Applications: Cellular Telephony and Data Services

- We now switch gears to talk about practical applications
- First up: A review of the basic concepts of cellular telephony
- Space is partitioned into regular regions known as "cells" (hence the name "cellular").
- Each cell is served by a "base station"
- While within a cell, a mobile handset will create a radio link to that cell's base station

(Fig. 1)

- When mobiles move from one cell to another, a "handover" occurs – ensures calls and/or data sessions are not dropped.
- Why cellular? – Spatial reuse of frequencies.
- Two base stations sufficiently far apart will not interfere with each other – thus it is safe for them to use the same frequencies (i.e., the frequencies can be re-used)
- As long as cells between the re-using cells use different frequencies, there is no interference
- This leads to "re-use factors" and "re-use patterns"

(Fig. 2)

- Example. (a) A cellular phone system uses FDMA. The total available bandwidth is 98 MHz, and each individual call occupies 20 kHz. The re-use factor is 7. How many calls can be made simultaneously per cell?

- Example. (b) Same system. Each cell occupies 0.5 km². The area of the city is 28 km². How many calls can be made simultaneously across the city?
- Aside. Area of a hexagon.

(Eq. 1)

- so a cell occupying 0.5 km² has a radius of 438.7 m
- How would you increase the number of calls in the city?
    - Shrink the cell size (disadvantage: cost); and/or
    - Reduce the re-use factor (disadvantage: interference).
    - WRONG ANSWERS: Increase bandwidth (usually not possible) or decrease bandwidth per call (would decrease the quality of service).
- Example. (c) Same system as in example (a) and (b). Each cell occupies 0.25 km². How many simultaneous calls?
- Example. (d) Same system. Re-use factor is now 4. How many simultaneous calls?

Cellular "generations" and common protocols

- First generation (1G): Analog telephone service
    - 1980s-1990s; usually FDMA
    - Advanced Mobile Phone System (AMPS)
- Second generation (2G): Digital telephone and limited data service
    - 1991-present. Reduced power requirements; Vocoders reduced the required bandwidth; security.
    - GSM: FDMA+TDMA-based, worldwide
    - IS-95: CDMA-based, N. America and Asia
- "2.5G": Packet-switched data service (GPRS) at low speeds (56-114 kbps); EDGE (higher speed).
- Third generation (3G): High-speed data services

- o 2001-present. 348 kbps-14.4 Mbps
- o IMT-2000 is the internationally agreed standard, with several sub-standards
- Fourth generation (4G)
  - o Expected commercial availability in 2010
  - o 100 Mbps to 1 Gbps in the downlink
  - o Applications such as HDTV to the mobile