From Pervasive to Pervasive Computing

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Objective

- limited battery power
- limited processing capability
- limited storage
- radio communication
- lossy link
- unreliable routing

- What is the avg temp?
- How much food left?

- Long network lifetime
- reliable link with performance guarantees
- Efficient programming interface
Wireless Sensor Network

- Most of the nodes are static
- Batteries are non-rechargeable
- Multi-hop wireless communication
- Node redundancy
Steps

- **Step I: understanding the network**
  - Understanding the energy consumption
  - Detecting local congestion
  - Estimating the link quality
  - Estimating the packet delivery performance in different network scenarios
  - Fault detection
Steps (cont’d)

- Step II: taming the network
  - Energy conservation
  - Making the network more responsive to dynamics
    - node failure
    - transient congestion
  - Providing end-to-end performance guarantee
    - Delay, differentiated service, reliability
Steps (cont’d)

- Step III: utilizing the network for computing
  - in-network processing
  - defining new programming framework
    - light processing demands
    - energy efficient
    - storage efficient
Ongoing project I: Energy Conservation Employing 2-D Adaptation
-- with A. Yang and S. Yu

Active nodes:
forwarding packets

backup nodes:
Sleep + wakeup

How to determine the sleep interval?
- current solution:
  - using a fixed sleep interval that is small enough
  - energy conservation = sleep interval / wakeup time
- our solution:
  - adaptive sleep interval
Ongoing project I: Energy Conservation Employing 2-D Adaptation

How to adapt?

- temporal adaptation
  - the remaining energy of the active nodes
- spatial adaptation
  - Heuristic I: satellite
    - one or two backup nodes sleep very short; while others can sleep for a long time
  - Heuristic II: asynchronous sleep interval
    - neighborhood population
    - network distance to the routing path
Ongoing project I: Energy Conservation Employing 2-D Adaptation
Ongoing project II: Congestion Detection and Avoidance -- with B. Nath

- Active nodes: forwarding packets
- Congested nodes
- backup nodes: Sleep + wakeup

- How to detect congestion?
  - MAC layer statistics
    - Queue length, backoff window
    - link quality estimation

- How to increase resource to avoid congestion
  - really short-term congestion
    - Increase bandwidth
    - Increase transmission power
  - Short-term congestion
    - Increase # of nodes
    - Increase # of sinks
    - Increase # of routing paths