

# 2 G ARCHITECTURE– GSM, GPRS AND OTHERS

## Lesson 03

### SDMA, TDMA, and FDMA in GSM

# 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)

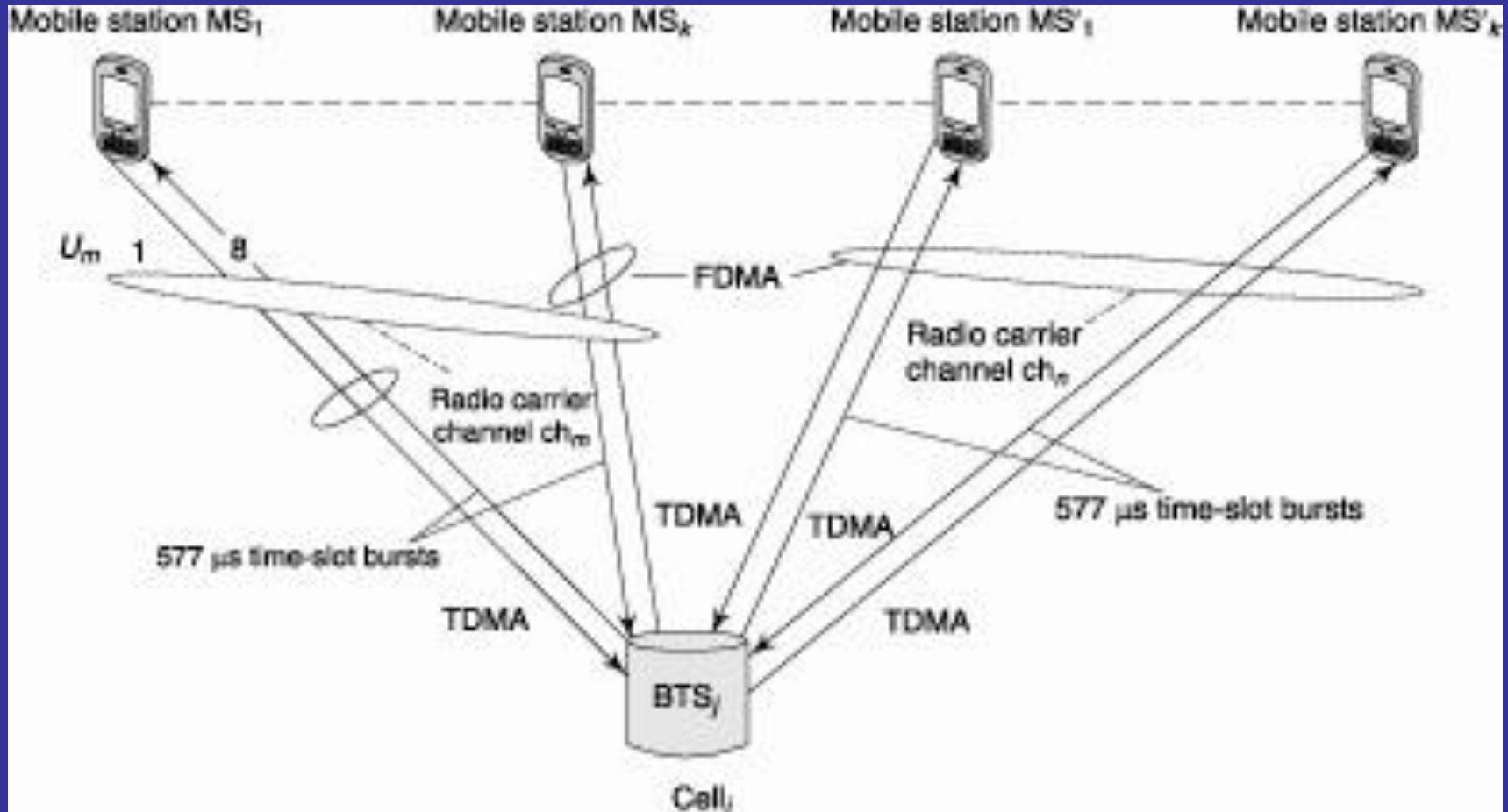
# SDMA— A DIVISION OF AVAILABLE SPACE

- 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, *R1*, *R2*, *R3*, and *R4* in space
- Group *A* uses *R1*, *B* uses *R2*, *C* uses *R3*, and *D* uses *R4* for transmitting and receiving signals to and from a base station at an instance using same signal frequencies

# A CELL, FORMED BY SDMA WITH TWO RADIO-CARRIER CHANNELS $CH_M$ AND $CH_N$



# SPACE DIVISION MULTIPLE ACCESS OF THE SIGNALS FROM THE MSs

- A given  $\text{BTS}_j$  covers the  $i^{\text{th}}$  cell-sector and the cell space is presently covering  $k$  mobile stations,  $\text{MS}_1, \text{MS}_2, \dots, \text{MS}_k$
- $k$  can vary with time — MS can always change its location and move into another cell)

# UPLINK AND DOWNLINK CAPACITIES OF GSM NETWORK CHANNELS

- Enhances using SDMA as this allows serving multiple users in the same frequency but in distinct time slots



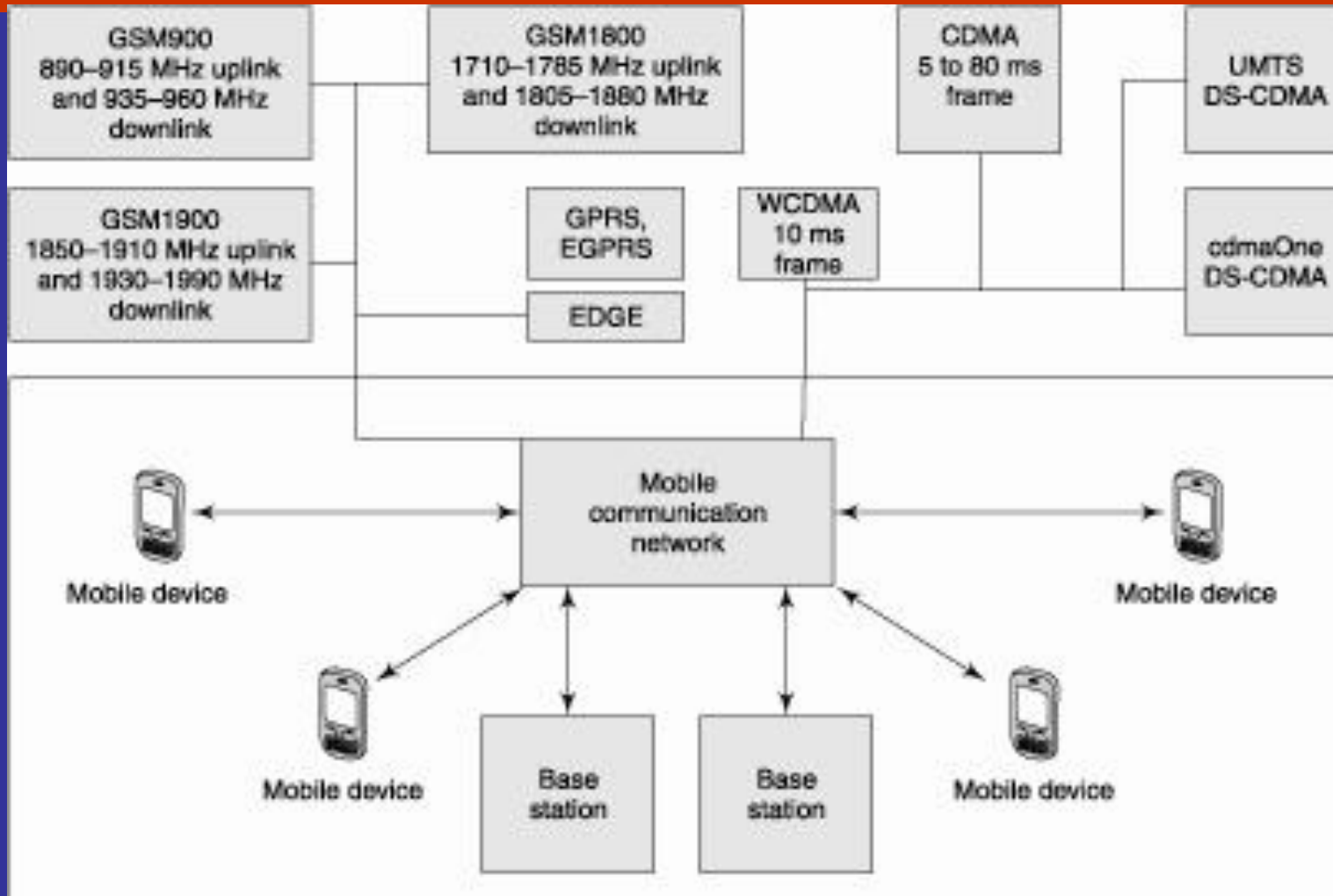
# TDMA IN A RADIO-CARRIER CHANNEL $CH_M$

- A set of maximum 8 MSs out of  $I/MS_s$  can be assigned a radio carrier channel by a  $BTS_j$  using FDMA
- Transmits in distinct time slots  $SL_0, SL_1, \dots, SL_7$ , each of  $577 \mu s$
- An MS uses one of the 8 distinct time slots in a given channel

# **TDMA— DIFFERENT SOURCES USING DIFFERENT TIME-SLICES FOR TRANSMISSION OF SIGNALS**

- An 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) C1, C2, C3, C4, C5, C6, C7, and C8 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 =  $577 \mu\text{s}$

# **FDMA— DIFFERENT SOURCES USING DIFFERENT FREQUENCY FOR TRANSMISSION OF SIGNALS**

- An 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

# FREQUENCY DIVISION MULTIPLE ACCESS

- Dividing the allotted or available bandwidth into different frequency channels for communication by multiple sources (sets of MTs)

# RADIO-CARRIER CHANNELS

- A set of maximum 124 radio-carrier channels each of 200 kHz can be used in GSM 900 downlink channel (MSC to BSC, BSC to BTS, and BTS to MS)
- 124 in the uplink channel (MS to BTS, BTS to BSC, and BSC to MSC)

# RADIO-CARRIER CHANNELS

- The 124 slots in GSM 900 in the uplink frequency range —ch1:  $890.1 \text{ MHz} \pm 100 \text{ kHz}$ , ch2:  $890.3 \text{ MHz} \pm 100 \text{ kHz}$ , and so on till ch124:  $914.9 \text{ MHz} \pm 100 \text{ kHz}$
- Downlink frequency slots —ch1:  $935.1 \text{ MHz} \pm 100 \text{ kHz}$ , ch2:  $935.3 \text{ MHz} \pm 100 \text{ kHz}$  ... and the last frequency is ch124:  $959.9 \text{ MHz} \pm 100 \text{ kHz}$



# GUARD BAND

- GSM 900 system permits a guard band of 50 kHz at the lowest frequency end and a guard band of 50 kHz at highest frequency band
- Thus Actual frequency band for the 890.1 MHz  $\pm$  100 kHz ch1 is 890.1 MHz  $\pm$  50 kHz
- The guard bands guard against frequency drifts in radio carriers

# CHANNELS ALLOTTED AT A GIVEN INSTANT TO A BTS

- Maximum 10
- The mobile service provider reserves one channel per BTS for transmission to MS or BSC

# GSM SYSTEM STATION CHANNELS

- Total number of channels assigned to a BTS is 11
- A GSM system station is permitted use the ch2 to ch123 only
- 122 channels are available in GSM 900
- Total number of reserve channels can be 32 for the data transmission of mobile service provider

# SUMMARY

- Space division multiple access (SDMA)
- When a cell divides in four groups  $A$ ,  $B$ ,  $C$ , and  $D$  of mobile users in four different regional slots (Sectors  $R1$ ,  $R2$ ,  $R3$ , and  $R4$ ) in space then four MTs use same time slots and same frequency channels

# SUMMARY

- Time division multiple access (TDMA)
- GSM Eight phones (GSM devices) simultaneously transmit in the same frequency band (channel) and same space with Time-slice allotted to each =  $577 \mu\text{s}$

# SUMMARY

- Frequency division multiple access (FDMA)
- Maximum 124 radio-carrier channels each of 200 kHz can be used in GSM 900 downlink channel
- 124 in the uplink channel (MS to BTS, BTS to BSC, and BSC to MSC)

# End of Lesson 03

## SDMA, TDMA, and FDMA