Application of Sensor Networks

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Scenarios

- Habitat Monitoring
- Environment Monitoring
- Health Care
- Military Applications
- Industrial Applications
- Home Automation and Smart Interactive Places
Scenarios

- Habitat Monitoring
  - Great Duck Island
  - ZebraNet
- Environment Monitoring
- Health Care
- Military Applications
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- Home Automation and Smart Interactive Places
Great Duck Island: Problem

- Monitoring micro-climat of nesting burrows of Storm Petrel
- Large number of burrows
- Long-term observation
- Current techniques intrusive

Great Duck Island: Node Placement

- Over 100 sensor nodes (Mica)
- Pre-configured
- Long term observation

(Quelle: www.wired.com/wired/archive/11.12/network.html)
Great Duck Island: Communication Issues

- Multi-hop network
- Base station

Diagram:
- Base station
- Internet
ZebraNet: Problem

- Migration patterns of zebras unknown
- Zebras move in wide area
- Long-term observation

(Quelle: http://www.princeton.edu/~mrm/zebranet.html)
ZebraNet: Hardware

- Limited Weight
- Recharging battery
  - Designed for recharge after 5 days
- Two radios
  - long-range (base station)
  - short range (neighbors)
- Integrated into collar
- Sensors:
  - heart rate
  - body temperature
  - frequency of feeding
  - GPS

(Quelle: http://www.princeton.edu/~csadler/)
ZebraNet: Network Model

- Store and Forward model
  - Mobile base station
  - Priorization of data
ZebraNet: Schedule

- Complex Schedule:
  - 30 GPS position samples / 24 hours
  - Activity log for 3 minutes / 1 hour
  - 6 hours searching for neighbor nodes and communication / 24 hours
  - 3 hours searching for base station / 24 hours
  - 640 kilobytes of data / 5 days

overlapping
Scenarios

- Habitat Monitoring
- Environment Monitoring
  - Redwood Ecophysiology
  - Meteorology and Hydology in Yosemite National Park
- Health Care
- Military Applications
- Industrial Applications
- Home Automation and Smart Interactive Places
Redwood Ecophysiology: Problem

Today:

- Leaf physiology of trees good understood
- Extension to the entire tree canopy is open problem

Data acquisition:

- Satellite observations: wide coverage, low resolution, canopy surface
- Single weather stations: single point in space
- Instrument elevator: haul data logger along vertical transect

Dense monitoring throughout canopy of sampling of trees throughout forest
Node Placement

(Quelle: http://www.cs.berkeley.edu/~culler/talks/mobihoc.ppt)
Experiment Setup

- Interior and Exterior Trees
- 40-50 nodes per tree
  - At different elevations
  - Multiple nodes per level, center and periphery
- 25 day duration
- Simple schedule: Sampling every 5 minutes
- Ground level weather station and fog sensors
- Data Loggers
- Sap Flow sensors
  - Internal indicator of level of photosynthetic activity
Meteorology and Hydology in Yosemite National Park

Monitoring of water system in Sierra Nevada

Properties:
- Inaccessible terrain
- Communication problems due to high relief of park
- No solar panels for wildlife protection

System design:
- Different communication technologies
  - radio
  - cell-phone
  - land-line
  - satellite
- Data loggers
Scenarios

- Habitat Monitoring
- Environment Monitoring
- Health Care
  - Code Blue
- Military Applications
- Industrial Applications
- Home Automation and Smart Interactive Places
Code Blue: Goals

- Enhance emergency medical care
- Management in disaster area
- Seamless patient transfer
CodeBlue: Sensor nodes

- Heart rate
- Oxygen saturation
- Endtidal CO₂
- Serum chemistries measurements

(Quelle: http://www.eecs.harvard.edu/~mdw/proj/codeblue/)
CodeBlue: Architecture

Vital sign sensors

Location beacons

CodeBlue information plane

<table>
<thead>
<tr>
<th>Naming and discovery</th>
<th>Authentication and encryption</th>
<th>Event delivery</th>
<th>Filtering and aggregation</th>
<th>Handoff</th>
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</thead>
</table>

Police and fire

Emergency medical technicians

Ambulance systems

(Quelle: IEEE Pervasive Computing, Oktober-Dezember 2004)
Scenarios

- Habitat Monitoring
- Environment Monitoring
- Health Care
- Military Applications
  - Counter Sniper System
- Industrial Applications
- Home Automation and Smart Interactive Places
Counter Sniper System PinPtr

- Sniper = danger to military operation
- Location preferable
- Only short time for location
- Sniper optical difficult to spot
Acoustic/Shockwave detection

(Quelle: http://www.isis.vanderbilt.edu/projects/nest/documentation/Vanderbilt_NEST_Sensys.ppt)
PinPtr: User Interface

(Quelle:http://www.isis.vanderbilt.edu/projects/nest/applications.html)
Scenarios

- Habitat Monitoring
- Environment Monitoring
- Health Care
- Military Applications
- Industrial Applications
  - Condition based Monitoring
- Home Automation and Smart Interactive Places
Industrial Application: Condition Based Monitoring

- Maintenance regarding condition of a machine
  - Continuous monitoring of machine
- Autonomous data collection
- Autonomous analysis
Scenarios

- Habitat Monitoring
- Environment Monitoring
- Health Care
- Military Applications
- Industrial Applications
- Home Automation and Smart Interactive Places
  - Smart Kindergarten
Smart Kindergarten

Goal:
- Learn about behaviour patterns of children in group settings
- Design interactive classroom

Sensors:
- Tags
  - record voice
- Intelligent objects
  - Table
  - Textbook

Network:
- Report to central database

(Quelle: http://nesl.ee.ucla.edu/projects/smartkg/photos.htm)
Summary

- Sensor networks are used to monitor complex phenomenon
- Sensor networks are used to monitor large areas. Inaccessible areas can be monitored.