

WIRELESS MEDIUM ACCESS CONTROL AND CDMA, 3G, WIMAX, 4G AND 5G NETWORKS

Lesson 02

Medium Access Control

MEDIA ACCESS CONTROL

- Means methods to enable the use of number of channels simultaneously accessing the medium with minimum interference or collision
- Wired networks use a number of MAC protocols and MAC

MEDIA ACCESS CONTROL

- OSI as well as TCP/IP models define a data link layer (DLL)
- DLL functions enable point-to-point or point-to-multipoint transmission and reception
- DLL consists of two sub-layers: logical link control (LLC) and MAC

MAC METHODS

(i) A bus controller (base station)
coordinating all communication (single
hop or centralised protocol)

Based on the concept that *a token is sent to the addressed listener and then the listener listens. The listeners are addressed successively.*

MAC METHODS

(ii) TDMA (time division multiple access) meaning scheduled or distributed time slots for media access

MAC METHODS

(iii) Contention based or hybrid [contention based along with reservation (scheduling)] Contention based protocols are as follows:

(a) Carrier Sense Multiple Access (CSMA): It is based on the concept of *keep searching silence continuously and speak on discovering the silence*

MAC METHODS

(b) CSMA/Collision Avoidance (CSMA/CA): It is based upon the concept *keep searching for silence after a waiting period and speak on discovering the silence.*

(c) CSMA/Collision Detect (CSMA/CD): It is based on the concept of *speak and sense interference, in case of interference then speak again.*

WIRELESS MEDIUM ACCESS PROBLEM

- Medium access such that wireless stations (WSs) transmit at any instant without interference with signals from other WSs

WIRELESS MEDIUM ACCESS PROBLEM

- WS— can be a mobile terminal (TE) at a mobile station (MS), a base transceiver system (BTS), or a wireless LAN node

WAYS TO ELIMINATE INTERFERENCE BETWEEN THE SIGNALS AT ANY INSTANT T

- Facilitate access to wireless medium by multiple sources or channels of same source when each one is using a distinct set of physical space, time, frequency, and code at each instant

WAYS TO ELIMINATE INTERFERENCE BETWEEN THE SIGNALS AT ANY INSTANT T

- Specialize methods for wireless medium Access control
- SDMA
- TDMA
- FDMA
- CDMA, OFDM, ...

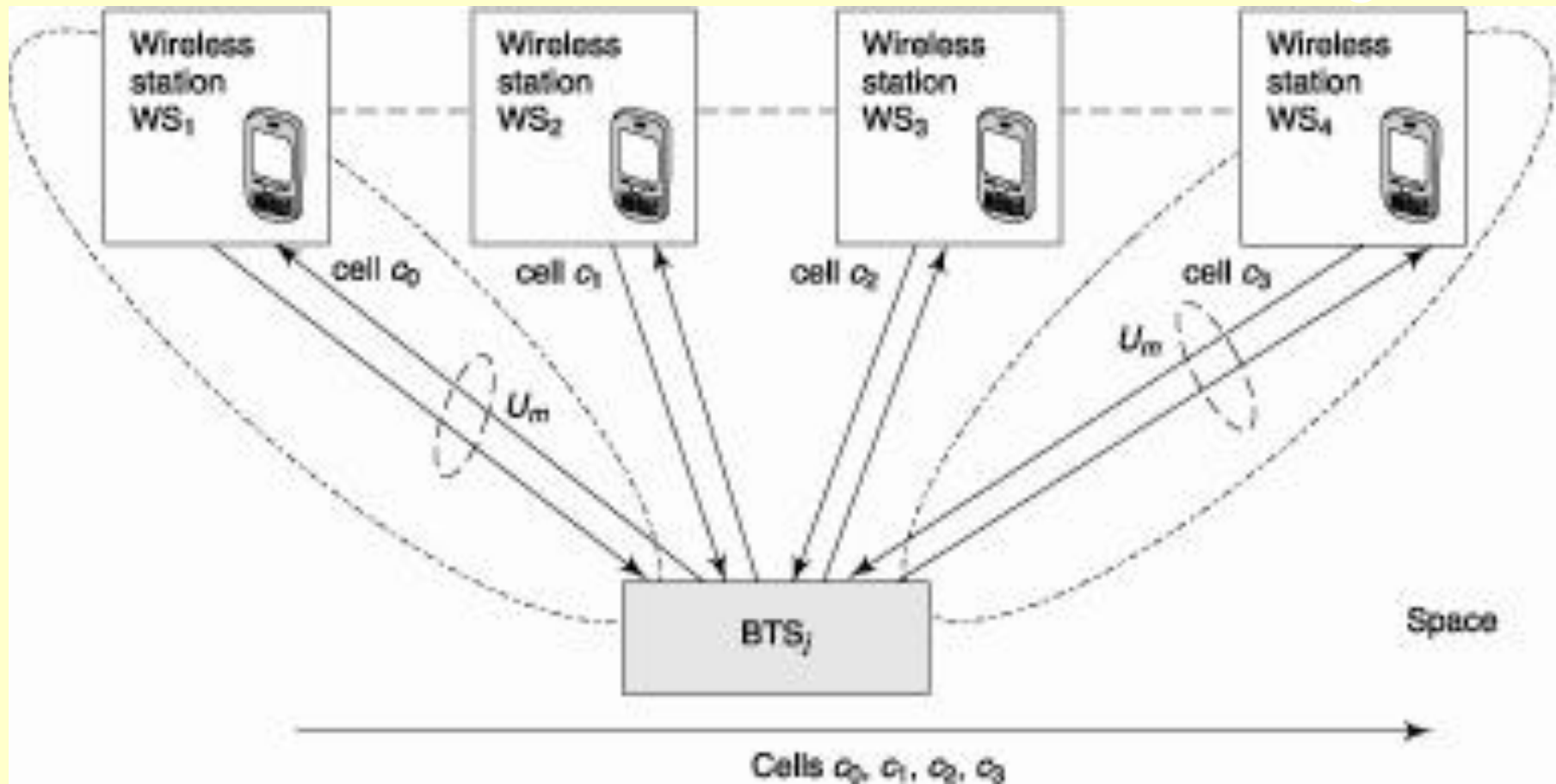
SDMA (SPACE DIVISION MULTIPLE ACCESS)

- WSSs that are distantly located access the medium by transmitting at the same f_{c0} as well as in the same time-slot SL ($t' \leq t \leq t''$) in different spaces (cells) only

SDMA (SPACE DIVISION MULTIPLE ACCESS)

- WSS located at suitable distances from each other are then said to transmit using SDMA

FOUR WIRELESS STATIONS, IN FOUR DISTINCT CELLS, SIMULTANEOUSLY TRANSMITTING WITH THE SAME f_c



TDMA-FDD-FDMA FOR MEDIUM ACCESS CONTROL

- GSM
- GPRS
- HSCSD

TDMA (TIME DIVISION MULTIPLE ACCESS)

- m time slots in a communication system
- When the WSs ($\leq m$) located in the same space (cell c), then the WSs access the medium in m different time-slots, SL_0 to SL_{m-1}

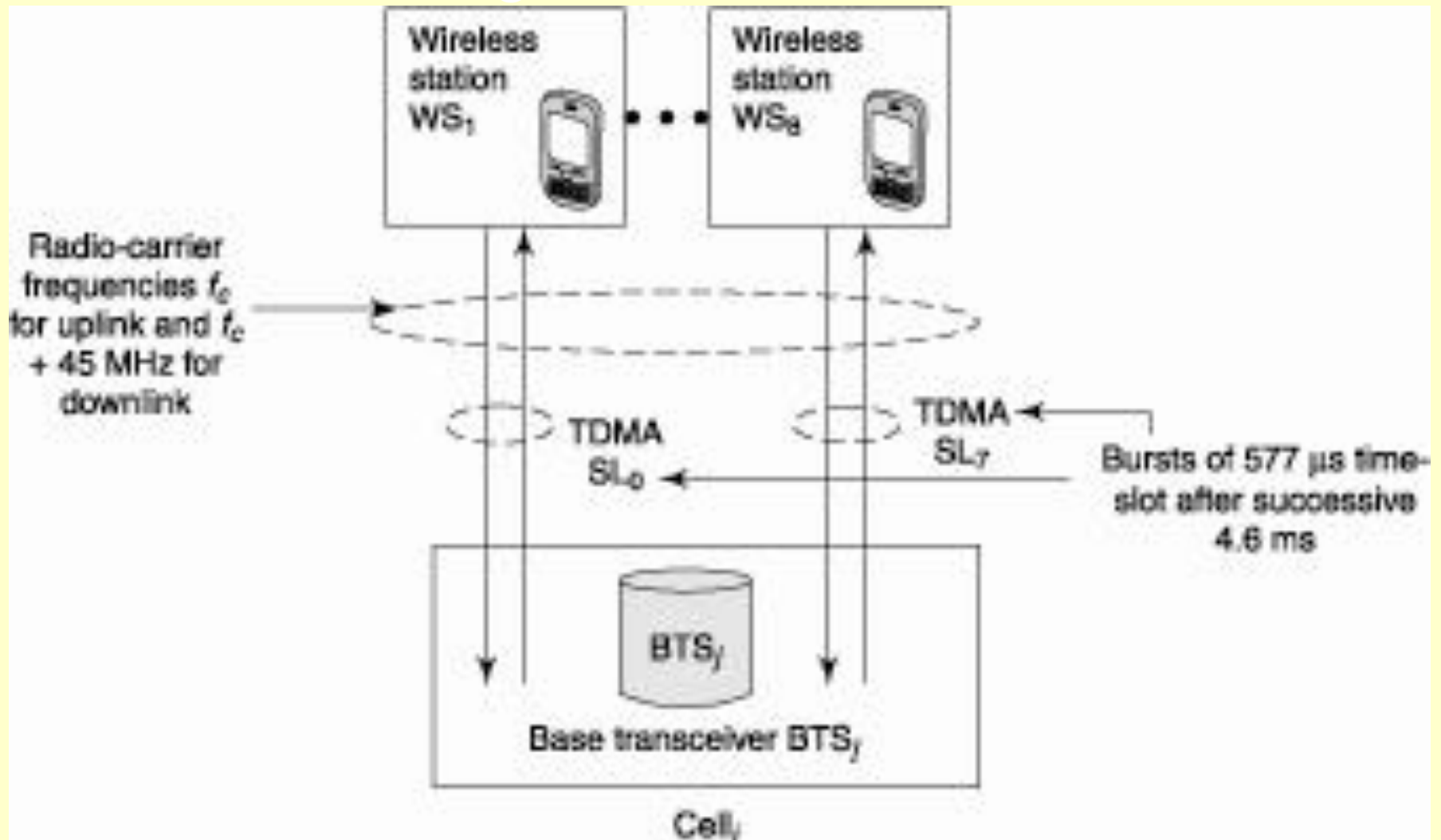
TDMA IN GSM 8 TRANSMITTING WSSs

- Distinct time-slots SL0, SL1, ..., SL7 using the same radio-carrier frequency f_c using TDMA
- A limit to the number of wireless stations that can be served using different slots

TDMA IN GSM 8 TRANSMITTING WSS

- Transmission slots for a WS repeated after small intervals (called frame intervals)
- Total data throughput from each WS does not become too small

8 WSS TRANSMITTING IN DISTINCT TIME-SLOTS SL_0, SL_1, \dots, SL_7 USING THE SAME f_c USING TDMA



GSM SYSTEM

- Collisions avoided due to drifts in receiver and transmitter clock frequency or computational delays in placing the data in a slot

DECT WSS MEDIUM ACCESS CONTROL BY TDMA

- Half of the TDMA slots are used for uplink and half for downlink
- The transmitting WS channels allotted a fixed pattern by the BTS
- Each of the m stations can transmit with a maximum delay interval equal to the frame interval $m \times (t' - t'')$

DECT WSS MEDIUM ACCESS CONTROL BY TDMA

- Data bursts transmit in time-slots of $417 \mu\text{s}$
- Total 12 uplink and 12 downlink channels in 24 slots in a total duration of 10 ms now be kept identical, as the time-slots used for them are distinct

DECT WSS MEDIUM ACCESS CONTROL BY TDMA

- After each successive 10 ms interval, the slots in a frame are repeated
- Uplink and downlink frequencies can now be kept identical, as the time-slots used for them are distinct

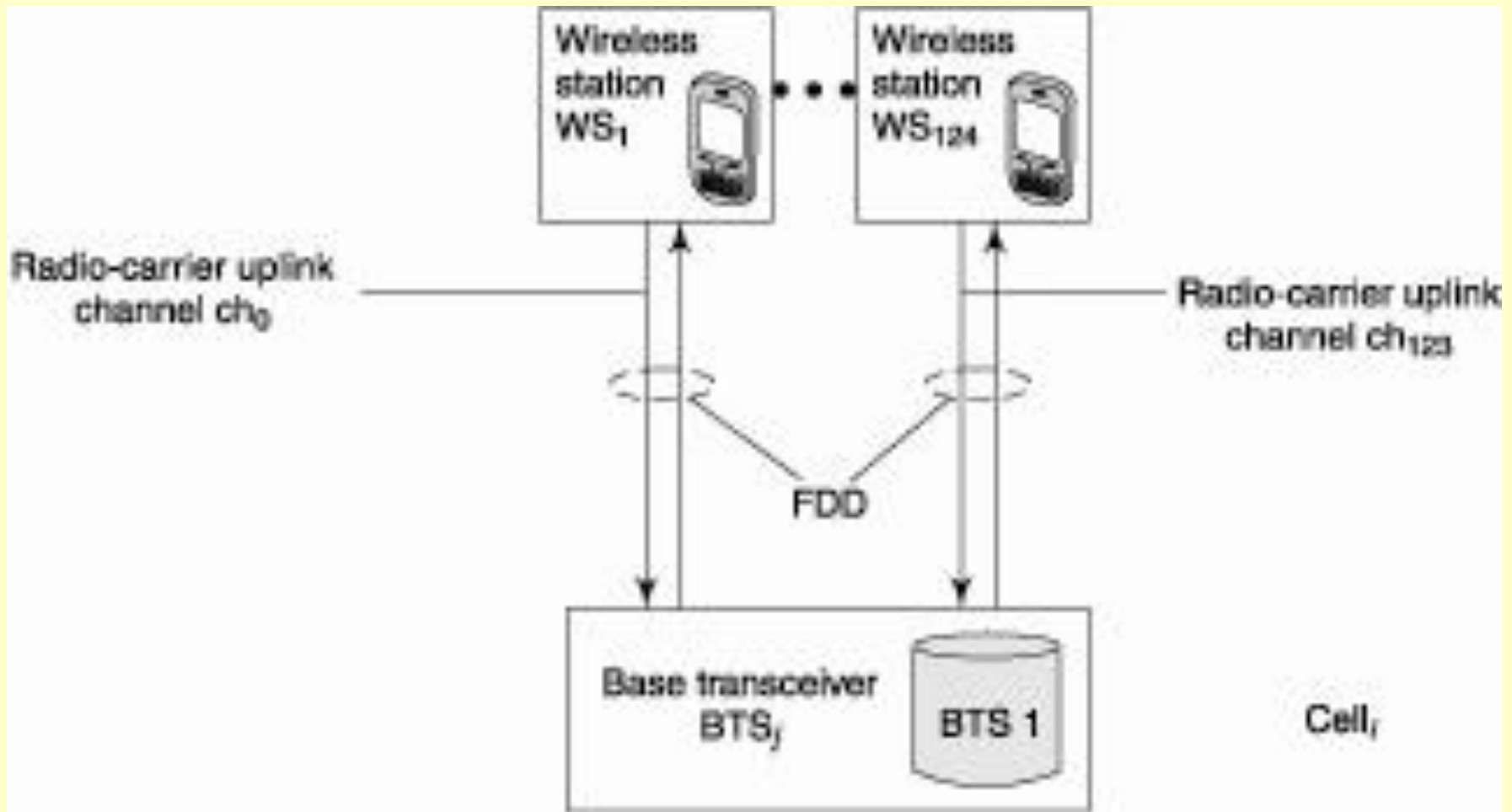
FDD (FREQUENCY DIVISION DUPLEX) UPLINK AND DOWNLINK ACCESSSES OF THE WSSs

- In different time-slots or in the same slots (shifted by a constant delay), SL_0 to SL_{m-1}
- The uplink and downlink frequencies of the radio carrier, f_c , are distinct

FDD (FREQUENCY DIVISION DUPLEX) UPLINK AND DOWNLINK ACCESSSES OF THE WSSs

- Example— f_c and $f_c + 45$ MHz for FDD access to the medium
- Different uplink–downlink frequency-pairs are assigned distinct f_c s (out of the n values from f_{c0} to f_{cn-1}) in a cell

CELL / WITH 124 RADIO-CARRIER CHANNELS USING FDMA AND F_c FOR UPLINK AND $F_c + 45$ MHZ FOR DOWNLINK



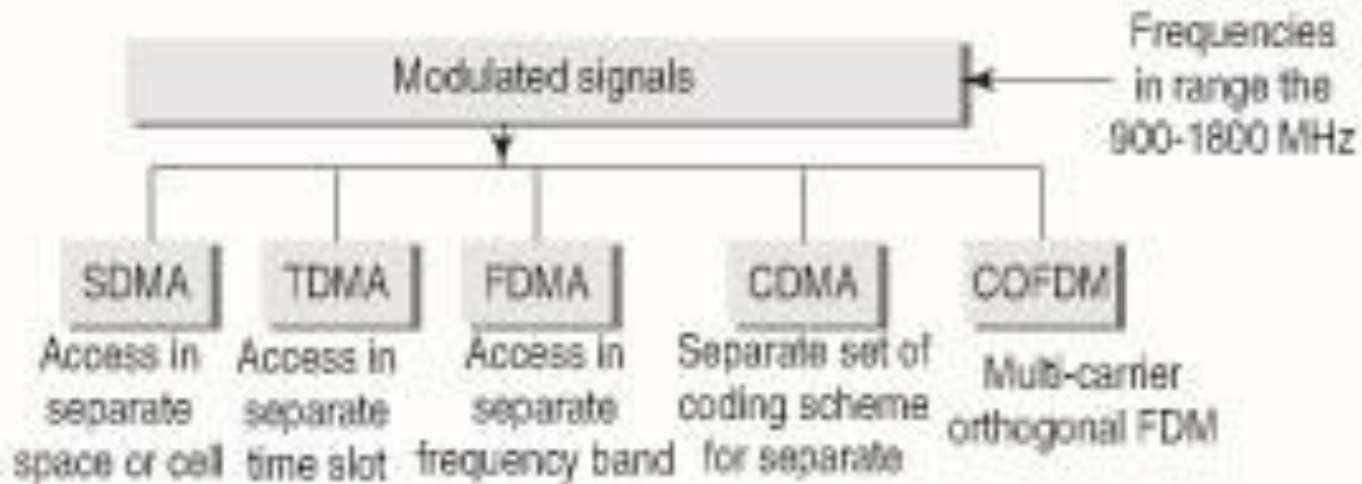
CDMA (CODE DIVISION MULTIPLE ACCESS) BASED SYSTEM

- When the WSs using the same space (cell), same time-slot, and same frequency f_c , then CDMA is alternative to access the medium

CDMA (CODE DIVISION MULTIPLE ACCESS) BASED SYSTEM

- Each WS uses a distinct code between C_0 and C_{p-1} when accessing the medium
- p values from C_0 to C_{p-1}

MULTIPLEXED ACCESS METHODS IN MEDIUM FOR THE MODULATED SIGNALS



SUMMARY

- Other Specialize methods for wireless medium Access control
- SDMA
- TDMA
- FDMA
- FDD
- CDMA

End of Lesson 02
Medium Access Control