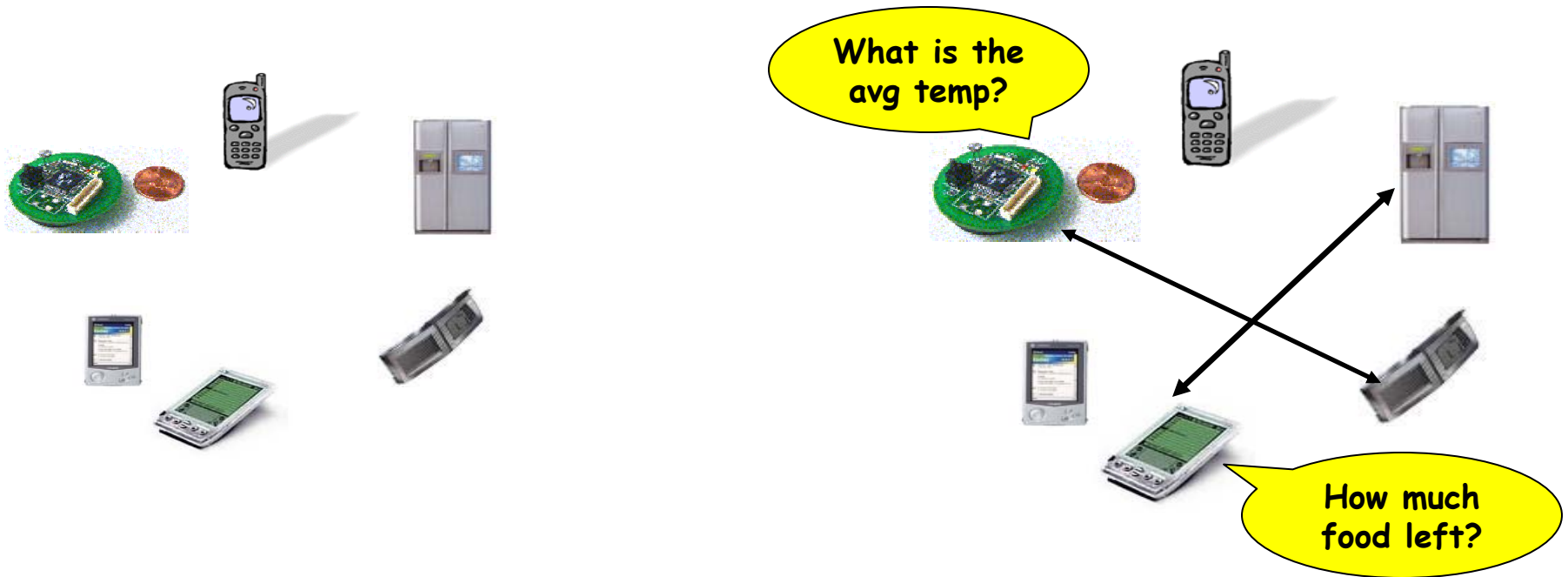


# From Pervasive to Pervasive Computing

**Yanyong Zhang**

Dept. of Electrical & Computer Engineering  
Rutgers University

# Objective



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

- 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

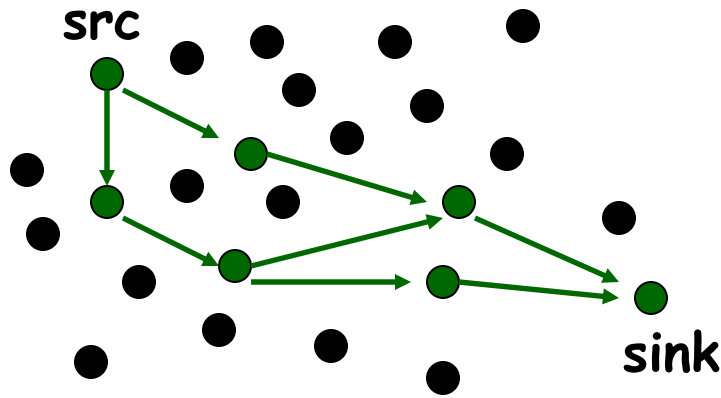
# Steps (cont'd)

- **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



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**

● Active nodes:  
forwarding packets

● backup nodes:  
Sleep + wakeup

# 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*

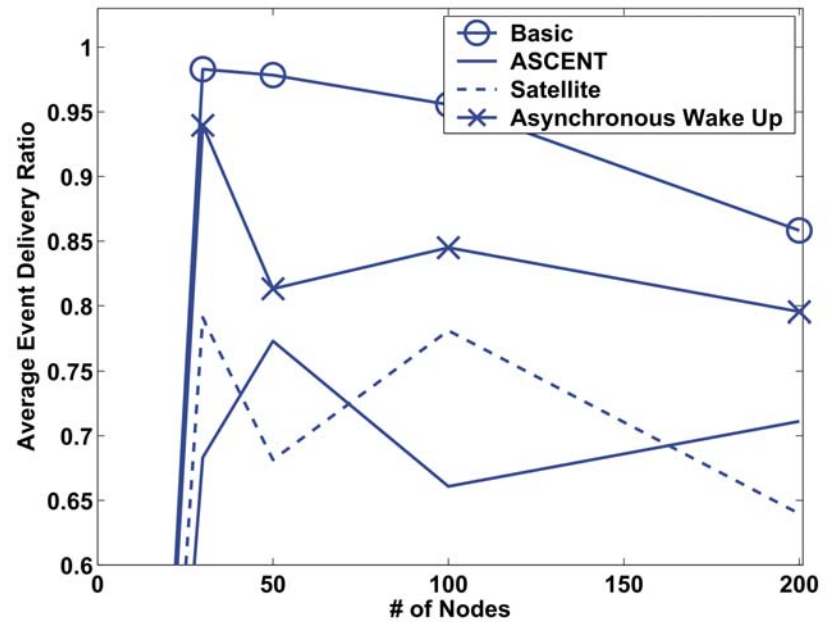
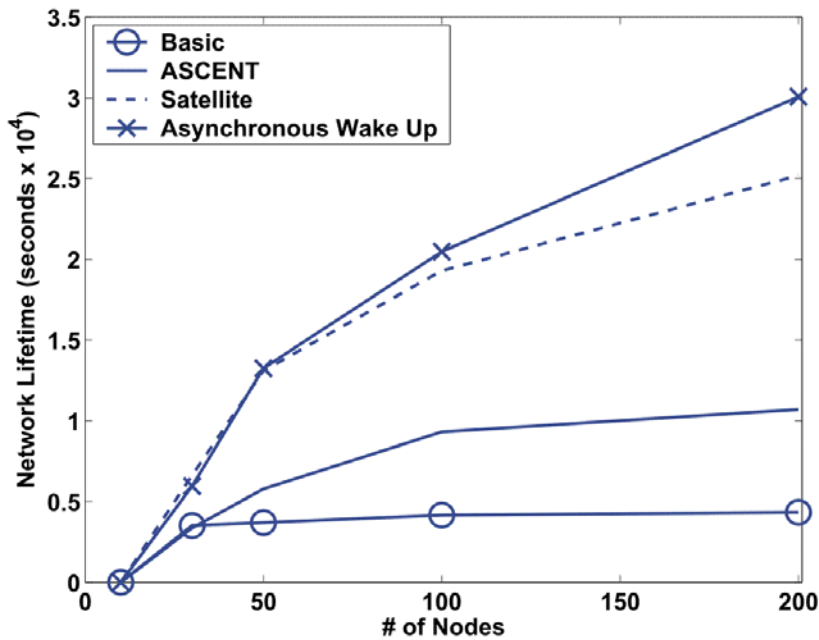
- ◆ one or two backup nodes sleep very short; while others can sleep for a long time

- Heuristic II: *asynchronous sleep interval*

- ◆ neighborhood population
- ◆ network distance to the routing path

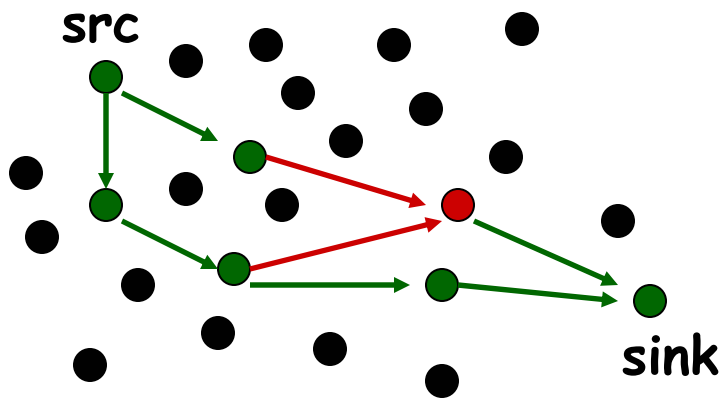
# Ongoing project I:

## 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