
Wireless Networks

Lecture 1: Course Organization, A Bit of History

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Schedule for Today

- **Goals and structure of the course**
- **Administrative stuff**
- **A bit of history**
- **Wireless technologies**

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Goals of the Course

- **Learn about the unique challenges in wireless networking**
 - » Starting point is “regular” wired networks
- **Gain an understanding of wireless technologies at the physical, MAC, and higher layers**
 - » Physical layer essentials
 - » Focus is on the wireless protocol layer
 - » Implications for the higher layers of the protocol stack
- **Get experience in working with wireless networks**
 - » Measurements of wireless networks
 - » Implementing protocols, algorithms

Lectures

- **Introduction**
 - » Why are wireless networks so interesting?
 - » A very quick overview of networking
- **Physical layer concepts (6-7)**
 - » Focus on understanding the impact on higher layers
 - » Not an in-depth course on the communications field!
- **LANs and WiFi (7-8)**
- **Cellular networks (3-4)**
- **PAN, sensor networks (2)**
- **Ad hoc, localization, etc. (5-6)**

Projects

- **Projects are hands-on, team-based**
- **Measurement project to improve your understanding of wireless link properties**
 - » Measure signal strength and other signal properties
 - » How do they relate to the physical context?
- **Implementation of an ad hoc routing protocol**
 - » Needs to deal with the unpredictable nature of wireless links and with mobility
 - » Multi-phase projects: start small and work your way up to larger networks

Prerequisites

- **This course assumes you have taken an “Introduction to Computer Systems” course**
 - » For example based on the O'Hallaron and Bryant book
- **We will also build on basic networking and signals but the course includes introductory material on these topics**
- **Programming experience**
 - » C/C++ programming for the project
- **Course should be accessible to students with a broad range of backgrounds, but ...**
- **I don't know you, so please ask questions when something is not clear!**

Grading

Grade distribution:

- 4 quizzes: 20
- Project 1: 10
- Project 2: 20 + 10
- Midterm: 20
- Final: 30

Administrative Stuff

- **Two textbooks:**
 - » “移动互联网导论”，王新兵，清华大学出版社，2015
 - » "Wireless Communication Networks and Systems", Corry Beard and William Stallings, Pearson, 2015
 - » Will not cover all the material in the book, but slides are detailed
- **Web page is primary source for information**
 - » Lecture material
 - » Dates for quizzes, exams and project deadlines
- **Teaching assistant: Jing Wang**
<jing.wang@pku.edu.cn>

Collaboration

- **Traditional rules of collaboration apply**
 - » <http://dean.pku.edu.cn/notice/content.php?mc=61513&id=1419312543>
- **You must complete individual assignments and tests by yourself**
- **You must collaborate with your partner in the team-based projects**
- **It is acceptable and encouraged to help fellow students with generic problems**
 - » E.g. where to find documentation, use of tools, ..
- **Provide proper credit when reusing material**
 - » But check with instructor or TAs first

Course Material

- **Most slides were prepared by the course instructor**
- **Some slides contain material from other sources**
 - » Previous co-instructors have contributed slides
 - » Some figures are taken from the textbook
 - » Some lectures contain material from other presentations or tutorials

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Common Theme in Wireless?

Benefits

- Can be used while mobile
 - » No wires
- Infrastructure is often cheaper
 - » No wires

Answer: No Wires!

Challenges

- Signal strength and link quality are highly variable, unpredictable
 - » No wires to “protect” signal from interference
- Throughput limited by spectrum availability
 - » No wires means that spectrum must be shared with lots of other users

Some History...

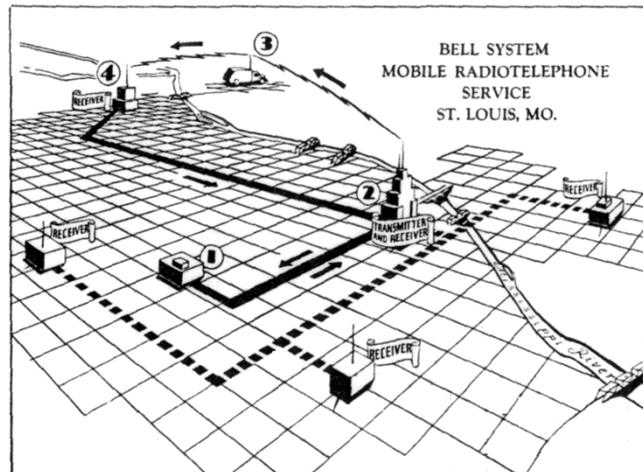
- **Tesla credited with first radio communication in 1893**
- **Wireless telegraph invented by Guglielmo Marconi in 1896**
- **First telegraphic signal traveled across the Atlantic ocean in 1901**
- **Used analog signals to transmit alphanumeric characters**

Mobile phones

- **2-way 2-party communication using digital transmission technology**
- **In 2002 the number of mobile phones exceeded that of land lines**
 - » More than 1 billion mobile phones!
- **In 2013, there were almost as many cell phone subscriptions as people**
 - » 6.8 billion subscriptions versus 7 billion people
- **The only telecommunications solution in developing regions**
- **How did it all start?**

The MTS network

<http://www.privateline.com/PCS/images/SaintLouis2.gif>



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The origin of mobile phone

- America's mobile phone age started in 1946 with MTS
- First mobile phones bulky, expensive and hardly portable, let alone mobile
 - » Phones weighed 40 Kg~
- Operator assisted with 250 maximum users



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Cell Phones Today

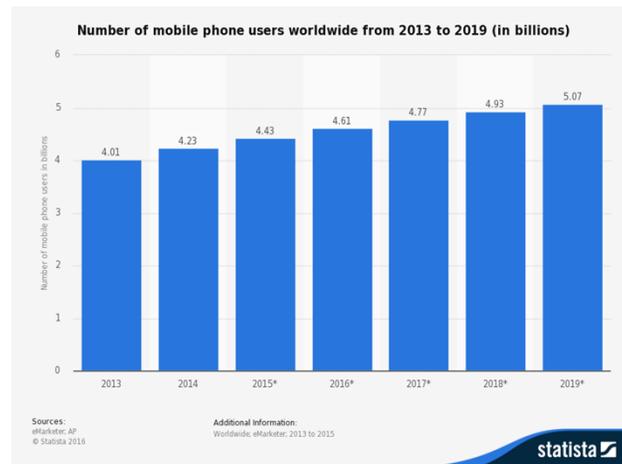
Some statistics for the US:

- **Two hundred trillion text messages/day**
 - » Average US teens sends 3339 texts per month
 - » 42% of teens can text while blind folded
 - » No 2 use of cellphones (what is No 1?)
- **People use their phones for lots of things**
 - » Take pictures (83%), play music (60%) and games (46%)
 - » Exchange videos (32%), access the web (27%) and social networks (23%)
 - » Use of cell phones for voice calls is declining
- **It is a big business**
 - » Dollars spent on mobile devices: 42.8 M\$ (2010) versus 1.8 B\$ (2015)

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Cell Phone User Trends



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Short History of WiFi

- In 1985, the FCC opened up the 900 Mhz, 2.4 GHz and 5.8 Ghz bands for unlicensed devices
- NCR and AT&T developed a WiFi predecessor called “Wavelan” starting in 1988
 - » NCR wanted to connect cashier registers wirelessly
 - » Originally used the 900 MHz band and ran at 1 Mbps
- Standardization started in early 90s and led to 802.11b (1999) and 802.11a (2000)
 - » Pre-standard products were available earlier
- Today –many standards!
 - » Working on 802.11aq - rates up to several 100 Mps
 - » Very sophisticated technology: OFDM, MIMO, multi-user MIMO, ..

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Early WiFi Interfaces



PCMCIA form factor
make Wavelan more
portable

Wavelan at 900MHz
1 Mbps throughput



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Trends in Wireless

- **Early days: specialized applications**
 - » Broadcast TV and radio, voice calls, data, ..
 - » Holds for wireless and wired
- **Today: flexible wireless platforms**
 - » Phones, tables, and laptops all support similar applications
 - » Same trend as for wired networks: the internet took over
 - » Wireless technology is still different but gap is shrinking
- **Wireless is expanding in new domains**
 - » Sensor networks, body area networks, ...
 - » Edge of the internet is increasing wireless
 - » Many of these applications are unique to wireless
- **Future?**

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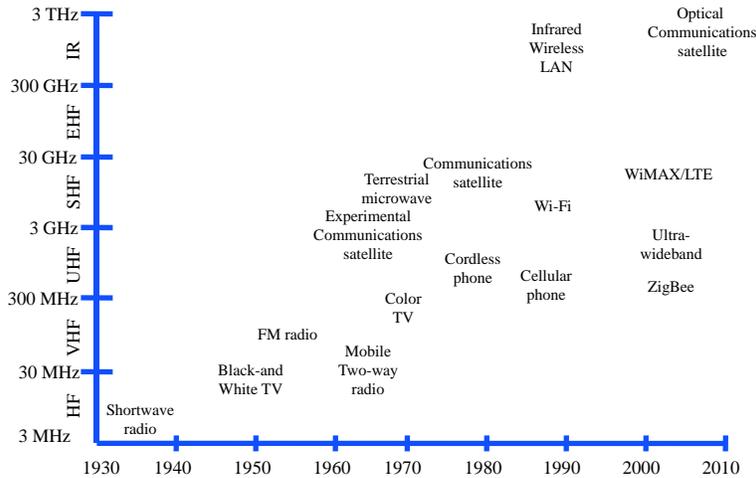
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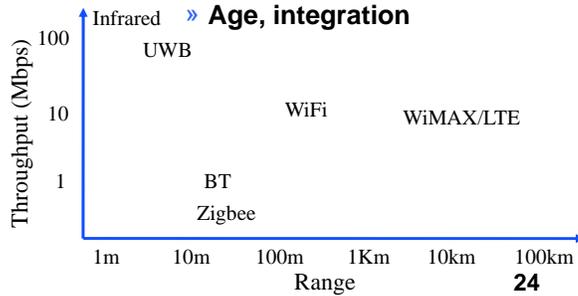


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Why so many?

- **Diverse application requirements**
 - » Energy consumption
 - » Range
 - » Bandwidth
 - » Mobility
 - » Cost
- **Diverse deployments**
 - » Licensed versus unlicensed
 - » Provisioned or not
- **Technologies have different**
 - » Signal penetration
 - » Frequency use
 - » Cost
 - » Market size
 - » Age, integration



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