

Cellular Mobile Communication Systems

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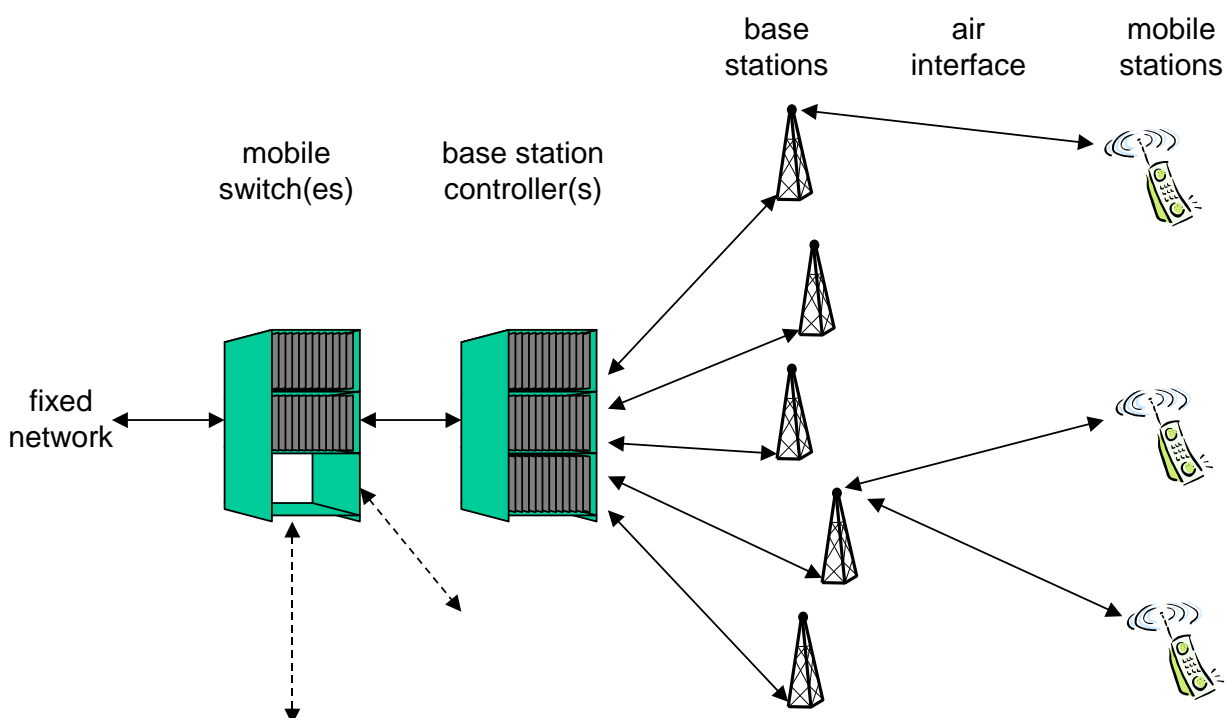
Contents of presentation

- Introduction to cellular systems
 - GSM/GPRS/EDGE
 - 3G (WCDMA, UMTS)
 - TDMA vs. CDMA
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History

- Analog systems (e.g NMT)
 - speech
 - Digital systems (e.g GSM)
 - speech and simple data, improved capacity
 - Evolved digital systems (GPRS, EDGE)
 - improved data services
 - Third generation (WCDMA)
 - high bitrates, improved flexibility, improved capacity
 - Fourth generation?
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Architecture Overview



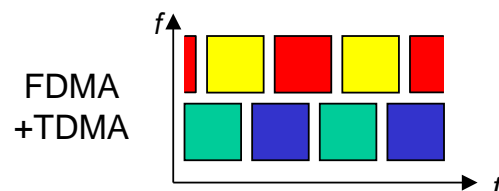
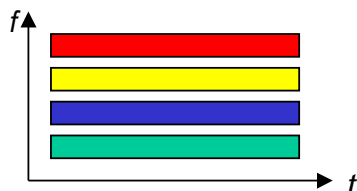
Resource Limits

- attenuation, shadowing, and receiver noise
 - multipath fading & time dispersion
 - interference
 - transmitter power

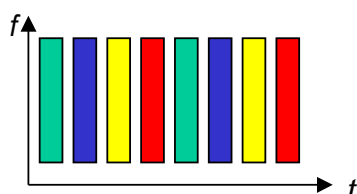
 - coverage vs. capacity limits
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Multiple Access: Handling Several Users Simultaneously

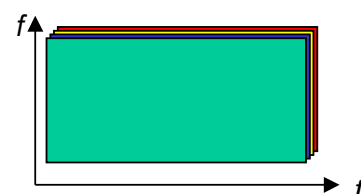
FDMA: Frequency Division Multiple Access



TDMA: Time Division Multiple Access



CDMA: Code Division Multiple Access



The GSM Air Interface

FDMA

174 frequencies with 200kHz spacing (GSM 900)

Separate bands for uplink and downlink

Divided between operators

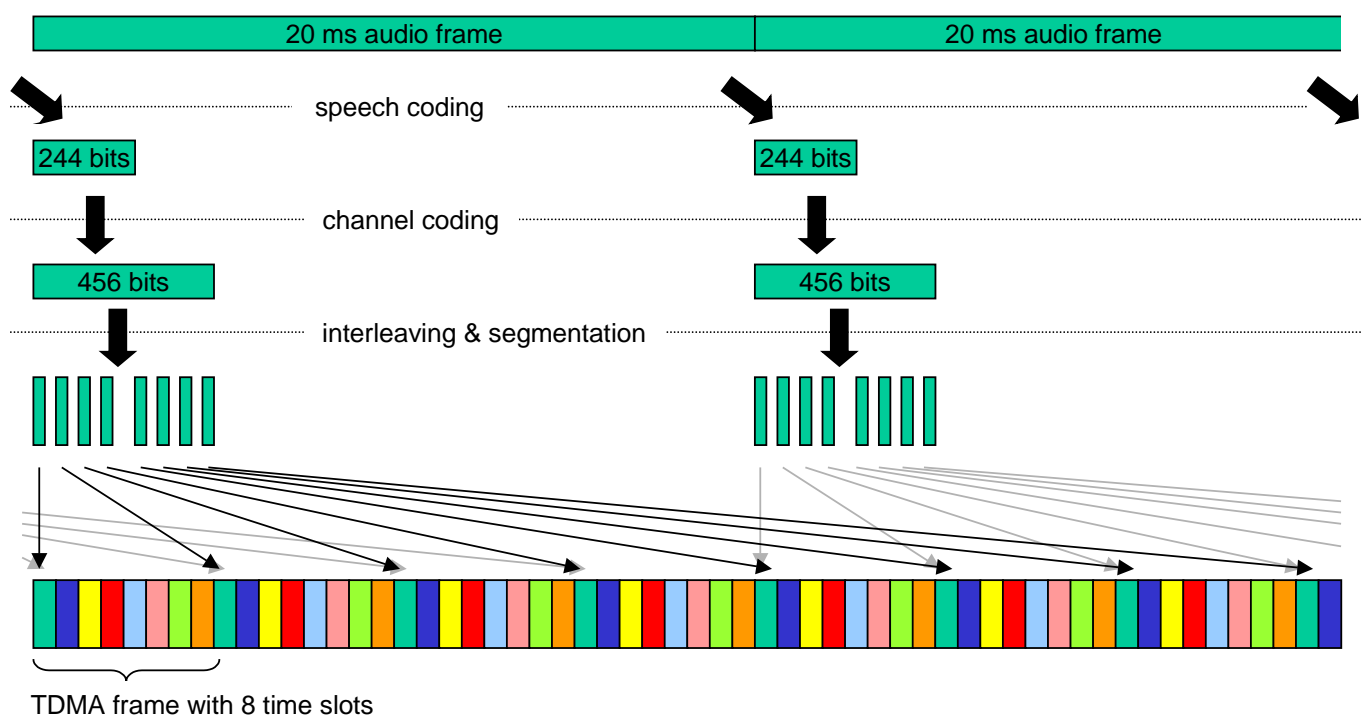
TDMA

8 time slots per frequency band (one user per time slot)

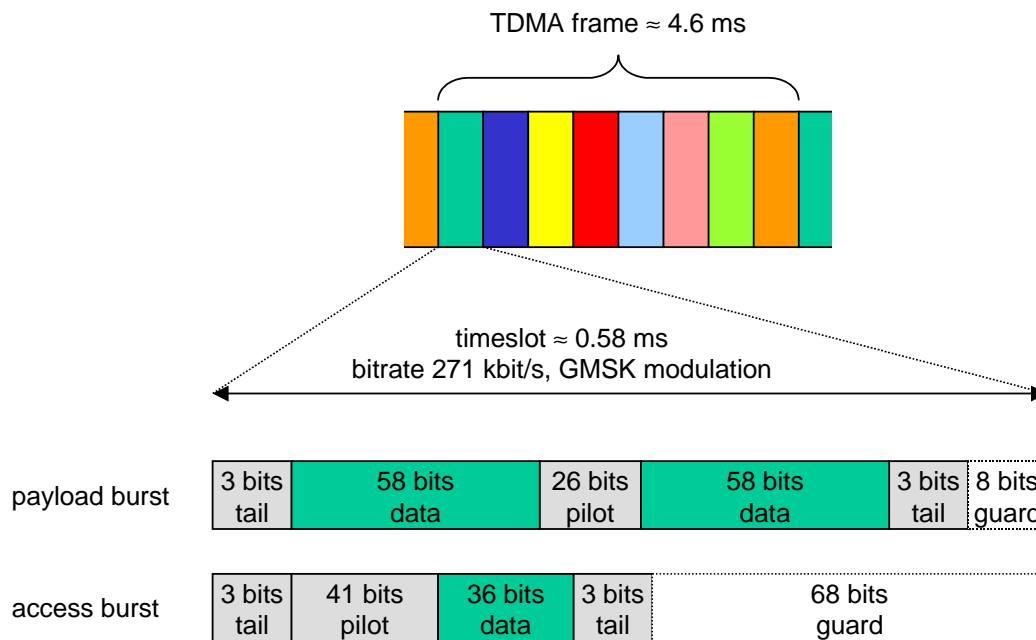
Modulation

271 kbit/s GMSK

The GSM Air Interface, cont.

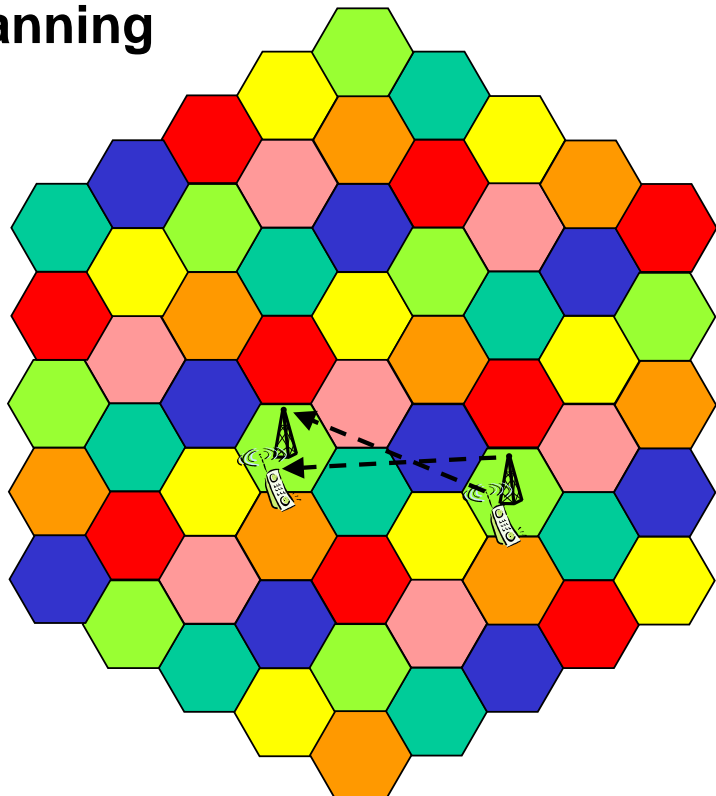


The GSM Air Interface, cont.



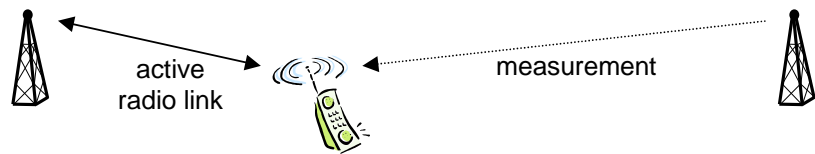
GSM: Frequency Planning

- Reuse factor
- Tighter reuse:
 - + higher capacity
 - interference between cells

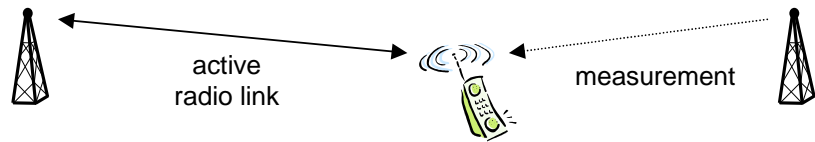


GSM: Handover

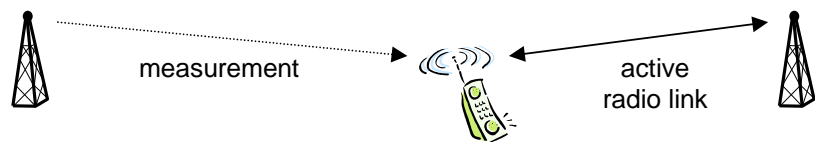
1. mobile measures other cells



2. better cell detected, handover initiated



3. handover completed



GSM, cont.

- Power control
 - maintain adequate quality at minimum power
 - reduces interference
 - increases battery life
- Frequency hopping
 - avoids bad quality due to fading and interference

GPRS: General Packet Radio Services

- Uses GSM air interface
 - Channel setup and release on demand
 - always connected at low cost
 - Timeslot scheduling
 - allows several time slots per user
 - Different coding schemes
 - bitrate depends on radio conditions
 - Retransmission of erroneous packets
-

EDGE: Enhanced Data rates for GSM Evolution

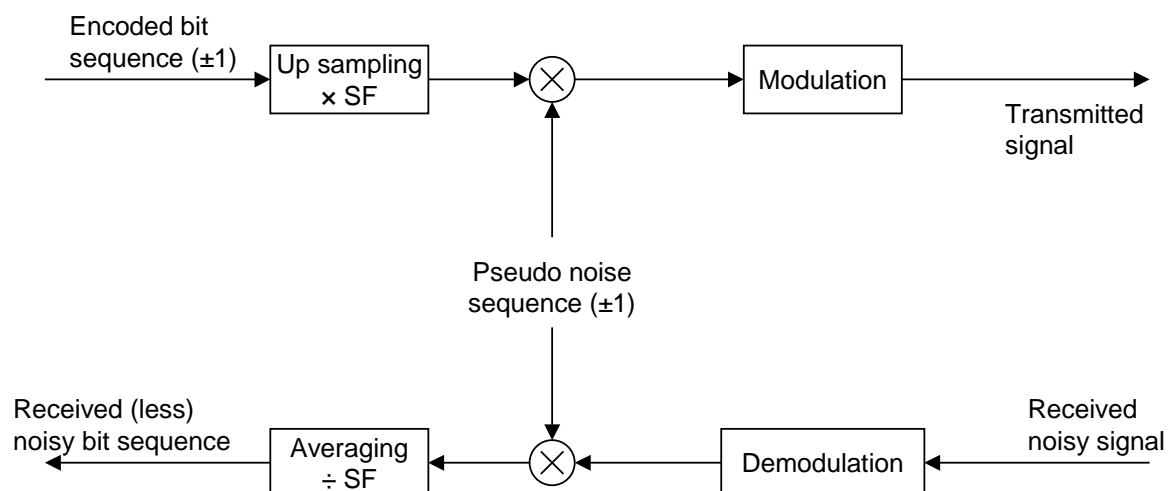
- Higher-order modulation
 - 8-ary phase-shift keying
 - high bitrates at good channel conditions
 - Fast link adaptation
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WCDMA (UMTS, 3G)

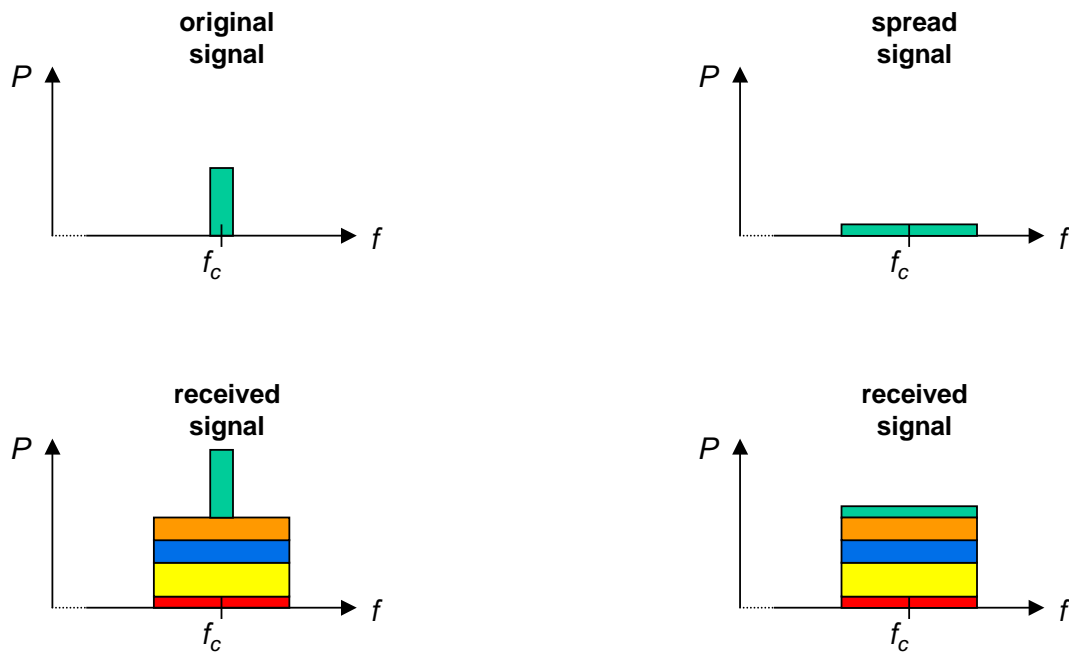
Requirements:

- Speech capacity & coverage better than GSM
 - Efficient & flexible services:
 - realtime
 - variable bitrate
 - packet
 - 2 Mbit/s in good conditions
 - 384 kbit/s everywhere
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CDMA Principle



CDMA Interference Suppression



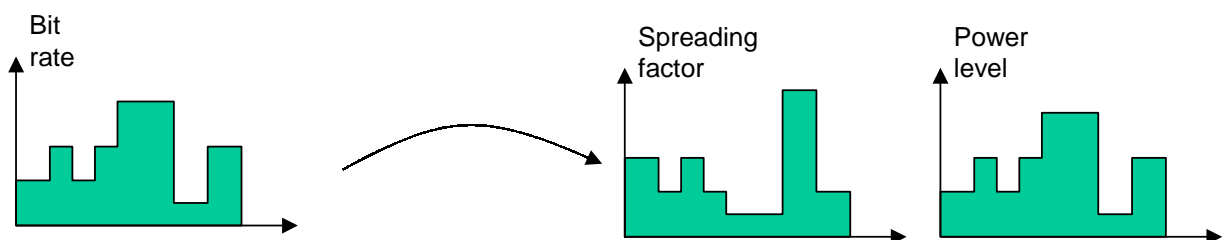
CDMA Bit Rate Flexibility

Power is the common shared resource

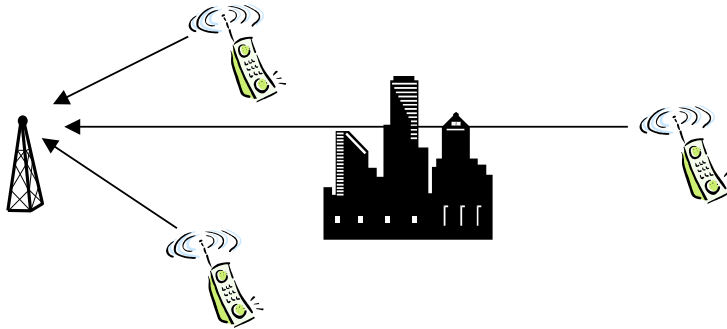
Varying
User Bit Rate

Translates into

Varying spreading factor
Varying power level
But, same physical resource



CDMA Near/Far Effect

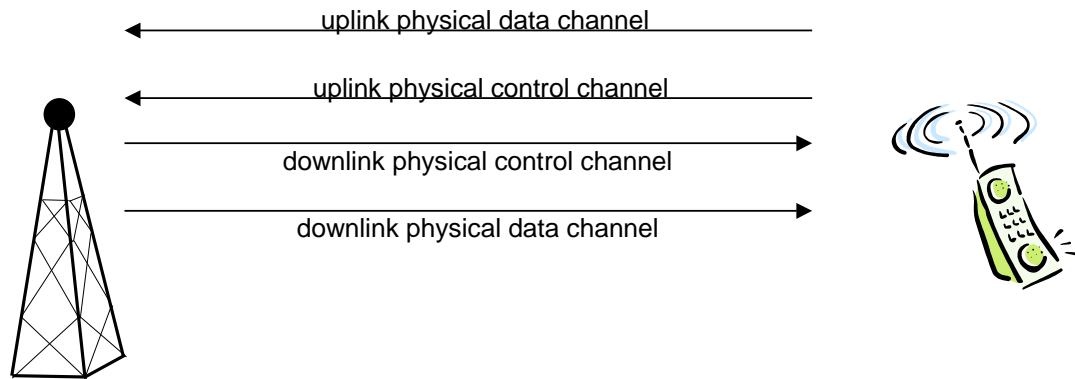


Power control needed to
keep interference down

WCDMA Air Interface Basics

- 3.84 MHz chip rate
 - QPSK modulation, 5 MHz bandwidth
 - Spreading factor from 4 to 256
 - Bitrates up to
 - 2 Mbit/s with multicode
 - 480 kbit/s with single code
 - 1500 Hz closed-loop power control
 - Frame length 10-80 ms
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WCDMA Physical Channels and Power Control



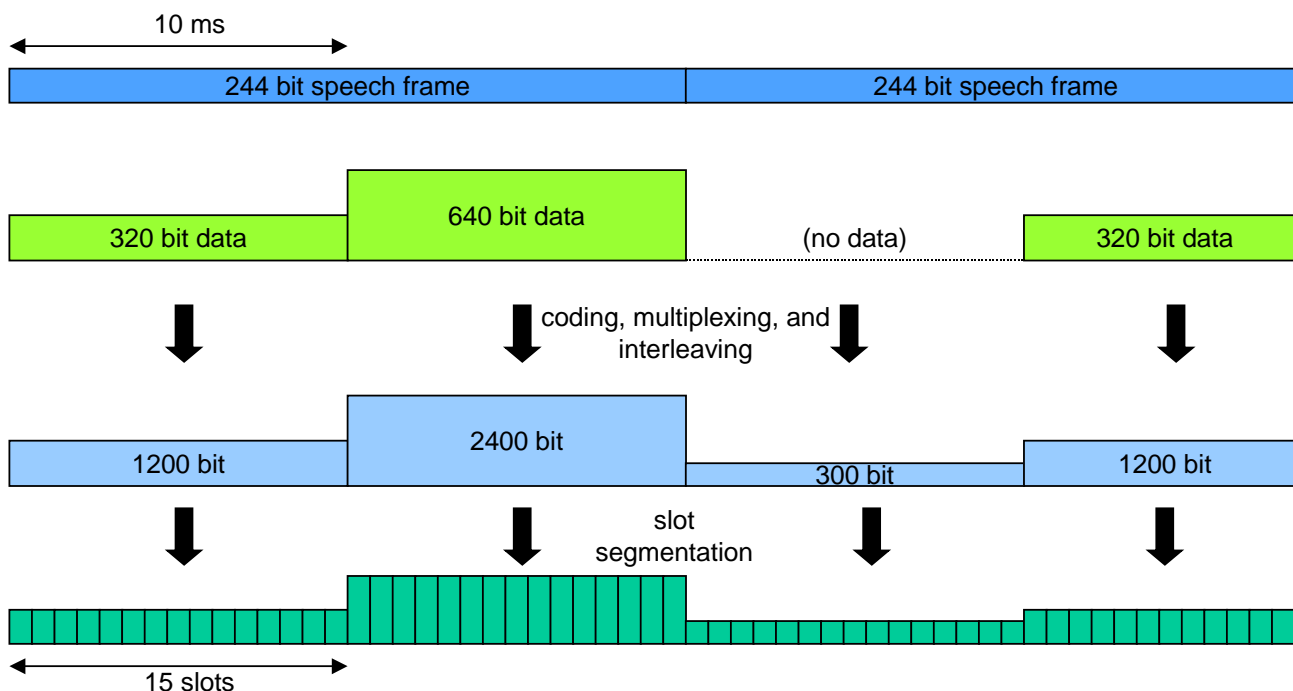
Physical control channel:

- pilot for channel estimation
- power control commands
- data format information

Physical data channel:

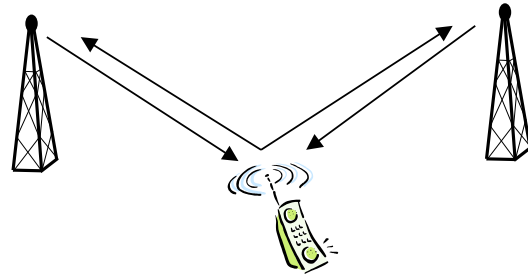
- user data

WCDMA Air Interface Example: Speech and Data Multiplexed

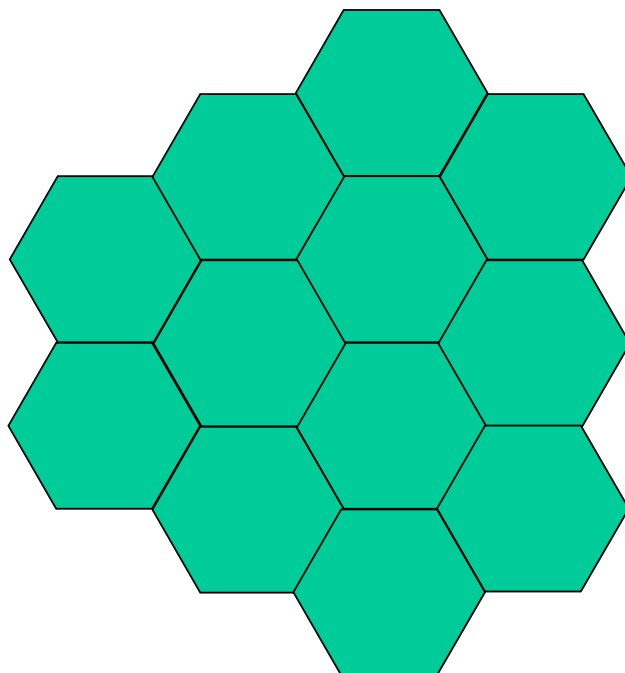


WCDMA: Soft Handover

- Enhances quality
- Reduces interference due to fast fading
- Transmit power determined by best link



GSM: Frequency Reuse 1



FDMA/TDMA vs. CDMA

- fading resistance
 - flexibility
 - frequency planning
 - radiation
 - complexity
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