

# Wireless Sensor Networks

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# Wireless Sensor Network (WSN)

- Detects

- Temperature
- Sound
- Vibrations
- Pressure
- Motion
- Pollutants

- Uses

- Industrial process & monitoring
- Machine monitoring
- Monitoring the environment
- Healthcare
- Home automation
- Traffic control

# Nodes

- What it consists of
  - Can have more than one sensor
  - Usually has a radio transceiver
    - For wireless communication
  - Small microcontroller
  - Energy source
    - Ex: battery
- Prices
  - Varies
    - Size
    - Complexity
  - A more complex sensor could be a few hundred
  - A less intricate one could be fairly cheap

# How they work

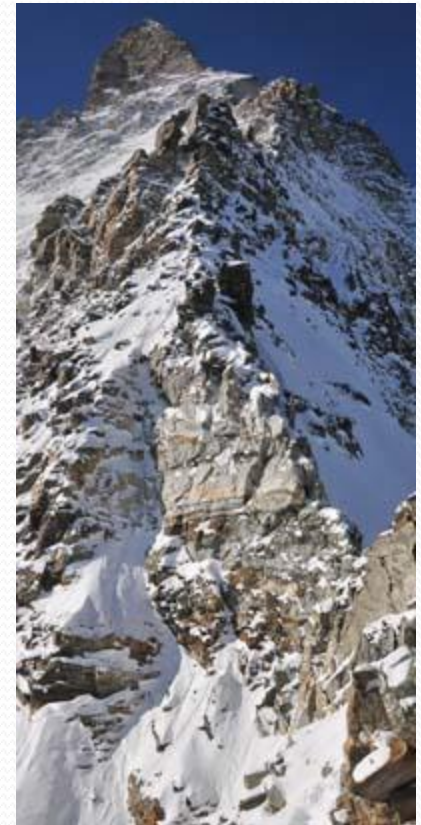
- Sensors support a multi-hop routing algorithm
  - nodes function as forwarders
  - Relay data packets to a base station
    - (known as a wireless ad-hoc network)
- Think of a sensor like a computer

# Applications

- Area Monitoring
  - WSN would be put in an area where something is being monitored
    - Ex: a country at war with another may place nodes over a battlefield to detect enemy intrusion, sensors would detect heat, pressure, sound, light, electro-magnetic fields, vibrations, etc... If a sensor went off it would report it to a base station (message might be sent through internet or satellite)
    - Ex: detecting vehicles

# Applications

- Environmental Monitoring
  - Similar to area monitoring
  - Ex (pictured): state of permafrost in the Swiss Alps
  - Ex: coastal erosion
  - Ex: glacier monitoring



# Applications

- Greenhouse Monitoring
  - Involves monitoring temperature and humidity levels in a greenhouse
    - If temperature and/or humidity drops a sensor could notify the manager of the greenhouse (through email/text) or trigger a misting system, open vents, turn fans on, or control other system responses



# Applications

- Machine Health Monitoring
  - Using WSNs saves money
    - Wires can be up to \$1000 per foot
  - WSNs utilizes more functions
    - More accessible areas
  - Sensors monitor machinery which involves less human errors
- Landfill/Ground Well monitoring
  - Can monitor something such as a leachate level
    - Wireless device would log data, perform calculations, or notify personnel
    - Saves room for human error




# Characteristics

- ability to withstand bad environmental conditions
- can deal with node failures
- portable
- have dynamic network topology
- communicate failures,
- their node heterogeneity
- large scale of deployment
- unattended operation
- capacity of a node is scalable
  - only limited by the bandwidth of a gateway node.

# Sensors Now

- Sensor nodes are more of a prototype
- Current producing challenges
  - Small & low cost
  - Scarcest resource of nodes is energy
    - Which establishes how long the WSN will last
  - Meant to be sent out in a large scale
- Algorithms & protocols are needed to fix
  - lifetime maximization
  - Robustness
  - Fault tolerance
  - Self-configuration
  - Security & mobility (when the nodes/base stations are moving)

# Types of Operating Systems

- eCos
- uC/COS
- TinyOS- One of first operating systems designed for WSNs
  - Event driven programming
  - External event  event handler
- nesC- Language used for TinyOS and other WSN operating systems
  - Extension to C programming Language

# Operating Systems Cont.

- Some WSN operating systems use C
  - Contiki, MANTIS, BTnut, and Nano-RK
- Contiki designed to support loading modules over the network
  - Event driven
  - Includes protothreads
- MANTIS and Nano-RK kernels are based on preemptive multithreading (kernel not event driven)

# Newer Operating Systems

- LiteOS- Newly devolved OS for WSNs
  - Provides UNIX like abstraction
  - C programming language
- ERIKA Enterprise- open-source real-time kernel

# Algorithms

- Distributed algorithms
- Energy in WSNs limited
  - Idle listening- very costly with energy
- Energy aware algorithms
- Transmission distance from sensor to base station
  - Data transmission usually multi hop

# Simulators

- Specially designed network simulator platforms
  - TOSSIM
- Agent based modeling and simulation
  - Complex systems
- Allows designer to solve actual problem with an application design

# Data Gathered

- Numerical data
- Central base station
- Open Geospatial Consortium (OGC)
  - Standards for interoperability interfaces and metadata encodings
  - Control of Wireless Sensor Networks through a Web Browser
- Different techniques for retrieving data

Source:

[http://en.wikipedia.org/wiki/Wireless\\_sensor\\_network](http://en.wikipedia.org/wiki/Wireless_sensor_network)