Wireless Networks for Mobile Applications

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Presentation

- LANGUAGE:
  - English
- PREREQUISITE:
  - Computer Networks
- TEXT BOOK (NOT mandatory, only part of the class is based on it):
  - Wireless Communications & Networks (2nd Edition), William Stallings; Prentice Hall; 2005; 0131918354
- OTHER MATERIAL:
  - **slides and scientific papers**
- WEB SITE:
  - **http://www.math.unipd.it/~cpalazzi/WNMA.html**

Program 1/2

- Introduction, wireless systems, protocols architecture, issues and measures
  - Physical Layer (fundamentals and mobility effects)
  - Data Link Layer (fundamentals on duplexing, TDMA, FDMA, CDMA)
  - Network Layer (addressing/routing with device mobility)
  - Transport Layer (Reliable communication and mobility impact on TCP)
  - Application Layer (Geolocalized services, DTN, smart applications, distributed sensing, crowd computing, intelligent transportation system,…)

- Wireless Network Architectures: management and challenges
  - WLAN, Infrastructure and Hot-Spot Networks
  - Wireless Mesh Networks (WMN)
  - Sensor Networks (Sensor Networks)
  - Mobile Ad Hoc Networks (MANETs)
  - Vehicular Ad-Hoc Networks (VANETs)
  - Flying (Drone) Ad-Hoc Networks (FANETs)
  - Satellite systems, challenged networks

Program 2/2

- Consumer market technology; main standards; advanced issues:
  - IEEE 802.11b/g/a/e/n/s/p
  - IEEE 802.15.1 (Bluetooth)
  - IEEE 802.15.4 (ZigBee)
  - RFID

- Services:
  - Location-based services
  - Client/Server and alternative service paradigms
  - Wireless Internet
  - Pervasive wireless communication systems
  - Other fields where Wireless Networks apply: existing and visionary services

- Practical implementation or study of course-related scenarios
  - Performance evaluation of protocols in wireless scenarios
  - Development of applications for mobile environments (e.g., videogames or other applications for smartphones)

Exam 1/2

- Project development
  - To be decided with the Professor
  - Project (simulation, implementation testing)
    - Paper presentation + oral discussion
  - Survey (topics to be determined)
    - Slide presentation + Paper + oral discussion
- Oral discussion on class material (slides, etc.)
  - Material may very depending on the project
- TOTAL CREDITS: 6 (4 + 2)
  - Availability of more challenging projects as first step of a Thesis

Exam 2/2

- Project evaluation
  - Difficulty
  - Results
  - Autonomy
  - Possible topics:
    - Critical analysis of the state of the art, new solutions for wireless issues (protocols, algorithms), verification through simulations or real experiments, wireless systems implementation (e.g., games on mobile phones), mobile applications, sensing, drones…
    - Possible shared projects with other classes (e.g., Mobile Programming and Multimedia)

At the End of this Class …

- You'll understand or have some knowledge of
  - MAC protocols (who gets the chance to talk)
  - Routing (path selection algorithms and issues)
  - Reliability (wireless congestion control, rate control)

  - Applications (Device-to-Device networks)
  - Human sensing, Urban sensing
    - Localization (extracting the location of a device)
    - Mobility (how it helps and disrupts communication)
    - Interfaces (phones are more than communication devices)

  - Energy-awareness (how it percolates various network functions)
  - Emerging Topics (vehicular networks, drone networks)
  - Capacity (what is feasible, what are performance bounds)

Examples of What You'll Learn

- What's the difference between 802.11 b/g/n/p/s/e..?
- Why is the bandwidth really available in wireless networks much smaller (about half) than the nominal one?
- Why do VoIP and Online games scatter when there is someone else in the WLAN browsing the Internet? What solutions have been proposed?
- How do current routing protocols perform if we use them in a network of drones?
- How can smartphones be used to improve our lives and society?

What this Class Does Not Cover

- Not a wireless communication class
- Does not cover
  - Modulation schemes
  - Transmitter/Receiver design
  - Signal processing and antenna design
  - Source coding / channel coding
  - Privacy / Security
  - Etc.

- This is class on
  - Design, analysis, and implementation of protocols and algorithms in (mobile) wireless network systems and their implication in the design of popular/innovative mobile applications

Some other Thoughts

- Dilemma
  1. Teach very advanced stuff for the networking pro
  2. Teach from absolute scratch for the uninitiated

I will try to strike a balance

Please bear with me if materials are sometimes too easy/difficult for YOU

Credits

- Credits for various slides and figures used in this class material:
  - A. A. Abouzeid
  - J.J. Aceves
  - I. F. Akyildiz
  - B. Awerbuch
  - L. Bononi
  - A. Bujari
  - C. Caini
  - R. R. Choudhury
  - Q. Fang
  - R. Firrincieli
  - J. Gao
  - M. Gerla
  - L. J. Guibas
  - A. Hande
  - J.F. Kurose
  - P. Kyasanur
  - J. Levy
  - A. Mishra
  - A. Nahapetian
  - K. W. Ross
  - J. Schiller
  - Sudhir Tiwari
  - N. Vaidya
  - M. Zorzi

Thoughts on Reading Papers

- Know why you are reading the paper
  - Reading for absorbing concepts (class assignment)
    - Read fully, think, reread, ask, challenge
  - Reading for excitement (deciding project topic)
    - Read initial parts, don't try to understand everything, get a feel
  - Reading for problem identification
    - Read the **problem carefully**

Most Important

  - Reading to discriminate (before finalizing project)
    - Read solution, ensure your ideas different, analyze performance

Paper Projects

- Projects/papers consist of 4 parts:
  - Problem identification
  - State of the art discussion
  - Solution design
  - Performance evaluation

- Each paper you read is someone's project
  - Many papers have actually emerged from class projects
  - Read them critically
  - Ask yourself
    - Is the problem really important? Should you care?
    - Is the solution sound? Under what assumptions?
    - Do you have other (better) ideas?
    - Is evaluation biased? Are results shown only in good light?

More on Projects

- Discuss your thoughts, ideas with your Professor
  - They need not be cooked, and can have many flaws
- If you like an area / direction
  - Read many related papers
- Don’t try to come up with a quick solution
  - Ensure your problem is a new, real problem
  - Finding the solution is typically easy

More on Projects

- Protocol evaluation typically requires coding
  - Think what you would like to do
  - Options are:
    - Coding on real devices (sensors, smartphones, routers)
    - Coding in existing network simulators (ns2, ns3, Qualnet, etc.)
    - Coding your own simulator
    - Theoretical projects involve MATLAB, CPLEX, etc.
- Project ideas take time … think now and then
  - Spending 3 hours for 10 days better than 10 hours for 3 days

More on Projects

- Find a project partner early
  - Discuss reviews, papers, potential project themes
- Class project often bottlenecked by platform
  - Think of the evaluation platform during project selection
  - If you are not familiar with the Linux OS, it's a bad idea to do a project involving router-programming
- This class is about research
  - Be active, ask questions, debate, and disagree

Slide Presentation Projects

- Choose a topic of interest
- Find related scientific bibiliography
  - scholar.google.com
  - http://ieeexplore.ieee.org/
  - http://dl.acm.org/

- Prepare a 20min presentation and discussion on the topic
  - Read about (depending on their size and of the number of team members) 5 related papers critically
  - For each paper ask yourself
    - What is the problem? Is it really important? Why?
    - Is the solution sound? Under what assumptions? What kind of experiments/analysis were performed?
    - Are there common classes of solutions?
    - Do you have other (better) ideas?
    - Is evaluation biased? Are results shown only in good light?

- These projects *should* (if possible) be presented during class hours