

# Introduction and Applications

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## Resources

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## 1 Advantages of WSN

- Small size
- (Relatively) low cost of nodes
- Reduce (eliminate?) cost of wiring
- Self-configuring and self-optimizing
- Self-healing: redundancy and fault-tolerance
- Long lifetimes (?)
- Interfacing with the physical world.

## 2 Sensors & Actuators

## 3 Energy

- Energy: a measure of being able to do work.
- Unit: 1 J(Joule) = one watt per seconde

### 3.1 State of the Practice

The energy cost of communication is very expensive.

## 4 Core Principles

### 4.1 Laws and Principles to Follow

- Propagation laws for communications:
  - Think volume:
    - \* Surface area of a sphere of radius  $r = 4\pi r^2$
  - Think signal quality:
    - \* **Multipath** effects result from radio signals reaching a receiver by two or more paths (Rayleigh fading)
    - \* **Attenuation** results from dissipation of energy
    - \* Frequency shifts from **Doppler effect**
  - Think noise:
    - \* Ambient white noise
    - \* Interference from other electro-magnetic sources.
- Physical distribution
- Estimation theory for detection
- Control and hybrid systems theory for control.

### 4.2 Challenges

- Scale
  - Network control and routing
  - Collaborative signal and information processing
- Limited access
  - Security
  - Limited energy
- Extreme dynamics
  - Ad-Hoc network discovery
  - Tasking and querying

### 4.3 Why not adapt “end-to-end” Lookup tables in routers

- Internet routes data using IP addresses in packets and lookup tables in routers
  - humans get data by “naming data” to a search engine
  - Many levels of indirection between name and IP address
  - embedded, energy-constrained, unattended systems cannot tolerate communication overhead of indirection.

#### 4.4 Fine-Grained Time and Location

fine-grained localization and time synchronization needed to detect events in 3-D space and improve estimation across nodes.

#### 4.5 Coverage Measure

- Area coverage: fraction of area covered by sensors
- Detectability: probability that sensors detect moving objects
- Node coverage: fraction of sensors covered by other sensors.

#### 4.6 In-Netowrk Processing

- Communication expensive when limited power and bandwidth
- so perform data processing in network.

#### 4.7 Distributed Representation and Sotrage

- Data-centric protocols, in-netowrk processing
- Pattern-triggered data collection

#### 4.8 Sensor Database System

Sensor database supports distributed query processing over sensor network

#### 4.9 New WSN Paradigms

- Self-configuration systems that adapt to unpredictable environment
- Leverage data processing inside the network
  - exploit computation near data to reduce communication
  - collaborative signal processing
  - achieve desired global behavior with localized algorithms
- Long-lived, unattended, un-tethered, low duty-cycle systems