Rural Telecommunications Access Technology I Cellular Systems

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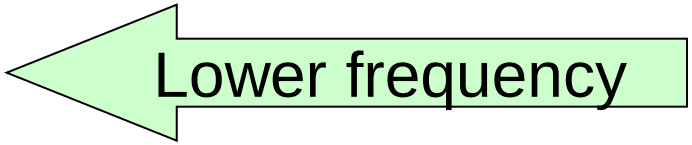
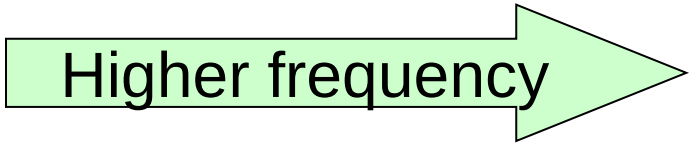
Characteristics of Radio Wave



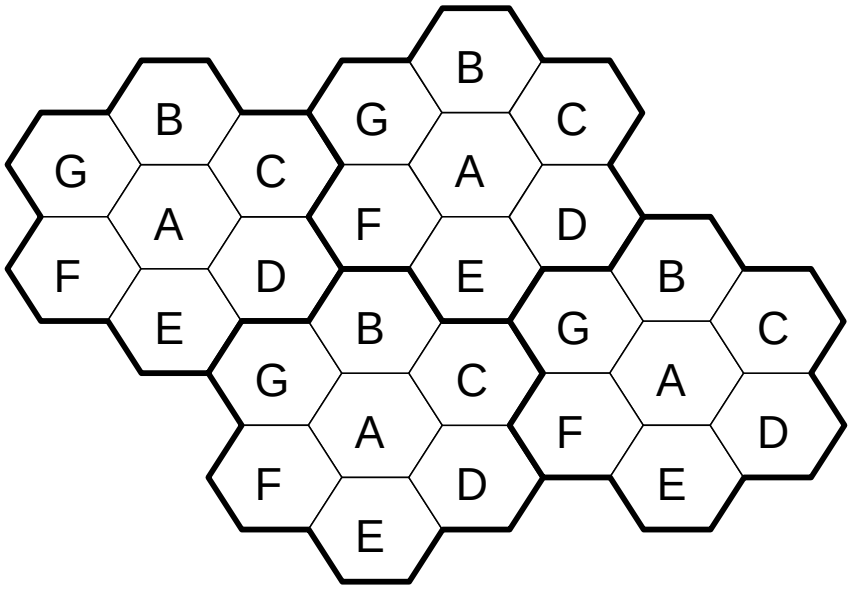
- Diffraction dominant propagation
  - Long distance
  - Shadowed area
- Narrow bandwidth
- Bigger and less directive antennas
  - Bigger antenna loss



- Line-of-sight dominant propagation
  - Short distance
  - Line-of-sight
- Wide bandwidth
- Smaller and more directive antennas
  - Smaller antenna loss

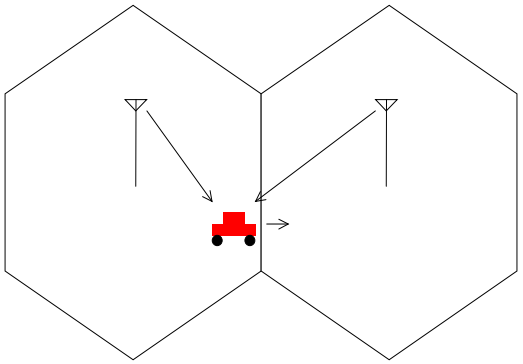
Cellular Concept

- Each base station (BS) covers a cell
- Spatial frequency reuse technique (in FDMA/TDMA)
- Reuse factor limited by co-channel interference (in FDMA/TDMA)



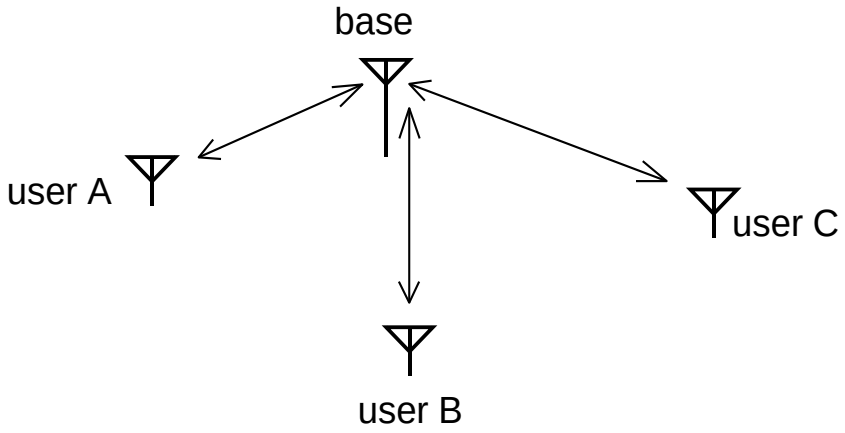
Handoff

- Smooth transition of wireless link between adjacent cells



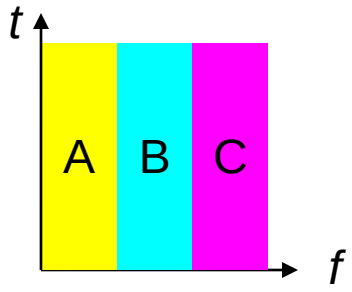
Multiple Access (1)

- Multiple users share the same transmission channel

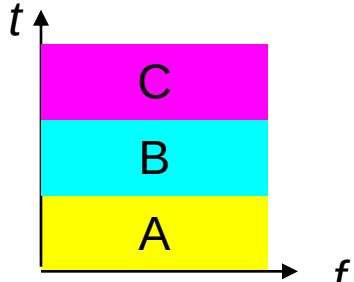


Multiple Access (2)

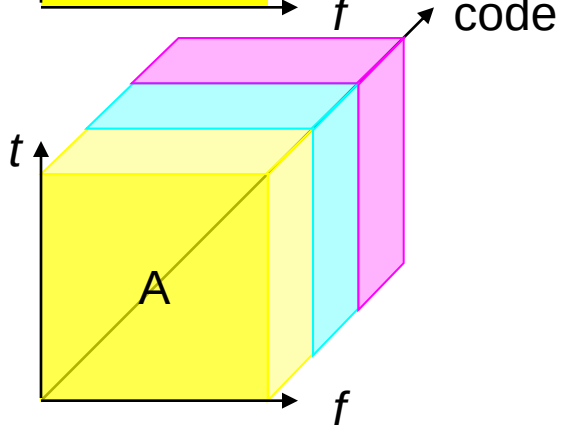
Frequency division (FDMA)



Time division (TDMA)



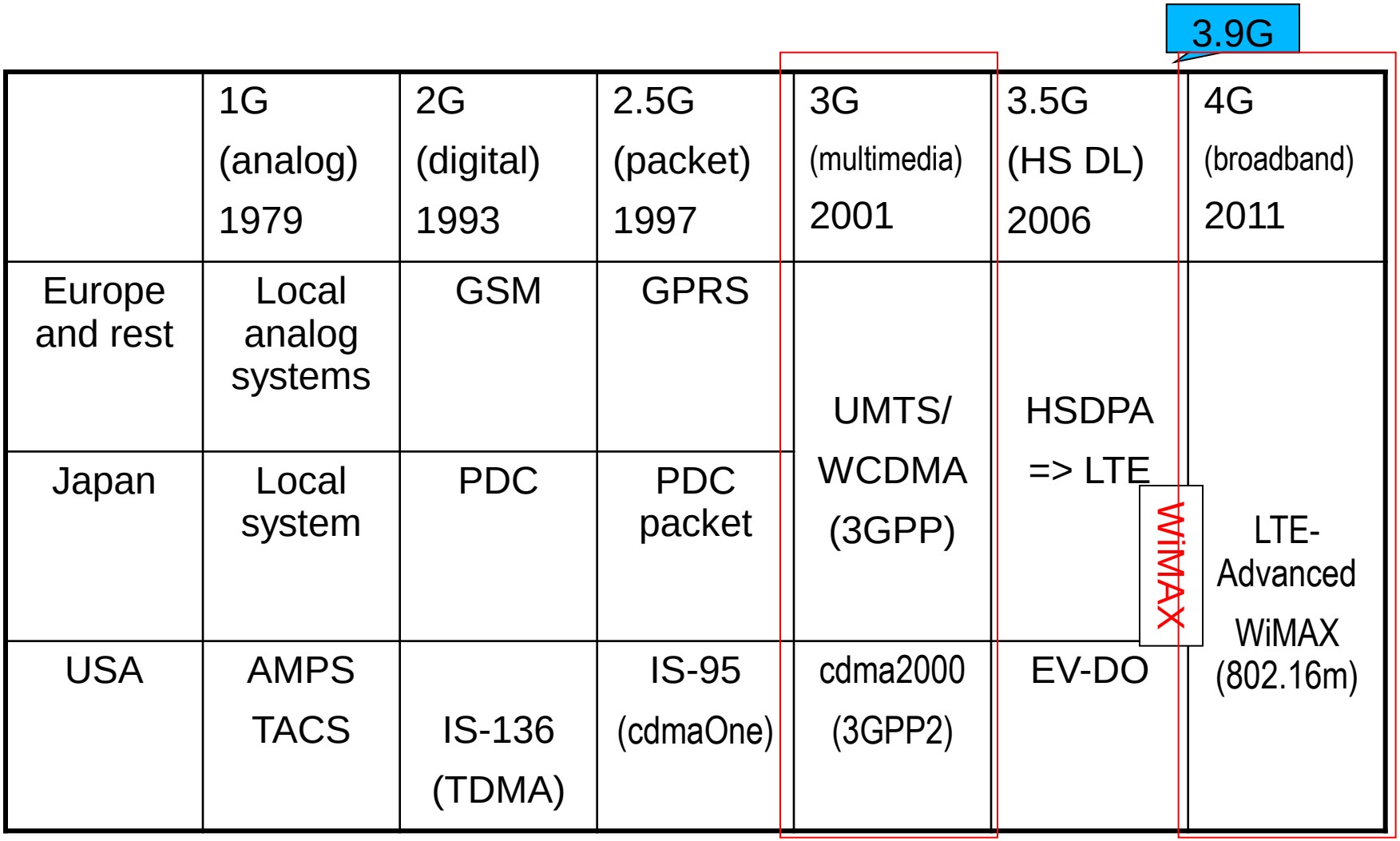
Code division (CDMA)



Duplex (TDD/FDD)
CSMA

Filter and duplexer issue

Evolution of Cellular Systems

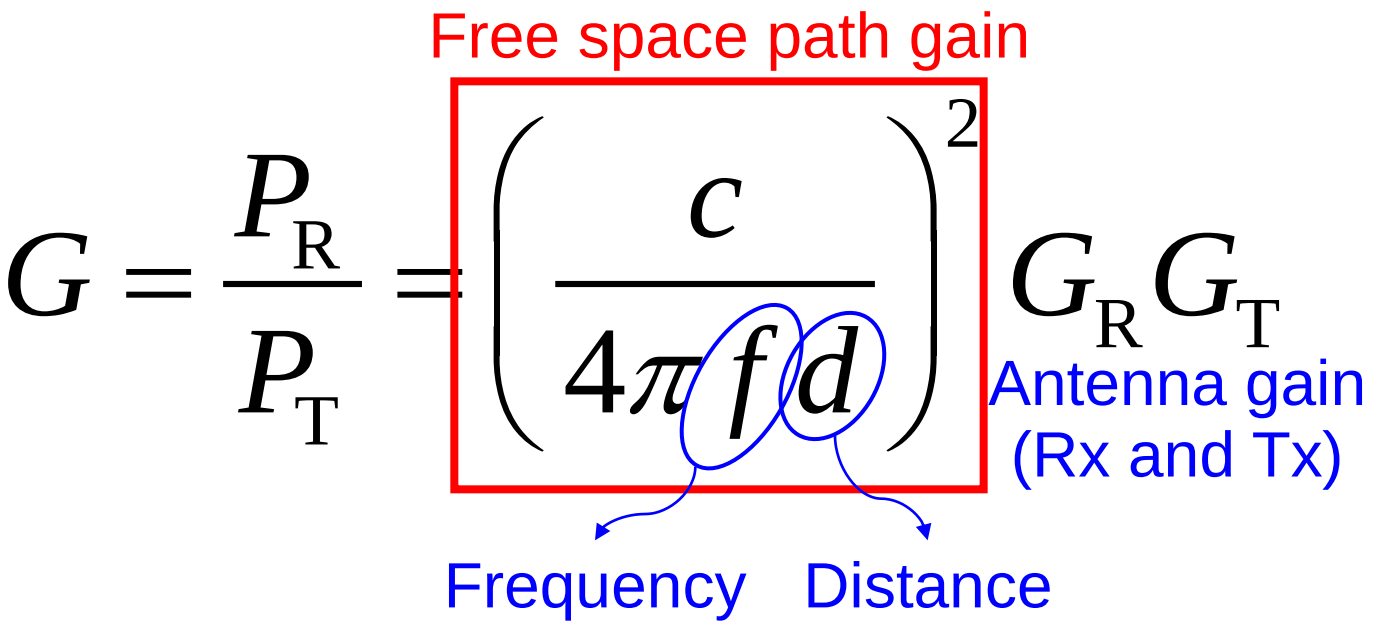


GSM

- GSM = Global System for Mobile
  - European cellular standard penetrated in all over the world *except Japan and South Korea*
  - 3 bands are used in ordinary service
    - 800 MHz
    - 1,800 MHz
    - 1,900 MHz (mainly in USA)
  - Voice and messaging (SMS)

Free Space Propagation

- Friis' Transmission Formula



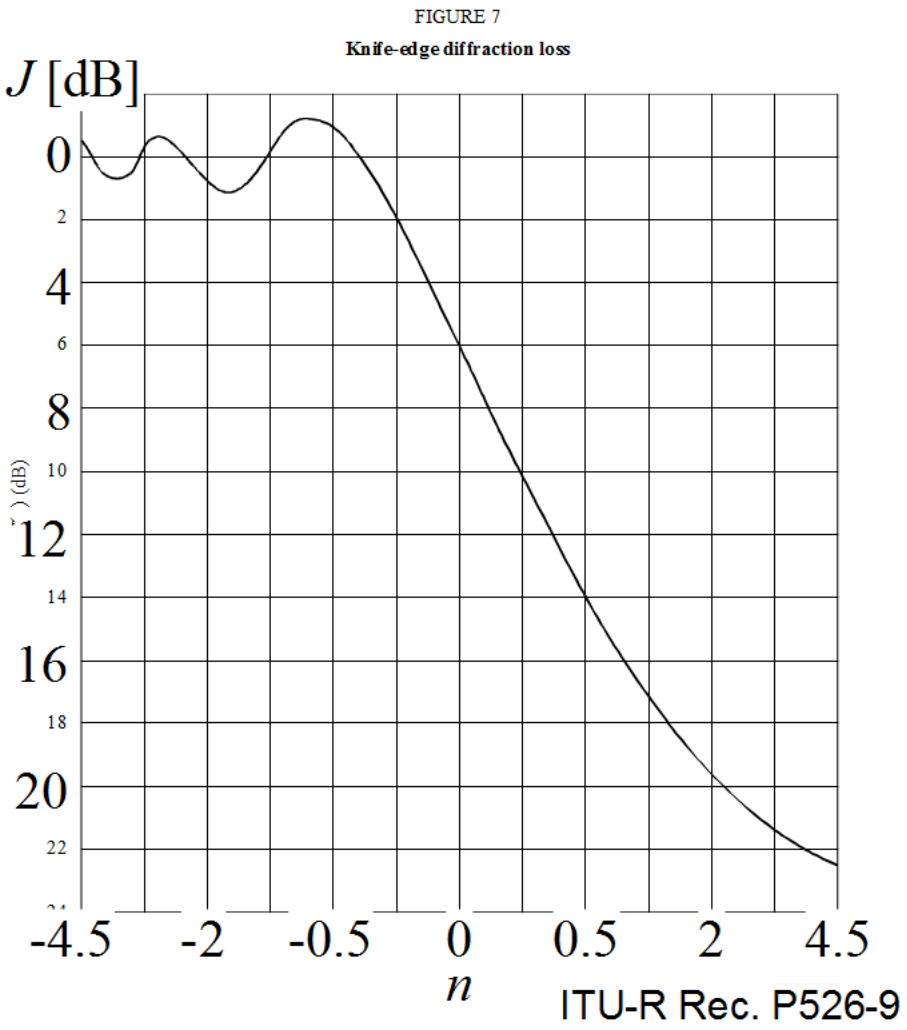
Higher frequency is disadvantageous with respect to coverage.

Knife Edge Diffraction Loss

- Shadowing of LOS ~ -6 dB
- Shadowing of 1st Fresnel zone ~ -16 dB

- n is bigger for higher frequency

$$n = \frac{h^2(d_1 + d_2)}{\lambda d_1 d_2}$$



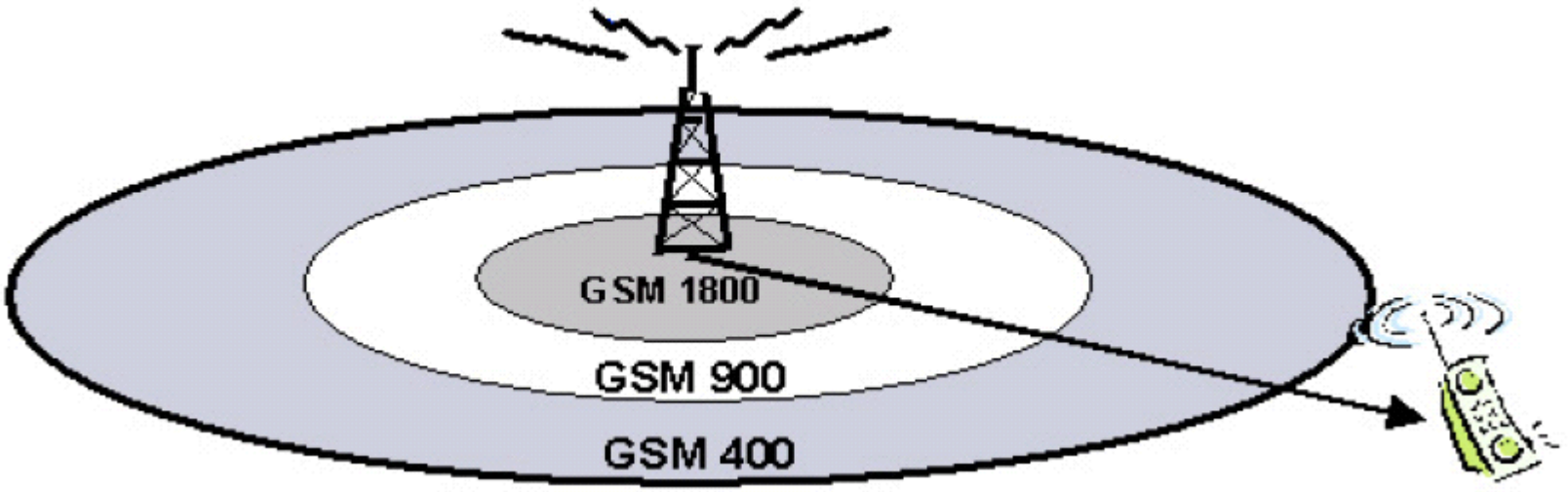
For same *h* (depth of obstruction), *n* is smaller when frequency is lower.

GSM 400

- According to Friis' fomula, lower frequency can expect larger reach with same power.
- Replacement of NMT 450
  - NMT – Nomadic Mobile Telephone
  - 1G analog cellular to 2G digital cellular

GSM 400

Advantage of GSM 400 over other GSMs



- Wider coverage area
  - 2 W terminal for 40 km radius

– GSM 400 bites the dust – What happened to GSM 400?

- Support of both Nokia and Ericsson at the beginning
- Expectation of nationwide services though a joint GSM 400/WCDMA (2GHz) network
- Nokia and Ericsson pulled out later.
- Operators were uninterested in it.
- Manufacturers are unwilling, or in some cases unable, to supply handsets in commercial volumes until there is a perceived demand.

Specific system for rural application may not be feasible commercially.

http://www.allbusiness.com/information/telecommunications-wireless/1001913-1.html

GSM Evolution

- High Speed Circuit Switched Data (HSCSD)
  - Circuit switch
- Wireless Application Protocol (WAP)
  - 1.0 (original) vs 2.0 (i-mode compatible)
- General Packet Radio Service (GPRS)
  - 115 kbit/s
- Enhanced Data for GSM Evolution (EDGE)
  - 384 kbit/s

Feedback from Students

- Countries without 3G service yet
  - Thailand: not in full function
  - Sierra Leone: not yet completed for installation
- Popularity of GSM (9) vs 3G (5)
- Within GSM
  - EDGE (5)
  - GPRS (3)
  - Both (1)
- Smart phone on GSM
  - Blackberry (3)
  - iPhone/Android/Symbian (7)