

Unit III Medium Access Control

→ Motivation for Specialised MAE

→ SDMA

→ FDMA

→ CDMA

→ TDMA

Motivation of Specialised MAC

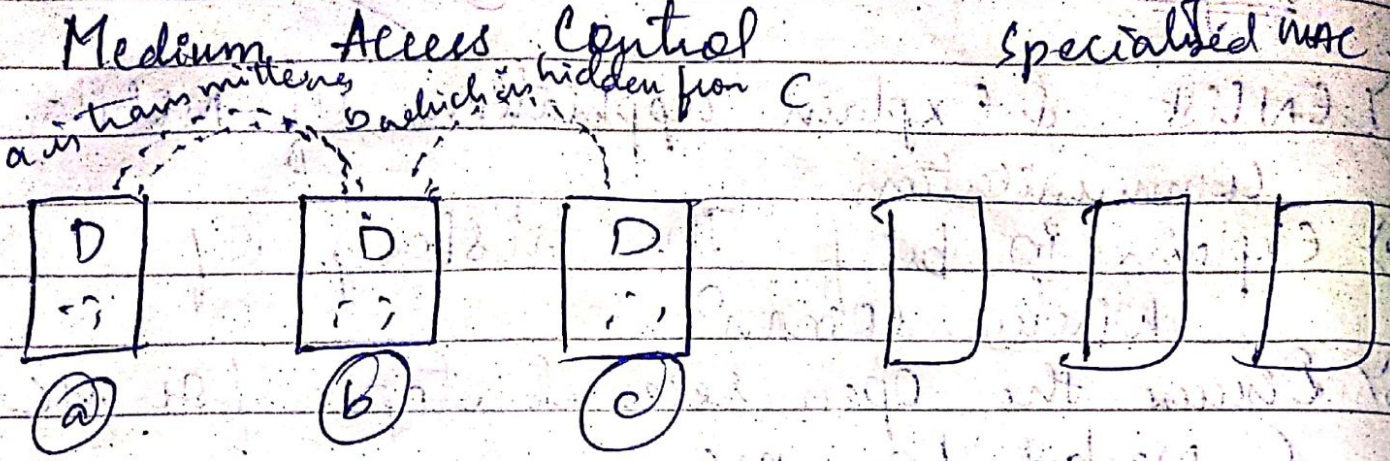


Fig Hidden terminal transmit b istransmitter to c

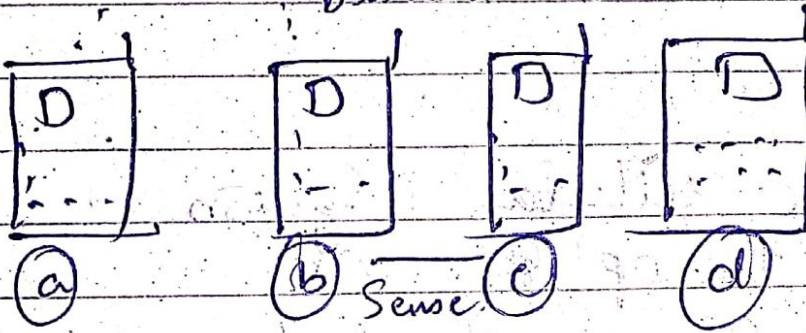


Fig -> Exposed terminal

Hidden terminal -> Consider the scenario with 3 mobile phones as shown in fig. the transmission range of 'a' reaches 'b' but not 'c' (the detection range) does not reach 'c' either. the transmission range of 'c' reaches 'b' but not 'a'. Finally, the transmission range of 'b' reaches 'a' & 'c' i.e. 'a' cannot detect 'c' & vice versa.

'a' starts sending to 'b', 'c' does not receive this transmission. 'c' also wants to send something to 'b' & senses the medium. The medium appears to be free, the carrier sense fails. 'c' also starts sending, causing a collision at 'b'. but 'a' cannot detect this collision at 'b' & continues with its transmission. 'a' is hidden for 'c' & vice versa.

Exposed Terminal :- Consider the situation that 'b' sends something to 'a' & 'c' wants to transmit data to some other mobile phone outside the interference range of 'a' & 'b'. 'c' senses the carrier & detects that the carrier is busy (B's signal). 'c' postpones its transmission until it detects the medium as being idle again. but 'a' is outside the interference range of 'c', waiting is not necessary. causing a collision at 'b' does not matter because collision is too weak to propagate to 'a'. In this situation, 'c' is exposed to 'b'.

Near & far terminal

30th July

with FDMA/CDMA used in mobile networks

Approach SDMA

TDMA

Idea: Segment space into cells/sectors

Segments spending time in disjoint time slots demand driven or fixed pattern

Terminal Only one terminal can be active in one cell / one sector

all terminals are active for short period of time on the same frequency.

Signal Separation cell structure directed antennas

Synchronisation in the time domain

Advantage Very simple, increases capacity per km^2/sq

Established, fully digital, Very flexible

Disadvantage inflexible, antennas typically fixed

large space needed, synchronisation difficult

Comment Only in comb^o usefull with FDMA/TDMA/CDMA

~~only~~ standard in link network together

FDMA

segments the frequency band into disjoint sub bands.

Every terminal has its own frequency Uninterrupted

filtering in the frequency domain

simple, established, Robust

Inflexible frequencies are a core resource.

typically combined with TDMA / SDMA

CDMA

Spread the spectrum using orthogonal codes

all terminals can be active at the same place at the same moment Uninterrupted

code + special receiver

flexible, less planning needed / soft handover

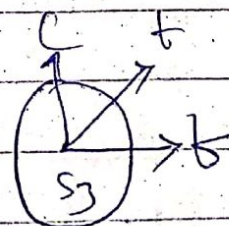
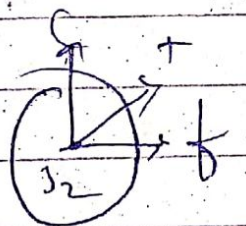
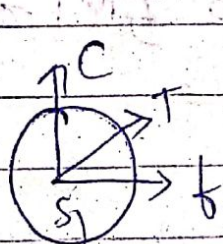
Complex receivers, needs more complicated power control for sender

used in many 3G systems, higher complexity required

SDMA

- ① Fig shows 'G' channels k_1 & introduces a 3 dimensional co-ordinate system.
- ② System shows dimension of code 'c', time 't' & frequency 'f'.
- ③ For SDMA space S_i is also shown in this figure a space is represented by circle.
- ④ The k_1 to k_3 can be mapped on to the three space S_1, S_2, S_3 .

Channel k_i :



SDMA

1) Frequency planning :- is the process of assigning frequencies, transmitter locations & parameters of wireless communication system to provide the sufficient coverage & capacity for the services required. The radio frequency of plan of Comⁿ system has two objectives :- coverage & capacity.

2) Coverage :- it relates to the geographical footprints within system that has sufficient radio frequency signal strength to provide for a call / data session.

3) Capacity :- Capacity relates to the capability of system to sustain a given no^r of participants. Capacity & coverage are inter-related to improve coverage, capacity has to be sacrificed while doing to capacity, coverage will have to be sacrificed.

4) Optimisation :-

FDMA \rightarrow FDMA is a process of dividing one channel or bandwidth into multiple individual bands, each for use by a single user. Each individual band or channel is wide enough to accommodate signal spectrum of transmission to be propagated, the data to be transmitted is modulated on each sub carrier & all of them are linearly mixed together.

FDMA divides the shared medium bandwidth into individual channels. Subcarriers modulated by the infoⁿ to be transmitted to occupy the channel.

Eg:-

The best Eg of this is cable television system. The medium is the single coaxial cable i.e. used to broadcast 100's of channels of video/ audio programmes to homes.

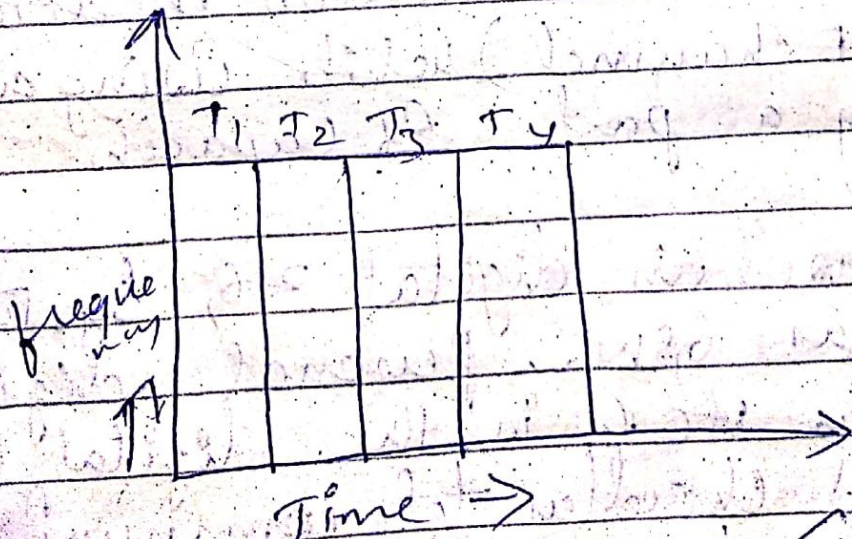
The coax has useful bandwidths for about 4 mhz to 2 giga hertz. This bandwidth is divided up into 6 mhz wide channels.

(This technique is also used in fiber optic communication system. A single fiber optic cable has enormous bandwidth that can be subdivided to provide FDMA. Different data or info sources are each assigned a different

Light ~~data~~ ^{light} frequency for transmission.
Light generally is not referred to by frequency, but by its wavelength as a result fiber optic FDMA is called wavelength division multiple access.
One of the older FDMA systems is the original analog telephone system, which used a hierarchy of frequency multiplex techniques to put multiple telephone calls on a single line.

TDMA

Time division multiple access is channel access method for shared medium networks. It allows several users to share the same frequency channel by dividing the signal into different time slots.



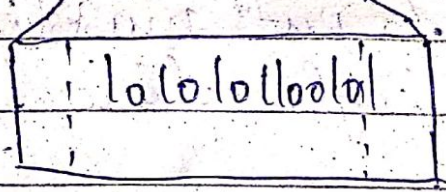


Data streams
divided into
frames.



frame divided into
time slots each user
is allocated one slot

Guard
period



Time slot contain data for
with guard period if
needed for synchronization

fig TDMA

The user transmit (sequentially) one after
the other, each using its own time
slots. This allows multiple stations to
share the same transmission medium,
(e.g. :- RF channel) while using a part
of only a part of capacity.

- TDMA used in digital 2G systems
such as GSM, Personal Digital
Cellular etc. in the digital
Enhanced Cordless Telecommunication (DECT)
Standard for portable phones.

ch...

TDMA is type of time division multiplexing (TDM) with special point that instead of having one transmitter connected to one receiver, there are multiple transmitters. In case of uplink from a mobile phone to Base Station this become particularly different bcz phone can move around & vary the timing advance required to make its transmission match the gap in transmission from its peers.

Band 12.3 mhz

Near & Far terminal

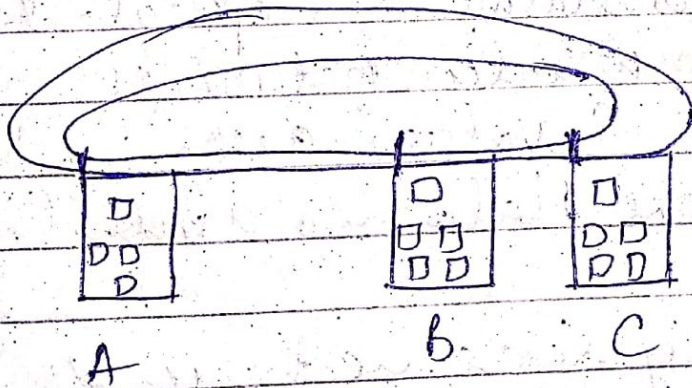


Fig → Near & Far terminal

- 1) Consider the situation A & B are both sending with same transmission power.
- 2) Signal strength decreases proportional to the square of distance.

③ So ~~weak~~ signal draws making 'c' unable to receive A's transmission. making if 'c' is an arbiter for sending rights, B draws out A's signal on the physical layer making 'c' unable to hear out A.

④ The Near/Far effect is a severe problem of wireless networks using CDMA.

SDMA (continued)

- 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.
- a mobile phone may receive several BS with different quality
- A mac algorithm would now decide which BS is best, taking into account. with frequencies (FDM), time slots (TDM) or code (CDM) are still available (depending on technology)
- typically SDMA is never used in isolation but always in

combination with one or more other schemes
→ The basis for the CDMA algorithm is
joined by cell & sectorised antennas
which constitute the infrastructure
implementing CDMA.

CDMA

Code Division Multiple Access refers to any of the
several protocols used in IInd gen^o & IIIrd gen^o
wireless comm^o. as the term implies, CDMA
is a form of multiplexing, which allows nume-
rous signals to occupy a single transmission
channel, optimising the use of available
bandwidth. the technology is used in
(ultra high freq) UHF cellular Telephone systems
in the 800mhz & 1.9ghz.

CDMA employs the analog to digital
conversion (ADC) in comb^o with spread spectrum
technology. audio input is first digitised
into binary elements, the frequency of the
transmitted signals is then made to
vary according to defined patterns (code).
So it can be intercepted only by the receiver
whose frequency response is programmed
with the same code, so it follows exactly
along with transmitter frequency. there are
trillions of possible frequency sequencing
codes; which enhances privacy & ~~next~~ makes

downing difficult. The CDMA channel is nominally 1.23 MHz wide. CDMA networks use a scheme called soft handoff, which minimizes signal breakup as a handset passes from one cell to another. The combination of digital & spread spectrum modes supports several times as many signals per unit bandwidth as analog modes.

CDMA is compatible with other cellular technologies. This allows for nation wide roaming.