# 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 users 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

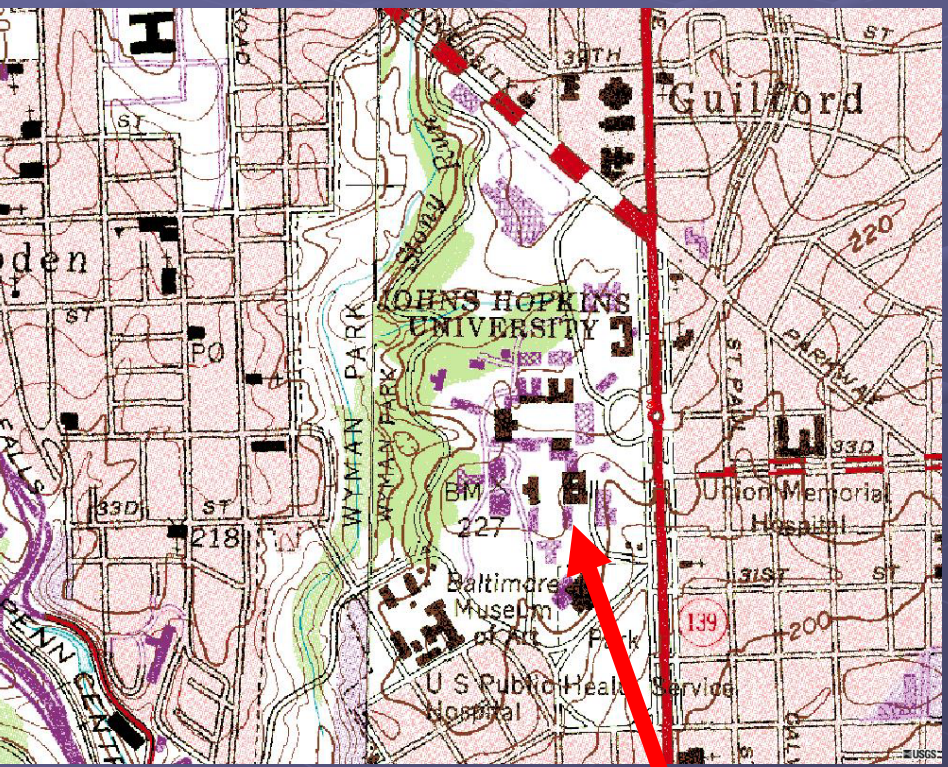
# Opportunistic Media Sharing

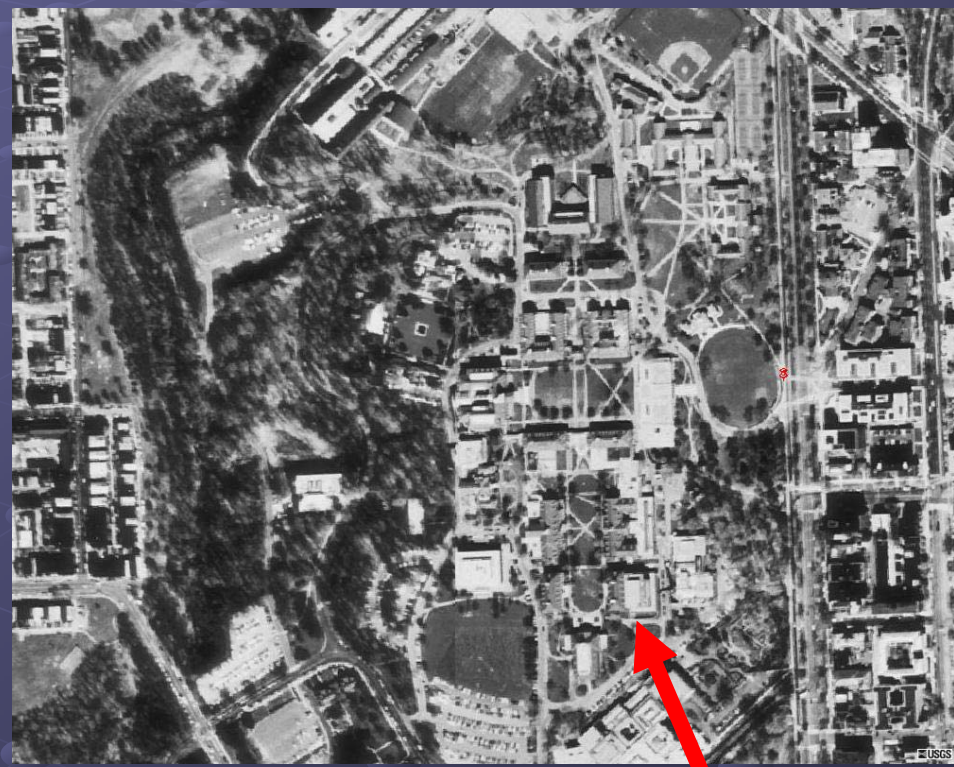
- Users can add media to their device which is publicly accessible (Files, Photos, RSS feeds, etc.)
- Opportunistically (when users come within range) media can “jump” from one device to another
- When you receive media from another users it resides in a cache on your device
  - User can choose to move 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:
- http://www.cnds.jhu.edu/research/networks/archipelago/testbed/testbed.html

# Class Info

- 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)