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.
  - 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
- 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

- Limited Power Supply
- Dynamic Channel Condition
- QoS Provision
- Bandwidth Utilization
• 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.
• CachePath: Cache the data path.
  • Suppose $N_I$ has requested a data item from $N_{II}$. $N_3$ knows that $N_I$ has the data. Later if $N_2$ requests for the data, it forwards the request to $N_I$ instead of $N_{II}$.

• 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.
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 cannot 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.