Lecture 1b

Introduction

Wireless Communication Systems

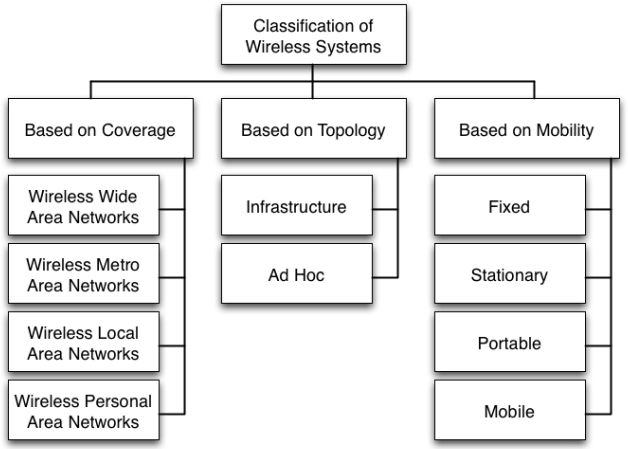
- Wireless communication system
  - Any electrical communication system that uses a naturally occurring communication channel, such as air, water, earth
- Examples:
  - Cell phone, sonar, ground penetrating radar
  - Broadcast: (one way)
    - Radio, TV, pagers, satellite TV
  - Two Way:
    - Walkie talkie, cell phones, satellite phones, WiFi, Bluetooth
- Fundamentally different from wired networks

Mobile Vs. Wireless

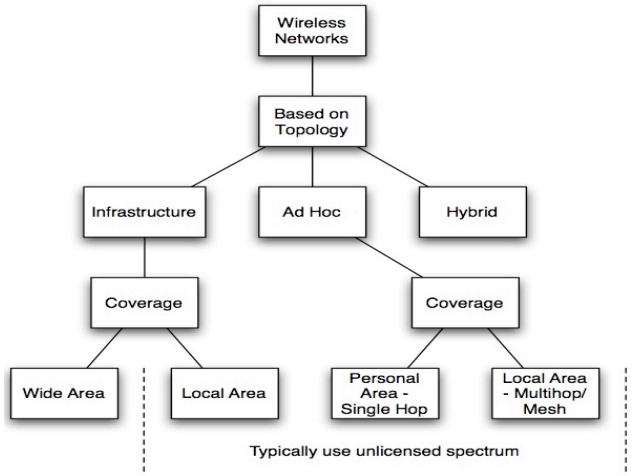
- Mobile and Wireless are not interchangeable
- *Mobile* and *wireless* communication systems
  - Communicate over the air via radio-waves
  - Support "some" form of user mobility

Mobile	Wireless	Example
×	×	Desktop computer with Ethernet, pay phone
×	✓	Wireless local loop
✓	×	Calling card, call forwarding
✓	✓	Cell phone, laptop with WLAN

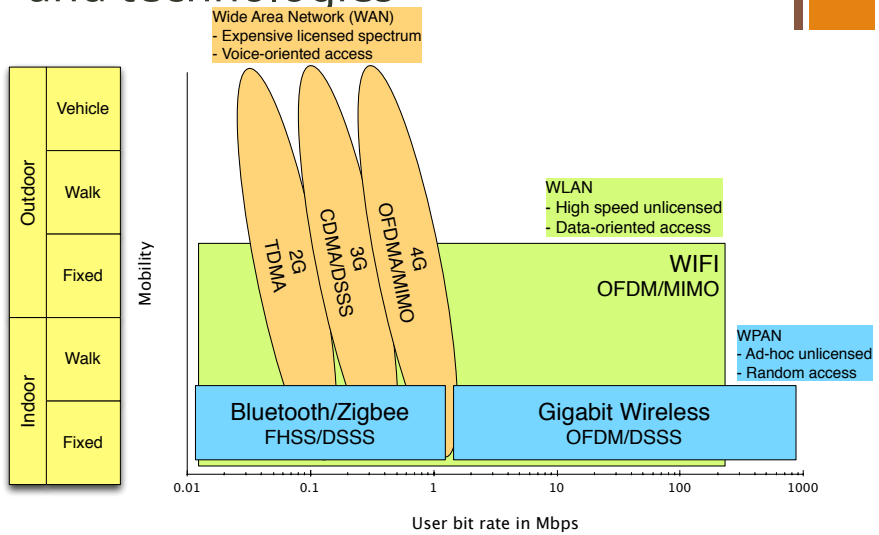
Classification of Wireless Systems (1)



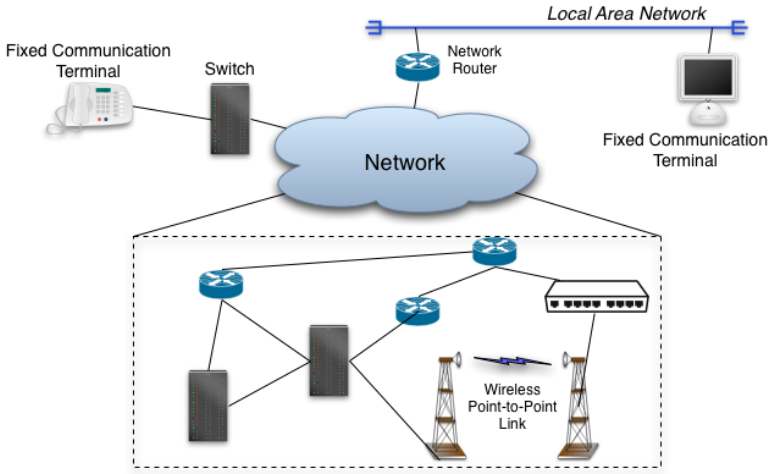
Classification of Wireless Systems (2)



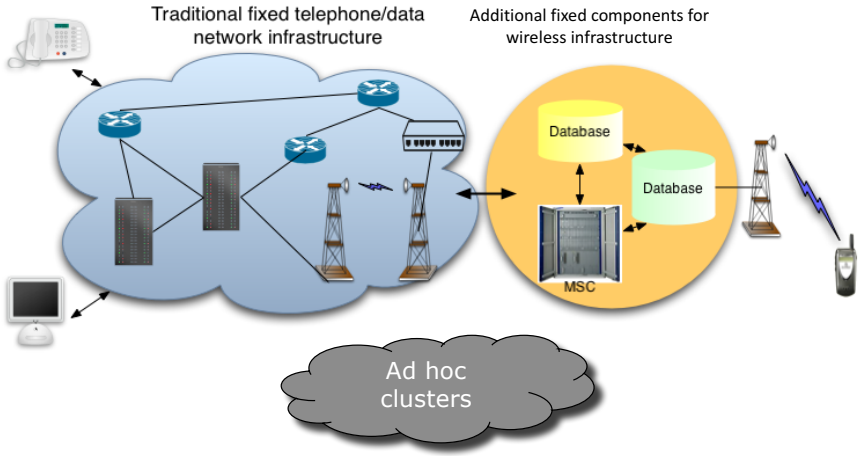
Classification based on data rates and technologies



Traditional Wired Networks



Positioning of Wireless Networks



Infrastructure Topology

- Basics
  - A wired (fixed) infrastructure supports communications between wireless devices and between wireless devices and fixed devices
- Base Stations (BSs) or Access Points (APs) form the point of access to the network
  - Each BS covers an area called a “cell”
  - Multiple BSs are interconnected to cover a larger geographical area
- Star topology
  - The BS or AP is the hub
  - Any communication from a wireless device to another has to be sent through the BS or AP
  - The BS or AP manages user access to the network

What is extra?

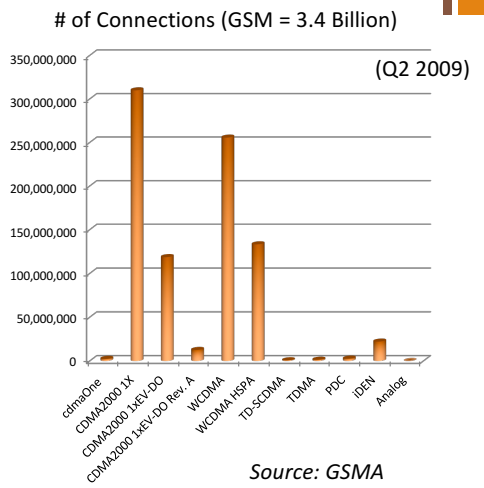
- Wireless transceivers
  - Base stations – BSs and Access points – APs
  - Mobile stations - MSs
- Spectrum
  - Frequency bands for uplink and downlink
  - Air interface
- Management Entities
  - Mobility management
  - Power management
  - Radio resource management
  - Security
- Deployment
  - Frequency reuse
  - Network design

Examples of Infrastructure Wireless Networks

- Wide area
  - Voice oriented - Cellular telephone systems
  - Data oriented - Mobile data systems
- Local Area
  - Voice oriented - Wireless PBXs
  - Cordless phones
  - Data Oriented - Wireless LANs
- Today
  - Mixed environments (e.g., UMTS and LTE)

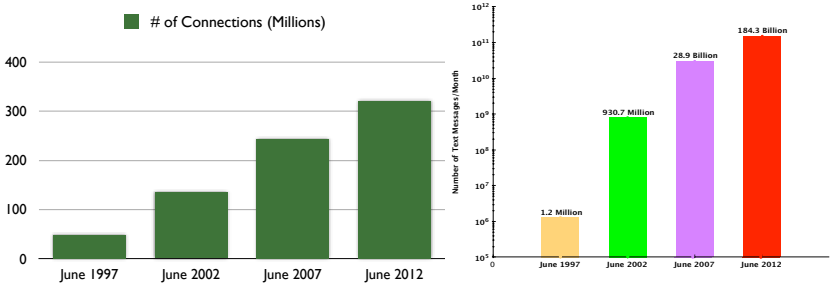
The Cellphone Industry

- Mobile phone systems
  - Support communication to mobile users via wireless radio channel
- Fastest growing technical device EVER!
  - Variety of systems
    - 4.3 Billion Connections (Q2 2009)
      - Over 7 billion connections today
      - Over 3.6 billion unique subscribers



Source: GSMA

US Statistics

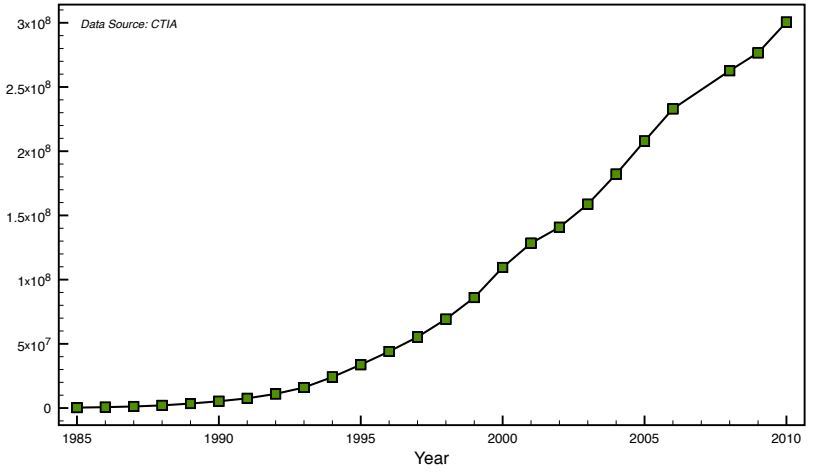


34% of Households are "Wireless Only"

Annual Total Wireless Revenues in 2012: $ 178.4 Billion
Annual Revenues from Data Traffic in 2012: $ 68.3 Billion

Data Source: CTIA - http://www.ctia.org/advocacy/research/index.cfm/AID/10323

Number of cellphone subscribers



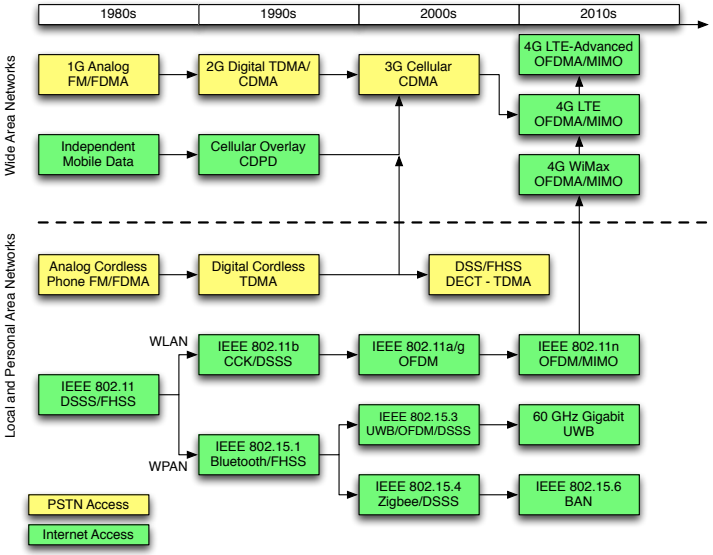
History of Wireless Voice Networks

Year	Event
1970s	Exploration of first generation mobile radio at Bell Labs; First generation cordless phones
1982	Exploration of second generation digital cordless CT-2
1982	Deployment of first analog cellular system: NMT
1983	Deployment of first US analog cellular system: AMPS
1983	Exploration of 2G digital cellular GSM
1985	Exploration of wireless PBXs and DECT
1988	Initiation of GSM development and IS-54 development
1988	Exploration of Qualcomm's CDMA technology
1991	Deployment of GSM
1993	Deployment of PHS/PHP and initiation of IS-95
1995	PCS Band auction
2000	Wireless Web, Wireless Application Protocol, GPRS
2002	3G Networks; Advances in 3G Networks
2011	LTE; Voice over LTE (VoLTE)?

Generations of mobile communications

Feature/ Decade	1980s	1990s	2000s	2010s	2020s
Generation	**First**	**Second**	**Third**	**Fourth**	**Fifth**
Keywords	Analog	Digital Personal	Global World Standards;	MIMO, High data rate; IP-Based	Cognitive? Open spectrum? high mobility? Massive MIMO
Multiple Access	FDMA	TDMA CDMA	CDMA, OFDM	OFDMA & MIMO	Mixed?
Cellular Systems	Analog Cellular	Digital Cellular	UMTS, cdma2000 (3G-Cellular) Rates ~ 10 Mbps	LTE, WiMax, HSPA+	LTE-Advanced, 5G-Cellular, ITS
Wireless Local Area Networks		Mobile Data Early WLAN	3G Data, 802.11b, a, g, n	801.ac	802.11ad, 802.11ax?

An evolutionary view of wireless technologies



Next Weeks

- More on generations of wireless networks
- Basic definitions
  - Channel
  - Spectrum efficiency
  - dB
  - Access