

G 364: Mobile and Wireless Networking

CLASS 17, Mon. Mar. 15 2004

Stefano Basagni

Spring 2004

M-W, 11:40am-1:20pm, 109 Rob

Personal Communication Services (PCS)

- ◆ Wireless access and personal mobility services
 - High-tier cellular systems
 - Low-tier communication systems for residential and business application (cordless)
 - Wideband, wireless systems for internet and multimedia

High-tier cellular systems

- ◆ Advanced Mobile Phone Service (AMPS)
- ◆ Global System for Mobile Communications (GSM)
- ◆ EIA/TIA IS-136 TDMA (Digital AMPS)
- ◆ Personal Digital Cellular (PDC)
- ◆ EIA/TIA IS-95 CDMA-based cdmaOne System

Low-tier Communication Systems

- ◆ Cordless Telephone 2 (CT2)
- ◆ Digital Enhanced Cordless Telephone (DECT)
- ◆ Personal Access Communications Systems (PACS)
- ◆ Personal Handy Phone System (PHS)

Wideband Wireless Systems

- ◆ cdma2000 (from cdmaOne)
- ◆ W-CDMA
- ◆ SCDMA
- ◆ Also included under the PCS umbrella
 - Paging systems
 - Mobile satellites systems
 - ISM band technologies (Bluetooth, IEEE 802.11/15)

PCS Architectures

- ◆ Two major kinds
 - Cellular telephony
 - Cordless and low-tier PCS systems
- ◆ One common basic architecture
 - Radio network
 - Wireline transport network

Radio Network

- ◆ Mobile stations (MSs) (mobile users)
 - Different MSs have different characteristics: Power range, radio coverage
- ◆ Base station (fixed infrastructure)
 - Radio coverage of a base station = **CELL**
 - BSs reach the wireline transport network via land links

Wireline Transport Network

- ◆ Mobile Switching Center (MSC)
 - Switch tailored to support mobile applications
- ◆ MSC is connected to the Public Switched Telephone Network (PSTN)
- ◆ Mobility databases for tracking, roaming, billing and other services

Cellular Telephony

- ◆ Brief description of four popular cellular networks:
 - Advanced Mobile Phone Service (AMPS)
 - Global System for Mobile Communications (GSM)
 - EIA/TIA IS-136 digital cellular system
 - EIA/TIA IS-95 digital cellular system

AMPS, 1st gen. system, 1

- ◆ First cellular system, Bell labs, 70s
- ◆ Large scale trial in Chicago
- ◆ Commercially available since 1983
- ◆ FDMA with frequency reuse
- ◆ 832 full duplex channels
 - 832 uplink channels (from MS to BS)
 - 832 downlink channels (from BS to MS)

AMPS, 2

- ◆ Frequency reuse = cells are grouped into clusters
- ◆ Cell within a cluster may interfere → they must use different frequencies
- ◆ Frequencies can be **reused** in different clusters
- ◆ Implies 50 channels per cell
- ◆ Roaming and management according to EIA/TIA IS-41

Global System for Mobile Communications, GSM

- ◆ Digital cellular system, 2nd generation
- ◆ Developed in Europe, CEPT/ETSI
- ◆ Goal: Offer compatibility all around Europe
- ◆ TDMA and FDMA combined
 - Each frequency is divided into 8 slots: 8 voice channels for each BS tx/rx vs. the 1 of AMPS

GSM, 2

- ◆ BS are provided with power control (lowers interferences)
- ◆ Development similar to AMPS, 4 years; no large scale trial, property right waived
- ◆ Roaming management protocol is specified by GSM Mobile Application Part (MAP)
- ◆ GSM provides services like SMS, group addressing, call waiting

EIA/TIA IS-136 Digital Cellular System, 1

- ◆ Also called Digital AMPS, DAMPS:
Second generation AMPS
- ◆ TDMA air interface, similar to GSM
- ◆ Successor to IS-54, named IS-136 at revision C
- ◆ Four months development, no large scale trial

IS-136, 2

- ◆ Each frequency support 3 voice channels (via TDMA)
- ◆ Built to make the transition from AMPS graceful
- ◆ Similar to GSM, IS-136 features: SMS, broadcast messaging, group addressing
- ◆ Mobility managements as in AMPS: IS-41

EIA/TIA IS-95 Digital Cellular System, 1

- ◆ Qualcomm, since 1996
- ◆ Based in CDMA: Signal to Noise Ratio (SNR) does not depends on distance from BS (like in AMPS)
- ◆ Estimated capacity: 10 that of AMPS (IS-136 was 3 times)
- ◆ Two years development, no large scale trial
- ◆ IS-41 for mobility management

Unlicensed Systems

- ◆ Systems allowed to transmit in the ISM band
 - Wireless LANs (e.g., IEEE 802.11)
 - Bluetooth systems
 - Cordless telephones
- ◆ Interest of having this systems interoperating with the cellular network (e.g., TIA IS-94)

Third Generation Wireless Systems

- ◆ AMPS: 1st generation system
- ◆ GSM, IS-136, IS-95 + Low-tier technologies: 2nd generation systems
- ◆ All design for speech with low-bit-rate data services
- ◆ Third generation systems: Better system capacity, high speed, wireless internet access, multimedia services: Wideband CDMA (W-CDMA) and cdma2000

Mobility Management

◆ Crucial problem in PCS

- Affect the performance of the system
- Determine customer happiness

◆ PCS architecture:

- BSs, MSs, MSCs
- Two types of databases
 - ◆ Home location register (HLR)
 - ◆ Visitor location register (VLR)

Mobility in PCS Networks

- ◆ **Handoff:** The MS moves from a BS to another BS while engaged in conversation (also handover or automatic link transfer)
- ◆ **Roaming:** The MS moves from one PCS system (e.g., Boston) to another (e.g., New York City)
- ◆ Mobility management is described in (sub)standards: EIA/TIA IS-41 (for AMPS, IS-136, IS-95) and GSM MAP

Handoff, Strategies

- ◆ Three strategies for detecting the need of handoff
 1. Mobile-controlled handoff: MSs monitor the signal with surrounding BSs
 2. Network-controlled handoff: BSs measure the signal strengths with MSs (AMPS)
 3. Mobile-assisted handoff: The network asks the MS to measure the signals from BSs (GSM, IS-95)

Handoff, Types

◆ Inter-BS handoff

- The new and the old BS are connected to the same MSC

◆ Intersystem handoff

- The new and the old BS are connected to different MSCs

Inter-BS handoff, 1

- ◆ Example with mobile-controlled handoff
 1. MS suspends conversation and signals on an idle channel of the new BS
 2. MSC transfers the encryption information to the selected idle channel of the new BS and sets up the new conversation path to the MS. The paths are bridged by the MSC and the MS is informed to switch to the new channel

Inter-BS handoff, 2

3. After the MS has been transferred to the new BS it signals the network and resume conversation on the new channel
4. Upon receiving the handoff completion signal the network releases the resources associated with the old channel

Inter-BS handoff, 3

- ◆ For **network-controlled** handoff all signaling messages are exchanged between the MS and the old BS on the failing link (→ must be fast)
- ◆ If the new BS does not have an handoff channel, the call can be dropped: **Forced termination** (least desirable event)

Assignments

- ◆ Read Chapter 1 and 2 of the textbook
- ◆ Updated information on the class web page:

www.ece.neu.edu/courses/eceg364/2004sp