CS698T
Wireless Networks: Principles and Practice

Topic 08
Embedded Wireless Sensors: An Introduction

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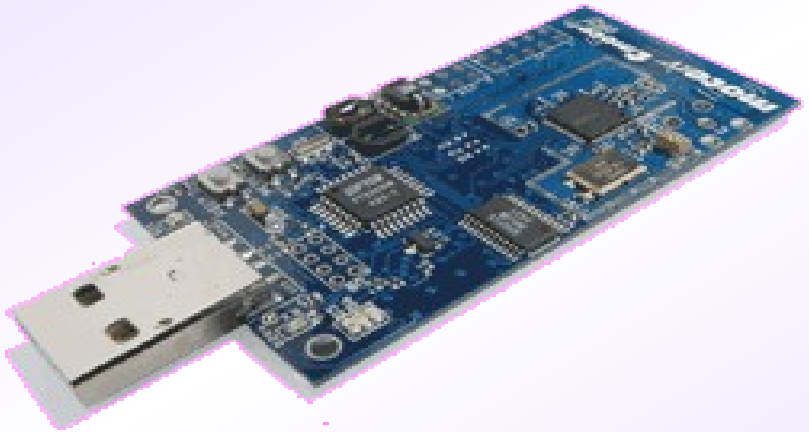
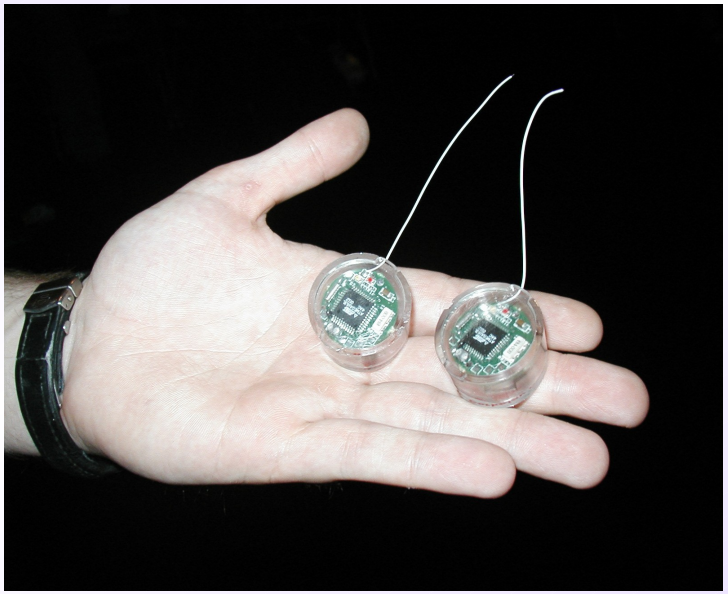
http://www.cse.iitk.ac.in/users/braman/courses/wless-spring2007/

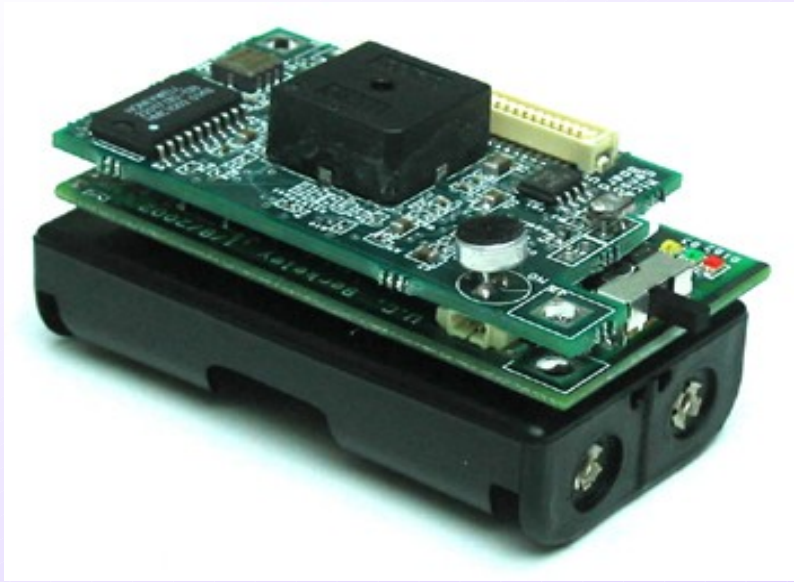
Wireless Sensor Networks

- What are sensors?
- Why "wirel ess" sensor "n etworks"?
- What do we need to make a wireless sensor network node?
  - Sensor
  - Processing
  - Radio
  - Memory
  - SENSOR MOTE

Sensor Motes







Wireless Sensor Networks

- Trends in semi-conductor technology
  - Moore's Law
  - More silicon per unit area
  - More processing per unit area
  - Miniaturization becomes possible
- Miniaturization of: computing, radios, sensors
- Reference: "Ov erview of Sensor Networks", D. Culler, D. Estrin, M. Srivastava, IEEE Computer Aug 2004

Sensor Network Applications

- Monitoring space
- Monitoring things
- Monitoring interaction of things in an encompassing space

Applications: Monitoring Spaces

- Environmental and habitat monitoring, precision agriculture, indoor climate control

Biological: Habitat

Chemical: Rivers

Physical: Agriculture

Monitoring Things

- Structural monitoring, condition based equipment maintenance, patient health monitoring/diagnostics

Bridge Health

Medical Diagnostics

Equipment Maintenance

Monitoring Interaction of things in an encompassing space

- Wildlife tracking, disaster management, manufacturing process flow

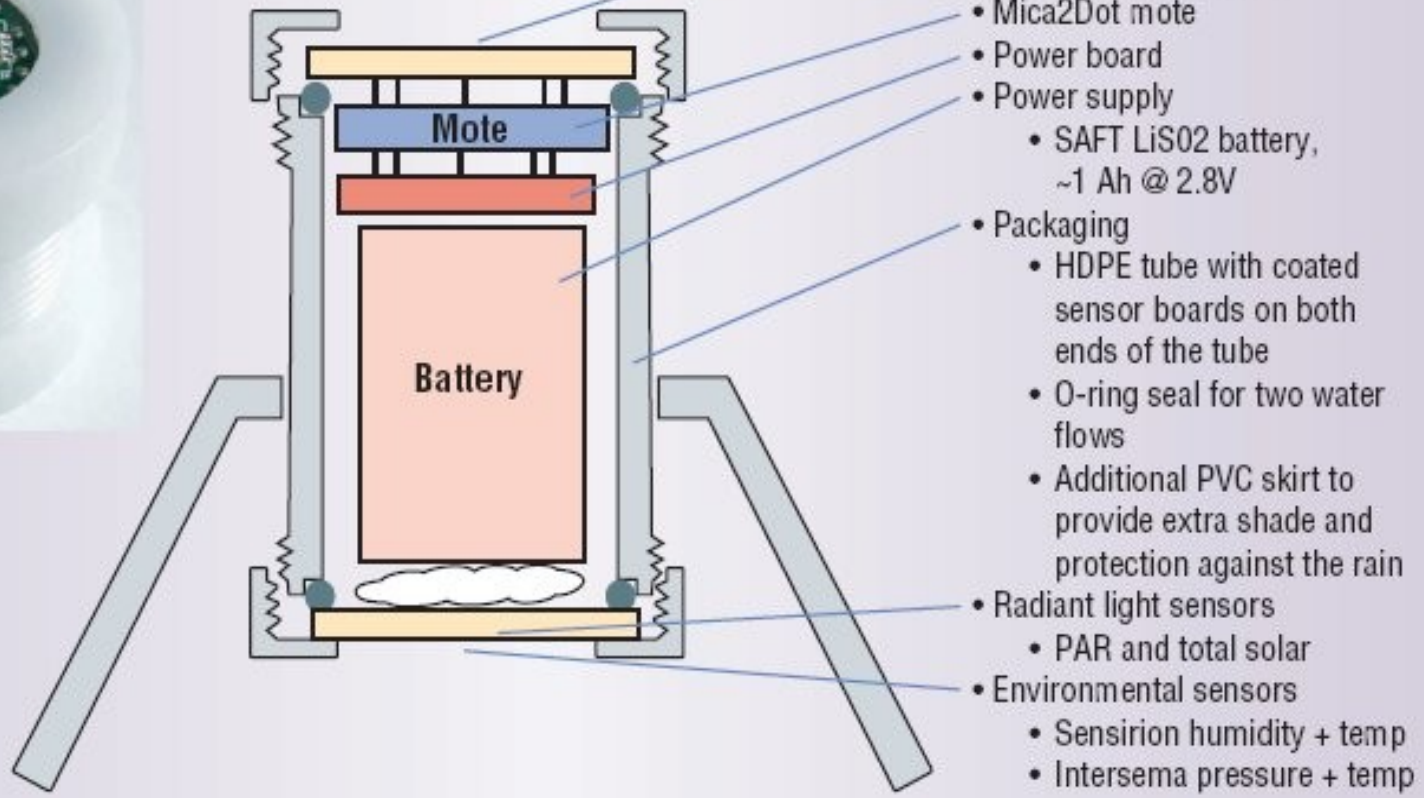
Animal Tracking

Disaster Management

Environment Monitoring: Example

- Redwood trees: microclimate monitoring
  - Rate of photosynthesis
  - Water and nutrient transport
  - Growth patterns
- Prior approach: suite of instruments, wires
- Can use wireless sensors instead

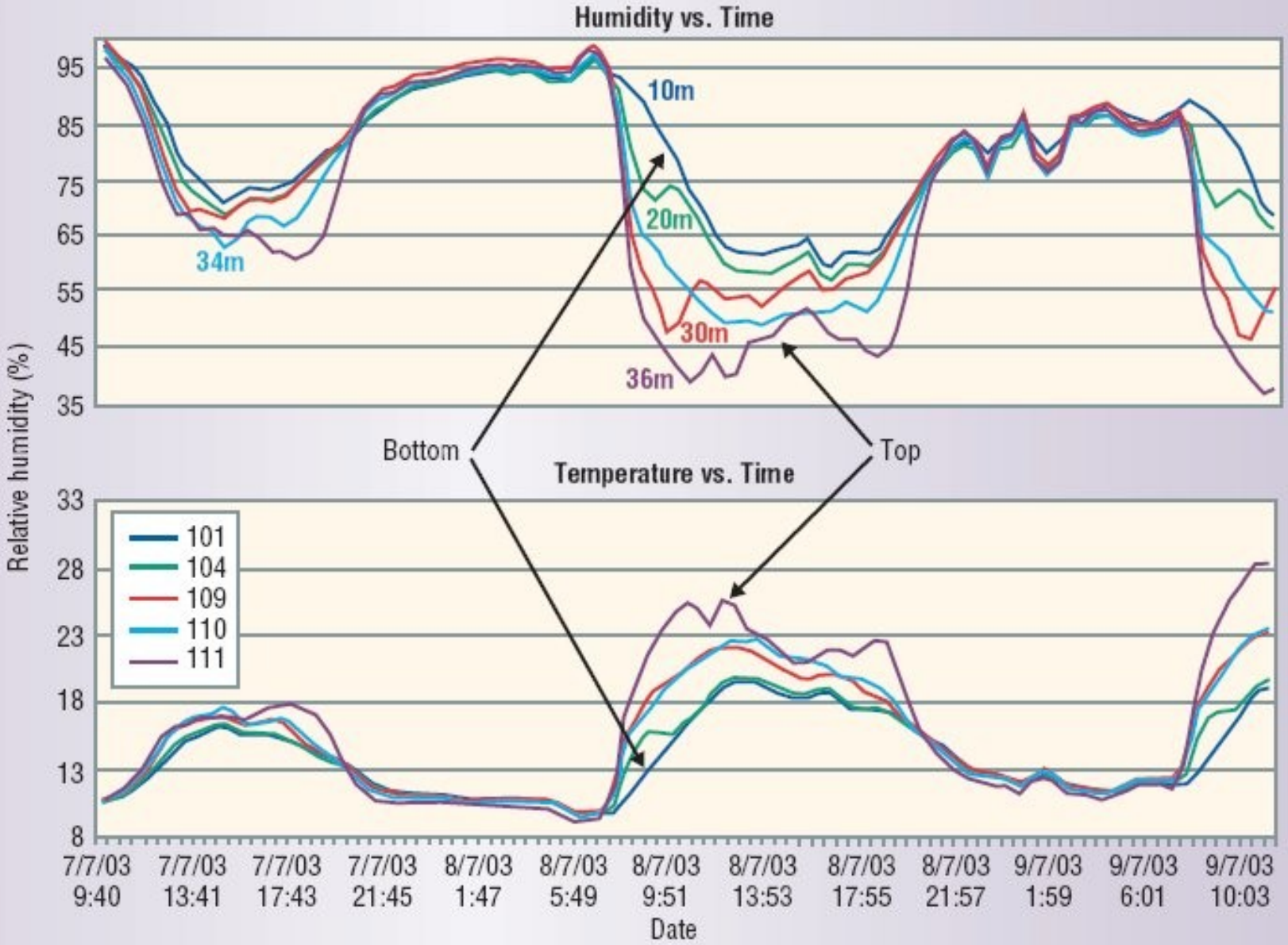
The Sensor Node



- Incident light sensors
  - TAOS total solar
  - Hamamatsu PAR
- Mica2Dot mote
- Power board
- Power supply
  - SAFT LiS02 battery, ~1 Ah @ 2.8V
- Packaging
  - HDPE tube with coated sensor boards on both ends of the tube
  - O-ring seal for two water flows
  - Additional PVC skirt to provide extra shade and protection against the rain
- Radiant light sensors
  - PAR and total solar
- Environmental sensors
  - Sensirion humidity + temp
  - Intersema pressure + temp

Source: Overview of Sensor Networks, D. Culler, D. Estrin, M. Srivastava, IEEE Computer Aug 2004

Some Measurements



Source: Overview of Sensor Networks, D. Culler, D. Estrin, M. Srivastava, IEEE Computer Aug 2004

Sensor Mote Requirements

- Typically long running, even up to one year
- Some basic processing and networking
- No electricity
- Interaction with environment rather than user

Issues in Sensor Networks

- Routing, data dissemination
  - Energy conservation
  - Lots of literature in this domain
- Localization, time synchronization
- Topology, power control

Processing and Storage

- Microprocessors:
  - 1 mW at about 10MHz speed
  - Duty cycle of 1% ==> 10 micro-watts
- Memory:
  - About 10KB of RAM, 100KB of ROM
- Battery:
  - Typically about 1AH per cu.cm.
  - Solar power: 10mW per sq.cm. outdoors, 0.01-0.1mW per sq.cm. indoors
  - Mechanical vibrations: 0.1 mW

Sensors, Radios

- Sensor size, power consumption depends on kind of sensor
  - Typically a few mW
- Radios: about 10-20mW for upto 10m range
  - Multi-hop network
  - Tx of 1 bit == about 1000 instructions

TinyOS

- Uses event-driven paradigm for concurrency
- Hardware interrupts and software tasks
- Tasks: deferred procedure call
  - Tasks are maintained in a queue
  - Tasks are atomic
- System modeled as a set of components
  - State + tasks
- Components interact via interfaces
  - Commands + events