Research Projects in the Mobile Computing and Networking (MCN) Lab

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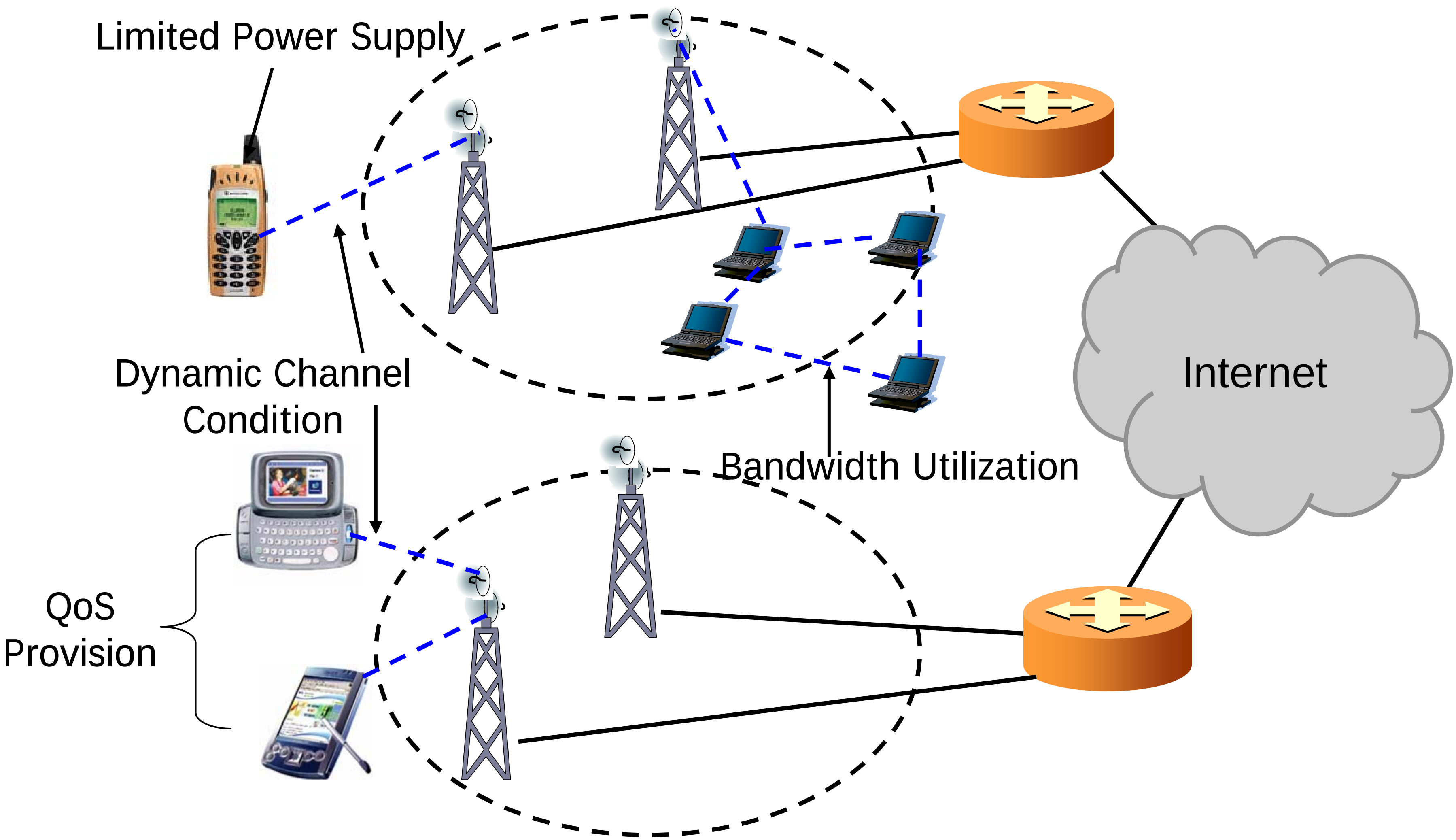
Mobile Computing and Networking (MCN) Lab

- MCN lab conducts research in many areas of wireless networks and mobile computing, emphasis on designing and evaluating mobile systems, protocols, and applications.
  - Current Projects: secure sensor networks, collaborative data access in mobile P2P networks, mobile sensor networks, data centric sensor networks, resource management in wireless networks.
  - Support: NSF (CAREER, ITR, NeTS/NOSS, CT, CNS), Army Research Office, DARPA, PDG/TTC and member companies Cisco, Telcordia, IBM and 3ETI.
- Current students: 7 PhD, 3 MS, and 3 honor BS students
  - Alumni: 3 PhD, two became faculty members at Iowa State University and Florida International University, one went to Motorola lab.
  - 9 MS students went to various companies
- For the last two years: 9 infocom papers, 2 ICNP papers, 1 mobihoc paper, and about 40 papers in other conferences and journals.

Current Research Projects

- Career: Resource Management in Wireless Networks, NSF
- ITR: Efficient Power-Aware Data Access in Pervasive Computing Environments, NSF
- NeTS-NOSS: Mobile sensor networks, NSF
- A Framework for Defending Against Node Compromises in Distributed Sensor Networks, NSF
- Distributed Self-Healing Mechanisms for Securing Sensor Networks, Army Research Office.
- PDG and its member companies, such as Cisco, IBM, 3ETI based support the following four projects:
  - Mobile multi-layered IPSec, Phase I, II
  - Security Solutions for Networks of Simple Devices, phase I, II.
- Also involved in a NSF infrastructure grant, and a NSF education grant.

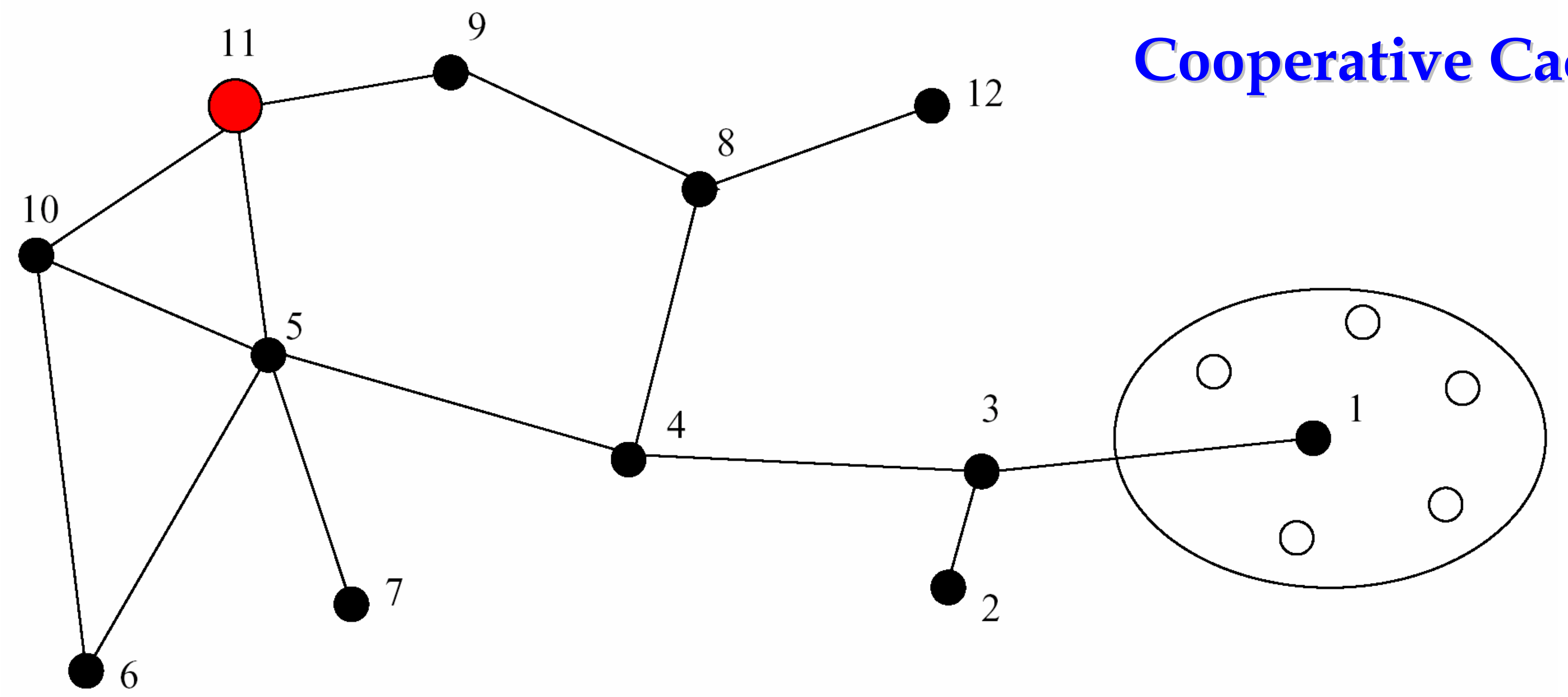
Resource Management in Wireless Networks



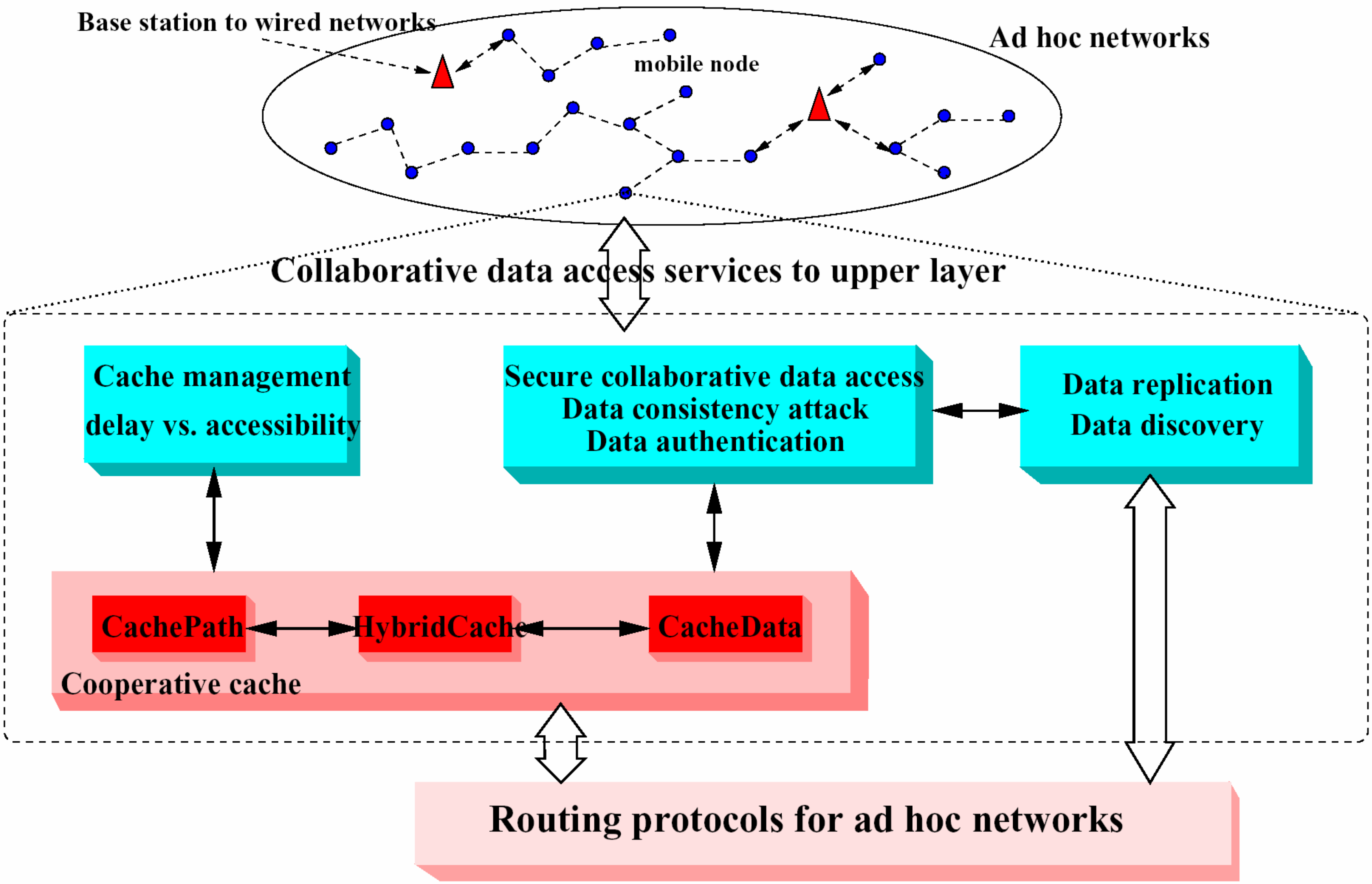
Data Access in Ad Hoc Networks

- Most of the previous researches in ad hoc networks focus on routing or MAC issues.
- Data access is also very important, since the ultimate goal of using ad hoc networks is to provide information access to mobile nodes.
- In Battlefield, after a soldier obtains enemy information (e.g., battlefield map, enemy distribution) from the commander (data center), it is very likely that nearly soldiers also need the same information.
  – Bandwidth and power can be saved if these data access are served by the soldier with the cached data instead of the data center which may be far away.

Cooperative Cache



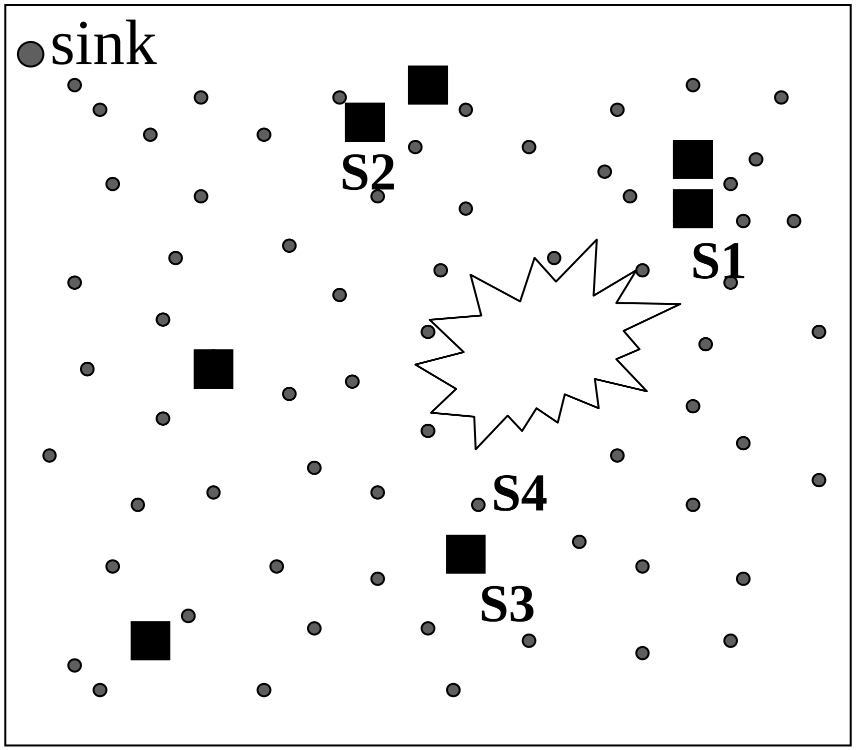
- CachePath: Cache the data path.
  - Suppose N_1 has requested a data item from N_{11}. N_3 knows that N_1 has the data. Later if N_2 requests for the data, it forwards the request to N_1 instead of N_{11}.
- CacheData: Cache the data
  - In the above example, N_3 caches the data, and forwards the data to N_2 directly.
- Many technical issues not shown here.

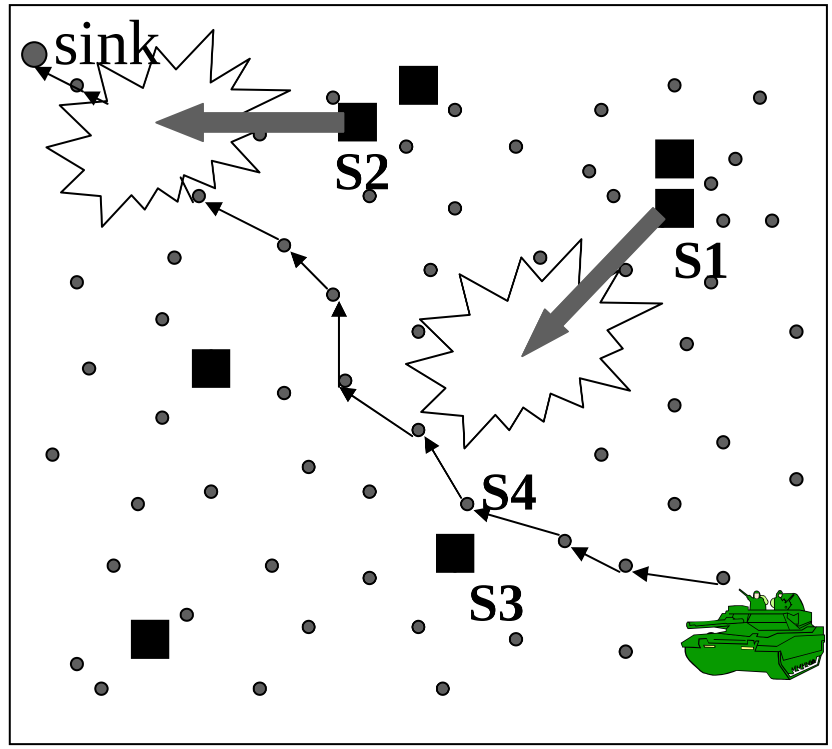

Base station to wired networks
Ad hoc networks
mobile node
Collaborative data access services to upper layer
Cache management
delay vs. accessibility
Secure collaborative data access
Data consistency attack
Data authentication
Data replication
Data discovery
CachePath
HybridCache
CacheData
Cooperative cache
Routing protocols for ad hoc networks

Mission Oriented Sensor Mobility

- Sensor networks can automate information gathering and processing, can support applications such as target tracking, perimeter defense, environmental monitoring, and intelligent transportation.
- Multiple missions, each with different requirements, may share common sensors to achieve their goals.
- Each mission may have its own requirements
  - In perimeter defense, the requirement is to have adequate sensors along a pre-define perimeter.
  - In target tracking, enough sensors should be deployed along the track of the target.
- As the mission changes, nodes may need to move.

Moving sensors to satisfy different mission requirements





Other reasons such as: sensor failure or new event such as chemical spill, target approaching, sensing obstacle (blocking video sensor or acoustic sensor).

Research Issues

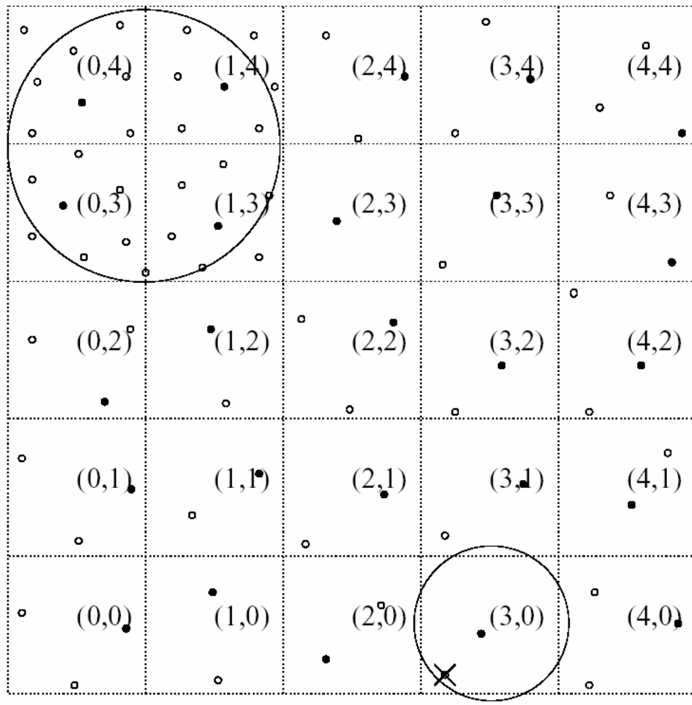
- Mobility assisted sensing: relocate sensors as the network condition changes (sensor failure or new event such as chemical spill, target approaching).
- Network monitoring: detect node failures and estimate the loss of coverage.
- Mobility assisted data dissemination (routing): moving sensors to improve network communication; increasing network lifetime, dealing with network partition.
- Integrated mobility management for sensing and routing: define utility functions that can capture the benefits of the movement from the perspective of all missions (e.g., routing or sensing).

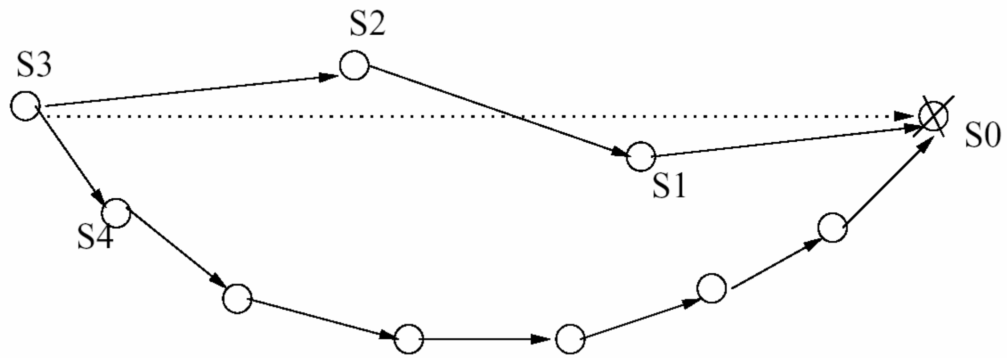
Challenges of Sensor Relocation

- Sensor relocation relocates mobile sensors from one place to another place. It has many challenges:
  - It has strict time constraint
  - Relocation should not affect other missions supported by the network
  - Since physical movement costs more energy, relocation must balance the power of different sensors to increase the network lifetime
- Due to these challenges, the sensor deployment protocol can not be directly applied due to its round-by-round nature.

Sensor Relocation

- Relocation has two parts:
  - Finding the redundant sensors
    - Flooding has too much overhead
    - Using a grid concept, combined with quorums. Many research issues.
  - Relocating them to the target location. Using a cascaded movement





Evaluations

- Currently evaluate with *ns*.
- Considering prototype with commercial off-the-shelf component. Each robot is small (5” x 2.5” x 3”) and costs under $200 each
- Mobility, built from remote-controlled toy cars.
- Runs TinyOS, based on Berkeley Mica Motes, has processor and wireless communication.