600.647 Advanced Topics in Wireless Networks

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Mon – Wed 10am – 11am
Shaffer 300

Class Webpage off of http://www.cnds.jhu.edu/archipelago/
General Overview

Monday

- Research Paper Discussions
  - Every week papers will be assigned that are related to the topic of the lecture.
  - Papers will be discussed in class in a group discussion format.
  - Class participation will count towards final grade

Tuesday

- Group Project Updates
  - Groups will present updates on the status of their projects.
  - Class can provide feedback, suggestions, answer questions
  - A component of the project will be due every Tuesday

Wednesday

- Lecture
  - Instructor, TA, or Guest will provide a lecture on wireless networking
  - Topic will be related to research papers that will be assigned
Class Topics

Wireless Fundamentals
- Shared Medium
- Waves, Signal, Noise, Information Theory, coding

Medium Access Control
- Hidden terminals
- Fairness

Ad hoc networking
- Multi-hop routing
  - AODV, DSR, Pulse, OLSR, DSDV
- Energy efficient operation
- Hybrid networks

Traditional Access Points

Distributed Algorithms
- Peer-to-peer directories, distributed agreement ...

Security for all of the above
Large Group Programming Project

- Develop a mobile application
  - Runs on Linux
  - May require GPS
  - Utilizes Wave Relay wireless ad hoc network which is currently in place
- Requires extensive application development on Linux
  - If you are not familiar with Linux and Network Programming you will have a major problem
  - How to use Linux and how to write network programs will not be taught in the class.
  - Completion of Distributed System, Object Oriented Systems, and Networking is basically required in order to complete the project.
Project Format

- Teams of at most 4 people
- Deadlines for components each week (Tuesday)
  - Create a webpage for your project
    - Will be actively maintained during semester
  - Develop an extensive project proposal detailing how you will complete the project
    - Break project down into concrete tasks for each group member
      - Task will be due each week
      - Project will be concluded with a demonstration during the last week of class and a research report
- Graded on: weekly deadlines, project demonstration, research report, aesthetics (extra effort above just functioning counts)
Suggested Projects

- Location Based Information Database
- Location Specific Question Service
- Distributed Interactive Map
- Opportunistic Information Sharing
- Personal Networking Tool
- Group Suggested Project (Must be approved)
Location Based Information

Database

- Fixed devices advertise location specific information
- Mobile devices collect and organize information
  - By category like Yahoo!
  - Sorted by user reviews and recommendations
- Users interact with location specific information
  - Where’s the nearest coffee shop?
  - Which coffee shop near my location do most users prefer?
  - Guide me to the shop I selected.
  - Shops can advertise coupons or specials which will be collected by the mobile devices.
- Similar to Yahoo! Local or Google SMS, but operates without internet connectivity and allows rapid changes by participants.
Location Specific Question Service

- People often have questions that people (strangers) in a specific location could answer.
  - e.g. Is there currently a line at the ticket counter?

- Users can specify a location by selecting it on a map.
- They then post a question to the system which will be received by users near that location.
  - Users can reply to the question (Yes/No, rate 1-10, etc).
  - Response in the form “80% said YES”.

- Additionally, other users can express interest in the question.
  - More interest results in more users being asked.
  - Response should be sent to all interested users.

- Users can express NEGATIVE interest in the question or mark it as SPAM.
  - If a user gets too many questions marked as SPAM, they should be unable to post more questions to the system.
  - Rate limit questions etc...
Distributed Interactive Map

- All users in the system have a display of a map
- Users should see the locations of all users of the system on the map
  - Locations should be updated when ever users move
- Users can add “information points” to any location on the map
  - Each point can contain original message and additional user comments (similar to a forum thread topic)
  - Users can leave blogs at certain locations in a city that other users can read (e.g. “Party here tonight at 11pm.”)
- Users should have several flexible user-to-user communication options
  - Communicate with one other user
  - Communicate with a group of other users
  - Text instant messaging and potentially voice communication
  - Should be able to send “map communications” like “go to this location”, “I’m covering this region”, “this is the best route”, etc.
- Similar to a shared white board application except the white board is a map

Applications
- Civilian: Search and rescue, Law enforcement, Multi-party coordination
- Military: users could mark targets and give order using the map
  - Laser range finder + compass + GPS = remote target marking
Opportunistic Media Sharing

Users can add media to their device which is publicly accessible (Files, Photos, RSS feeds, etc.)

Opportunistically (when users come within range) media can “jump” from one device to another

When you receive media from another users it resides in a cache on your device

- User can choose to move media to permanent storage
- Only media in permanent storage is sent between devices
  - Media people aren’t interested in disappears from the system
  - Popular content remains
  - Users can rank content/classify content and be more likely to receive things they are interested in
  - A lot of room for creativity on how this is done
  - Another possibility is to be able to search for content locally so it only searches people near you
Personal Networking Tool

- Think Friendster
- People add other users as friends
  - Users must approve that they are actually friends
- Users indicate preferences to the system and interests
- When user comes in range of a friend or friend’s friend etc., System notifies them
  - Users can look at people profiles with up to 3 degrees of separation
  - Allows people to meet new people and network
  - People can meet by instant messaging
  - Device can beep to indicate that a friend is near
    - Different beep when they are closer
    - People could meet by hearing the other person also beeping
    - Be Creative!

Applications
- Friendster type friend finding
- Business Networking (meet other people in your field, headhunters, etc)
- Dating Service (match people with personality / preference profiles)
Maps available Online

You are here!
Software Available Online

Software exists for Linux to provide
- Maps
- GPS Interface
- Update Map based on GPS
- Tons of software for Linux

Use what you can find! (if it’s open source)
- Don’t duplicate existing efforts
- Embrace and extend

Links to some of these programs are already on class webpage
Wave Relay Test-bed

- A multi-hop ad hoc networking platform
  - Allows users to wirelessly “hop” across other users to reach destination
- Deployed on campus
  - Currently in New Engineering Building
  - Soon will cover engineering quad as well
  - We are continuing to build network out across campus and surrounding areas
- Software runs on an embedded Linux platform
  - Boots off a compact flash card
  - Single board computer
  - Multiple wireless cards
  - Ad hoc access points, multiple frequencies or channels
  - Operates extremely well under mobility
    - Tested from moving vehicles
  - Devices can be battery powered
    - Battery lasts around 24 hours
Approximate Coverage Area
Adding Soon!
More devices coming...

- Currently ordering parts to build 25 more wireless routers
- Most likely will have a router building “party” for interested students
- Information on test-bed available at:
If you want to work hard and find wireless communication interesting, this class will be a ton of fun!

If you don’t like programming (on Linux, network applications, GUI’s etc..) or don’t have time for large projects, this class could be extremely challenging.

Things will get started immediately so that you have enough time.

- So joining the class late will not be possible
- Dropping class leaves a group with one less person
Pointers

Main Project Website:

http://www.cnds.jhu.edu/archipelago/

- Includes links to class website, Wave Relay website etc…

Wireless Communication Lab in NEB 213

Dr. Awerbuch’s office is in NEB 318? (I think)