

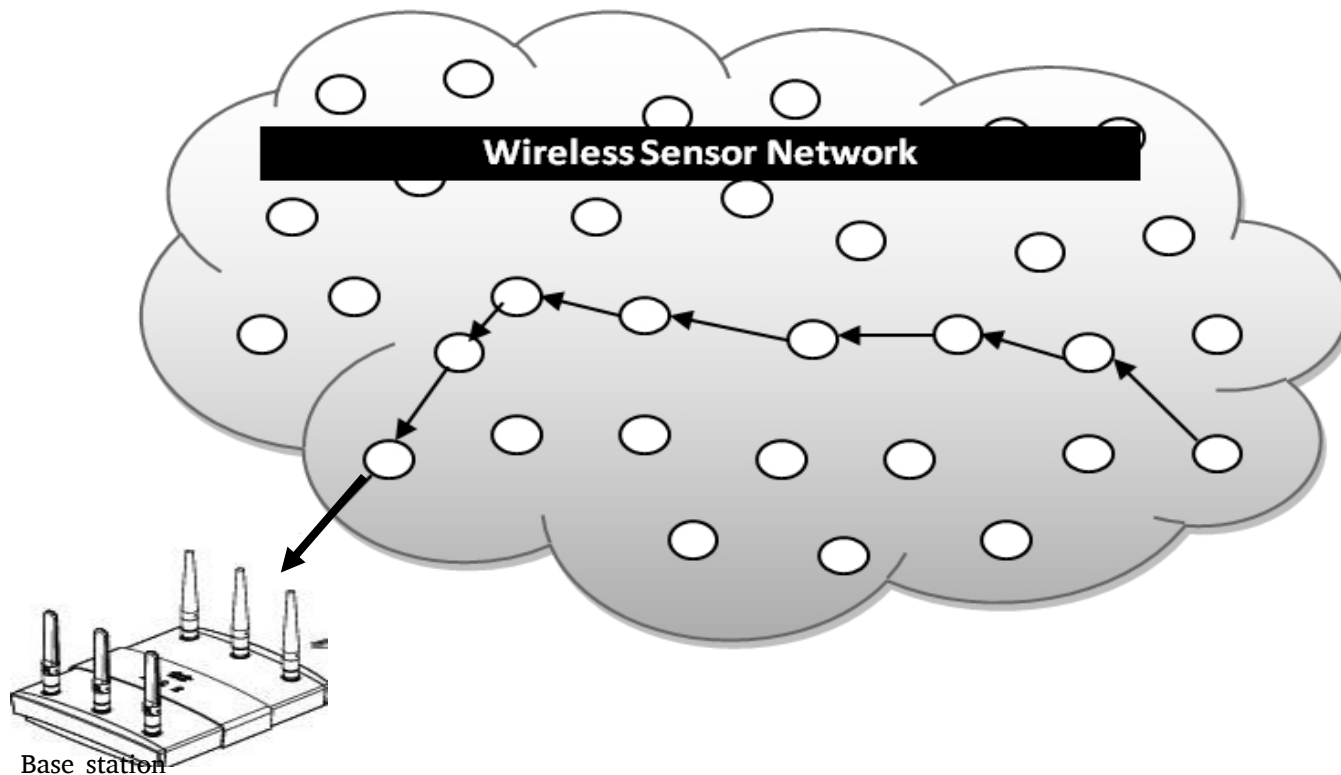


# Wireless Sensor Networks



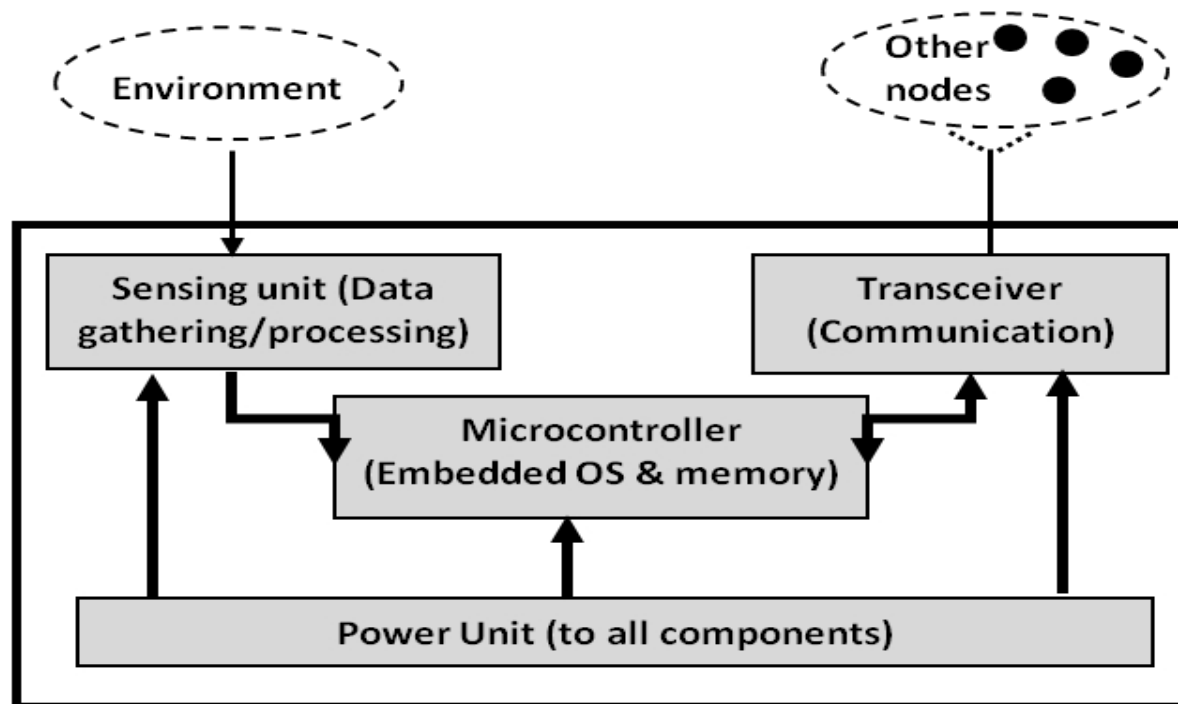
# Wireless Sensor Networks (WSNs)

- ★ A sensor network is a wireless network that consists of thousands of very small nodes called *sensors*.



# Wireless Sensor Networks (cont.)

- WSN **Sensors** are equipped with sensing, limited computation, and wireless communication capabilities.



# Introduction

- Wireless Sensor Networks are networks that consists of sensors which are distributed in an ad hoc manner.
- These sensors work with each other to sense some physical phenomenon and then the information gathered is processed to get relevant results.
- Wireless sensor networks consists of protocols and algorithms with self-organizing capabilities.

# Comparison with ad hoc networks

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- ❁ Wireless sensor networks mainly use **broadcast** communication while ad hoc networks use **point-to-point** communication.
- ❁ Unlike ad hoc networks wireless sensor networks are **limited by sensors** limited power, energy and computational capability.
- ❁ Sensor nodes may **not have global ID** because of the large amount of overhead and large number of sensors.

# WSNs Applications

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- § WSNs have many advantages over traditional networking techniques.
- § They have an ever-increasing number of applications, such as infrastructure protection and security, surveillance, health-care, environment monitoring, food safety, intelligent transportation, and smart energy.

# WSNs Applications

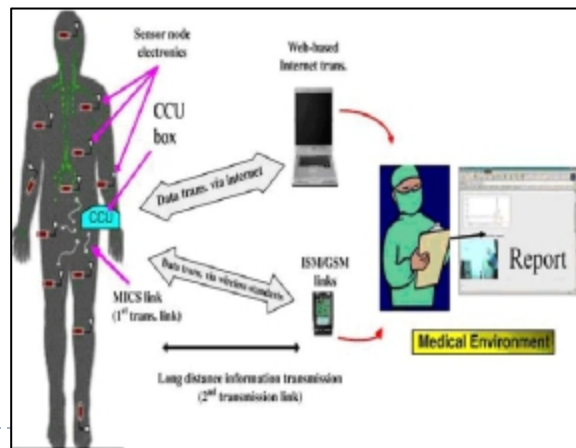
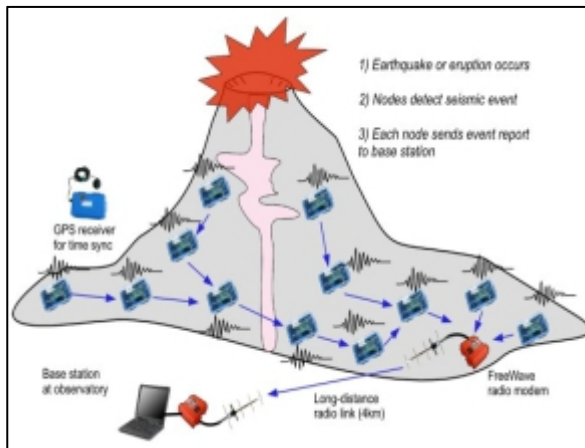
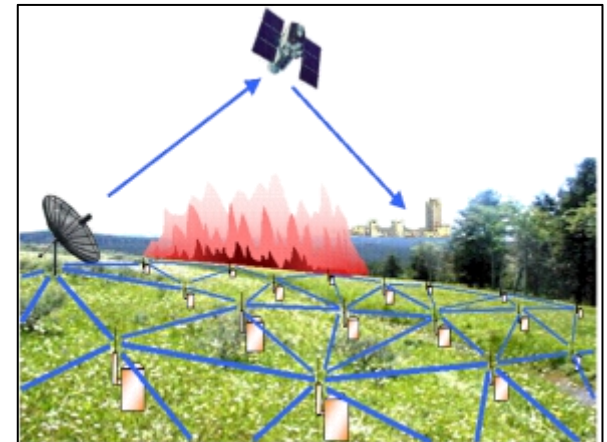
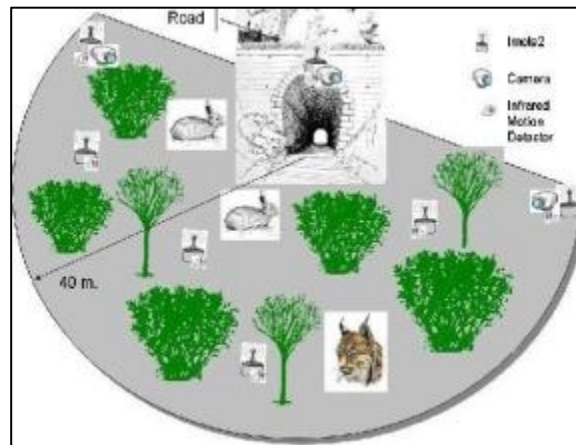
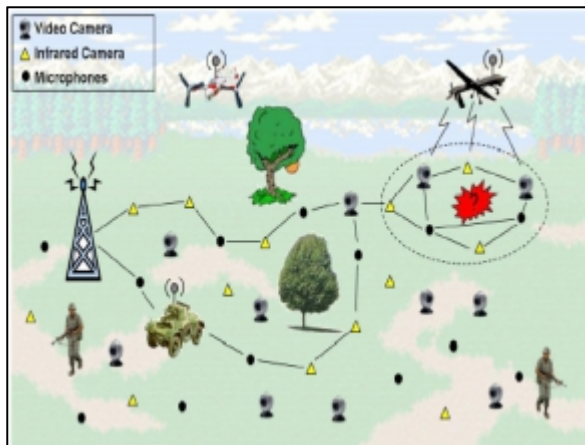


Figure 3: WSNs Applications

# Applications of Wireless Sensor networks

The applications can be divided in three categories:

1. Monitoring of objects.
2. Monitoring of an area.
3. Monitoring of both area and objects.

# Monitoring Area

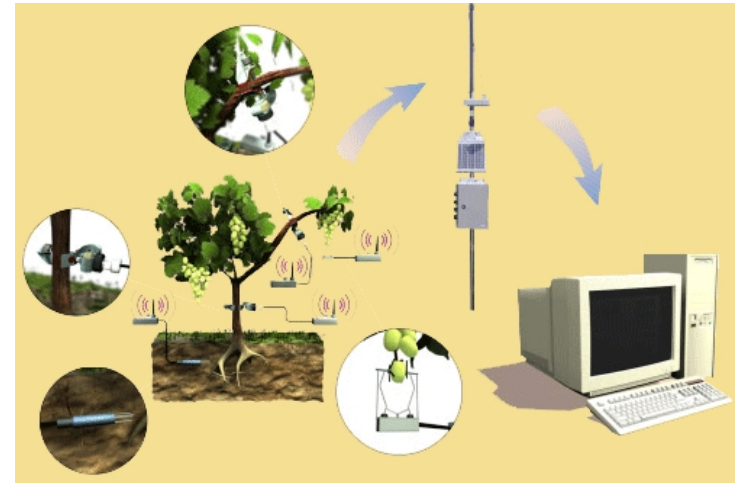
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- Environmental and Habitat Monitoring
- Precision Agriculture
- Indoor Climate Control
- Military Surveillance
- Treaty Verification
- Intelligent Alarms

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# Example: Precision Agriculture

- Precision agriculture aims at making cultural operations more efficient, while reducing environmental impact.
- The information collected from sensors is used to evaluate optimum sowing density, estimate fertilizers and other inputs needs, and to more accurately predict crop yields.



# Monitoring Objects

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- Structural Monitoring
- Eco-physiology
- Condition-based Maintenance
- Medical Diagnostics
- Urban terrain mapping

# Monitoring Interactions between Objects and Space

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- Wildlife Habitats
- Disaster Management
- Emergency Response
- Ubiquitous Computing
- Asset Tracking
- Health Care
- Manufacturing Process Flows

# Characteristics of Wireless Sensor Networks

- Wireless Sensor Networks mainly consists of **sensors**. **Sensors** are -
  - low power
  - limited memory
  - energy constrained due to their small size.
- Wireless networks can also be deployed in **extreme environmental** conditions and may be prone to enemy attacks.
- Although deployed in an ad hoc manner they need to be **self organized** and **self healing** and can face constant reconfiguration.

# Design Challenges

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## ✱ Heterogeneity

- ✱ The devices deployed maybe of various types and need to collaborate with each other.

## ✱ Distributed Processing

- ✱ The algorithms need to be centralized as the processing is carried out on different nodes.

## ✱ Low Bandwidth Communication

- ✱ The data should be transferred efficiently between sensors

# Continued..

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## ★ Large Scale Coordination

- ★ The sensors need to coordinate with each other to produce required results.

## ★ Utilization of Sensors

- ★ The sensors should be utilized in a ways that produce the maximum performance and use less energy.

## ★ Real Time Computation

- ★ The computation should be done quickly as new data is always being generated.

# Operational Challenges of Wireless Sensor Networks

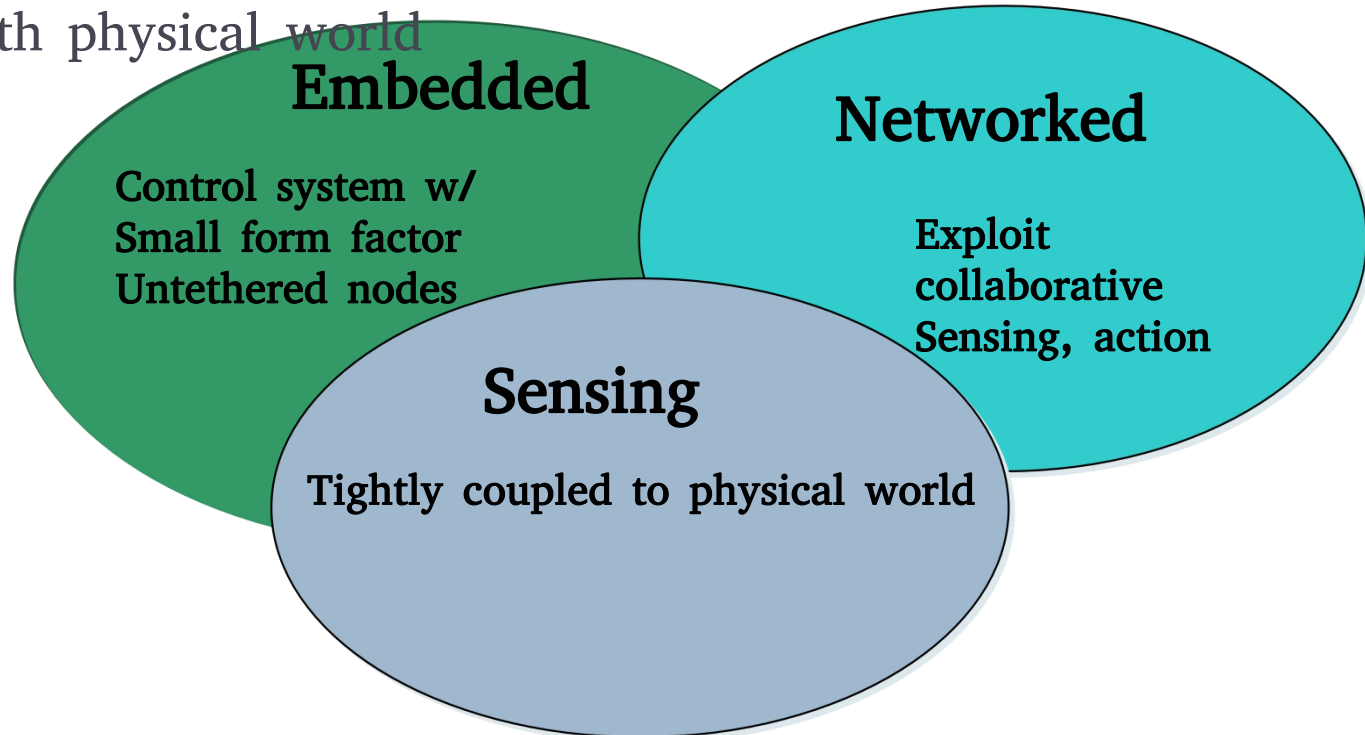
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- Energy Efficiency
- Limited storage and computation
- Low bandwidth and high error rates
- Errors are common
  - Wireless communication
  - Noisy measurements
  - Node failure are expected
- Scalability to a large number of sensor nodes
- Survivability in harsh environments
- Experiments are time- and space-intensive

# Enabling Technologies

Embed numerous distributed devices to monitor and interact with physical world

Network devices to coordinate and perform higher-level tasks



Exploit spatially and temporally dense, in situ, sensing and actuation



# Future of WSN

## Smart Home / Smart Office

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- Sensors controlling electrical devices in the house.
- Better lighting and heating in office buildings.
- The Pentagon building has used sensors extensively.

# Biomedical / Medical

## Health Monitors

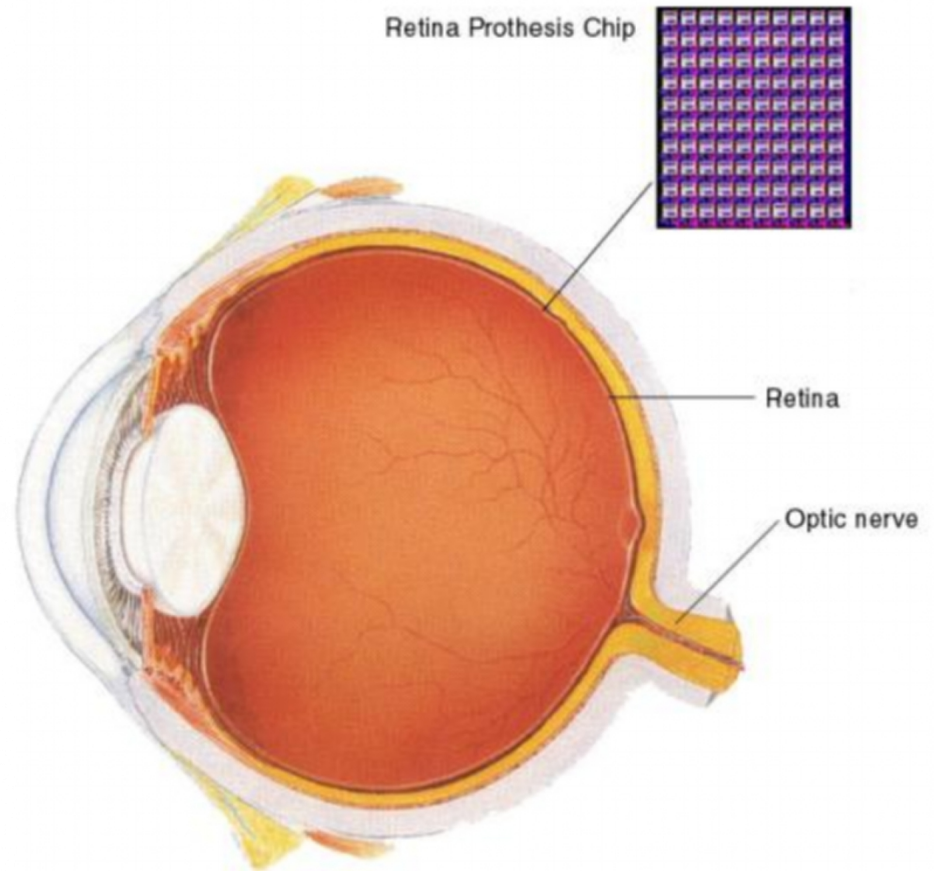
- Glucose
- Heart rate
- Cancer detection

## Chronic Diseases

- Artificial retina
- Cochlear implants

## Hospital Sensors

- Monitor vital signs
- Record anomalies

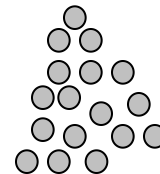
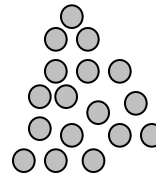
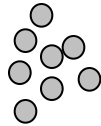


# Military

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Remote deployment of  
sensors for **tactical  
monitoring** of enemy troop  
movements.

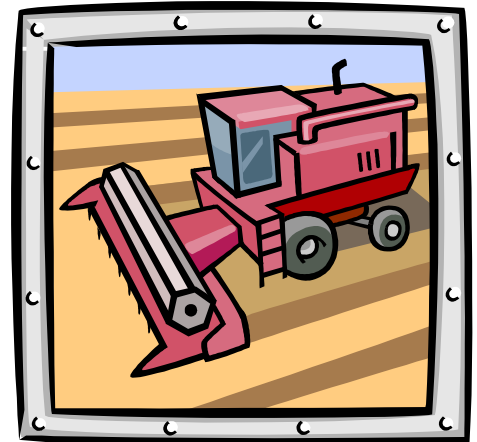


# Industrial & Commercial

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## ■ Numerous industrial and commercial applications:

- Agricultural Crop Conditions
- Inventory Tracking
- In-Process Parts Tracking
- Automated Problem Reporting
- Theft Deterrent and Customer Tracing
- Plant Equipment Maintenance Monitoring



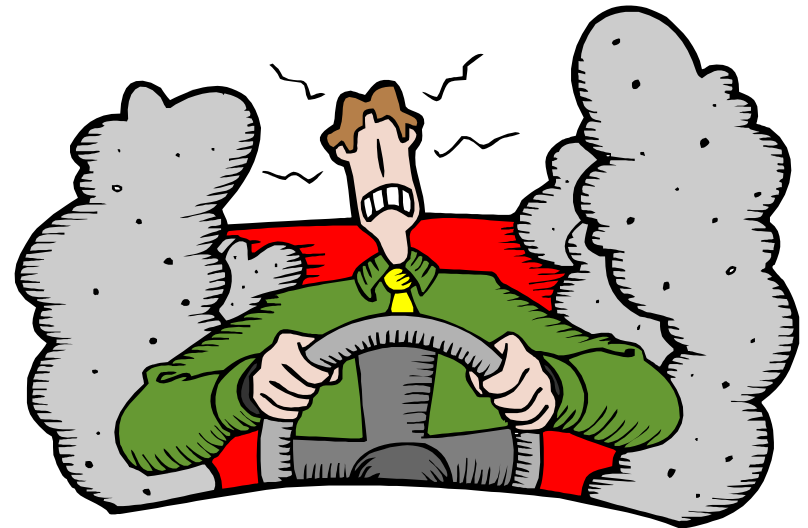
# Traffic Management & Monitoring

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- ¢ Future cars could use wireless sensors to:
  - 1 Handle Accidents
  - 1 Handle Thefts

- ü Sensors embedded in the roads to:
  - Monitor traffic flows
  - Provide real-time route updates



# One More Example of Sensor Board - MTS400/420

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- ✦ Besides the functions of MTS 300, it mainly adds GPS functionality

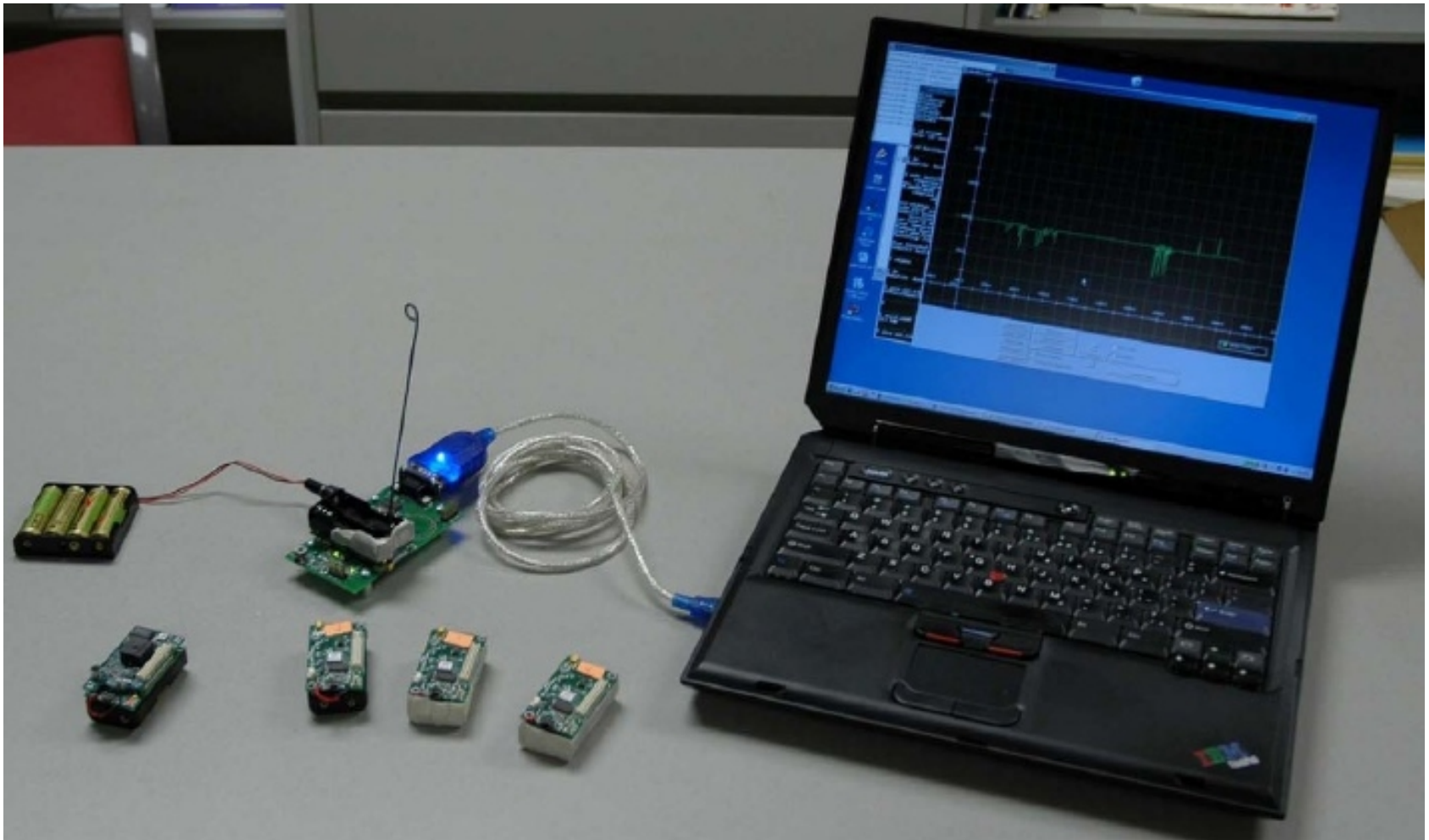


## ☉ Further Reading

- 1 [http://firebug.sourceforge.net/gps\\_tests.htm](http://firebug.sourceforge.net/gps_tests.htm)

# Hardware Setup Overview

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# Sensor Network Algorithms

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- Directed Diffusion – Data centric routing
- Sensor Network Query Processing
- Distributed Data Aggregation
- Localization in sensor networks
- Multi-object tracking/Pursuer Evader
- Security

