Data Dissemination

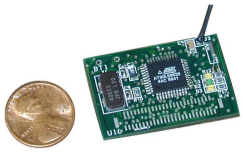
Instructor: Dr. Sunho Lim (Ph.D., Assistant Professor)

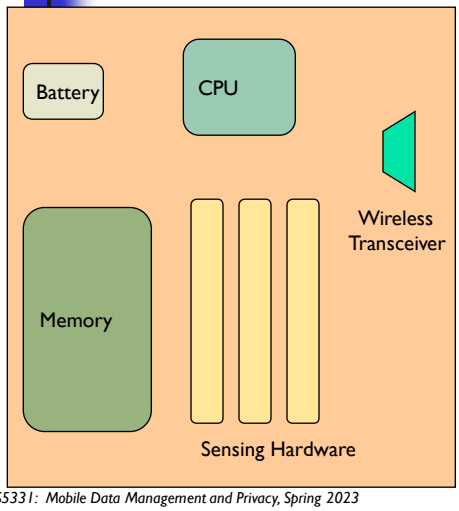
Lecture 07

sunho.lim@ttu.edu

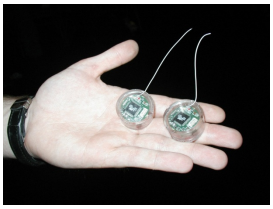
Adapted from J. Kulik, W. Heinzelman, H. Balakrishnan, Negotiation-Based Protocols for Disseminating Information in Wireless Sensor Networks, Wireless Networks 2002

Sensors





- sensors
  - enabled by recent advances in MEMS technology
  - integrated wireless transceiver
  - limited in
    - energy
    - computation
    - storage
    - transmission range
    - bandwidth

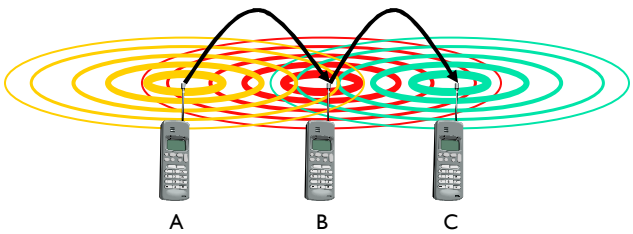


Networked vs. Individual Sensors

- Extended range of sensing
  - Cover a wider area of operation
- Redundancy
  - Multiple nodes close to each other increase fault tolerance
- Improved accuracy
  - Sensor nodes collaborate and combine their data to increase the accuracy of sensed data
- Extended functionality
  - Sensor nodes can not only perform sensing functionality, but also provide **forwarding** service

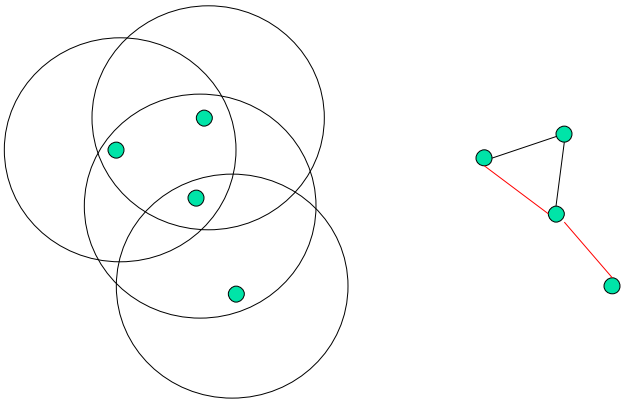
Mobile Ad hoc NETworks (MANETs)

- Sometimes there is NO infrastructure!
  - remote areas, ad-hoc meetings, disaster areas
  - cost can also be an argument against an infrastructure!
- Main topic: routing
  - no default router available
  - every node should be able to forward



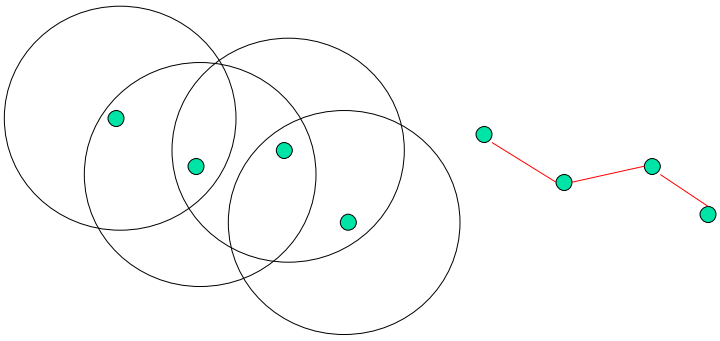
Mobile Ad hoc NETworks (MANETs) (cont.)

- May need to traverse multiple links to reach a destination



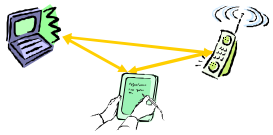
Mobile Ad hoc NETworks (MANETs) (cont.)

- Mobility causes route changes



Mobile Ad hoc NETworks (MANETs) (cont.)

- Network without infrastructure
  - Use components of participants for networking
- Examples
  - Single-hop: All partners max. one hop apart
    - Bluetooth piconet, PDAs in a room, gaming devices…
  - Multi-hop: Cover larger distances, circumvent obstacles
    - Bluetooth scatternet, TETRA police network, car-to-car networks (i.e., vehicular ad hoc networks (VANETs) – V2V,V2I)
- Internet: MANET (Mobile Ad-hoc Networking) group



Why Ad Hoc Networks ?

- Ease of deployment
- Speed of deployment
- Decreased dependence on infrastructure
- Many Applications:
  - Personal area networking
    - cell phone, laptop, ear phone, wrist watch, etc.
  - Military environments
    - soldiers, tanks, planes, etc.
  - Civilian environments
    - taxi cab network, meeting rooms, sports stadiums, boats, small aircraft, etc.
  - Emergency operations
    - search-and-rescue, policing and fire fighting, etc.

WSNs vs. MANETs

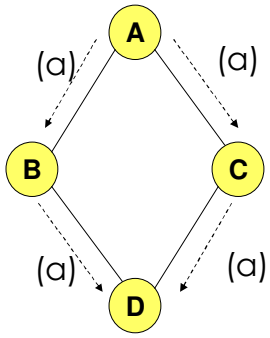
- Wireless sensor networks may be considered a subset of Mobile Ad-hoc NETworks (MANETs)
- WSN nodes have less power, computation and communication compared to MANET nodes
- MANETs have high degree of mobility, while sensor networks are mostly stationary
  - Freq. node failures in WSN -> topology changes
- Routing protocols tend to be complex in MANET, but need to be simple in sensor networks
- Low-power operation is even more critical in WSN
- MANET is address centric, WSN is data centric

Why Not Port Ad Hoc Protocols?

- Ad hoc networks require significant amount of routing data storage and computation
  - Sensor nodes are limited in memory and CPU
- Topology changes due to node mobility are infrequent as in most applications sensor nodes are stationary
  - Topology changes when nodes die in the network due to energy dissipation
- Scalability with several hundred to a few thousand nodes not well established
- GOAL: Simple, scalable, energy-efficient protocols

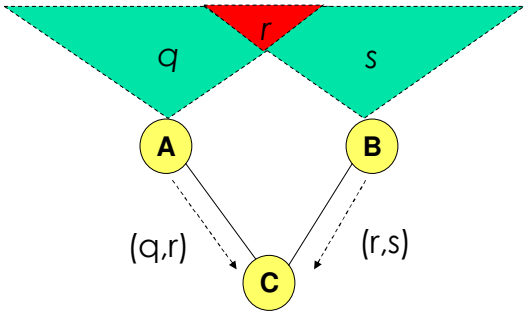
The Implosion Problem

- SPIN (Sensor Protocols for Information via Negotiation),
  - negotiation
  - resource-adaptation
- Limitations of conventional **classic flooding**
- Implosion:
  - Two copies of the data eventually arrive at node D
  - The system energy waste energy and bandwidth in one **unnecessary send and receive**



The Overlap Problem

- Overlap:
  - Two sensors cover an overlapping geographic region.
  - C receives two copies of the data marked r.



Resource Blindness

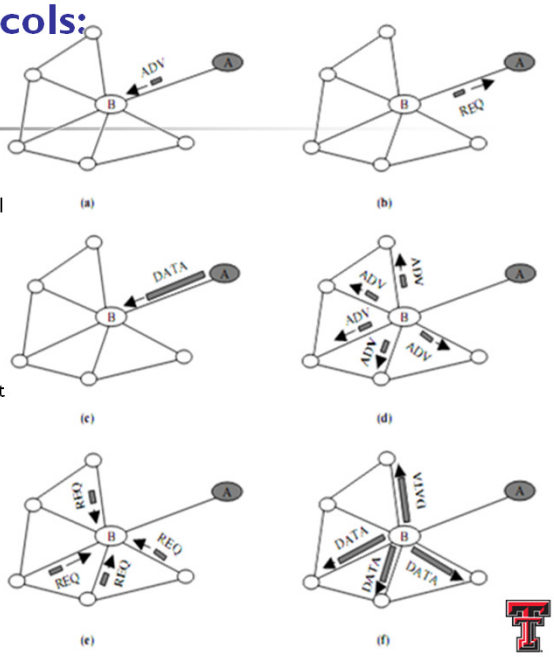
- Classic flooding,
  - nodes do not modify their activities based on the amount of energy available to them at a given time
- "Resource-aware",
  - adapt its communication and computation to the state of its energy resource

SPIN Protocols

- Two basic ideas,
  - Operate efficiently and to conserve energy
  - Monitor and adapt to changes in their own energy resources to extend the operating lifetime of the system
- Meta data,
  - SPIN does not specify a format for meta-data
  - SPIN relies on each application to interpret and synthesize its own meta-data
- SPIN messages
  - ADV, new data advertisement
  - REQ, request for data
  - DATA, data message

SPIN Protocols: SPIN-PP

- SPIN-PP :
  - A three-stage handshake protocol for point-to-point media
  - ADV-REQ-DATA
- Node A starts by advertising its data to node B (a).
- Node B responds by sending a request to node A (b).
- After receiving the requested data (c), node B then sends out advertisement to its neighbors (d), who in turn send requests back to B (e, f).

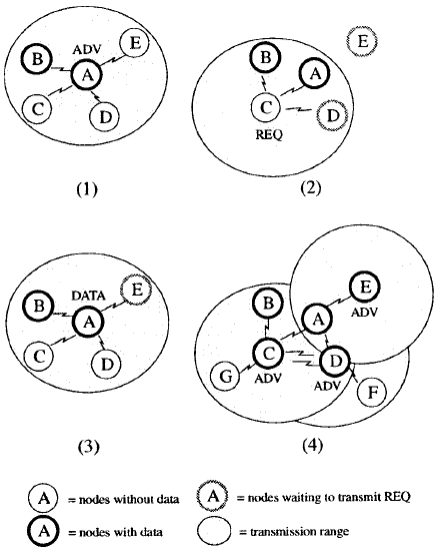


SPIN Protocols: SPIN-EC

- SPIN-EC,
  - SPIN-PP with a **low-energy threshold**
  - ADV-REQ-DATA
- When energy is plentiful,
  - communicate using the same 3-stage protocol as SPIN-PP node
- When its energy is approaching a low-energy threshold,
  - reducing its participation in the protocol

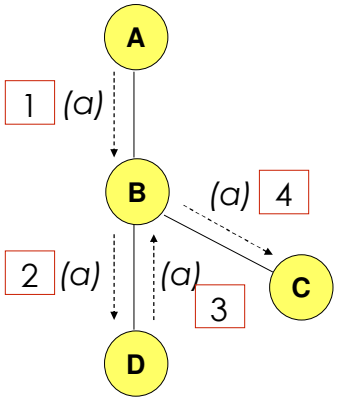
SPIN Protocols: SPIN-BC

- SPIN-BC,
  - A three-stage handshake protocol for broadcast media
- (1) Node A starts by advertising its data to all of its neighbors
- (2) Node C responds by broadcasting a request, specifying A as the originator of the advertisement
  - **Request suppression** with a random time
- (3) Node C receives the requested data
- (4) E's request is also suppressed, and C, D, and E send advertisements out to their neighbors for the data that they received from A



Other Data Dissemination Algorithms: Gossiping

- Gossiping,
  - An alternative to the classic flooding approach using randomization to conserve energy
- At every step, each node only forwards data on to one neighbor, which it selects randomly
- After node D receives the data, it must forward the data back to the sender (B),
- otherwise the data would never reach node C
- Although gossiping largely avoids implosion, it does not solve the overlap problem



Other Data Dissemination Algorithms: Ideal Dissemination

- Ideal dissemination,
  - Every node sends observed data along a shortest-path route
  - Every node receives each piece of distinct data only once
  - No energy is ever wasted transmitting and receiving useless data
- Potential implosion, caused by B and C's common neighbor, and overlap, caused A and C's overlapping data, do not occur