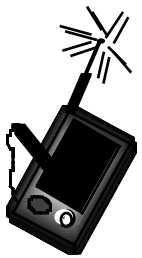
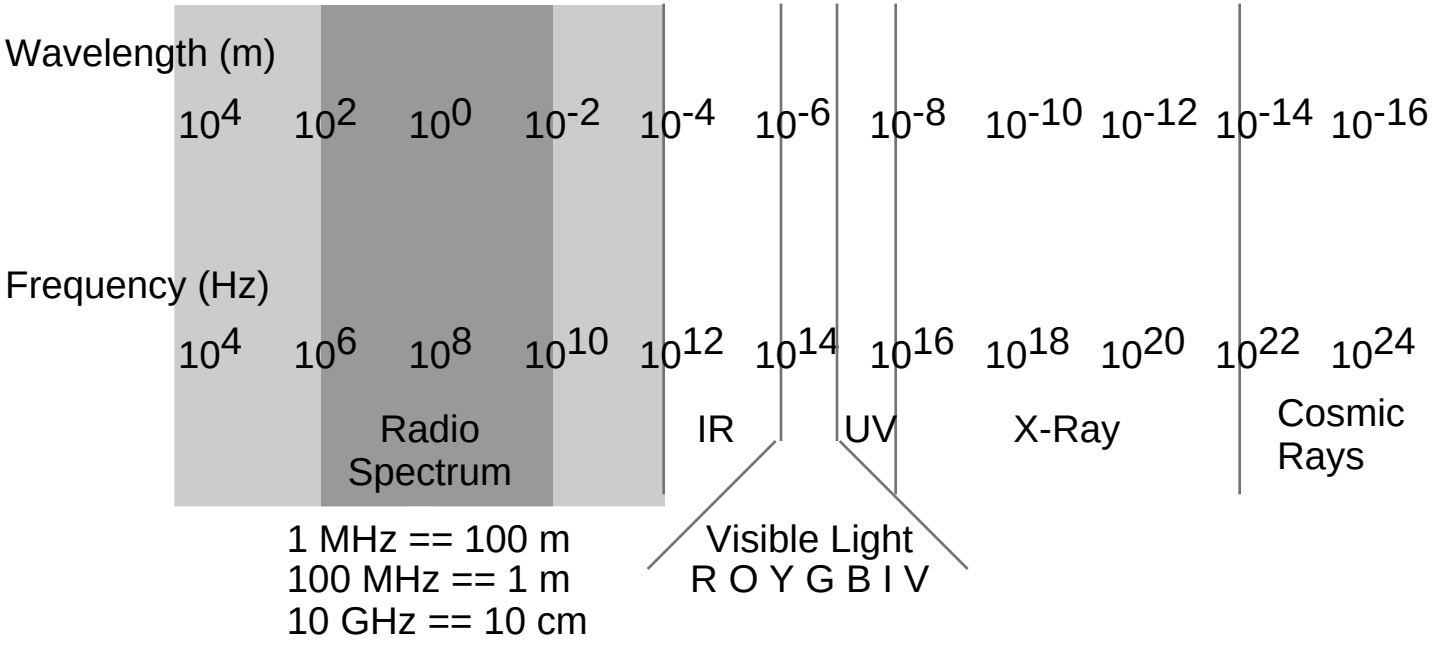
CS 294-7: Course Overview

Prof. Randy H. Katz
Computer Science Division
University of California, Berkeley
Berkeley, CA 94720-1776



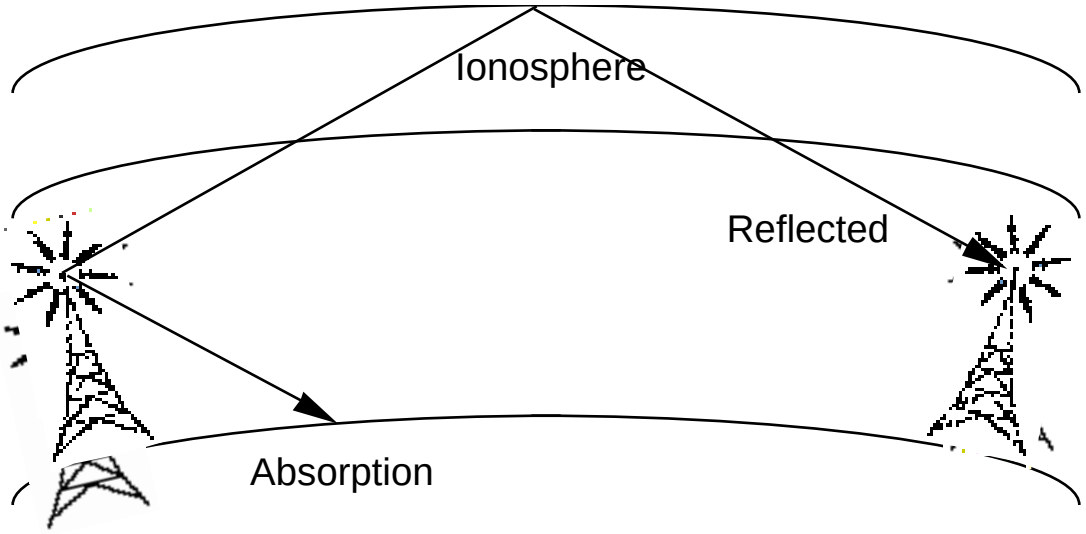
Radio Basics



< 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

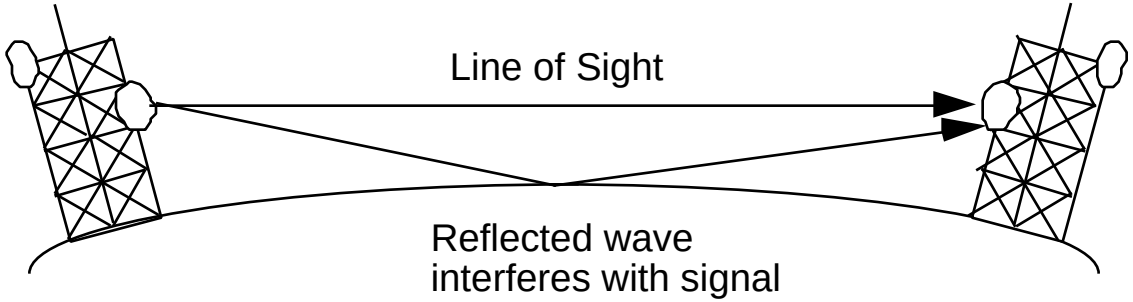
Radio Basics

HF Transmission

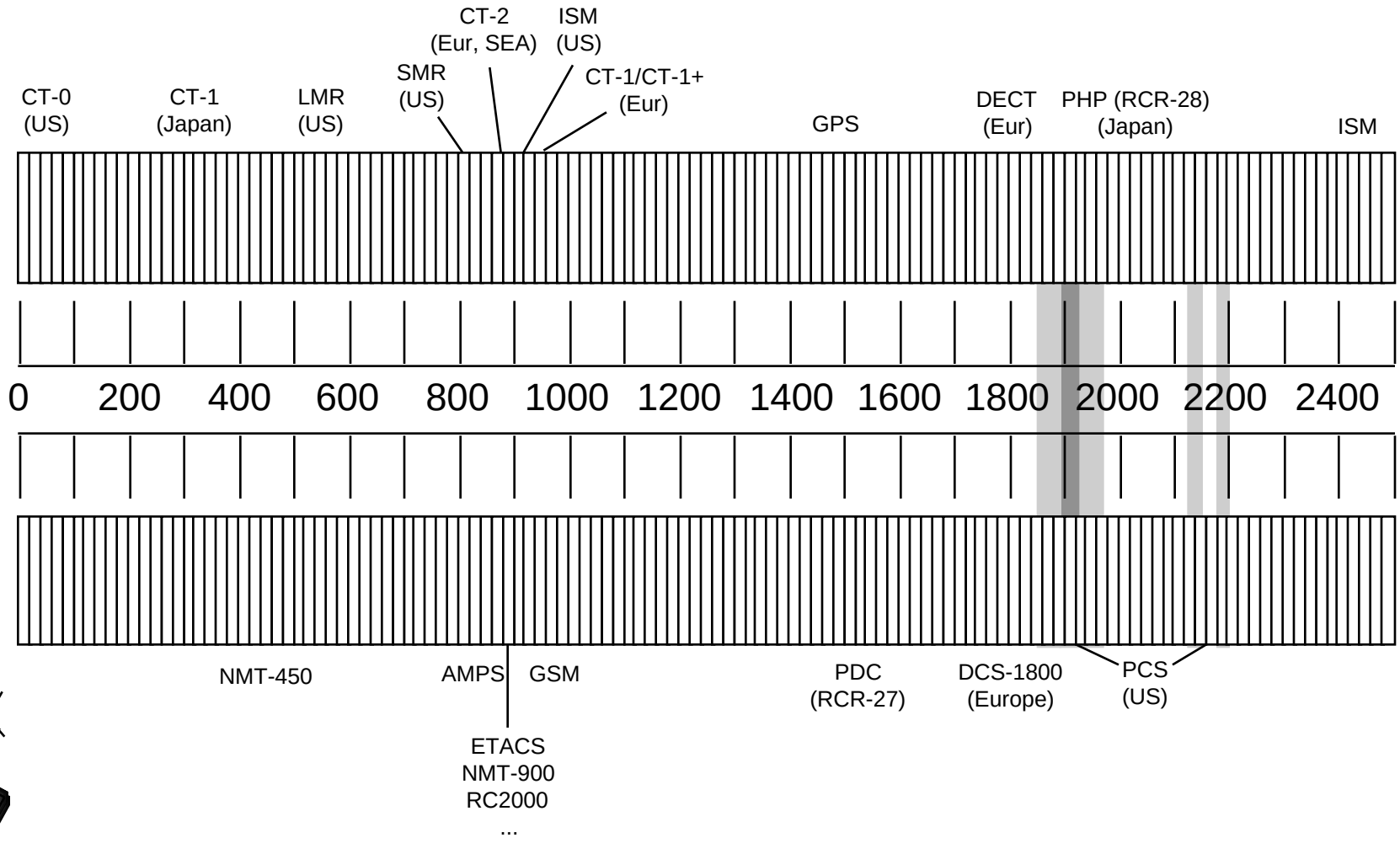


Directional Antenna

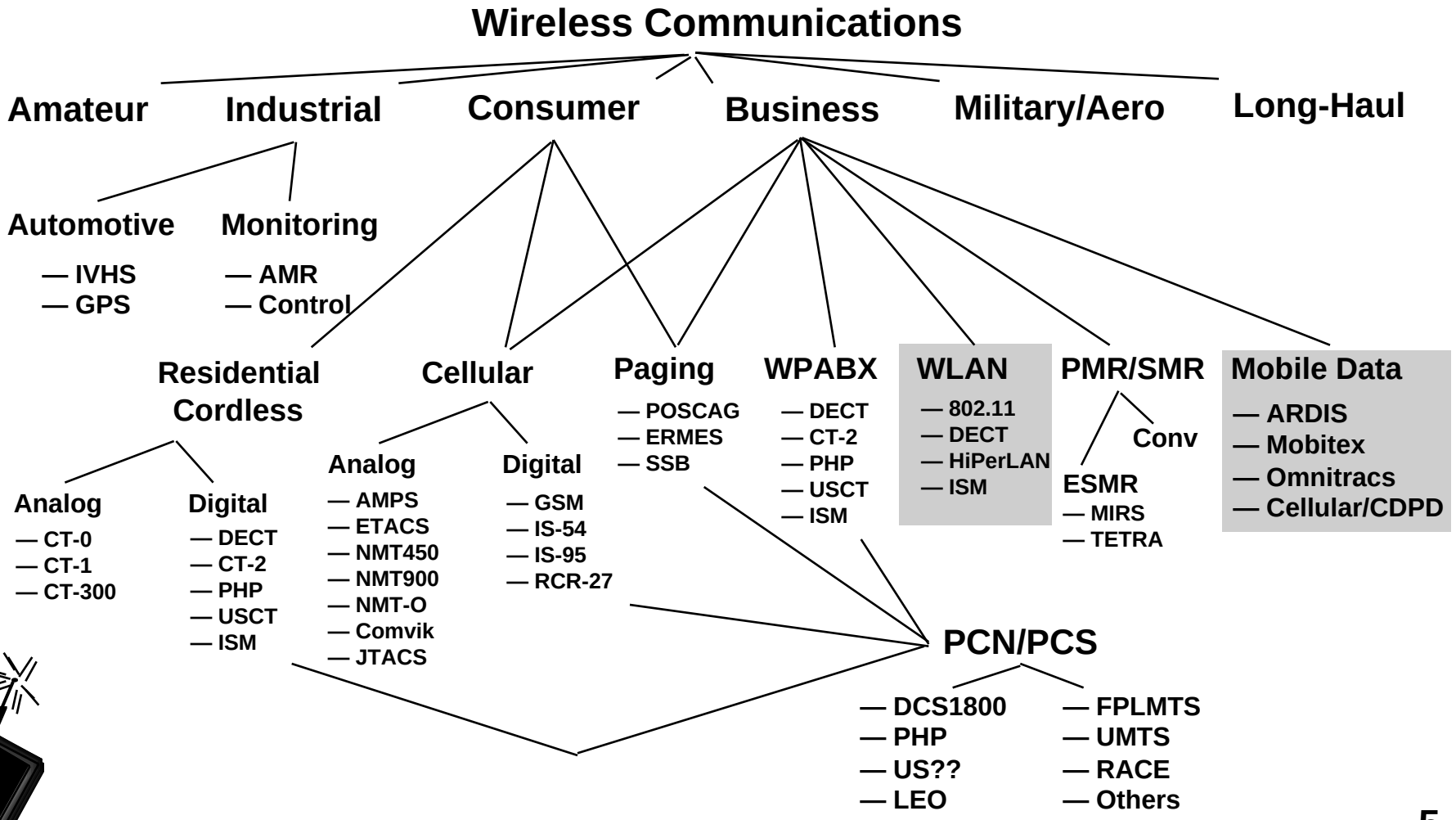
VHF Transmission



Wireless Spectrum



The Wireless Universe



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**

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**

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

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**

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

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

CS 294-7

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

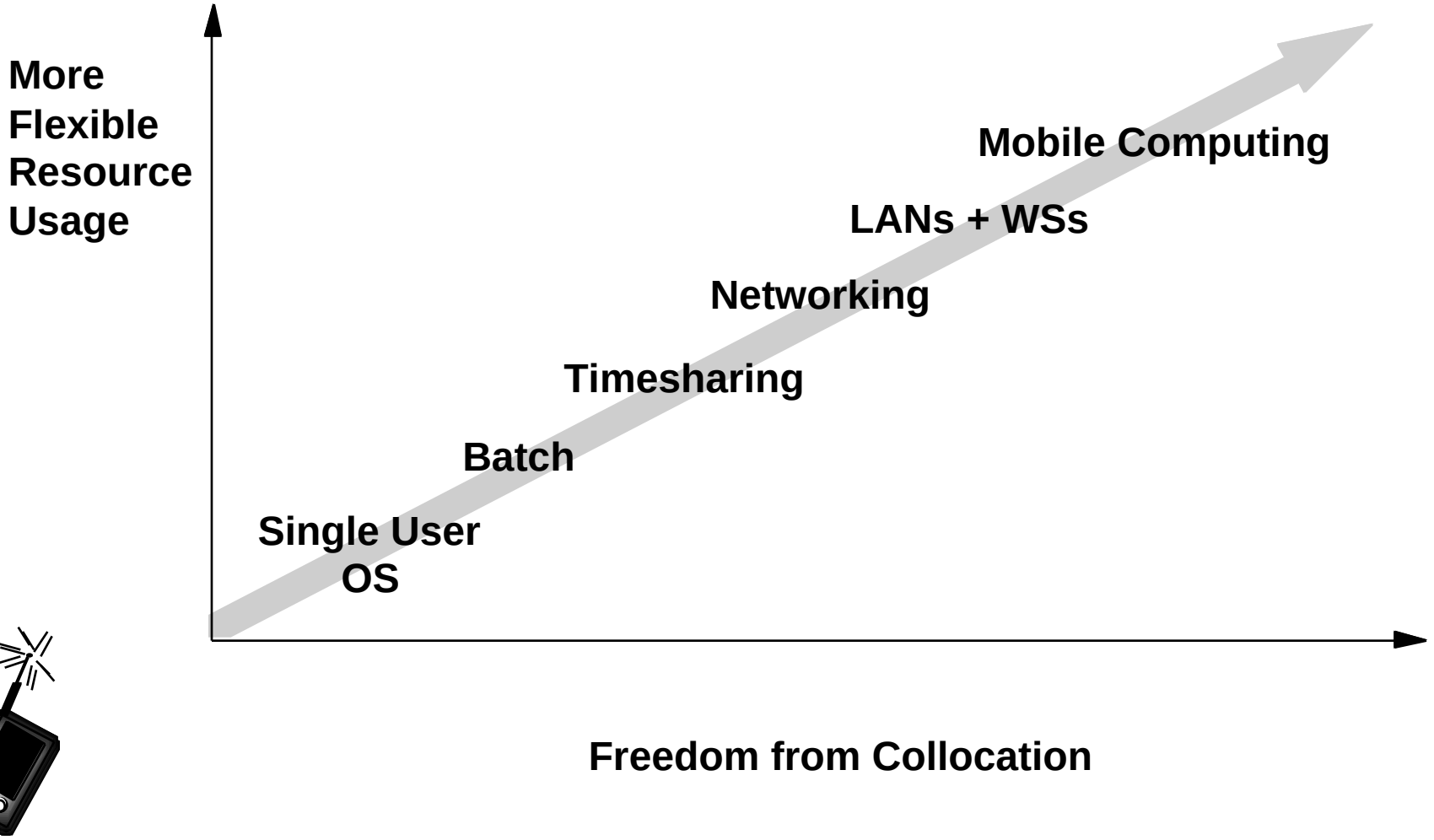
CS 269

Mobile Systems Architecture

This Course

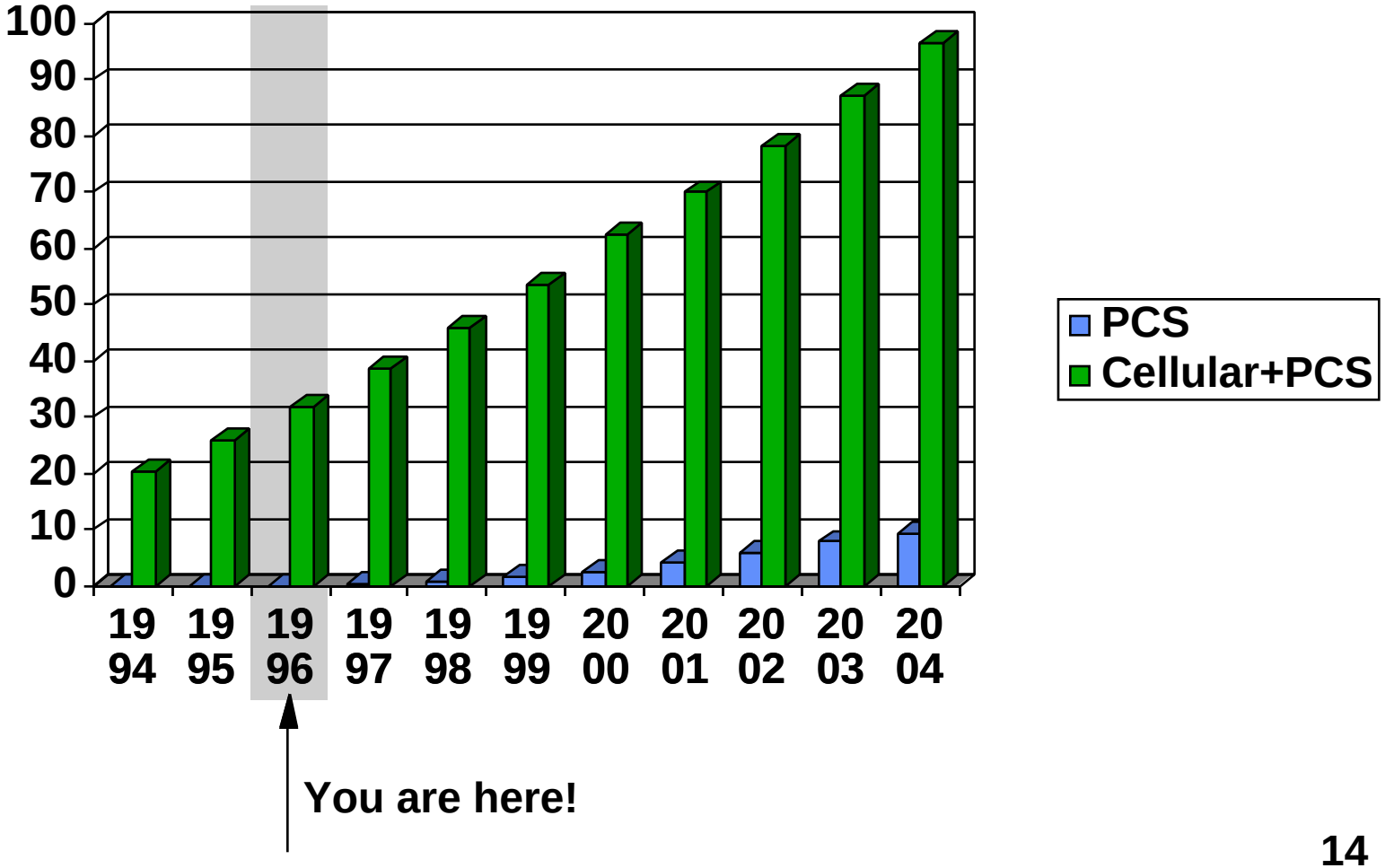
TCP/IP	Mobile/ Wireless Subnet Cntr	Link Controller	Tranceiver Frame Controller	Physical Radio
	Non-RT Subnet Control Routing, QoS Multicasting Neighbor Discovery Pwr Save Modes Pre-transport cond Internet-to-subnet routing & addr xlation Subnet Security Subnet Mgmt Client Subnet Measurements	**Realtime 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

Why Mobile Computing?
Natural Evolution of Computing

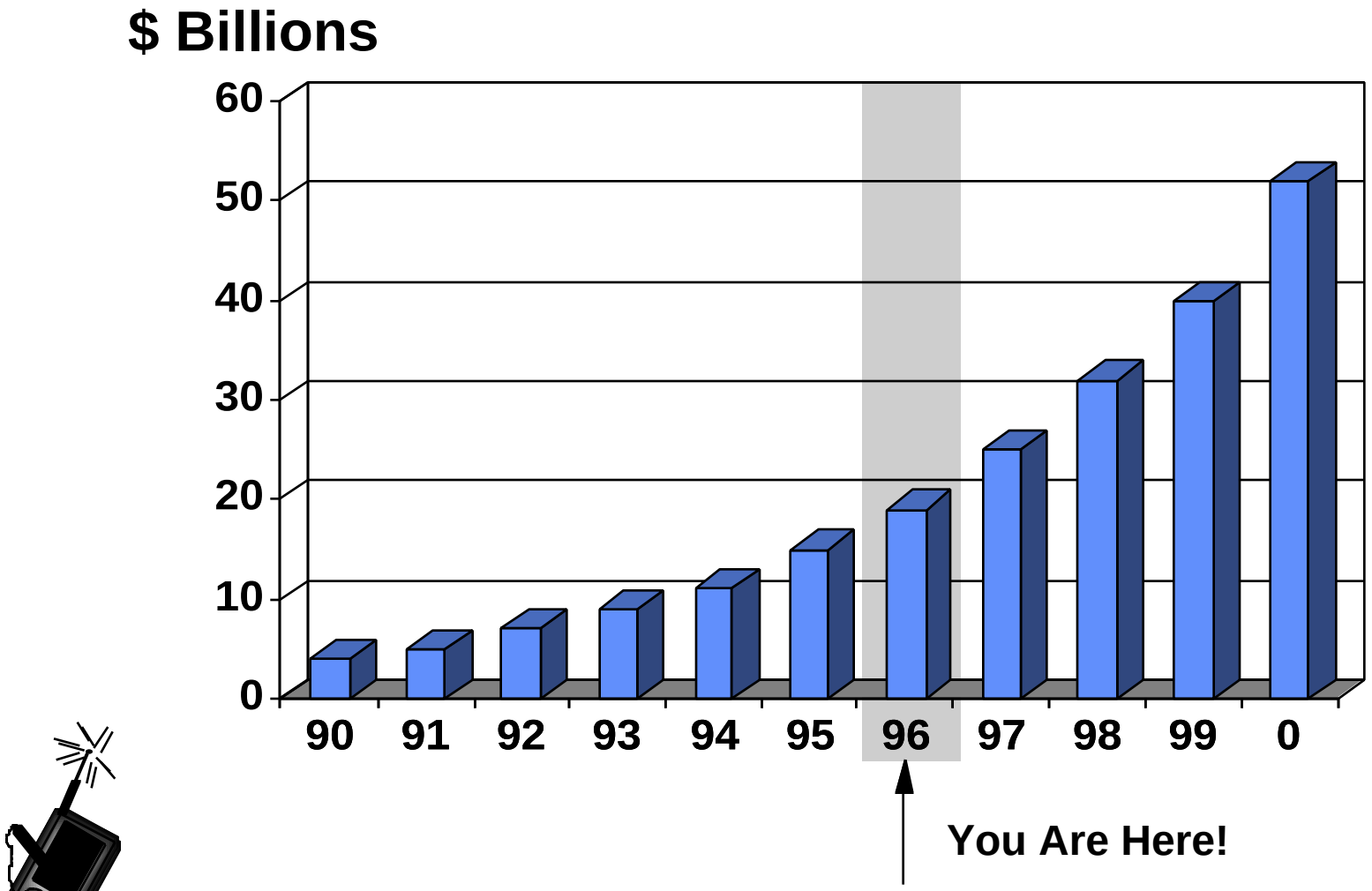


Why Mobile Computing?
Proliferation of Wireless Services

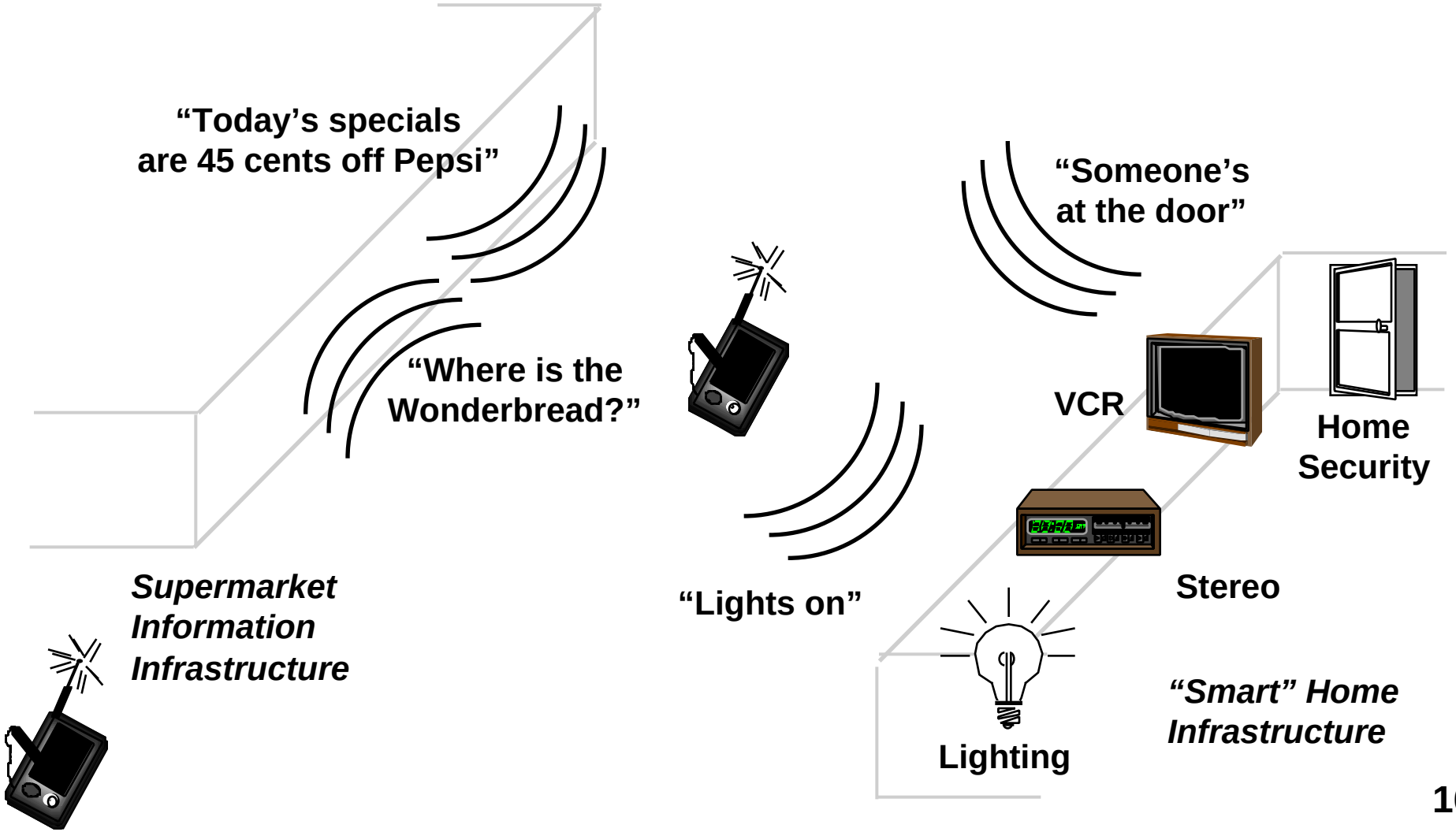
Yankee Group Forecast



Why Mobile Computing?
Global Markets for Portable Computers



Universal Interactor: Adaptation to Services



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**

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**

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**

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**

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?**