Middleware for Sensor Networks

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INF5040 - Student Presentation

Agenda

- Introduction
- Research History
- Sensors
- Sensor Networks
- Middleware - challenges
- Middleware - solutions
- MiLAN

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Introduction

- Motivation:
  - Monitor environmental properties, e.g., temperature and light conditions, where power and communication cables are unfeasible, cover large areas with a large number of sensors
  - Ex.1: Monitoring the habitat of endangered birds during their burrows
  - Ex.2: Fire detection in forests
  - Ex.3: Monitor temperatures and humidity to harvest grapes with maximum quality wine at vineyards

Research History #1

- Early research dates back to the cold war
  - Sound Surveillance System (SOSUS) deployed on ocean bottoms to track quiet Soviet submarines.
  - Airborne Warning and Control System (AWACS)
- Distributed Sensor Networks (DSN) program at Defense Advanced Research Projects Agency (DARPA) around 1980

"Mobile" Wireless Sensor Node. DSN test bed around 1985

Research History #2

"Business Week" (1991): Networked Micro sensors among 21 most important technologies for the 21st century

[Cong et al. 2003 - "Sensor Networks: Evolution, Opportunities, and Challenges]

Future

- Sensors or motes will be small and cheap

mote (*plural* **motes**)

1. A small particle; a speck.

Sensors #1

- MICA2 868, 916 MHz(Crossbow technologies)
  - Wireless Platform for Low-Power Sensor Networks
  - 868/916 MHz Multi-Channel Radio Transceiver
  - 38.4 kbps Data Rate Radio
  - Multi Year Battery Life
  - Designed Specifically for Deeply Embedded Sensor Networks
  - Wireless Communications with Every Node as Router Capability

[http://www.xbow.com]

Sensors #2

- TinyOS:
  - De facto operating system
  - Written in nesC (Simplified C)
  - Simplify access to lowest levels of hardware in an energy-efficient way
  - Only one application at a time
  - Components to modulate packets over radio
  - Read sensor values
  - Synchronize clocks between sender and receiver
  - Put hardware into a low-power state

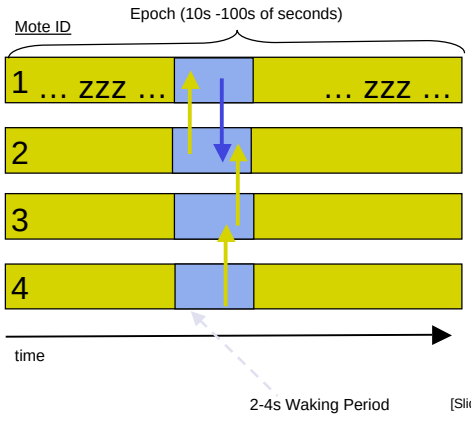
Sensors #3

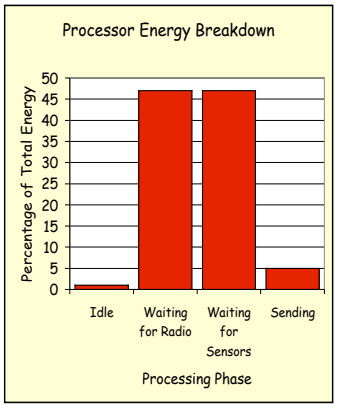
- Cont. TinyOS:
  - UART protocol provides reliable mote communication
  - Protocols are packet-size independent
  - Single destination node, called “root-node”
  - Provide ad-hoc multi-hop routing
  - Shortest-path-first algorithm
  - Data movement and route decision engines are split into separate components to permit other route-decision schemes to be integrated in the future
  - Multi-hop routing is transparent to applications

[http://www.tinyos.net/] [www.tinyos.net]

Sensors #4

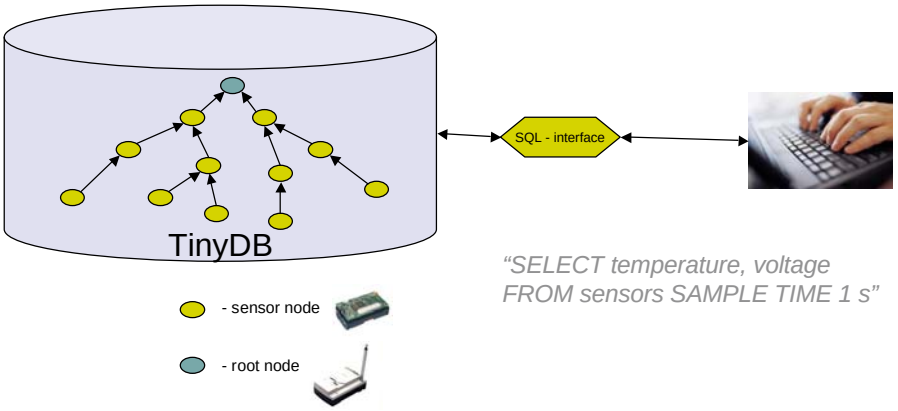
- Sleep as much as possible!





[Slide from http://telegraph.cs.berkeley.edu/tinydb/]

Sensor Networks



*"SELECT temperature, voltage
FROM sensors SAMPLE TIME 1 s"*

[http://telegraph.cs.berkeley.edu/tinydb/]

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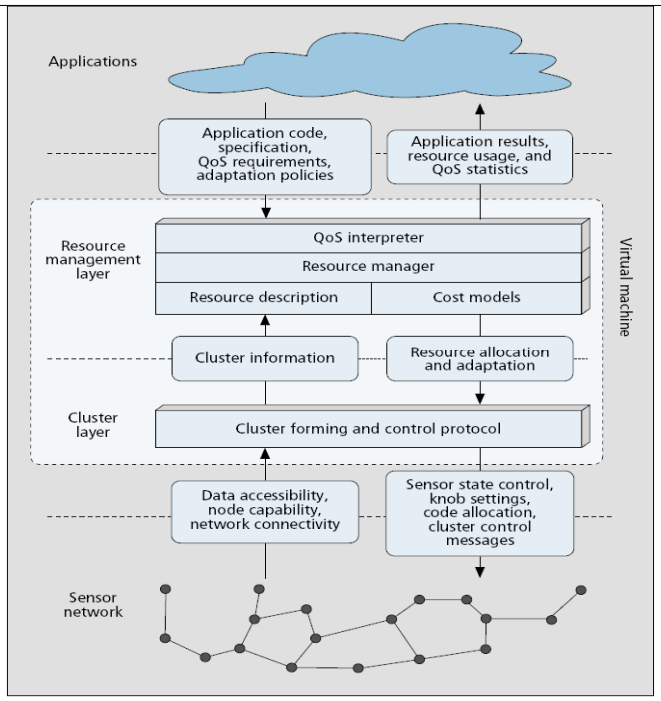
Middleware – challenges

- Heterogeneous environment
- Dynamic environment, sensors come and go
- Need to support multiple applications on top of node operating software
- Quality of Service in regard to resource usage versus Application needs (precision, coordination, update frequency)
- Two different approaches presented in papers

(see references)

Middleware – solutions

- A virtual machine on top of the WSN:
  - Solves heterogeneity issue trough abstraction
  - Solves resource allocation since the middleware handles this for the application
  - Solves coordination issue -> middleware responsibility



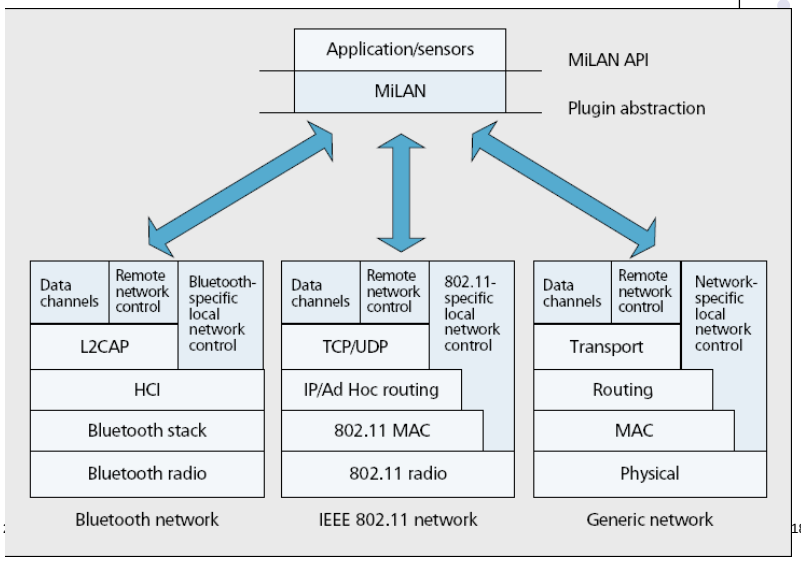
Clustering

- Allows tracking of dynamic phenomena
- Consists of node guards (perimeter)
- Cluster heads (controls cluster)
- Split/Join of cluster

Middleware – solutions cont.

- Resource management layers allows applications to submit their specific resource profile, the layer then adjust accordingly, approximately dividing resources equal.
- Clustering gives the ability to split the WSN in different zones with different resource usage.

Middleware – 2. solution



Middleware - MiLAN

- MiLAN instances runs on nodes, main MiLAN instance coordinate these
- Abstracts and provide unified resource distribution

References

- Middleware to Support Sensor Network Applications (Heinzelman et al, 2004)
- Issues in Designing Middleware for Wireless Sensor Networks (Yu et al, 2004)