CS8601 –MOBILE COMPUTING

UNIT 1

INTRODUCTION

1.5.Medium access control(MAC)

The **Media Access Control** (**MAC**) data communication protocol sub-layer, also known as the Medium Access Control, is a sublayer of the Data Link Layer specified in the seven-layer OSI model (layer 2). The hardware that implements the MAC is referred to as a **Medium Access Controller**. The MAC sub-layer acts as an interface between the Logical Link Control (LLC) sublayer and the network's physical layer. The MAC layer emulates a full-duplex logical communication channel in a multi-point network. This channel may provide unicast, multicast orbroadcast communication service.

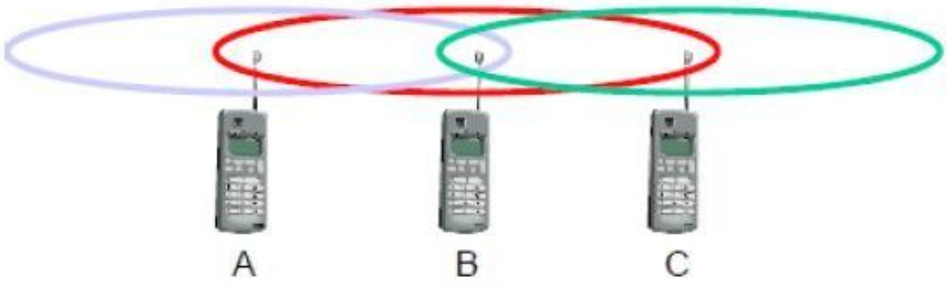
MOTIVATION FOR A SPECIALIZED MAC:

One of the most commonly used MAC schemes for wired networks is carrier sense multipleaccess with collision detection (CSMA/CD). In this scheme, a sender senses the medium (a wire or coaxial cable) to see if it is free. If the medium is busy, the sender waits until it is free. If the medium is free, the sender starts transmitting data and continues to listen into the medium. If the sender detects a collision while sending, it stops at once and sends a jamming signal. But this scheme doest work well with wireless networks. The problems are:

a) Signal strength decreases proportional to the square of the distance
b) The sender would apply CS and CD, but the collisions happen at the receiver
c) It might be a case that a sender cannot “hear” the collision, i.e., CD does not work
d) Furthermore, CS might not work, if for e.g., a terminal is “hidden”

Hidden and Exposed Terminals

Consider the scenario with three mobile phones as shown below. The transmission range of A reaches B, but not C (the detection range does not reach C either). The transmission range ofC reaches B, but not A. Finally, the transmission range of B reaches A and C, i.e., A cannot detectC and vice versa.



Hidden terminals

a) A sends to B, C cannot hear A
b) C wants to send to B, C senses a "free" medium (CS fails) and starts transmitting
c) Collision at B occurs, A cannot detect this collision (CD fails) and continues with itstransmission to B
d) A is "hidden" from C and vice versa

Exposed terminals

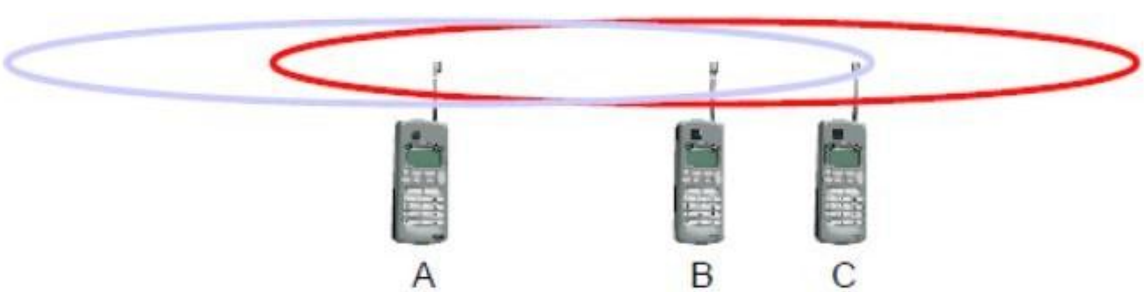
a) B sends to A, C wants to send to another terminal (not A or B) outside the range
b) C senses the carrier and detects that the carrier is busy.
c) C postpones its transmission until it detects the medium as being idle again but A is outsideradio range of C, waiting is **not** necessary
d) C is "exposed" to B

Hidden terminals cause collisions, where as Exposed terminals causes unnecessary delay.

Near and far terminals

Consider the situation shown below. A and B are both sending with the same transmission power.

a) Signal strength decreases proportional to the square of the distance
b) So, B's signal drowns out A's signal making C unable to receive A's transmission
c) If C is an arbiter for sending rights, B drown out A's signal on the physical layer makingC unable to hear out A.



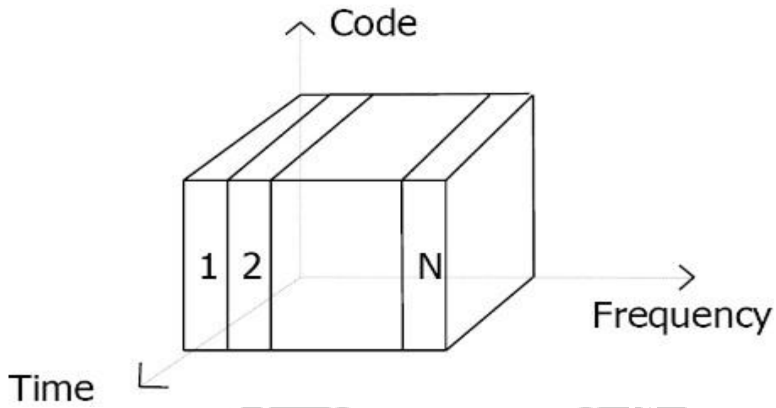
The **near/far effect** is a severe problem of wireless networks using CDM. All signals should arrive at the receiver with more or less the same strength for which Precise power control is to be implemented.

Space Division Multiple Access [SDMA]:

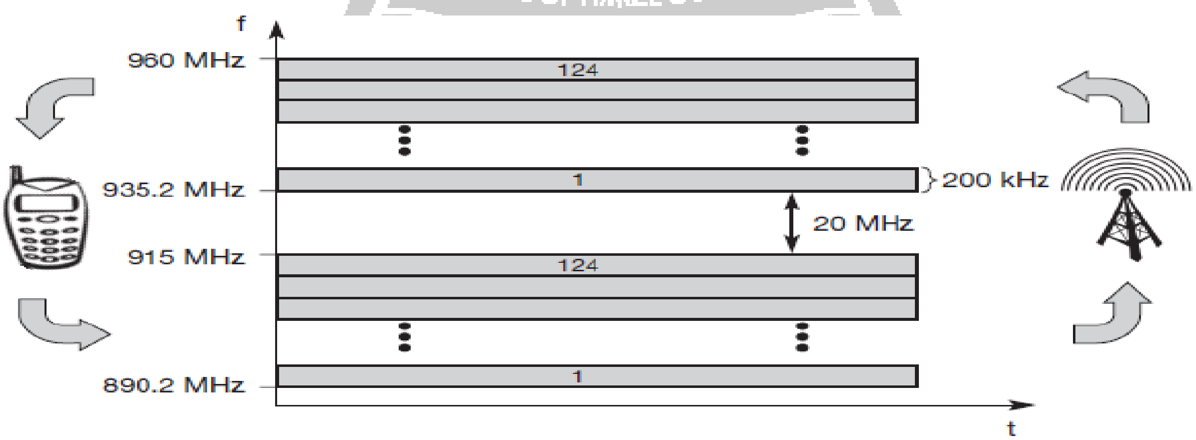
- **Space Division Multiple Access (SDMA)** is used for allocating a separated space to users in wireless networks.
- A typical application involves assigning an **optimal base station to a mobile phone user**. The mobile phone may receive several base stations with different quality.
- A MAC algorithm could **now decide which base station is best**, taking into account which frequencies (FDM), time slots (TDM) or code (CDM) are still available.
- The basis for the SDMA algorithm is **formed by cells and sectorized antennas** which constitute the infrastructure implementing **space division multiplexing (SDM).**
- SDM has the unique advantage of not requiring any multiplexing equipment.
- **It is usually combined with other multiplexing techniques** to better utilize the individual physical channels.

Frequency Division Multiple Access [FDMA]:

Frequency division multiplexing (FDM) describes schemes to subdivide the frequency dimension into several non-overlapping frequency



Frequency Division Multiple Access is a method employed to permit several users to transmit simultaneously on one satellite transponder by assigning a specific frequency within the channel to each user. Each conversation gets its own, unique, radio channel. The channels are relatively narrow, usually 30 KHz or less and are defined as either transmit or receive channels. Afull duplex conversation requires a transmit & receive channel pair. FDM is often used for simultaneous access to the medium by base station and mobile station in cellular networks establishing a duplex channel. A scheme called **frequency division duplexing (FDD)** in which the two directions, mobile station to base station and vice versa are now separated using differentfrequencies.



FDM for multiple access and duplex

The two frequencies are also known as **uplink**, i.e., from mobile station to base station or from ground control to satellite, and as **downlink**, i.e., from base station to mobile station or fromsatellite to ground control. The basic frequency allocation scheme for GSM is fixed and regulatedby national authorities. All uplinks use the band between 890.2 and 915 MHz, all downlinks use
935.2 to 960 MHz. According to FDMA, the base station, shown on the right side, allocates a certain frequency for up- and downlink to establish a duplex channel with a mobile phone. Up- and downlink have a fixed relation. If the uplink frequency is $f_u = 890$ MHz + $n \cdot 0.2$ MHz, the downlink frequency is $f_d = f_u + 45$ MHz, i.e**., fd = 935 MHz + n·0.2 MHz** for a certain channel n. The base station selects the channel. Each channel (uplink and downlink) has a bandwidth of 200 kHz.

This scheme also has disadvantages. While radio stations broadcast 24 hours a day, mobilecommunication typically takes place for only a few minutes at a time. Assigning a separate frequency for each possible communication scenario would be a tremendous waste of (scarce) frequency resources. Additionally, the fixed assignment of a frequency to a sender makes the scheme very inflexible and limits the number of senders.