Mobile Communication – An overview

Lesson 04

Introduction to SDMA, TDMA, FDMA, CDMA and OFDAM

Multiplexing

- Means that different channels, users, or sources can share a common space, time, frequency, or code for transmitting data

Multiplexing

- Space division multiple access (SDMA)
- Time division multiple access (TDMA)
- Frequency division multiple access (FDMA)
- Code division multiple access (CDMA)
- Code Orthogonal frequency division multiple access (COFDM) also called OFDM

SDMA– A DIVISION OF AVAILABLE SPACE

- Multiple sources can access the medium at the same time
- Wireless transmitter transmits the modulated signals and accesses a slot in space and another transmitter accesses another slot such that signals from both can propagate at same instance in two separate spaces in the medium without affecting each other

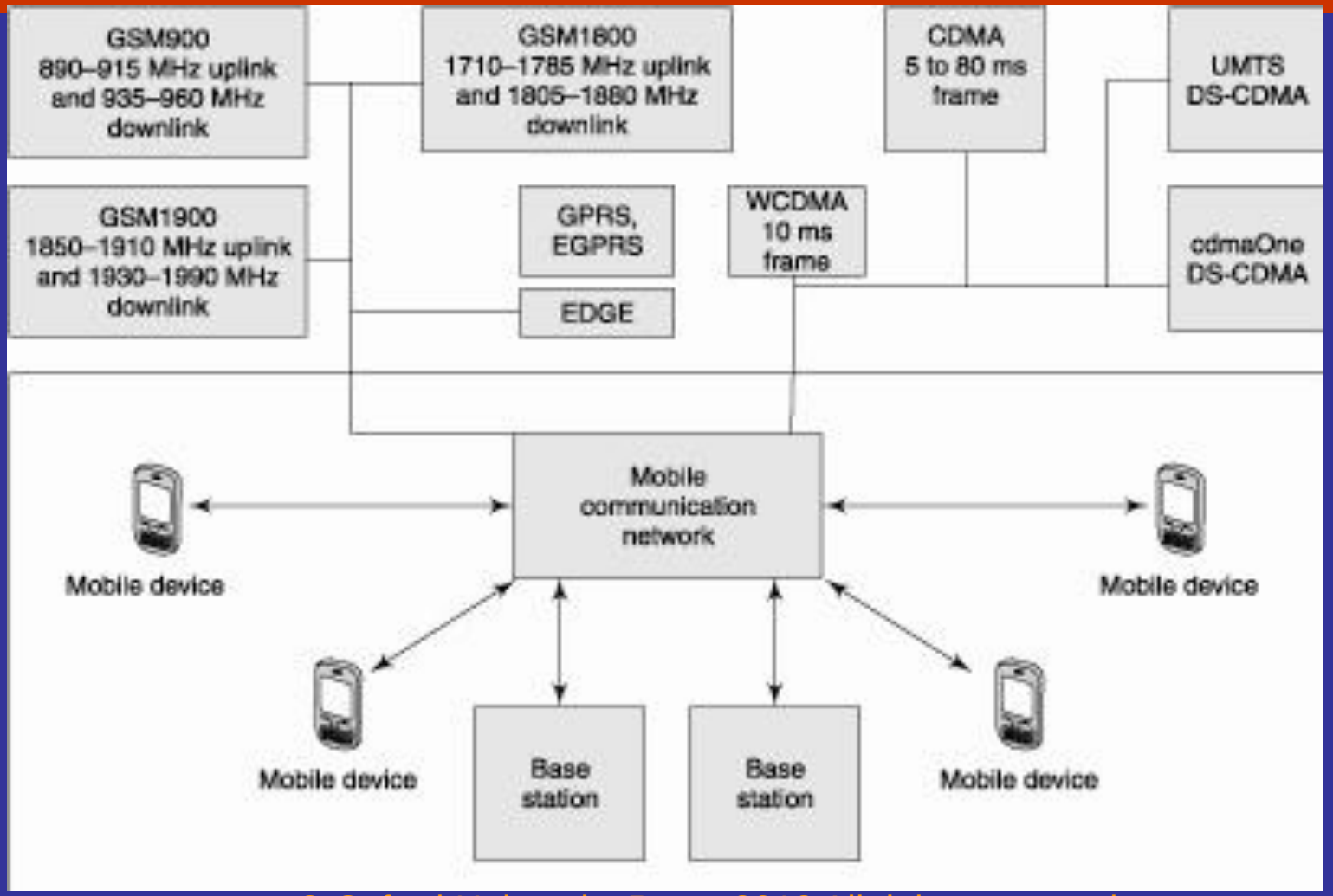
SDMA Example

- Four groups *A*, *B*, *C*, and *D* of mobile users and four different regional slots, *R*1, *R*2, *R*3, and *R*4 in space
- Group *A* uses *R*1, *B* uses *R*2, *C* uses *R*3, and *D* uses *R*4 for transmitting and receiving signals to and from a base station at an instance using same signal frequencies

TDMA– DIFFERENT SOURCES USING DIFFERENT TIME-SLICES FOR TRANSMISSION OF SIGNALS

- **A**n access method in which multiple users, data services, or sources allotted different time-slices to access the same channel (frequency band) in same slot in space.
- Available time-slice divided among multiple modulated-signal sources. These sources use the same medium, set of frequencies, and same channel for transmission of data.

GSM and CDMA based standards



TDMA Example

- GSM Eight radio-carriers (e.g., mobile phones) *C*1, *C*2, *C*3, *C*4, *C*5, *C*6, *C*7, and *C*8 in eight TDMA time-slices, one for each radio carrier.
- Eight phones (GSM devices) simultaneously transmit in the same frequency band (channel) and same space
- Time-slice allotted to each = 577 μs

FDMA– DIFFERENT SOURCES USING DIFFERENT FREQUENCY FOR TRANSMISSION OF SIGNALS

- **A**n access method in which multiple users, data services, or sources allotted different frequency-slices (bands) to access same space and time-slice
- Available frequency range divides into bands which are used by multiple sources or channels at the same time
- Various channels allotted distinct frequency bands for transmission

FDMA Example

- GSM 900 at 890–915 MHz uplink from user to the base station and 935–960 MHz downlink
- Each channel 200 kHz bandwidth
- 124-channel uplink needs 200 kHz $\times$ 124 = 24.8 MHz
- Similarly, 124-channel downlink requires 24.8 MHz

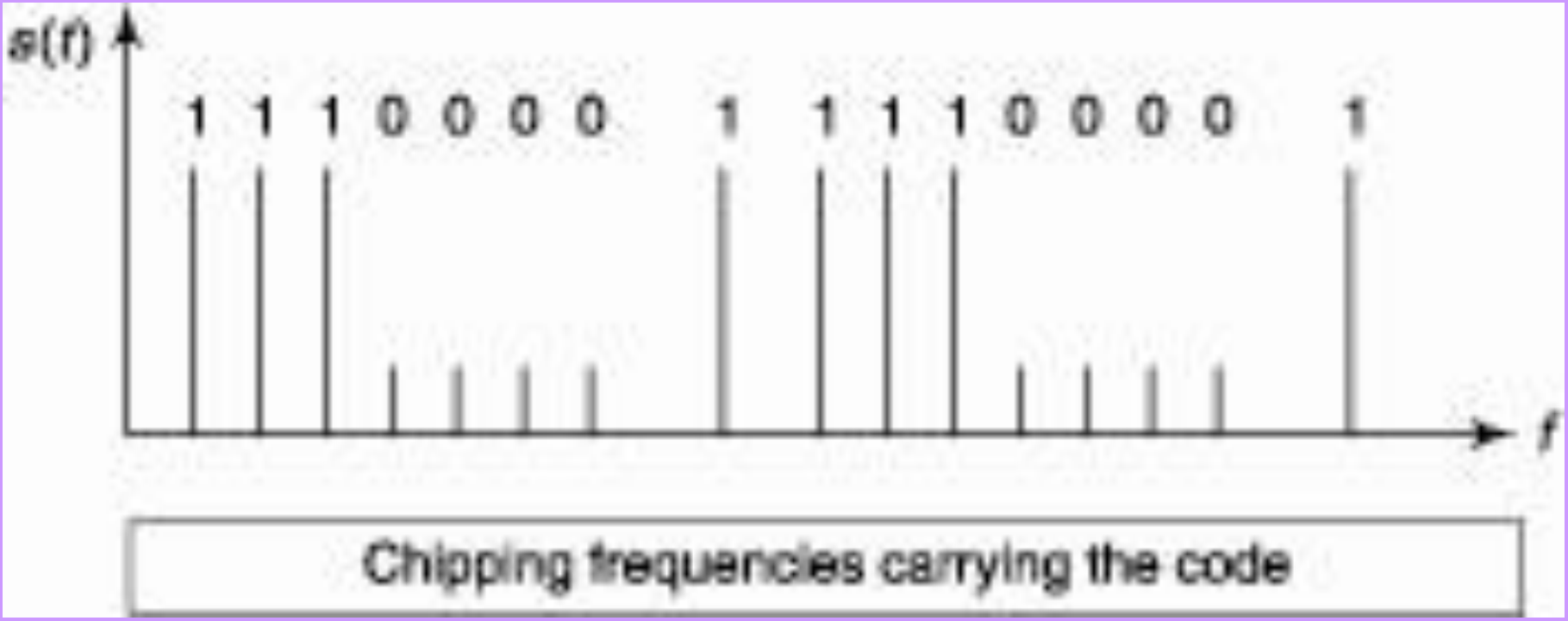
CDMA– different sources using different Codes for transmission of signals

- An access method in which multiple users are allotted different codes (sequences of symbols) to access the same channel (set of frequencies)
- A *symbol* is a bit (0 or 1) or pair of bits (00, 01, 10 or 11) or a set of bits which transmits after encoding and processing bits of data such as text, voice, pictures, or video

CDMA Example– Each code is uniquely made up of *N* symbols

- Used for transmitting a signal consisting of set of frequencies *fc*0, *fc*0 + *fs*, *fc*0 + 2*fs*, …, *fc*0 + (*n* – 2) *fs*, *fc*0 + (*n* – 1) *fs* by the same channel.
- Frequencies are also called chipping frequencies in a scheme called DSSS (Direct Sequence Spread Spectrum) and called hopping frequencies in FHSS (Frequency hopping Sequence Spread Spectrum)

CDMA Chipping frequencies when an exemplary code 1 1 1 0 0 0 0 1 1 1 1 0 0 0 0 1



OFDMA

- **A**n access method in which **multi-carrier, multi-tone transmitting for a set of symbols**
- Multiple users, data services, or sources allotted different frequency-slices (bands) to access in same space and time-slice but distinct codes which are orthogonal to each other

OFDMA

- Each carrier transmits a distinct set of sub-carriers and each set of sub-carriers is assigned a code which is orthogonal to another
- Two frequency signals $s1(t)$ and $s2(t)$ are said to be orthogonal if $s1(t)$ has maximum amplitude at the instant when $s2(t)$ has zero amplitude and vice versa

OFDAM

- An access method in which the adjacent sets of sub-carriers {[$f_{c0}/n_{sc}\ f_g + (f_{c0}\ n_{sc}^{-1} + n_{sc}^{-1} f_s)$, …], [$f'_{c0}/n_{sc}\ f_g + (f'_{c0} n_{sc}^{-1} + n_{sc}^{-1} f'_s)$, …], [$f''_{c0}/n_{sc}\ f''_g + (f''_{c0} n_{sc}^{-1} + n_{sc}^{-1} f''_s)$, …] that are carrying a subset of symbols are orthogonal

Summary

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End of Lesson 04
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