CS 294-7: Course Overview

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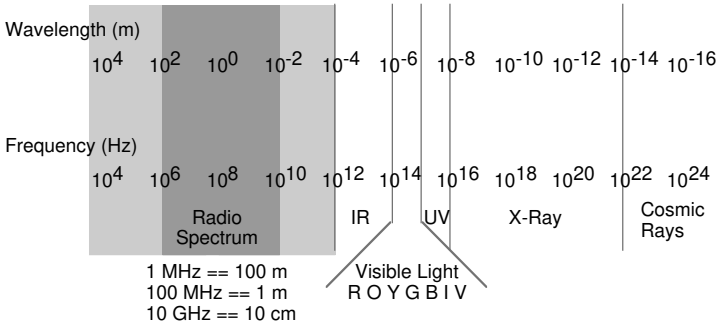
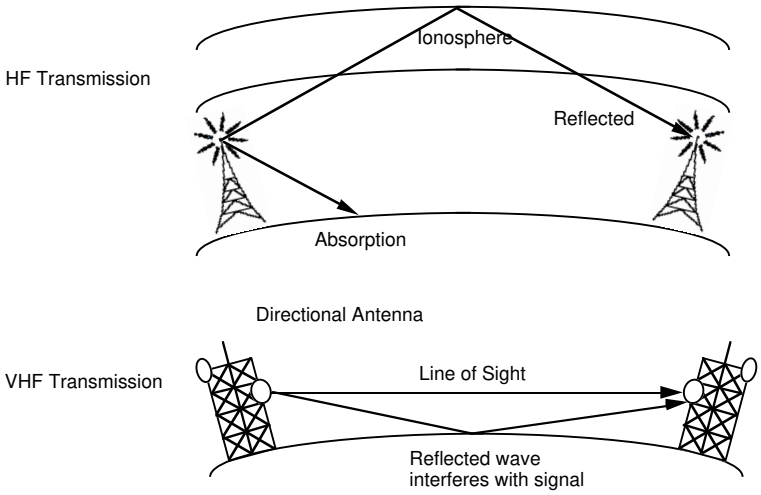
Radio Basics



< 30 KHz	VLF
30 - 300 KHz	LF
300 KHz - 3 MHz	MF
3 - 30 MHz	HF
30 - 300 MHz	VHF
300 MHz - 3 GHz	UHF
3 - 30 GHz	SHF
> 30 GHz	EHF

Radio Basics



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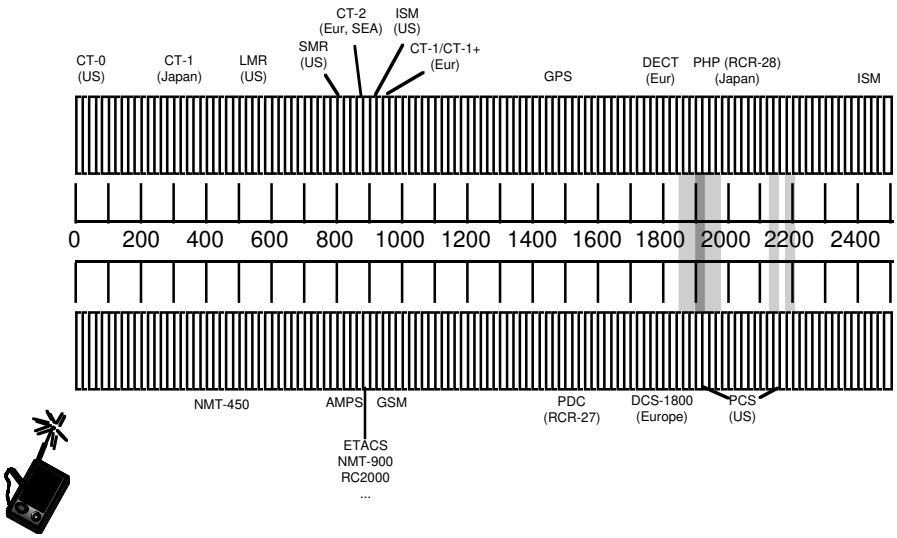
Wireless Spectrum



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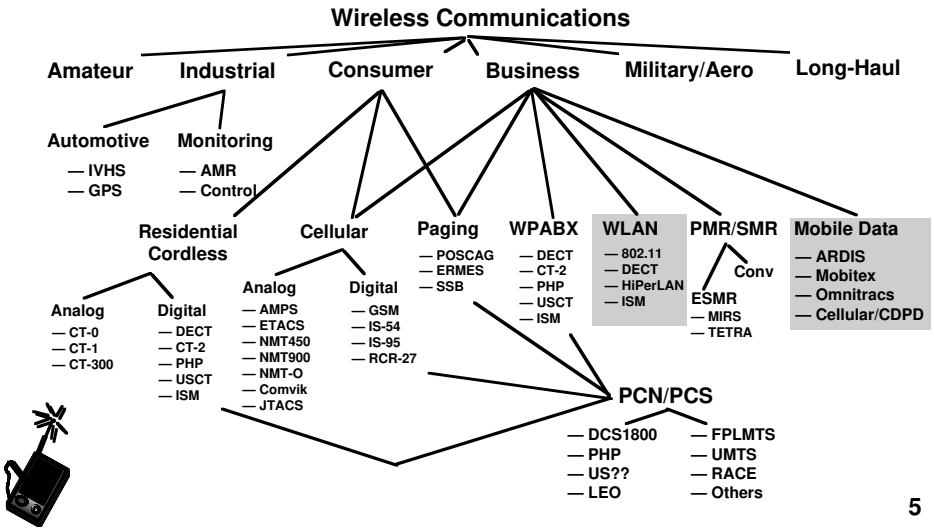
The Wireless Universe



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Radio Telegraphy (also know as “Wireless”)

- **Radio technology**
  - Communicate with ships and other moving vehicles
  - Messages sprayed into the “ether” crossing natl boundaries
  - Downfall of the nationally supported monopolistic telegraph companies
- **1896: Guglielmo Marconi**
  - First demonstration of wireless telegraphy
  - Built on work of Maxwell and Hertz to send and receive Morse Code (first radio broadcasts were digital!)
  - Based on long wave (>> 1 km), spark transmitter technology, requiring very large, high power transmitters
  - First used by British Army and Navy in the Boer War (first research funding by the military!)
  - 1899: Reported to shore America’s Cup yacht races

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Wireless

- 1907: Commercial Trans-Atlantic Wireless Service
  - Huge ground stations: 30 x 100m antenna masts
  - Beginning of the end for cable-based telegraphy
- WW I: Rapid development of communications intelligence, intercept technology, cryptography
- 1920: Marconi discovers shortwave (<100 m) radio
  - Longwave follow contour of land
    - » Very high transmit power, 200 KW+
  - Shortwaves reflect, refract, and absorb, like light
    - » Bounce off ionosphere
    - » Higher frequencies made possible by vacuum tube (1906)
    - » Cheaper, smaller, better quality transmitters

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Other Important Dates in Mobile Radio

- 1915: Wireless voice transmission NY to SF
- 1920: First commercial radio broadcast (Pittsburgh)
- 1921: Police car dispatch radios, Detroit
- 1935: First telephone call around the world
- WW II: Rapid development of radio technology
- 1968: Carterphone decision
- 1974: FCC allocates 40 MHz for cellular telephony
- 1982: European GSM and Inmarsat established
- 1984: Breakup of AT&T
- 1984: Initial deployment of AMPS cellular system

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Tradition View of Wireless Communications

- Physical Layer
  - Radio Propagation
  - Modulation Schemes
- Link Layer
  - Media Access
  - Channel Allocation
    - » Frequency Division Multiple Access (FDMA)
    - » Time Division Multiple Access (TDMA)
    - » Code Division Multiple Access (CDMA)
  - Error Coding
- Cellular Telephony
  - Frequency Reuse Schemes
  - Speech Coding
  - Algorithms for Handoff

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Topics to be Covered

- Basics of Radio Propagation
- Wireless Media Access
- Wireless Telecommunications Systems
- Wide Area Packet Radio Networks
- Wireless Local Area Networks
- Mobile IP/Wireless TCP
- Mobile Handoff and Network Services
- Security and Authentications
- Mobile Satellite Systems

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Effect of Mobility on Communications Systems

- **Data Link Layer**
  - Fading radio channels, characterized by burst errors
  - Reliable communications interrupted by fades
- **Network Layer**
  - Rerouting due to movement

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- **Presentation Layer**
  - Source coding for better spectrum efficiency
- **Application Layer**
  - Location dependent applications

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Mobile Systems Architecture

This Course

TCP/IP	Mobile/ Wireless Subnet Cntr	Link Controller	Tranceiver Frame Controller	Physical Radio
Non-RT Subnet Control Routing, QoS Multicasting Neighbor Discovery Pwr Save Modes Pre-transport cond Internet-to-subnet routing & addr xlation Subnet Security Subnet Mgmt Client Subnet Measurements	**Realtime Subnet Control** MAC-layer sched Cntl radio char LL Acks/Nacks LL Queuing Xcvr Src/Dst Addr for link addresses Routing/QoS cache table for MH nets Link Measurements	**Continuous framing ops** Frame synch Zero insertion Xcvr src/dst/bcast Xmt/Rcv FIFOs CRC ECC Framing stats	**Continuous radio ops** Carrier Freq. Code Cntl/Scan Phase/ Packet Acquisition RSSI Pwr Cntl Bit & Symbol Rates Carrier Detect Capture Detect	

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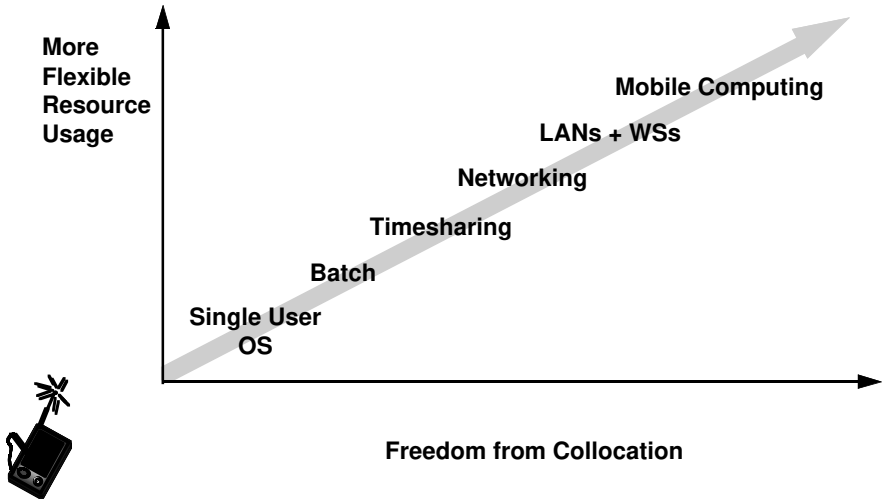
Why Mobile Computing?
Natural Evolution of Computing



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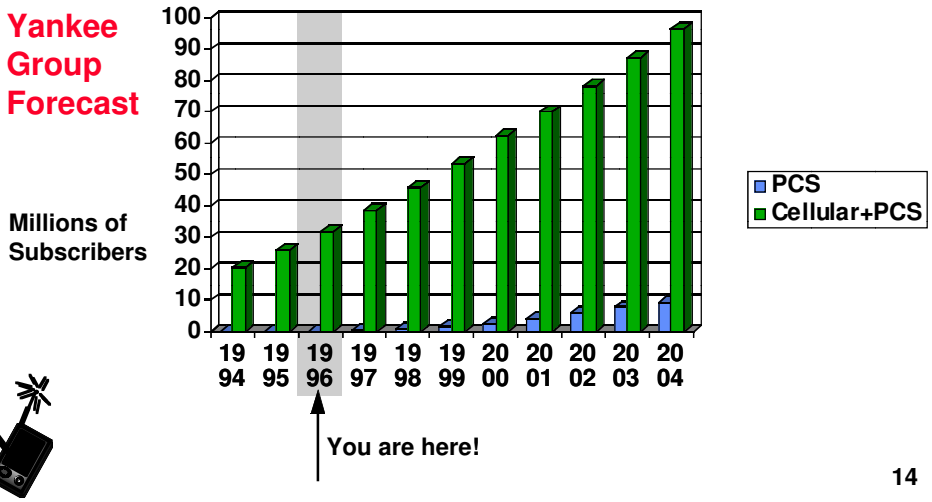
Why Mobile Computing?
Proliferation of Wireless Services



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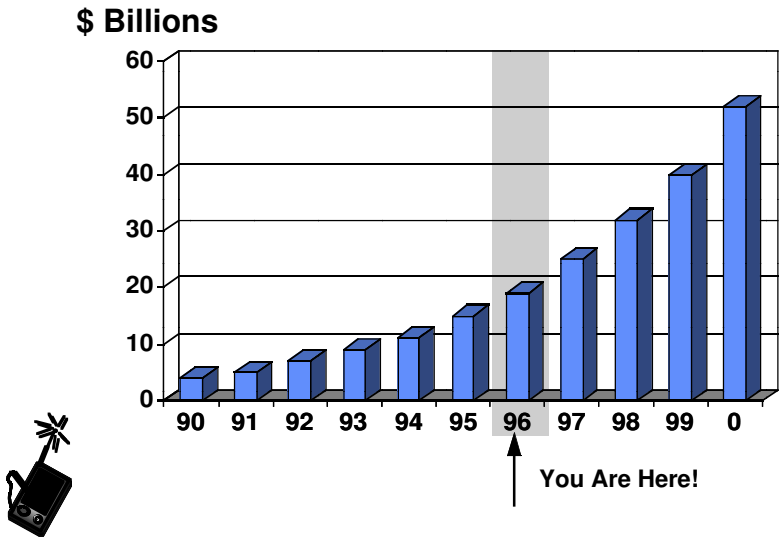
Why Mobile Computing?
Global Markets for Portable Computers



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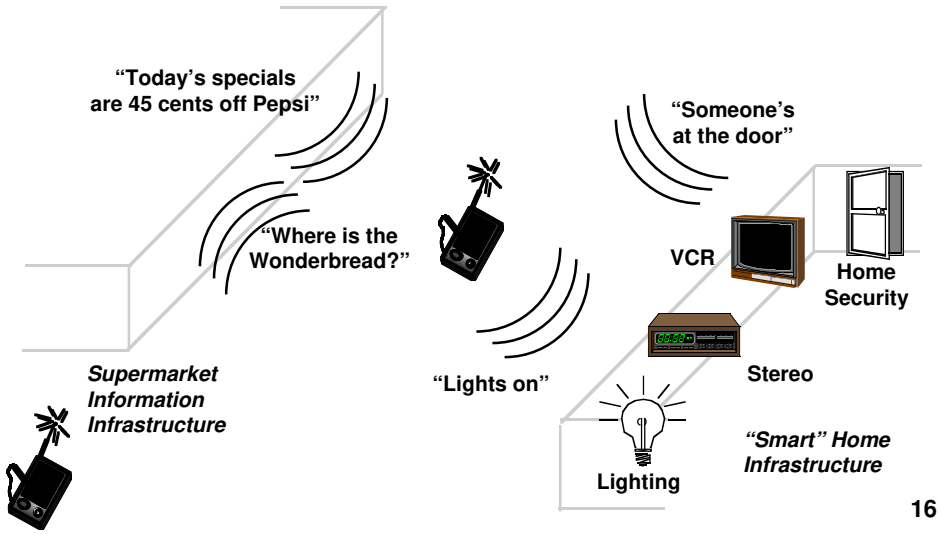
Universal Interactor:
Adaptation to Services



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The Computer for the 21st Century, Mark Weiser

- Not personal computing, but “ubiquitous computing”
  - Computers so pervasive and so cheap that they “disappear” into the work environment
  - Computers as devices so interchangeable that they can be swapped and shared like pieces of paper
  - Not screen focused, by embedded in the woodwork

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The Computer for the 21st Century, Mark Weiser

- Technology that Disappears into the Background
  - Location
    - » Ubiquitous computers must know where they are (to adapt to the local environment)
  - Scale
    - » Many sizes, suited to the task at hand
    - » Tabs, Pads, Boards
    - » Potentially 100s of computers in a room

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The Computer for the 21st Century, Mark Weiser

- **Active Badge System: the value of location awareness**
  - **Tab sized unit**
    - » **Doors open to right wearer**
    - » **Telephone call directed to nearest telephone**
    - » **Terminals retrieve user preferences**
- **Pad**
  - **Notebook sized**
  - **“Scrap” computers**
  - **Reverse of windows: many pads per desktop**
- **(Live) Boards**
  - **40 x 60 inch display devices**

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The Computer for the 21st Century, Mark Weiser

- **Technology underpinings**
  - **Cheap, low power computers**
    - » **1 gigop, 16 MB (???) by end of decade**
    - » **60 MByte disk drives size of matchbook**
  - **Displays**
    - » **1000 x 800 pixels, high contrast, weigh only 100 grams**
  - **Software for ubiquitous applications**
    - » **Limitations of existing windowing software**
  - **Network**
    - » **New protocols for machines that move space**
    - » **Needs for high bandwidth per cubic meter**
    - » **Multiple interfaces: tiny range wireless, long range wireless, very high speed wired interfaces**

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The Computer for the 21st Century, Mark Weiser

- **So What Ever Happened to Ubiquitous Computing?**
  - **Some real developments**
    - » **Echelon: a computer in every light switch**
    - » **Personal Digital Assistants (PDA)**
    - » **Lots of computers in my office**
  - **No killer application for Ubiquitous Computing (or PDAs for that matter)**
    - » **People who use computers are computer users**
    - » **Needed: breakthroughs in user interfaces and usability**
  - **Is it computers that are ubiquitous or information?**
    - » **The net is everwhere**
    - » **$500 Web computers?**

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