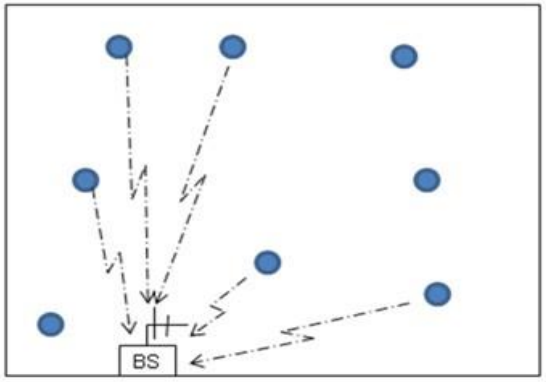
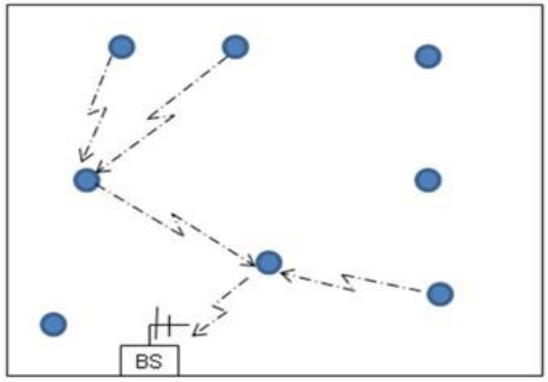
- Data transmission is much more energy-consuming than data processing (sending 1 byte consumes as much energy as performing **2,000** operations on it)
- Energy required for transmission is proportional to the square of the distance
- Clever data aggregation, routing and communication protocols are needed

- Scheduling measurements can also save energy
  - Not all sensors need to participate in every measurement
  - The measurement frequency can be varied according to the application´s current needs



(a) Single-hop communication without data reduction scheme



(b) Multi-hop communication with data reduction scheme

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