Chapter 0

Wireless Networks

無線網路概論
Books

- International Edition
- 608 Pages Paperback
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Reference Books

Administration

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- **Grade:**
  - Quiz 20%
  - Homework Assignments 20%
  - Midterm Exam 30%
  - Final Exam 30%
Course Overview

- Some “keywords”
- Wireless
  - What’s special about wireless?
- Mobile
  - What’s special about mobile?
- Networking
  - Cover topics in several OSI layers
- Cross-Layer
  - Design issues across several protocol layers (Physical and MAC)
What is special about “wireless”?

- Wireless channel
  - Electromagnetic
  - Channel variation
  - Signal power attenuation
  - Sharing wireless medium

Radio propagation model
What is special about “mobile”? 

- User mobility  ➔  where are you now?!  
  - Mobility management  
  - Handoff  

- Tradeoffs  
  - Precision of user location  
  - Time to find your exact location  
    - Signaling overhead  
  - Cost of updating your location  
    - Power consumption  
  - Updating your location consumes battery power
Sometimes wireless != mobile

- Usually, if a network is wireless, it is mobile.
- But...
  - wireless **not** mobile
    - Sit in a coffee shop using WiFi access
  - mobile **not** wireless
    - Unplug your Ethernet cable of your laptop and move to library
- When you see a special system design, you should think why the system is designed in such a way?
  - wireless channel
  - mobility
Keep these 2 questions in mind

- While learning this course, ask yourself
  - What is special about “wireless”?
  - What is special about “mobile”?
- Hope you still remember the basic ideas about wireless and mobility
- When you find something challenging, there are opportunities!
Overview of network architecture

- **OSI Layer Reference Model**
  - Open System Interconnection (OSI)
  - 7 Layers

- **Why reference model?**
  - Discuss communication protocols
  - Build product
Internet Protocol Stack

- **Application layer**
  - http, ftp, telnet

- **Transport layer**
  - TCP
  - UDP, RTP

- **Network layer**
  - IP

- **Data link layer**
  - 802.3 (Ethernet), 802.11

- **Physical layer**
  - Wireless, DSL
Why Layering?

- Modular design
  - Scalable network protocol design with separate modules
- Simplicity
  - Avoid complicated interactions between multiple layers
- Portability
  - Reuse the network protocol component in other scenarios
- Is layering always good? How about cross-layer approach?
Teaching Plan

- A layered approach
  - From PHY, to upper layers
  - Go through issues in each layers, and some practical solutions to them

- Try to help you building a strong system concept
  - Problem solving paradigms
  - Wisdom from (your and others’) experiences
  - Insight to future problems
Physical Layer

- Wireless medium characteristics
  - Radio propagation model
- Communication perspective on wireless transmission
  - Modulation
  - Coding
  - How do I select modulation/coding scheme for my wireless system?
Link Layer (1)

- Sharing wireless resource
  - When should I transmit?

- Differences
  - I can overhear you!
  - I can interfere with your transmission!
  - I am not sure who is around me
    - This might be a 2D (3D) distributed problem
Handoff

- User moves!
- Definition: a mobile user moves from one base station to another base station

Things to be done during handoff

- Search who is available to serve me
- Whom should I associate with?
- Connect to the new base station
  - Registration
  - Security (authentication, authorization)
- Update location database
Network layer

- Mobility
  - User can move!
  - Where are you?
- Mobility management and location management
  - Manage user location update
  - Cost to maintain precise user location
    - Registration signaling cost
  - Cost to find out exact user location
    - Paging cost
Transport Layer

- TCP
  - We use TCP everywhere
- Problem with TCP
  - TCP is designed to do congestion control
  - Packet loss is an indication for congestion
    - Packets are frequently lost in wireless and mobile networks
    - There might not be any congestion, but TCP agents think the network is congested
  - Acting weird!
Application Layer

- Data application
- Real-time applications
  - Video
  - Voice
  - Game
- Mixed traffic
- Optimized for multimedia delivery?
Wireless Spectrum Regulation

- Wireless spectrum is regulated by governments
  - Regulation has significant impact on technology advancement and business development
  - Who should use the spectrum? How should it be used?
    - Auction for licenses (e.g. 3G license)
- Organization
  - NCC (Taiwan)
  - FCC (USA)
Signal propagation ranges

- **Transmission range**
  - communication possible
  - low error rate

- **Detection range**
  - detection of the signal possible
  - no communication possible

- **Interference range**
  - signal may not be detected
  - signal adds to the background noise
Classify wireless access technologies

- Data rates
- Transmission range
- Technologies
- Spectrum
Heterogeneous wireless networks

Integration of heterogeneous fixed and mobile networks with varying transmission characteristics
Two campaigns of networks

- Computer network (Internet)
  - TCP, IP, HTTP, IEEE 802.11
  - Standardization: IETF (Internet Engineering Task Force)
    - Internet drafts, RFC documents, Internet standards

- Telecommunications networks (telephony networks)
  - PSTN (your wireline telephony network)
  - SS7 (signaling network of PSTN)
  - Extend to GSM, 3G wireless telephony networks
  - Standardization: UMTS, 3GPP, 3GPP2

- Future trends
  - Confluence of these two types of networks
  - The boundary becomes more blurry
Standards

- IETF
  - TCP, IP, Mobile IP, HTTP, SIP
- 3GPP, 3GPP2
- IEEE 802 (PHY/MAC)
  - 802.11 WLAN (wireless local area network)
  - 802.15 WPAN (wireless personal area network)
  - 802.16 WMAN (wireless metropolitan area network)
  - 802.20 (mobile wireless broadband access)
  - 802.21 (handoff over heterogeneous networks)
- ITU
Challenges: interference/fading

- Before Cellular (Improved Mobile Telephone Service)
  - Geographically Separated Large Cells
  - Low Capacity
  - Mobility Within Cell
- First/Second Generation (Cellular FDMA, TDMA, CDMA)
  - Smaller Cells Isolated by Frequency and/or Time Slots
  - High Capacity via Cell Splitting
  - Mobility Across Cells
- Second/Third Generation (W-CDMA)
  - Cooperating Cells Using Same Frequency
  - High Capacity without Cell Splitting
  - Mobility and Better Coverage Between Cells
Challenge: mobility

- Mobility management
  - How do I find the person I want to call?
  - User location and registration
    - Location register databases
  - Home network & foreign network

- Handoff
  - Fast handoff design
  - Vertical handoff in heterogeneous networks
Challenges: services

- What are the killer applications?
- Service ➔ $$$
- Application-driven system design
- A wireless/mobile networking system to support the desirable service
  - Multimedia?
  - Data?
- Service requirement
  - Design goals
  - Optimization objectives