

15.020 Competition in Telecoms

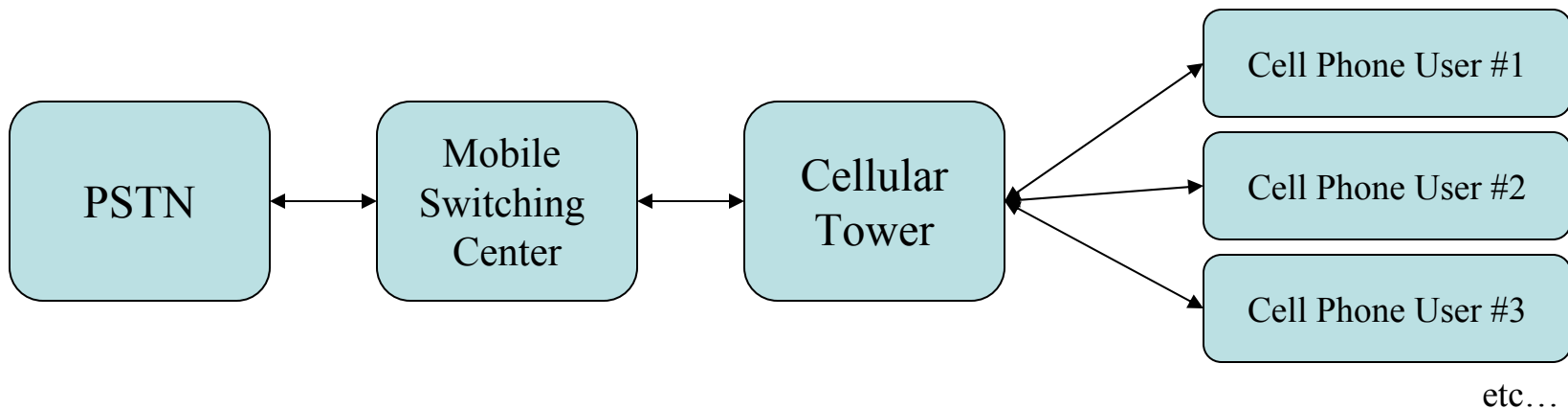
Recitation #4

Othman Laraki

Credits to Simon Hughes

Wireless Concepts

- Cell site: transmitter, receiver, base station
- Mobile Switching Center
- Frequency reuse through separated cell sites
- Roaming & Location Management



A Bit of History

- Cellular Technologies
 - 1985: Analog (1st Generation, voice): 800 Mhz band
 - 1991: Digital (2nd Generation, limited data transfer)
 - 800 and 900 MHz frequency bands
 - PCS in 1800 and 1900 MHz frequency bands
 - 2000: 3rd Generation (UMTS)
 - Access Methods
 - Multiplex several calls onto single cellular channel
 - FDMA: Frequency Division Multiple Access (analog)
 - CDMA: Code Division Multiple Access (codes)
 - TDMA: Time Division Multiple Access (timeslots)

Multiplexing Technologies

Allow multiple calls to share a single connection

- TDM Time Division Multiplexing (digital)
 - Each path shared by several channels which have timeslots
- SDM Space Division Multiplexing (analog or digital)
 - Each channel allocated an exclusive physical path
- FDM Frequency Division Multiplexing (analog)
 - Each channel allocated an individual frequency
- PDM Packet Division Multiplexing (digital)
- CDM Code Division Multiplexing (digital)
 - Each channel allocated an individual code within same path
- WDM: Wave Division Multiplexing (digital & analog!)
 - Each channel allocated an individual wavelength on a fiber

1st & 2nd Generation Variants

- **Analog (1st Generation – 1G)**
 - AMPS used mainly in the US - also in Latin America, Australia, New Zealand, parts of Russia and Asia-Pacific.
 - ETACS used in Europe and Asia-Pacific.
 - NMT used in Scandinavia and some European countries, as well as parts of Russia, the Middle East and Asia.
- **Digital (2nd Generation – 2G)**
 - GSM 900 (900 MHz) - Europe; also used in Asia-Pacific.
 - GSM 1800 (1800 MHz) also used in Europe and Asia, not as widely adopted as GSM 900.
 - GSM 1900 (1900 MHz) GSM system used in Americas and Canada.
 - TDMA & CDMA digital standards used in US, also Latin America, New Zealand, parts of Russia and Asia-Pacific.
 - PDC digital standard used in Japan

CDMA vs. TDMA

CDMA (Carrier Division Multiple Access)

- Segment a single (1.25MHz) channel into (64) multiple channels using a code to identify users
- Spreads call over entire spectrum: more immune to interference than TDMA; potentially supports more users
- Capacity not fixed, depends on coverage, total voice bandwidth
- During peak periods, cell size reduces due to spectrum use

TDMA (Time Division Multiple Access)

- Segment a single (30KHz) channel into (3 x 8kbit/s) timeslots, carrying specific user information
- Cell phones for TDMA networks will not work with CDMA networks and vice versa
- Capacity dependent on number of available timeslots

GSM

- GSM: Groupe Speciale Mobile
- GSM: Global System for Mobile Communications
- TDMA-based technology developed in late 1980s
- Worldwide (outside N America) de-facto digital standard:
200m GSM users; 370+ operators
- Two variants:
 - GSM: Transmit 890-915MHz, Receive: 935-960MHZ
 - PCN: Transmit 1850-1910MHz, Receive 1930-1990MHz

CDMA Technology

For this diagram, see Masson, Tim. *Wireless Technology Seminar: Third Generation (3G) Basics*. Agilent Technologies, 2000, page 18. Available at <http://www.agilent.com>.

Cell Sites

For this diagram, see Farley, Tom, with Mark van der Hoek. *Cellular Telephone Basics*. *Privateline.com*, page 2. Available at <http://www.privateline.com>.

For this diagram, see Masson, Tim. *Wireless Technology Seminar: Third Generation (3G) Basics*. Agilent Technologies, 2000, page 22. Available at <http://www.agilent.com>.