Sensor Networks and their applications

Presented to:
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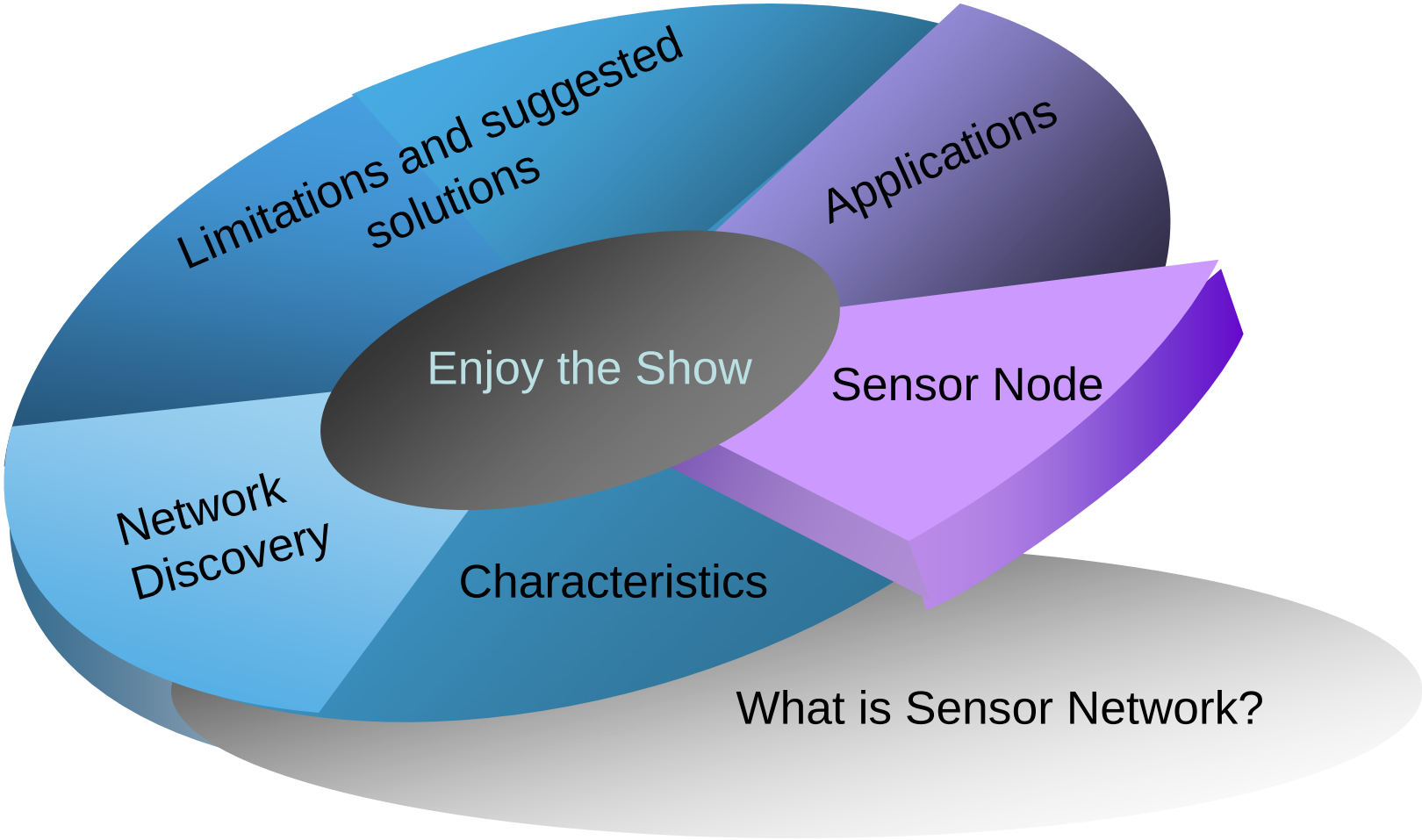
ELG5121: Multimedia Communications

Presentation Outline



What's a Sensor Networks

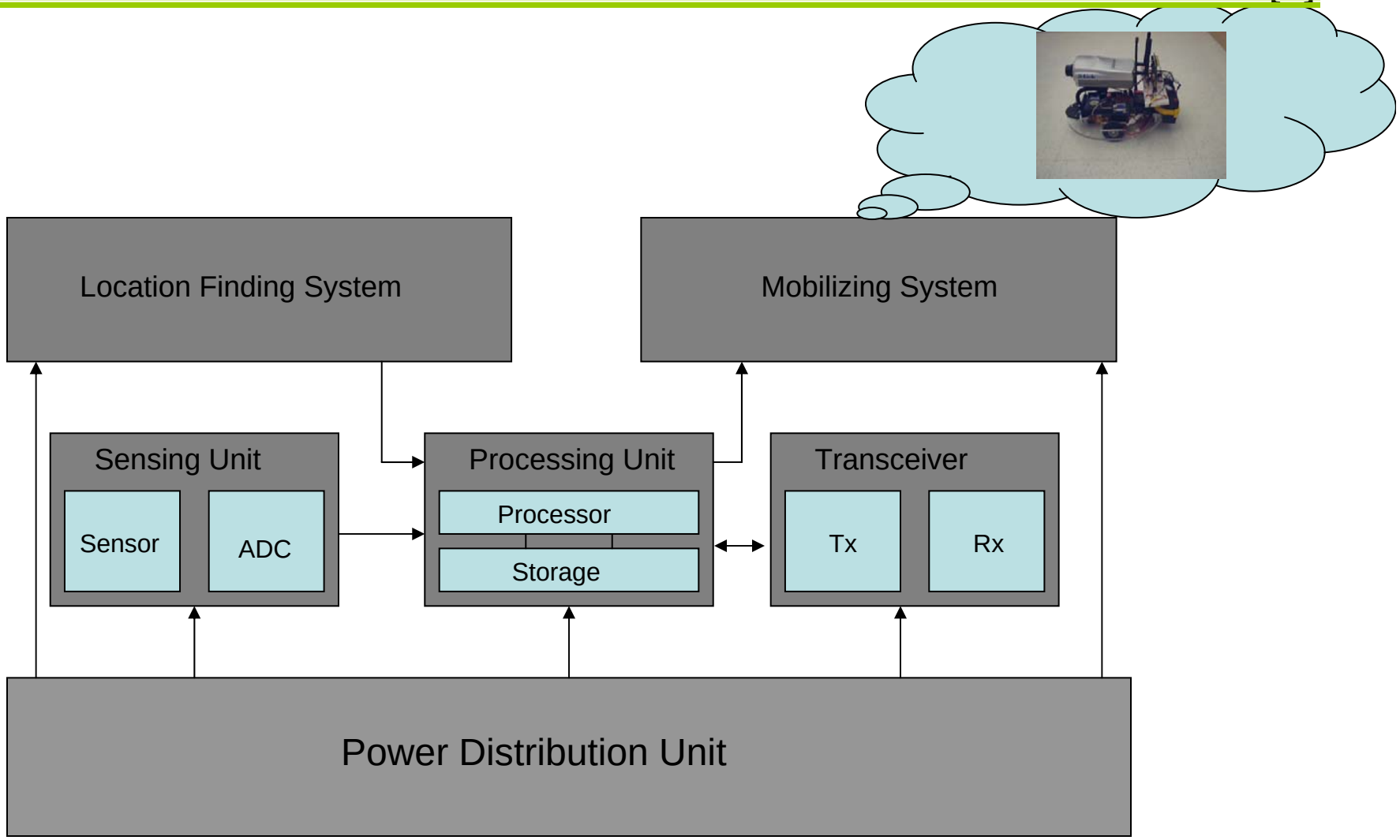
A simple equation:

Sensing + CPU + Radio

=

Thousands of potential applications

Generic Sensor Node Architecture [2]



Sensor nodes requirements

- Low cost
  - Large number used (much less than 1$)
- Small size
- Energy-efficient
- Operate in high volumetric densities
- Operate unattended
  - At the bottom of an ocean, in a biologically or chemically contaminated field, in a battlefield beyond the enemy lines,…

Platforms

WeC (1999)

250 Kbps, 100m range
512 KB flash
128 KB code
2KB data SRAM
CC2420 radio (2.4 Ghz, 802.15.4)

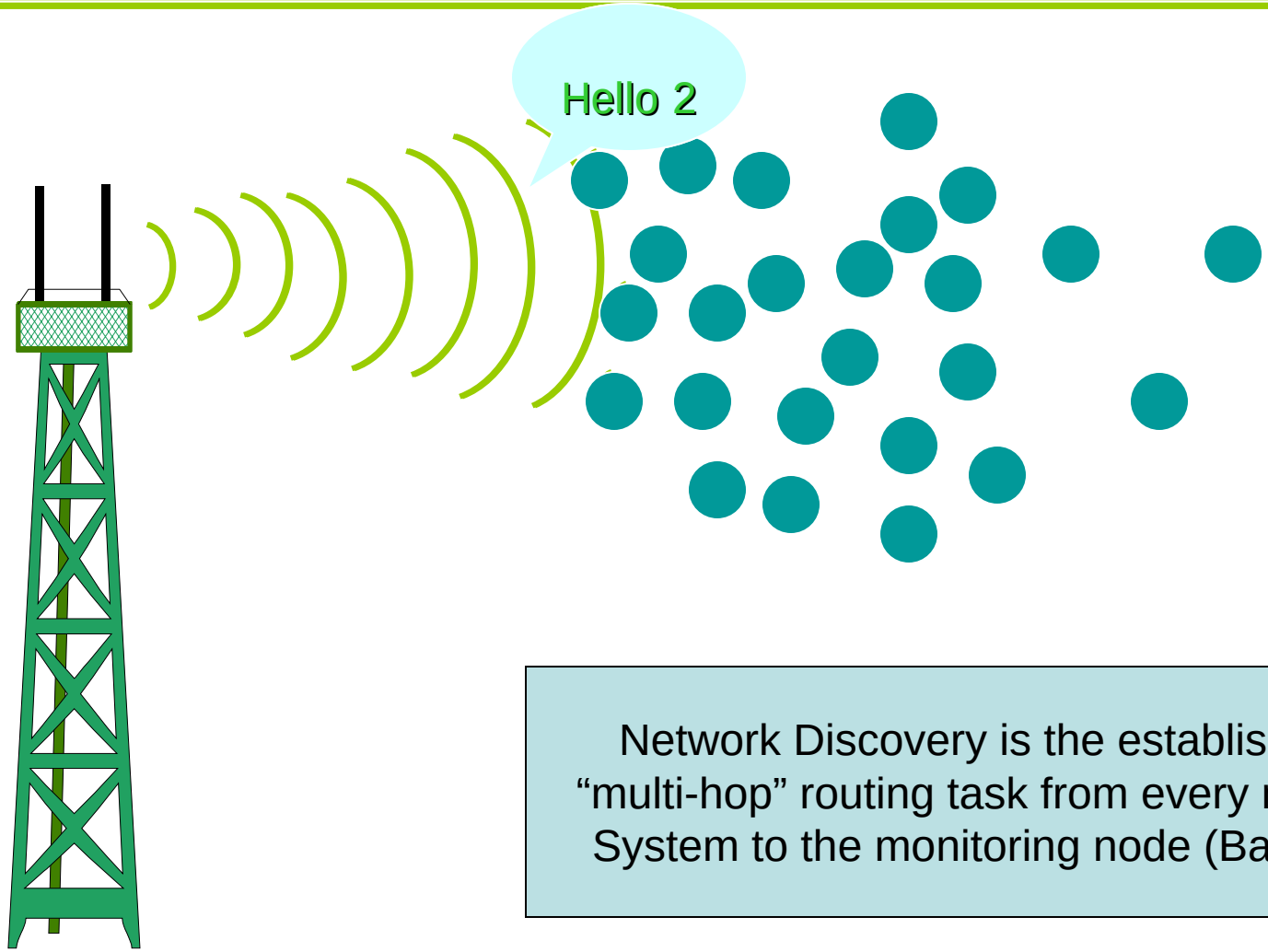
Telos (2004)

DOT (2001)

MICA (2002)

Network Discovery

Network Discovery

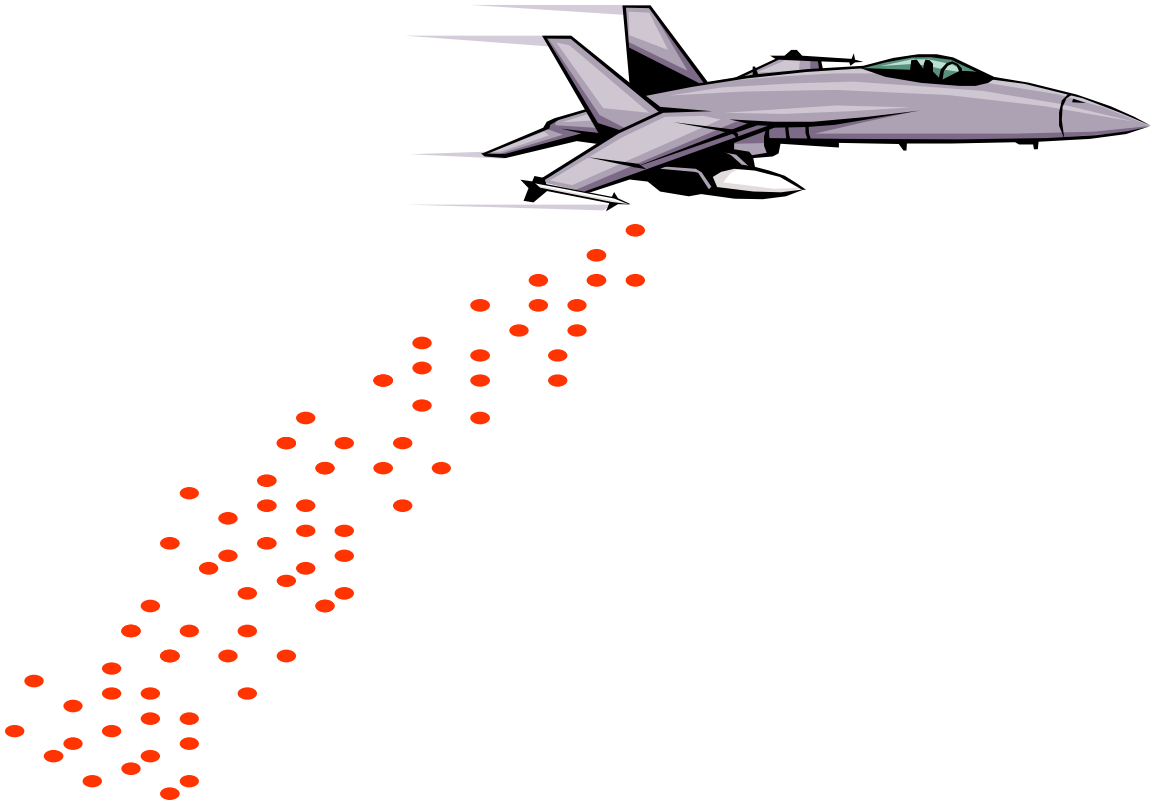


Network Discovery is the establishing of a “multi-hop” routing task from every node in the System to the monitoring node (Base station)

Characteristics

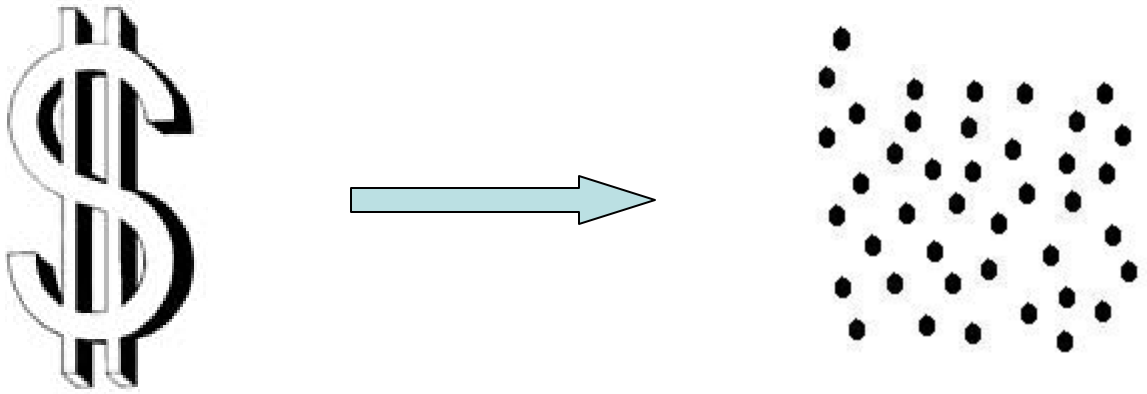
Characteristics

- Sensors are easily deployed.



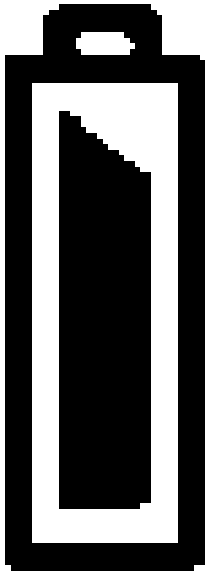
Characteristics

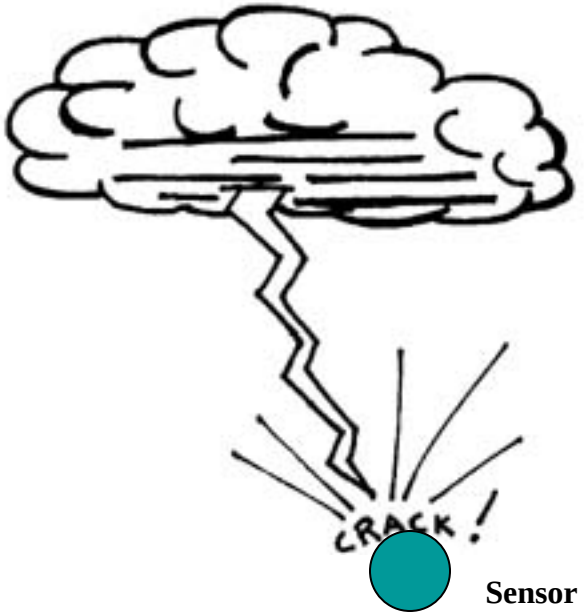
- Sensor are becoming less expensive, and more redundant.



Characteristics

- Sensors are prone to failure.





Characteristics

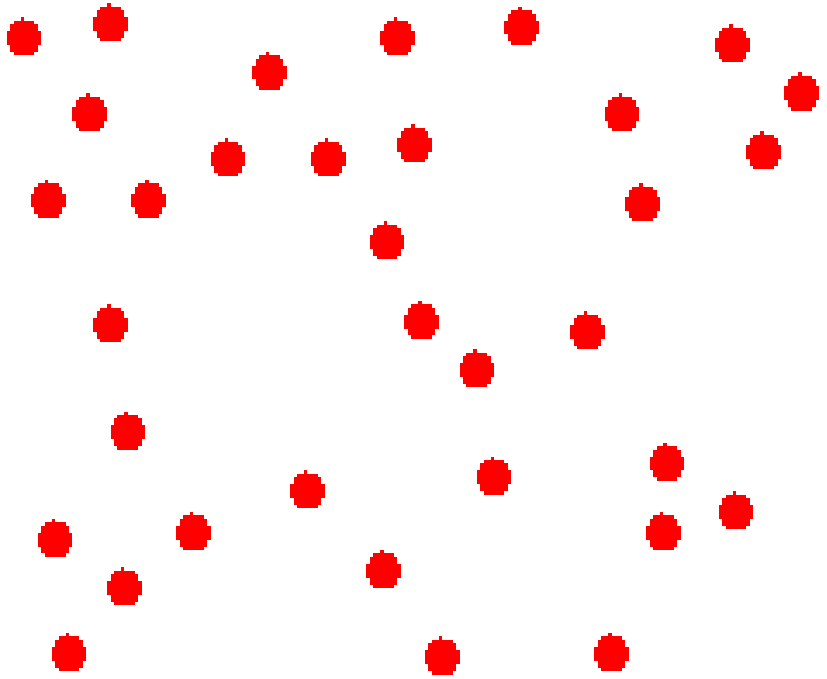
- Sensors are usually inaccessible.

In a jungle

In a war zone

Characteristics

- Sensors are usually dynamic.

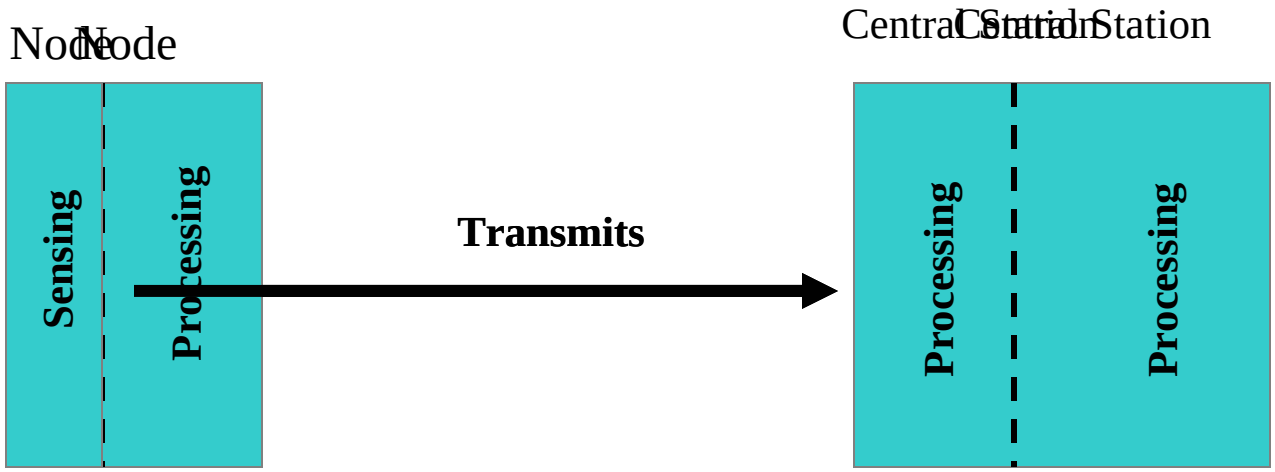


Limitations and Suggested Solutions for Sensor Networks

- Limited computational power
- Network Control and Routing
- Low Lifetime
- Coverage Issue

Limited computational power

- **Localized Processing:** *Computations done at the sensor.*
- **Centralized Processing:** *Computations done at the central station.*



Limited computational power

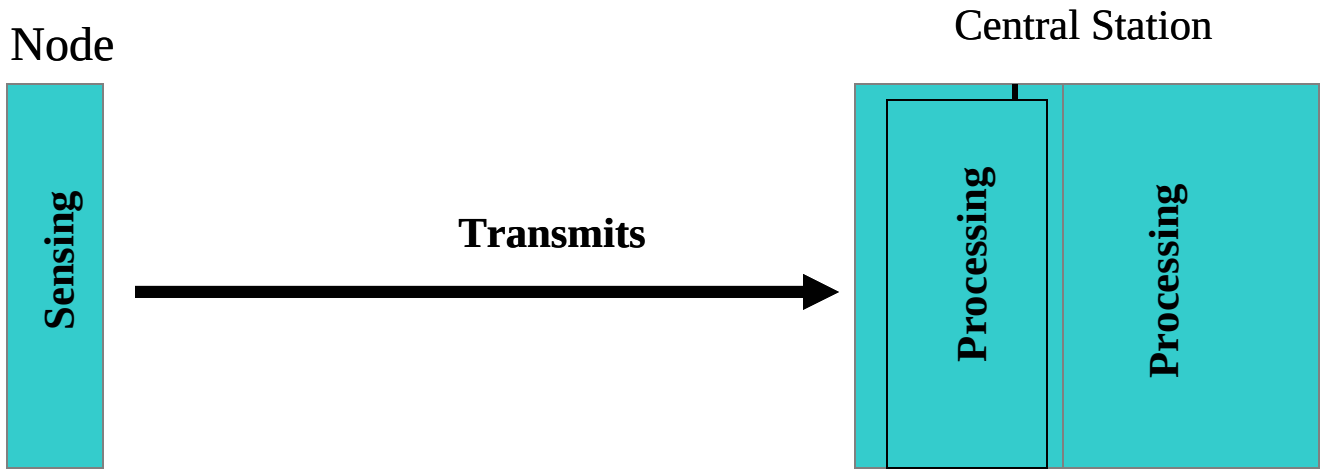
Localized	Centralized
Need for nodes to collaborate.	High bandwidth utilization.
Need for more computational power.	Not Scalable.
Higher costs per sensor.	More power consumption

Any Solutions ???

Why don't we make the computations ***mobile*** !!

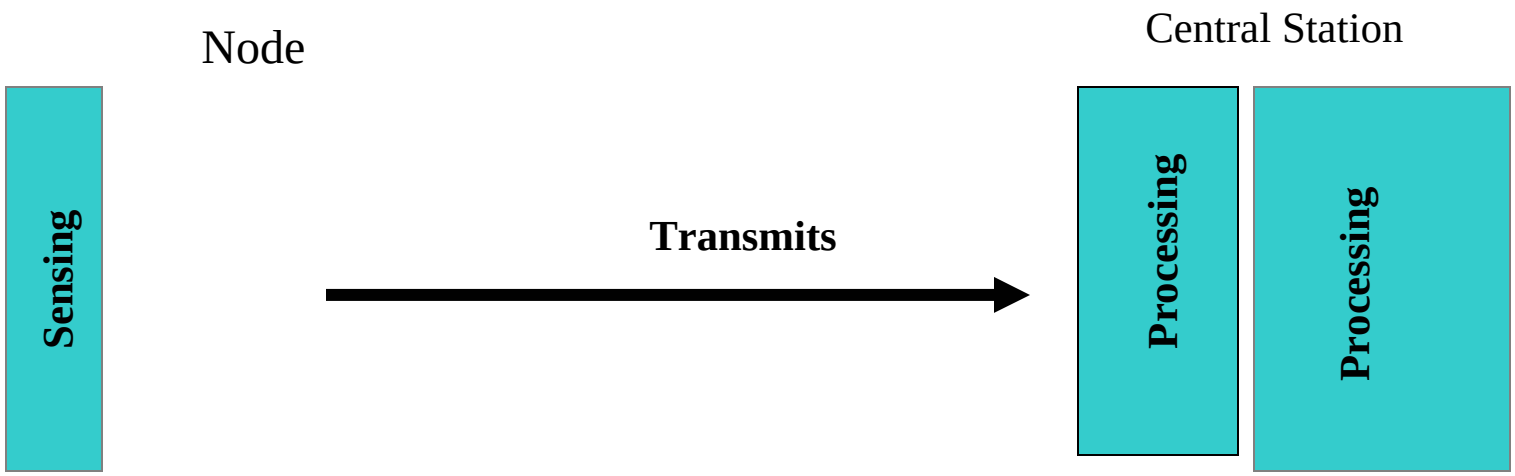
Limited computational power

- Mobile Agents: An autonomous software program (code) able to migrate across a network.



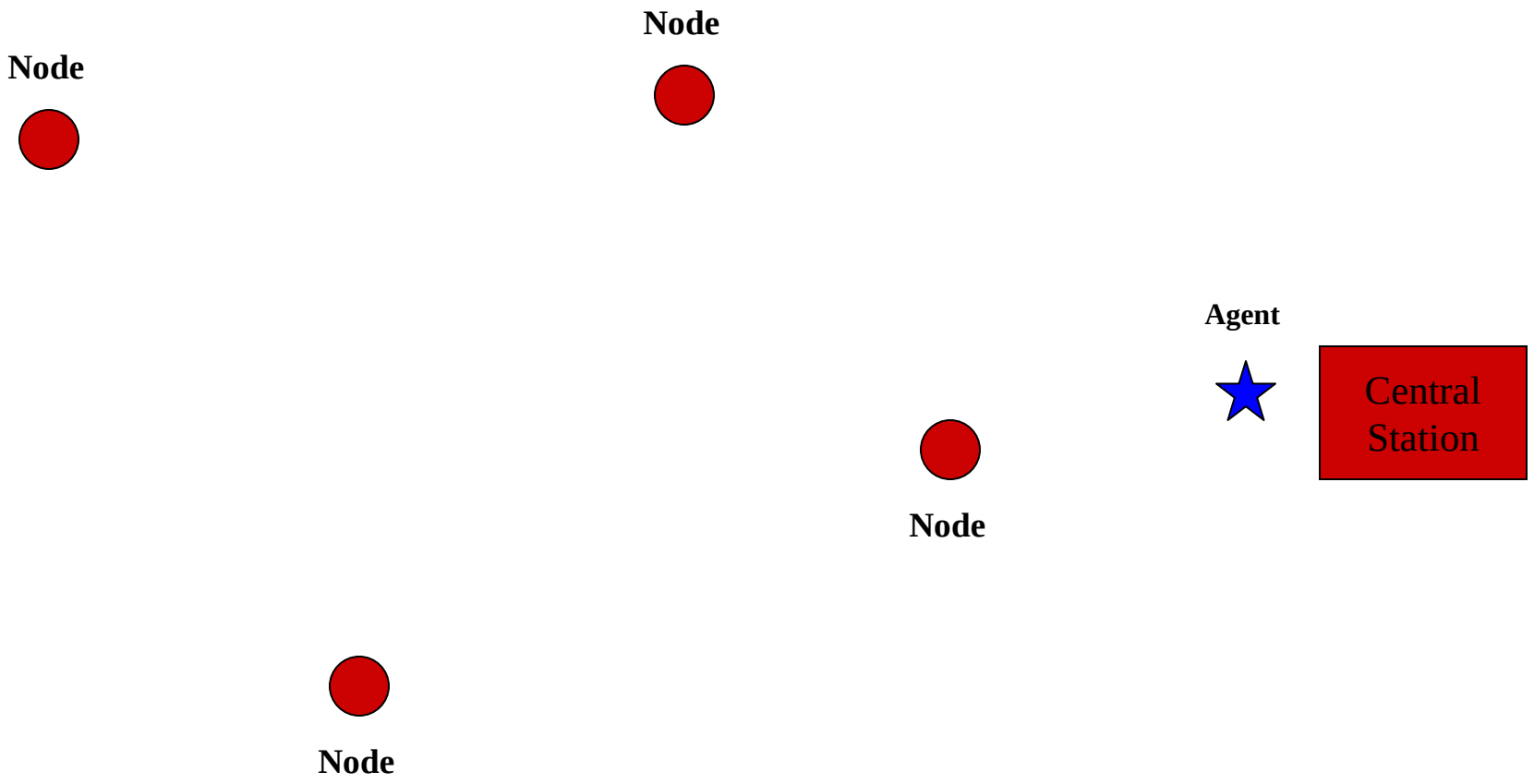
Limited computational power

- Mobile Agents: An autonomous software program (code) able to migrate across a network.



Limited computational power

- Use of mobile agents increases the network's scalability, decreases the nodes' use of resources, and decreases the use of bandwidth.



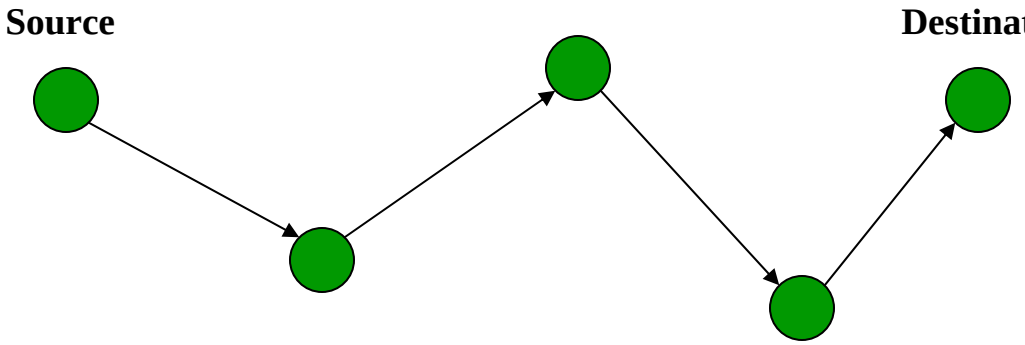
Dynamic Networks and Routing

- Routing is an important issue when dealing with mobile networks:
  - Routing tables at the nodes are constantly changing due to the dynamic nature of the network.
  - To communicate, node either need to have their routing tables constantly updated, or establish a link on demand.

Proactive Routing	**Reactive Routing**
Heavy utilization of Bandwidth (constant updates- not suitable for very dynamic networks)	*Long Delay before start of transmission (on demand communication- not suitable for real time applications)*

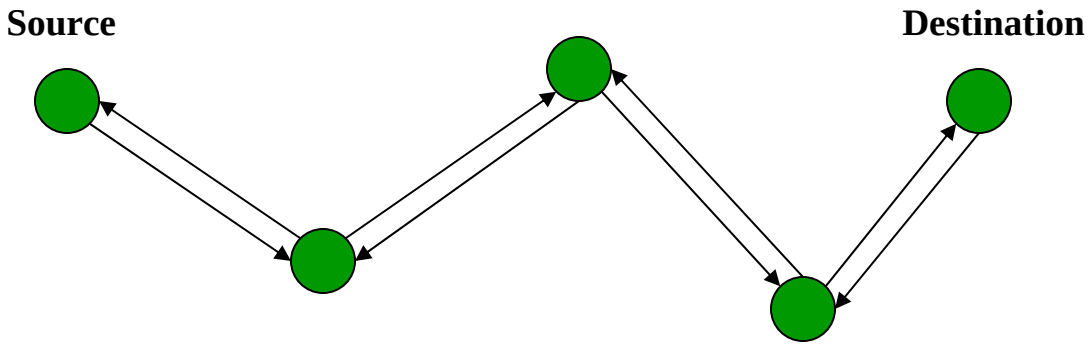
Dynamic Networks and Routing

Reactive



Delay

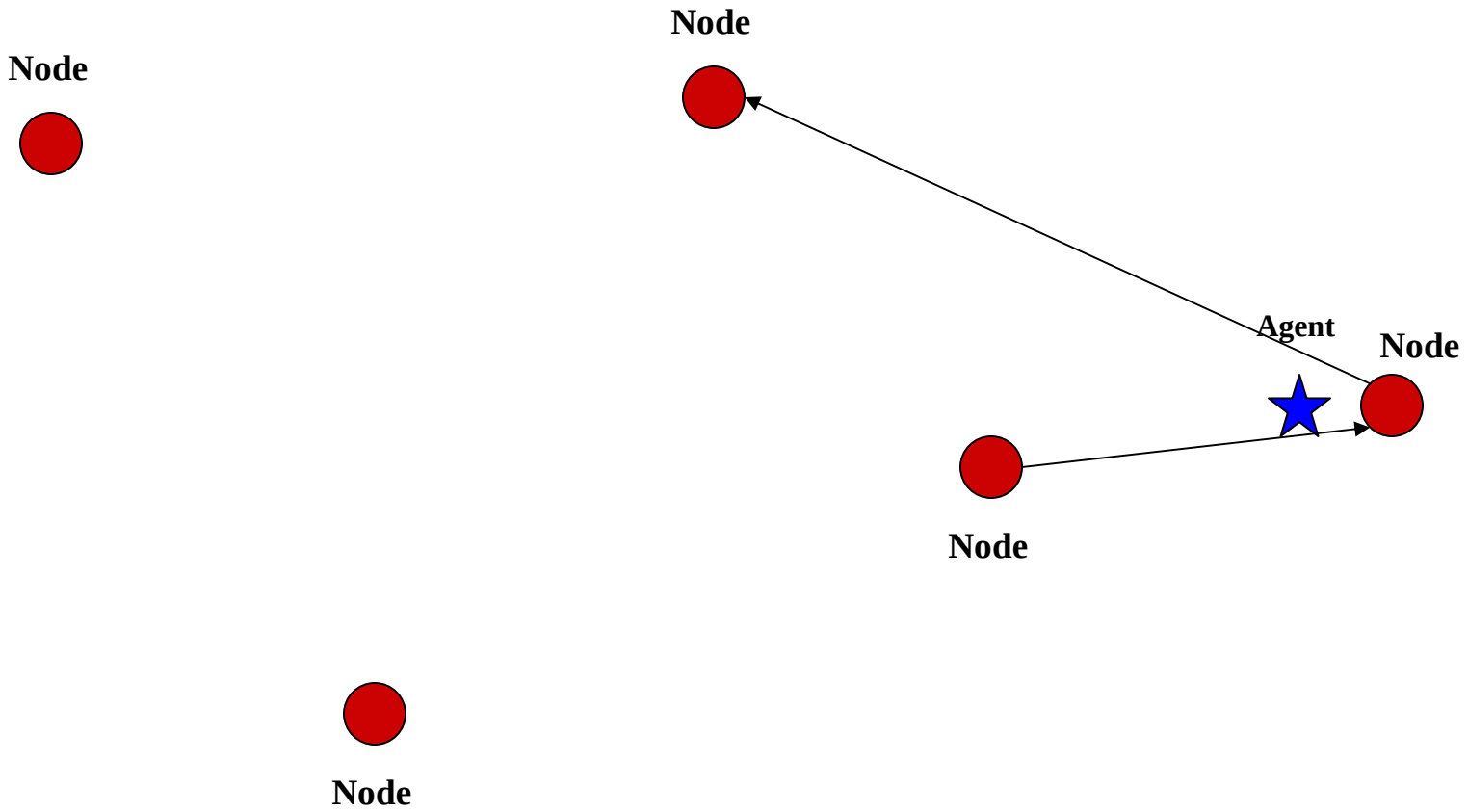
Proactive



Bandwidth

Dynamic Networks and Routing

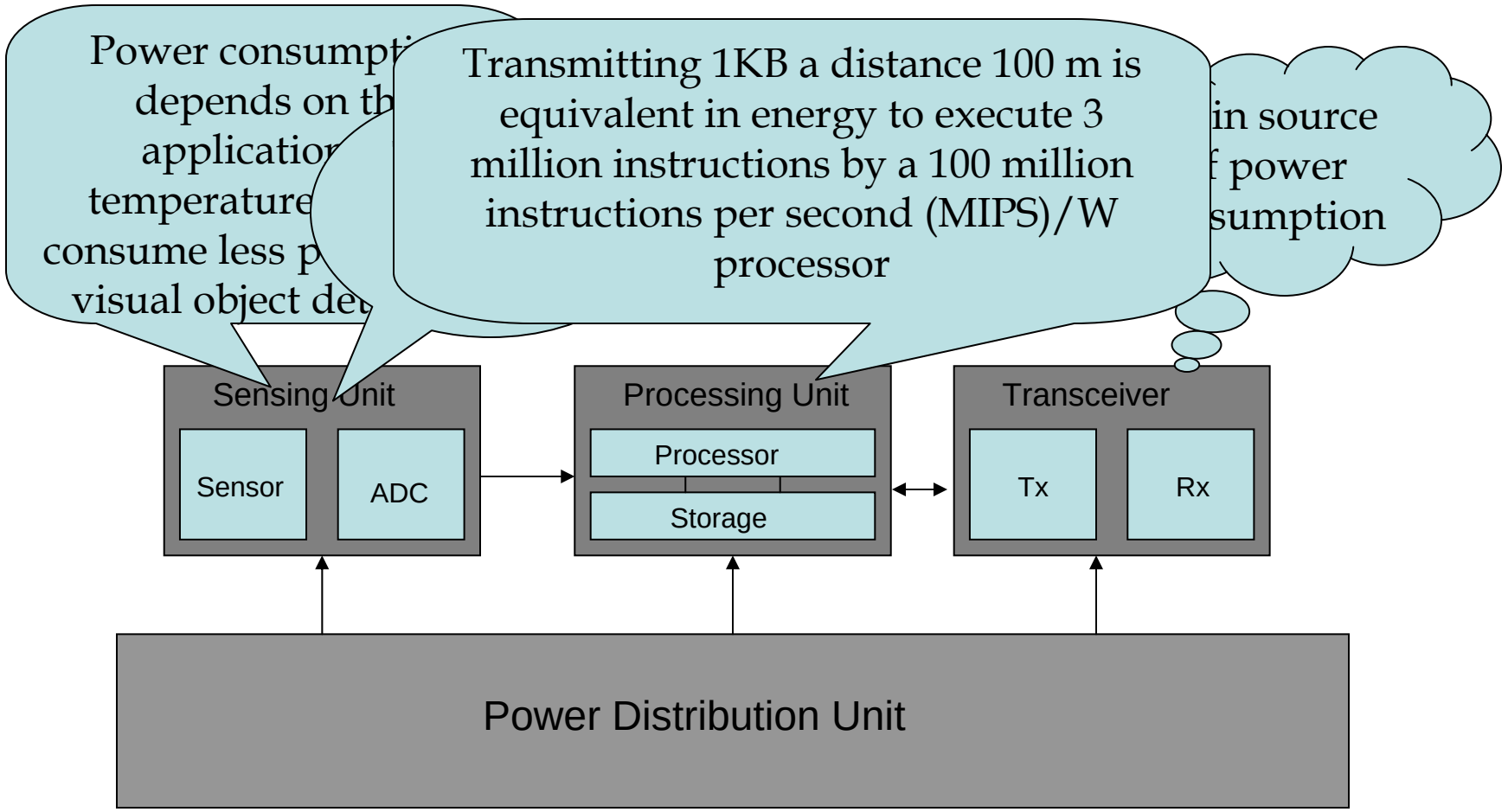
- Solution: A hybrid model that makes use of on demand communication with mobile agents for continuously updating the routing tables



Power Consumption

- Power consumption:
  - Long battery life is essential in WSN where line power is not available and recharging battery is not possible due to the unreachable locations of the node.
- Solution:
  - Most obvious, turn the transceiver off when it's not required (operation in a power saving mode is energy-efficient only if the time spent in that mode is greater than a certain threshold).
  - Deploying nodes in a high density (20 nodes/m3).
  - Usage of Energy-scavengers (ex: solar cells).

Déjà Vu: Power Consumption in Sensor Node



Coverage

Coverage: it represents the quality of service (surveillance) that it can provide. It can be used to determine how densely sensors should be deployed to guarantee that a fraction of the region is covered.[4]

Several model have been proposed to guarantee coverage ex:

The one defined in the MANNA Architecture that identifies backup node on a dense network and use it whenever a sparse area appear.

Coverage implies connectivity if radio range ≥ 2*sensing range.

Applications

- Medical Sensor Network
- Traffic Sensor Network
- Environment Sensor Network
- Military Sensor Network

Health Applications

- Telemonitoring of human physiological data

- Elderly Assistance.
- Drug administration in hospitals
- Tracking and monitoring doctors and patients inside a hospital
  - Each patient has a variety of small sensor nodes each with a different task. Ex: a sensor node to measure blood pressure.
- Artificial Retina.

Challenges

- Must be extremely robust
- Must scale to very large network
- Power constraints
  - In case the sensor is implanted in the body, there is a risk of infections due to the power added from the sensors.
- Security and Interference

Biomedical sensor network significantly reduce overall medical cost

Artificial Retina

CCD Camera

Camera Image Processing Unit

DSP Phase

Data Transmission

RF channel

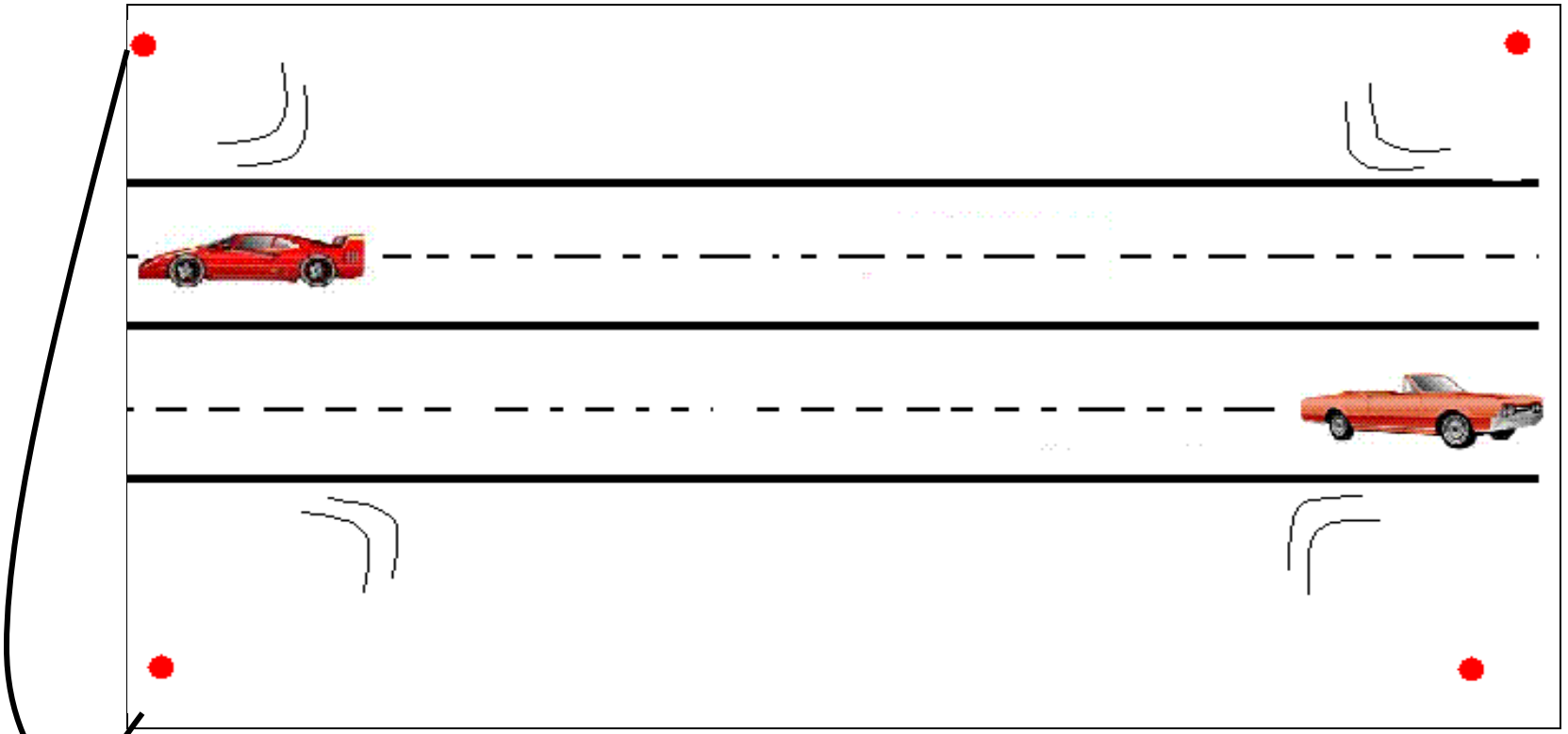
Neural Interface

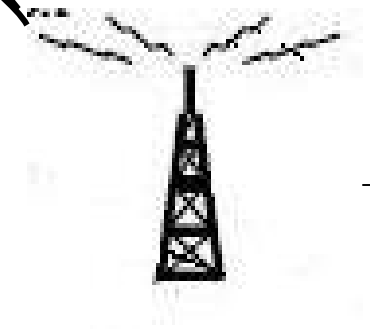
Retina Chip

Wireless transceiver

Smart Sensor

Traffic Sensor Network



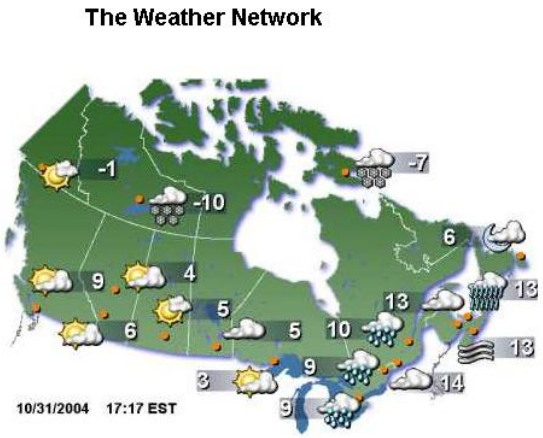


Traffic Sensor Network

- Special Characteristics:
  - Sensors' positions are usually predetermined
  - Sensor may have a permanent power supply
  - Sensors are relatively accessible
  - Sensors may be wired

Environment Sensor Network

Weather



Animals

Applications

Water Pollution

Air Pollution

Environment Sensor Network

- Special Characteristics:
  - Sensors positions may vary due to external influences.
  - Sensors are very prone to failure
  - Sensors are usually inaccessible
  - Environment Sensor networks scale up easily.
  - Sensors must be able to withstand natural elements, and must be environmentally friendly.

Military Sensor Network

- Military surveillance: Target detection, Area monitoring, etc…

Military Sensor Network

- Special Characteristics:
  - Sensors are usually placed on dynamic nodes
  - Network might be peer to peer or centralized.
  - Network must provide real time data
  - Data must be accurate, so QoS is very high.

Acknowledgments

- **Thanks to Dr. Elsaddik.**

- **Thank you "ladies and gentlemen" for your attention.**

QUESTIONS??

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