Sensor Network Architectures
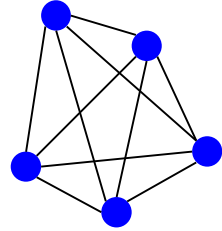
Sensor Networks

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Sensor Network Architectures

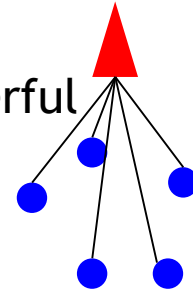- How to network sensors?
  - Single-hop network
    - Every node communicates with every other node
    - Network diameter limited by communication range
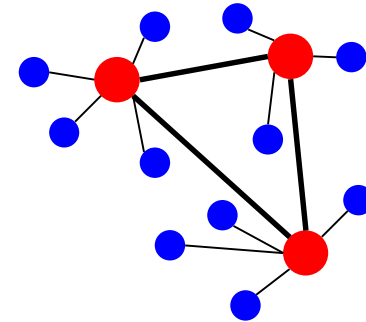 - Star network
    - Every node communicates with a more powerful hub node (cf. Smart Dust)
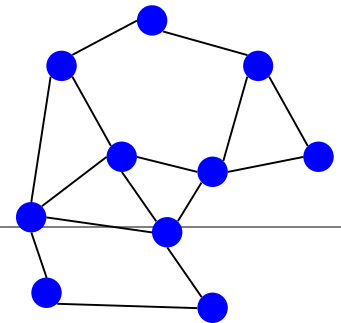   - Network diameter limited by twice the communication range
  - Clustering
    - Many interconnected star networks
    - Nodes communicate with cluster head
    - Heads communicate among each other
  - Multi-hop ad-hoc (mesh) network
    - Nodes communicate with their neighbors
   - Intermediate nodes relay messages to remote nodes

Node Roles

- Node play different roles in the network
  - Data source
    - Generate and send sensor data
  - Aggregator
    - Receive data from nodes, aggregate and forward
    - Data reduction
  - Router
    - Forward received data
  - Sink
    - Receive/process/store data
- One node may have multiple roles simultaneously
- Role assignment?
  - Static vs. dynamic
  - Often natural role assignment based on network architecture
    - Source => nodes, aggregators => cluster heads

Sinks

- Data collection points
- Network bottlenecks
  - Nodes close to sink forward data from many other nodes
  - Nodes close to sink exhaust battery first
- Approaches
  - Multiple sinks
 - Mobile sinks
  - Aggregation
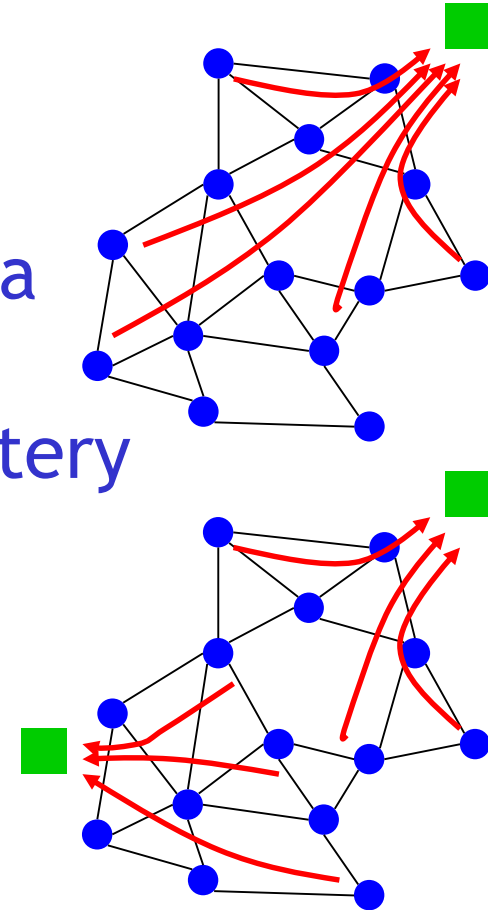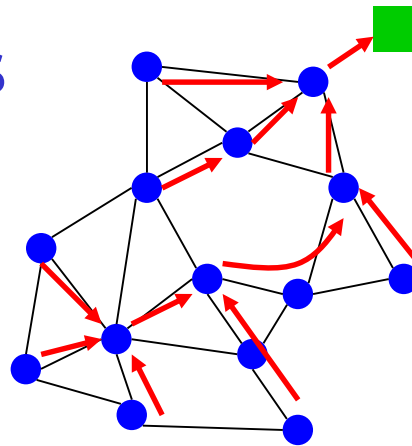
Sensor-Actuator-Networks

- Actuator nodes in addition to sensor nodes
  - Robot, lamp, blind, …
- Actuators controlled using sensor data
  - Control robot to follow an intruder monitored by a sensor network
- No sinks!
  - Autonomous network

Sensor Internet / IoT

- Sinks may form link to Internet
  - Mobile phone, laptop, embedded PC...
  - Global Sensor Network!

- Challenges
  - Internet integration
    - IP in sensor network or protocol translation?
    - IP address for each node or for whole sensor network?
  - Web integration
    - Nodes or network level?
    - Representation: web page, web service, REST?
    - Discovery and search
    - Physical mash ups

Internet

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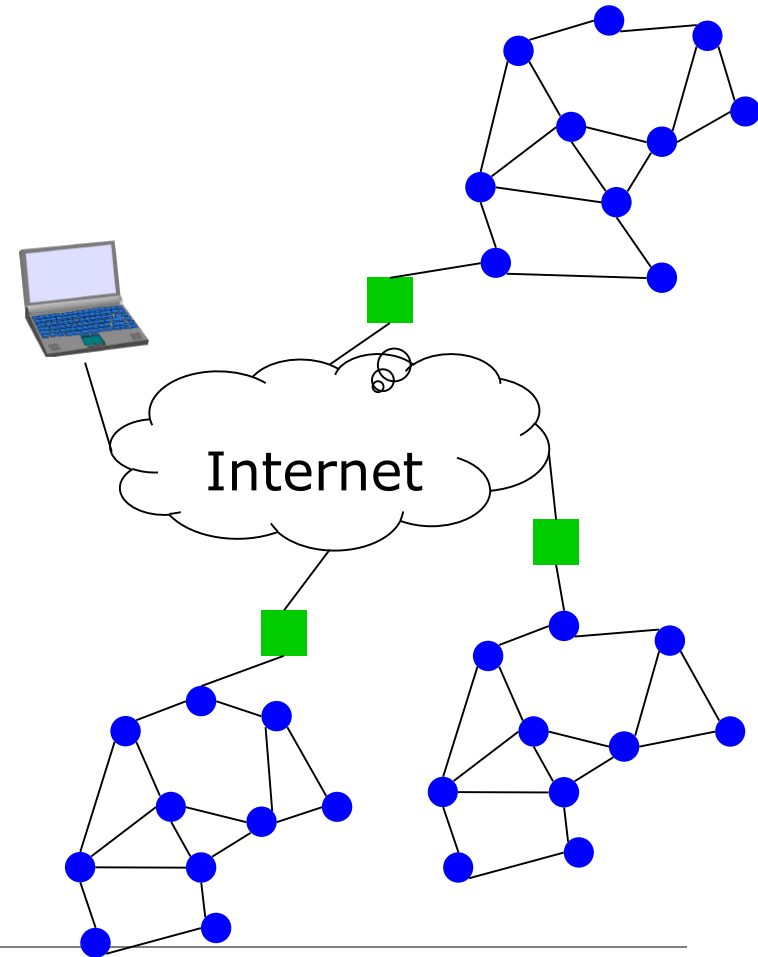
Network Properties

- Sensor networks differ from traditional (wireless) networks
  - Data-centric networking
  - Sensor data (vs. Emails ...)
  - Data processing in the network
  - Structure of protocol stacks

Data-Centric Networking

- Traditional: node-centric networks
  - Individually configured
  - Owned by users, user-specific data
- WSN are data-centric
  - Which node provides the data is often irrelevant
  - Nodes are identical and exchangeable
- Implications
  - Data-based addressing rather than node-based addressing
  - „Send to all nodes with low battery" instead of „Send to nodes with addresses X, Y, Z"

Sensor Data

- WSN deal with sensor data
  - Spatial and temporal correlations
  - Data is approximate
- Implications
  - Message loss often tolerable, just re-read sensor
  - Potential for data reduction
    - Neighbors send similar data
    - Data similar to data sent earlier

In-Network Data Processing

- Traditional networks: end-to-end delivery
  - Forward data unmodified from source to sink

- WSN: Data processed on the way through the network
  - Data reduction, aggregation

- Implication
  - Routing and data processing are merged

Cross-Layer Interactions

- Traditional networks: strong layering of protocol stacks
  - Cf. ISO OSI
- WSN: Interaction across layers
  - Important instrument to optimize energy and resource consumption
  - Example: routing / data processing
- Implications
  - Joint implementation of multiple layers
  - Exchange of information across non-neighbor layers

7 ▶	Application Layer
6 ▶	Presentation Layer
5 ▶	Session Layer
4 ▶	Transport Layer
3 ▶	Network Layer
2 ▶	Data Link Layer
1 ▶	Physical Layer