Nadar Saraswathi College of Engineering & Technology

NSCET E-LEARNING PRESENTATION

LISTEN … LEARN… LEAD…

COMPUTER SCIENCE AND ENGINEERING

III YEAR / VI SEMESTER

CS8601 – MOBILE COMPUTING

ARUL JOTHI S/M.E.,MISTE,
ASSISTANT PROFESSOR
Nadar Saraswathi College of Engineering & Technology,
Vadapudupatti, Annanji (PO), Theni – 625531.

TOPIC NAME

UNIT 01 - INTRODUCTION

LECTURE 01

INTRODUCTION TO MOBILE COMPUTING

- Definition
- Mobile computing Devices
- Mobile Computing Vs wireless Networking

Introduction to Mobile computing

- Mobile computing is described as the ability to compute remotely while on the move.
- It is also called ubiquitous computing as it is possible for people to communicate, access information and carry out important work from anywhere at any time. Also called nomadic computing.

Mobile computing = mobility + computing

Computing: Capability to automatically carry out certain processing related to service invocations on a remote computer.

Mobility: Capability to change location while communicating to invoke computing services at some remote computers

Mobile computing Devices

- Tablets
- Laptops
- Palmtops
- Smart phones
- Personal digital assistant
- Notebook PCs

Mobile Computing Vs wireless Networking

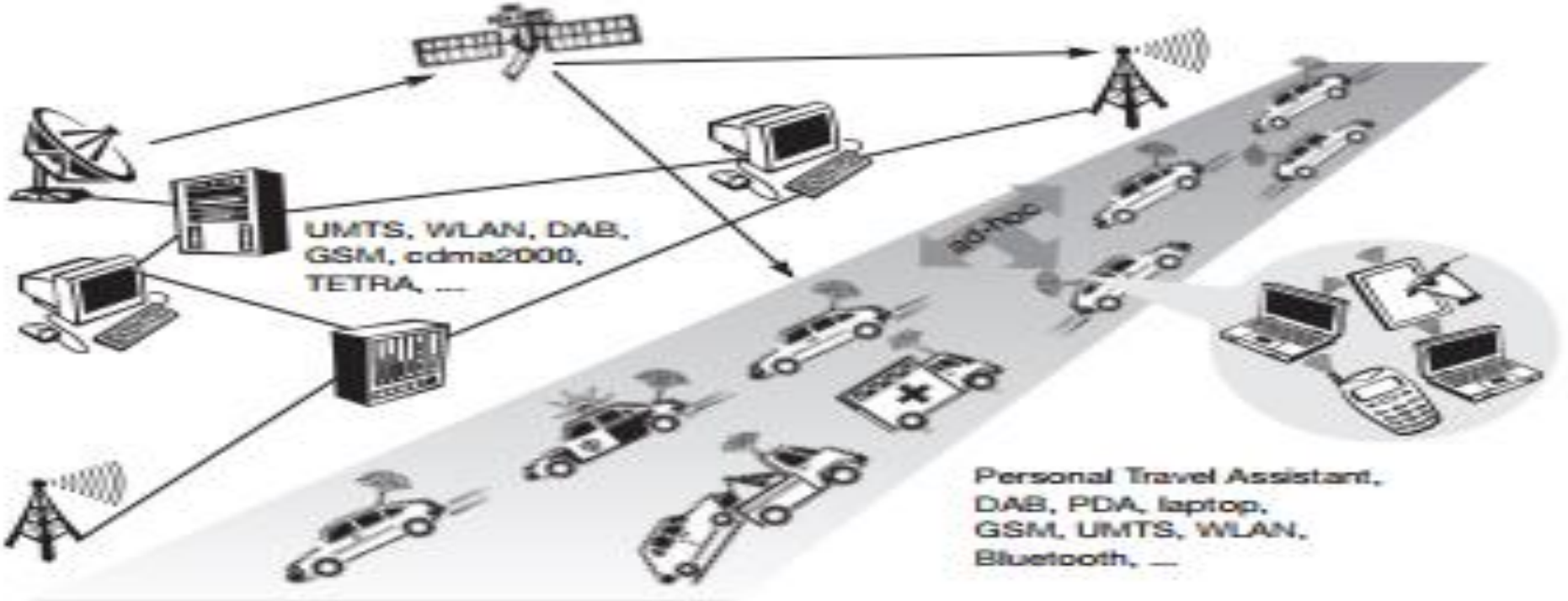
Sl.no	Mobile computing	Wireless Networking
1	Denotes accessing information and remote computational services while on move	Provides the basic communication infrastructure necessary to access information and computational services.
2	It is based on wireless networking.	It is an important ingredient of mobile computing. Wireless networks-2 types 1.Extension of wired networks 2.Ad-hoc networks

LECTURE-02

Applications of Mobile Computing

- Vehicles
- Emergencies
- Business
- Replacement of wired networks
- Infotainment & More-Location dependent services
- Mobile & Wireless devices

Applications of Mobile Communications- Road traffic



Generations of Mobile Communication Technologies

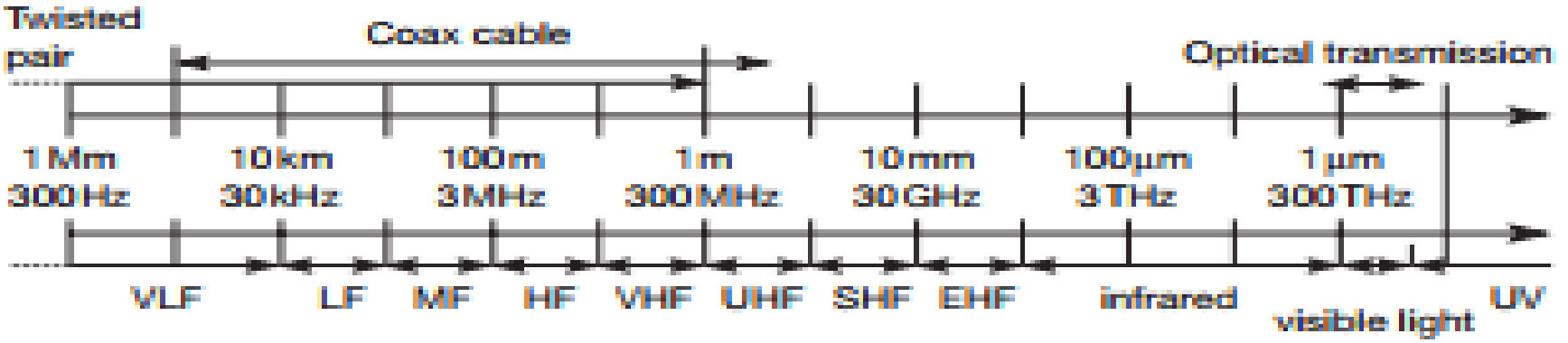
Generation	Speed	Technology	Time period	Features
1G	14.4 Kbps	AMPS,NMT, TACS	1970 – 1980	During 1G Wireless phones are used for voice only.
2G	9.6/ 14.4 Kbps	TDMA,CDMA	1990 to 2000	2G capabilities are achieved by allowing multiple users on a single channel via multiplexing. During 2G Cellular phones are used for data also along with voice.
2.5G	171.2 Kbps 20-40 Kbps	GPRS	2001-2004	2.5G the internet becomes popular and data becomes more relevant.2.5G Multimedia services and streaming starts to show growth. Phones start supporting web browsing though limited and very few phones have that.
3G	3.1 Mbps 500-700 Kbps	CDMA 200 (1xRTT, EVDO) UMTS, EDGE	2004-2005	3G has Multimedia services support along with streaming are more popular. In 3G, Universal access and portability across different device types are made possible. (Telephones, PDA's, etc.)
3.5G	14.4 Mbps 1-3 Mbps	HSPA	2006 – 2010	3.5G supports higher throughput and speeds to support higher data needs of the consumers
4G	100-300 Mbps. 3-5 Mbps 100 Mbps (Wi-Fi)	WiMax LTE Wi-Fi	Now (Read more on Transitioning to 4G)	Speeds for 4G are further increased to keep up with data access demand used by various services. High definition streaming is now supported in 4G. New phones with HD capabilities surface. It gets pretty cool. In 4G, Portability is increased further. World-wide roaming is not a distant dream.
5G	Probably gigabits	Not Yet	Soon (probably 2020)	Currently there is no 5G technology deployed. When this becomes available it will provide very high speeds to the consumers. It would also provide efficient use of available bandwidth

LECTURE-04

- Modulation
- Frequencies
- Signals
- Antennas
- Multipath propagation

Modulation

- Modulation is needed to transmit digital data via certain frequencies.
- Figure shows the Frequency Spectrum



Frequencies

Frequencies for radio transmission

-Radio transmission can take place using many different frequency band

-Radio transmission starts at several kHz, the very low frequency (VLF) range. Waves in the low frequency (LF) range are used by submarines.

-The medium frequency (MF) and high frequency (HF) ranges are typical for transmission of hundreds of radio stations either as amplitude modulation

Signals & Antennas

- Signals are the physical representation of data. Users of a communication system can only exchange data through the transmission of signals.
- Antennas couple electromagnetic energy to and from space to and from a wire or coaxial cable

Multipath propagation

- Together with the direct transmission from a sender to a receiver, the propagation effects lead to one of the most severe radio channel impairments, called multipath propagation.

LECTURE-05

Multiplexing

- Multiplexing describes how several users can share a medium with minimum or no interference
- One example, is highways with several lanes.
- Many users (car drivers) use the same medium (the highways) with hopefully no interference (i.e., accidents)

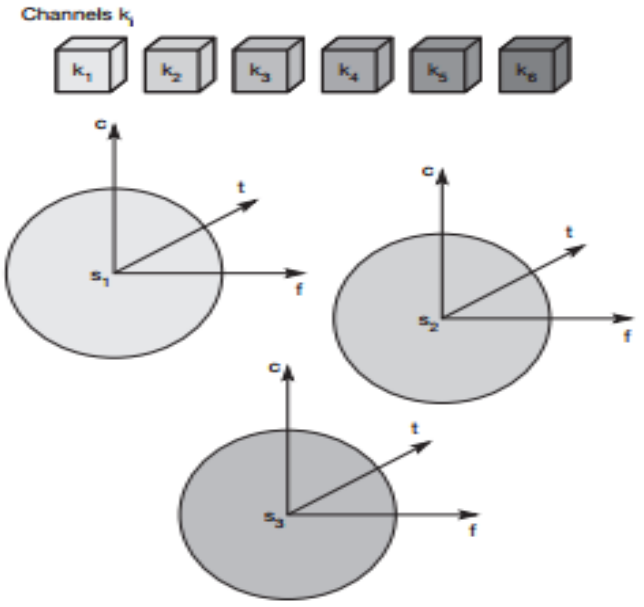
Multiplexing-Types

- Space Division Multiplexing(This is possible due to the provision of several lanes)
- Frequency Division Multiplexing
- Time Division Multiplexing(different cars use the same medium at different points in time)
- Code Division multiplexing

Space Division Multiplexing

The task of multiplexing is to assign space, time, frequency, and code to each communication channel with a minimum of interference and a maximum of medium utilization

Space Division Multiplexing



shows six channels k_i and introduces a three dimensional coordinate system. This system shows the dimensions of code c, time t and frequency f. For this first type of multiplexing, space division multiplexing (SDM), the (three dimensional) space s_i is also shown

Space Division Multiplexing

- The channels k1 to k3 can be mapped onto the three ‘spaces’ s1 to s3 which clearly separate the channels and prevent the interference ranges from overlapping
- The space between the interference ranges is sometimes called guard space

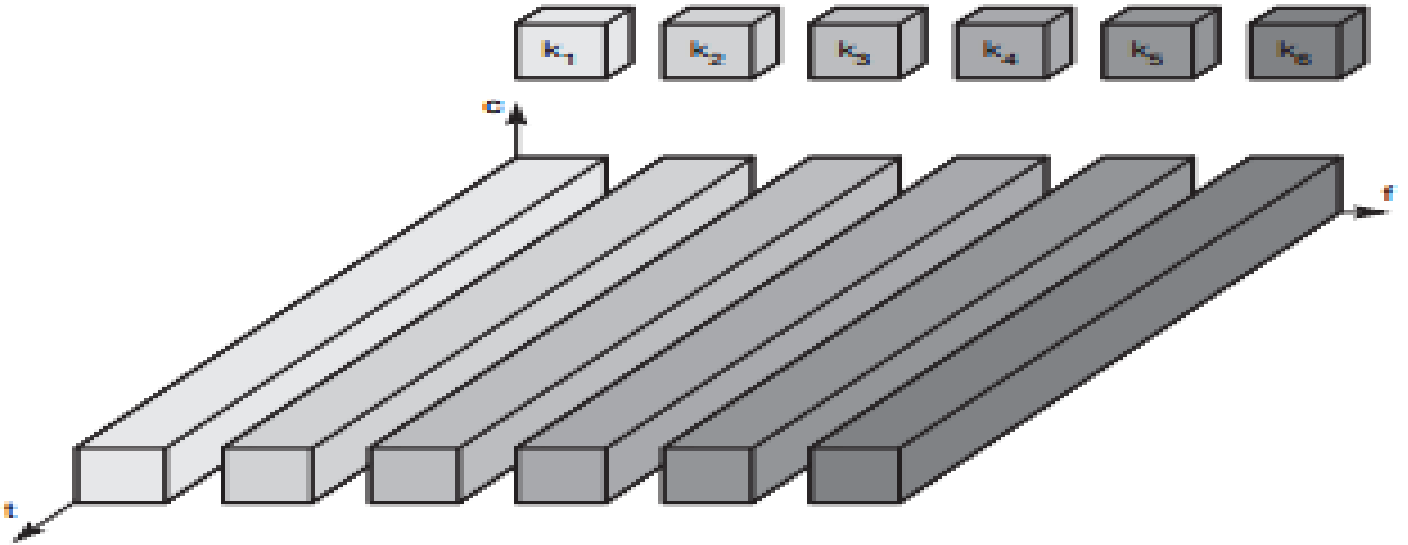
Space Division Multiplexing

Disadvantage:

- This scheme clearly represents a waste of space
- Using SDM, obvious problems arise if two or more channels were established within the same space.

Frequency division multiplexing

- This schemes to subdivide the frequency dimension into several non-overlapping frequency bands as shown in figure.



Frequency division multiplexing

- Each channel k_i is now allotted its own frequency band as indicated
- Again, guard spaces are needed to avoid frequency band overlapping (also called adjacent channel interference). This scheme is used for radio stations within the same region, where each radio station has its own frequency

Frequency division multiplexing

Advantage:

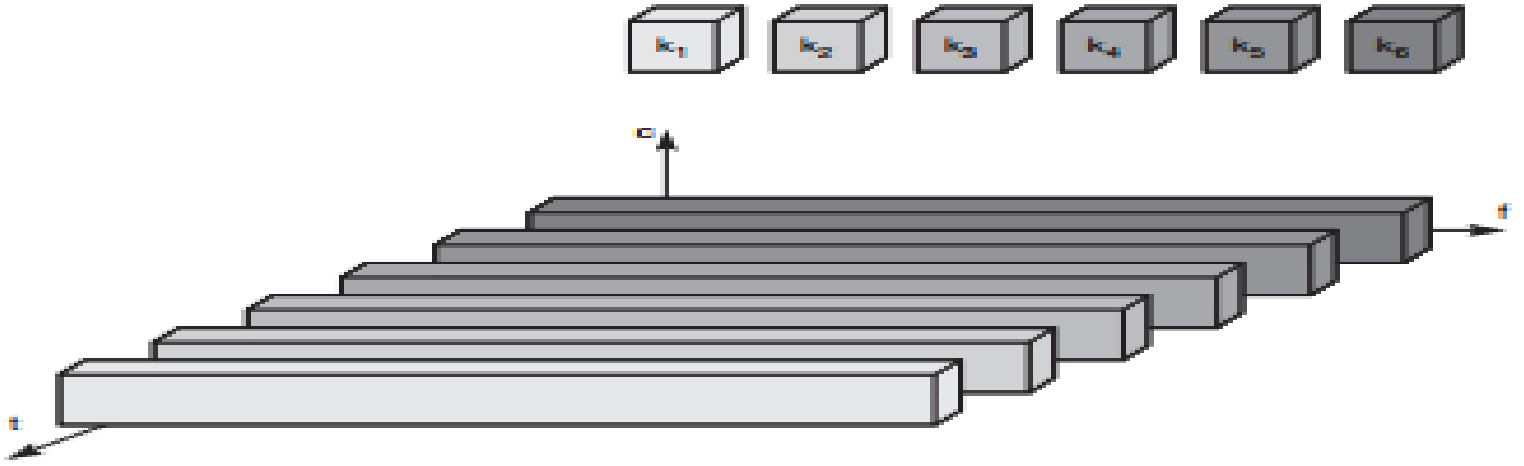
- very simple multiplexing scheme does not need complex coordination between sender and receiver

Disadvantage:

- The fixed assignment of a frequency to a sender makes the scheme very inflexible and limits the number of senders.

Time division multiplexing

A channel k_i is given the whole bandwidth for a certain amount of time, i.e., all senders use the same frequency but at different points in time



Time division multiplexing

- Again, guard spaces, which now represent time gaps, have to separate the different periods when the senders use the medium.
- If two transmissions overlap in time, this is called co-channel interference.
- To avoid this type of interference, precise synchronization between different senders is necessary.

Time division multiplexing

Disadvantage:

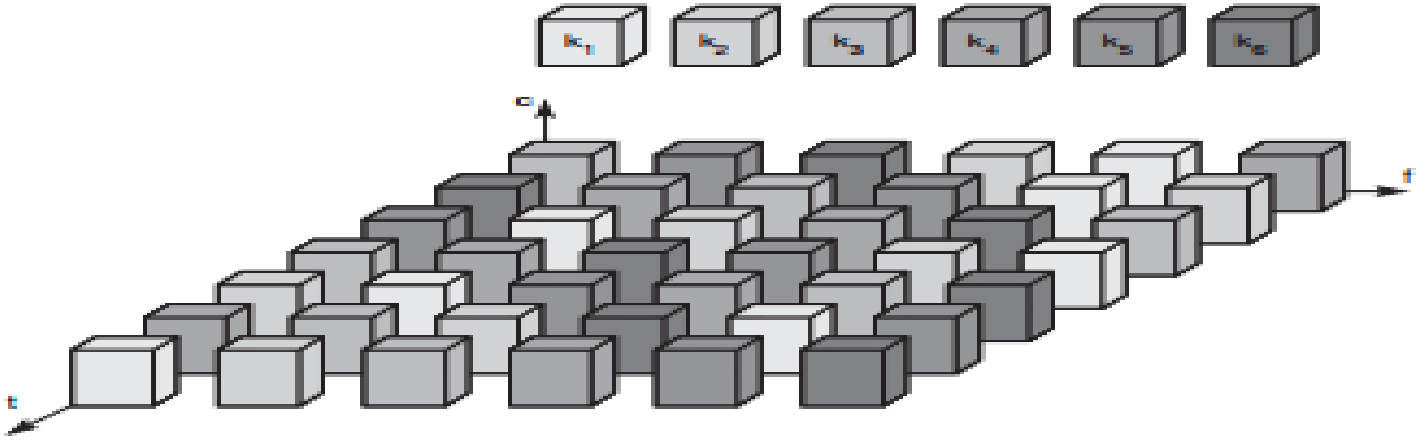
- All senders need precise clocks or, alternatively, a way has to be found to distribute a synchronization signal to all senders

Advantages:

- This scheme is quite flexible as one can assign more sending time to senders with a heavy load and less to those with a light load.

FDM & TDM

- The mobile phone standard GSM uses this combination of frequency and time division multiplexing for transmission between a mobile phone and a so-called base station

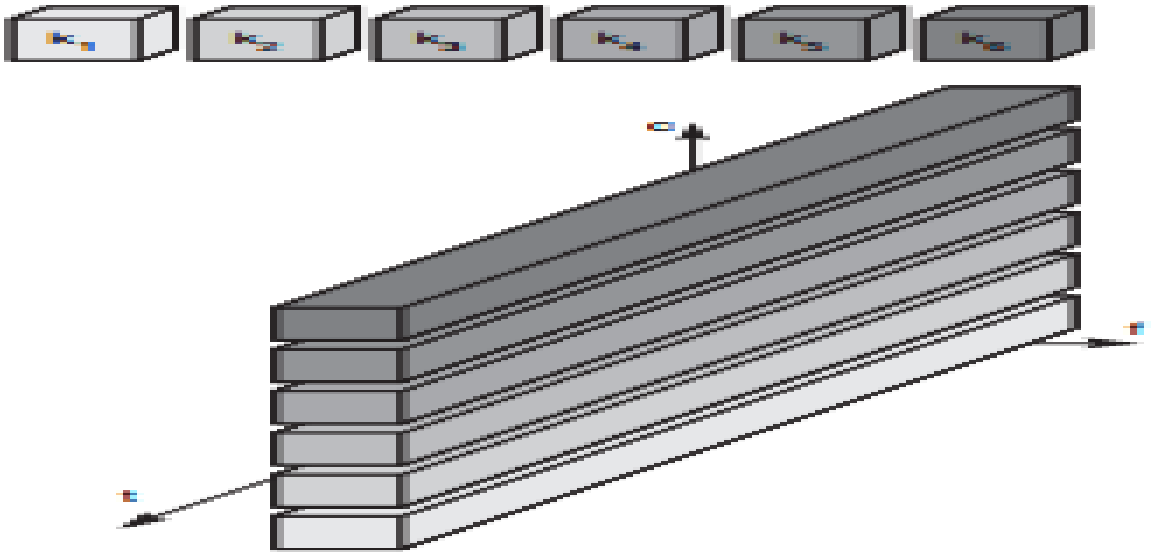


FDM & TDM

- A disadvantage of this scheme is again the necessary coordination between different senders.
- Two senders will interfere as soon as they select the same frequency at the same time

Code division multiplexing

- Separation is now achieved by assigning each channel its own ‘code’, guard spaces are realized by using codes with the necessary ‘distance’ in code space, e.g., orthogonal codes.



Code division multiplexing

Advantage:

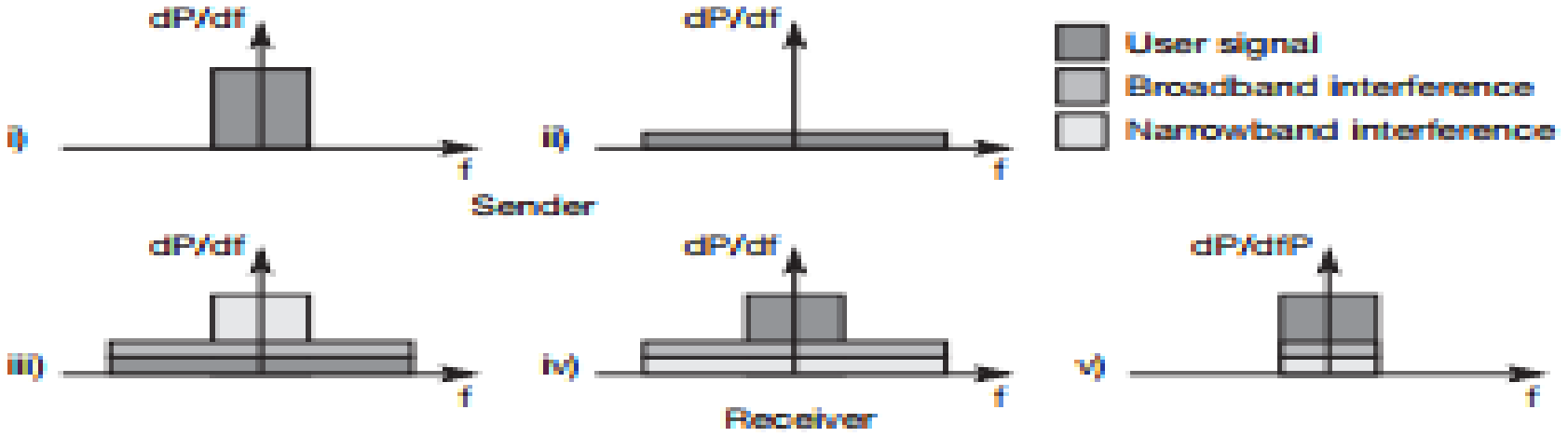
- for wireless transmission it gives good protection against interference and tapping

Disadvantage :

- Assigning individual codes to each sender does not usually cause problems
- This scheme is the relatively high complexity of the receiver

LECTURE-06 Spread spectrum

- Spread spectrum techniques involve spreading the bandwidth needed to transmit data
- The main advantage is the resistance to narrowband interference.



Spread spectrum

Fig i)shows that narrowband signal from a sender of user data

Fig ii)shows it converts the narrowband signal into a broadband signal.

Fig iii) shows the sum of interference and user signal is received.

Fig v) the receiver applies a band pass filter to cut off frequencies left and right of the narrowband signal

Spread spectrum

- Spreading of a narrowband signal is achieved using a special code
- Each channel is allotted its own code, which the receivers have to apply to recover the signal.
- Without knowing the code, the signal cannot be recovered and behaves like background noise. This is the security effect of spread spectrum.

Spread spectrum

- Features that make spread spectrum and CDM very attractive for military applications are the coexistence of several signals without coordination
- One disadvantage is the increased complexity of receivers that have to despread a signal
- Another problem is the large frequency band that is needed due to the spreading of the signal.

Spread spectrum

Spreading the spectrum can be achieved in two different ways :

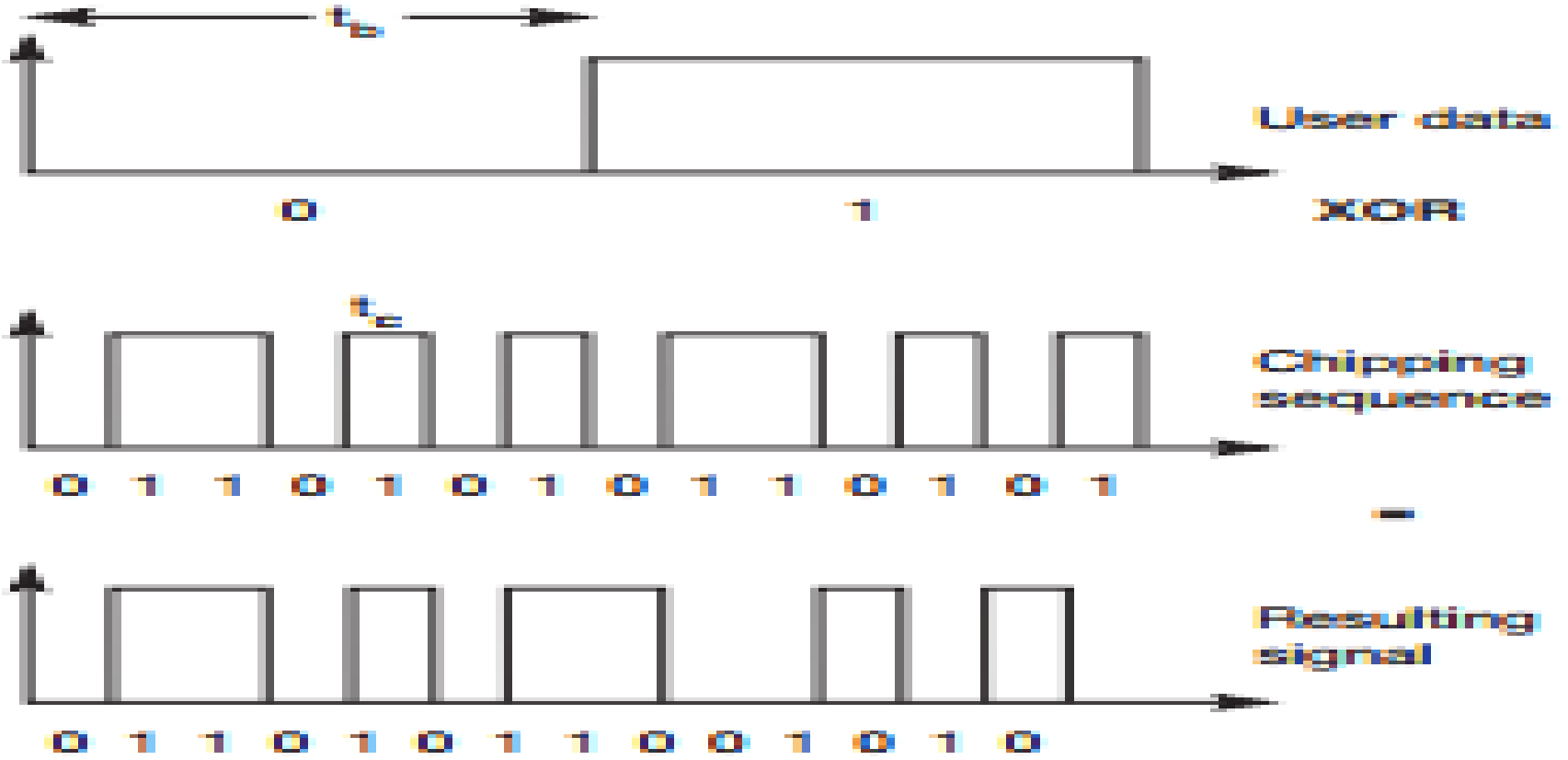
(i)Direct Sequence Spread Spectrum

(ii)Frequency Hopping Spread Spectrum

Direct Sequence Spread Spectrum

- Direct sequence spread spectrum (DSSS) systems take a user bit stream and perform an (XOR) with a so-called chipping sequence
- While each user bit has a duration t_b, the chipping sequence consists of smaller pulses, called chips, with a duration t_c.
- The spreading factor s = tb/tc determines the bandwidth of the resulting signal

DSSS

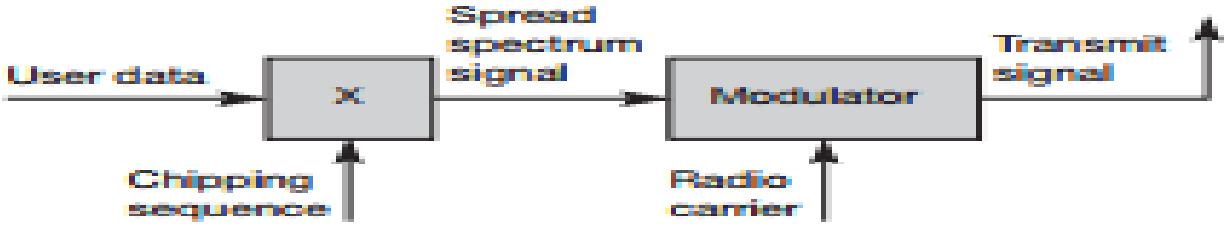

t_b
User data
0
1
XOR
t_c
Chipping sequence
0 1 1 0 1 0 1 0 1 1 0 1 0 1
=
Resulting signal
0 1 1 0 1 0 1 1 0 0 1 0 1 0

DSSS

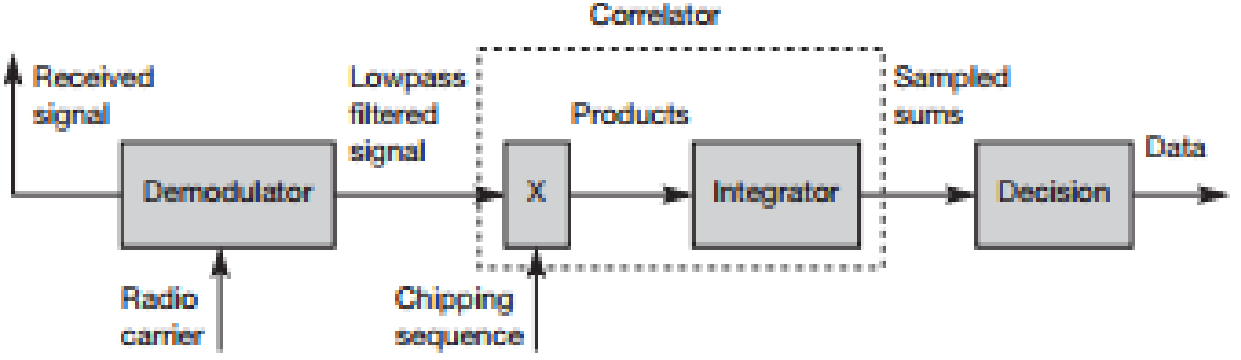
- For example the sequence 10110111000, a so-called Barker code, if implemented using DSSS. Barker codes exhibit a good robustness against interference and insensitivity to multi-path propagation
- Transmitters and receivers using DSSS need additional components

DSSS

DSSS TRANSMITTER



DSSS RECEIVER



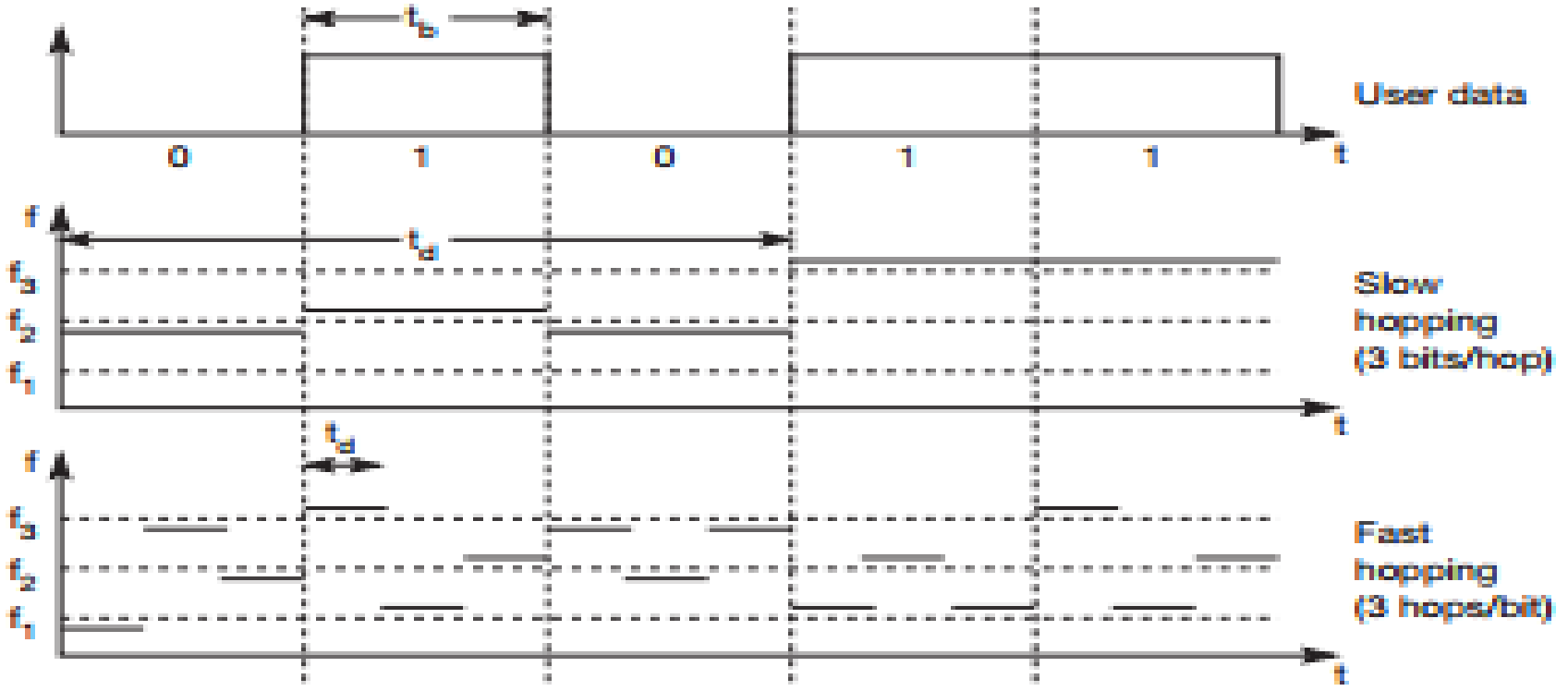
DSSS

- it is important to stay synchronized with the transmitter of a signal. Then several paths with different delays exist between a transmitter and a receiver.
- Additionally, the different paths may have different path losses.
- In this case,using so-called rake receivers provides a possible solution.

Frequency hopping spread spectrum (FHSS)

- For this systems, the total available bandwidth is split into many channels of smaller bandwidth plus guard spaces between the channels
- Transmitter and receiver stay on one of these channels for a certain time and then hop to another channel.
- This system implements FDM and TDM. The pattern of channel usage is called the hopping sequence, the time spend on a channel with a certain frequency is called the dwell time.

Slow and Fast Frequency Hopping



Slow and Fast Frequency Hopping

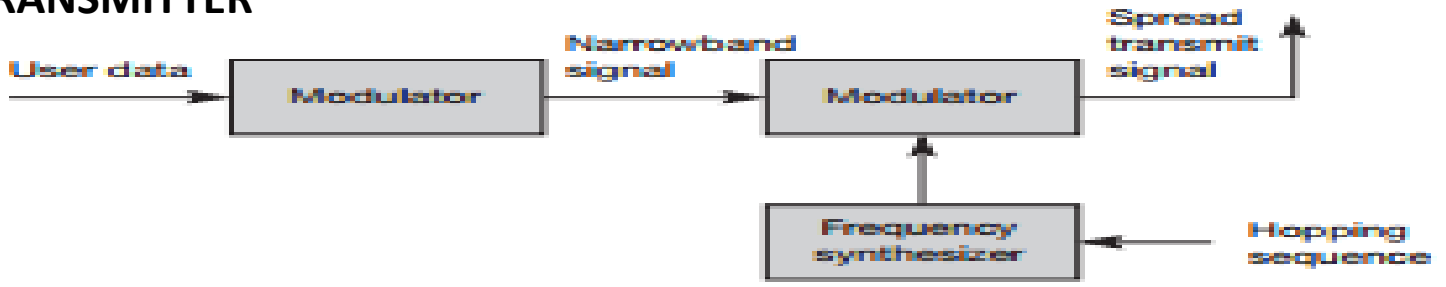
- In slow hopping, the transmitter uses one frequency for several bit periods.
- Slow hopping systems are typically cheaper and have relaxed tolerances, but they are not as immune to narrowband interference as fast hopping systems.It is an option for GSM

Slow and Fast Frequency Hopping

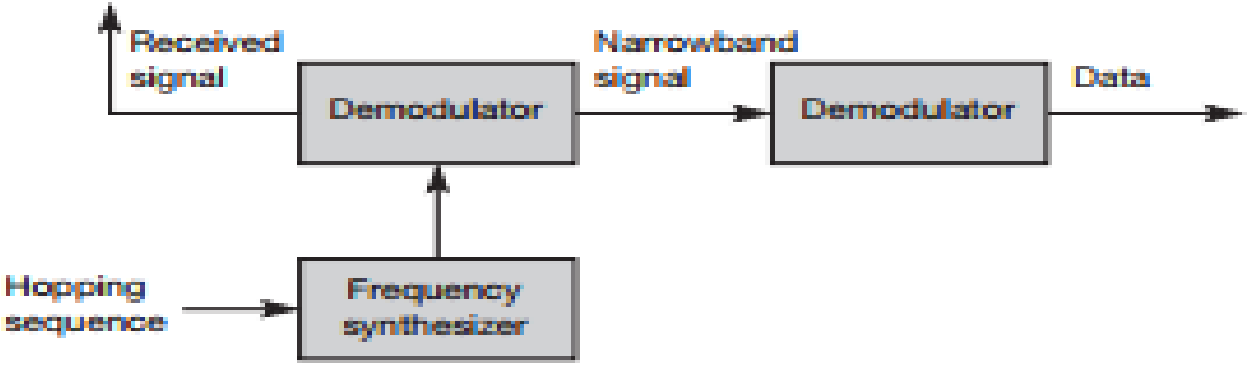
- For fast hopping systems, the transmitter changes the frequency several times during the transmission of a single bit.
- these systems are much better at overcoming the effects of narrowband interference and frequency selective fading.
- More complex to implement.

FHSS

FHSS TRANSMITTER



FHSS RECEIVER



LECTURE-06

Medium access control

- Medium access control comprises all mechanisms that regulate user access to a medium using SDM, TDM, FDM, or CDM. MAC is thus similar to traffic regulations in the highway/multiplexing.
- It requires rules to avoid collision
- one mechanism to enforce these rules is traffic lights.

Medium access control

- Carrier sense multiple access with collision detection,(CSMA/CD)- The signal should reach the receiver without collisions. But the sender is the one detecting collisions.
- The Problems arise in wireless networks are

(i)Hidd

Medium access control

(ii)Near and far terminals:

This effect is a severe problem of wireless networks using CDM. All signals should arrive at the receiver with more or less the same strength.

Medium access control-Types

- SDMA
- FDMA
- TDMA
- CDMA

SDMA

- Space Division Multiple Access (SDMA) is used for allocating a separated space to users in wireless networks.
- The basis for the SDMA algorithm is formed by cells and sectorized antennas which constitute the infrastructure implementing space division multiplexing (SDM)
- This can improve the overall capacity of a cell

FDMA

- Frequency division multiple access (FDMA) comprises all algorithms allocating frequencies to transmission channels according to the frequency division multiplexing (FDM) scheme
- Channels can be assigned to the same frequency at all times, i.e., pure FDMA, or change frequencies according to a certain pattern, i.e., FDMA combined with TDMA.

FDMA

- the two partners typically establish a duplex channel, i.e., a channel that allows for simultaneous transmission in both directions.
- The two directions, mobile station to base station and vice versa are now separated using different frequencies. This scheme is

  then called frequency division duplex (FDD)

FDMA

- 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 from satellite to ground control.

TDMA

- Time division multiple access (TDMA) offers a much more flexible scheme, which comprises all technologies that allocate certain time slots for communication, i.e., controlling TDM

TDMA

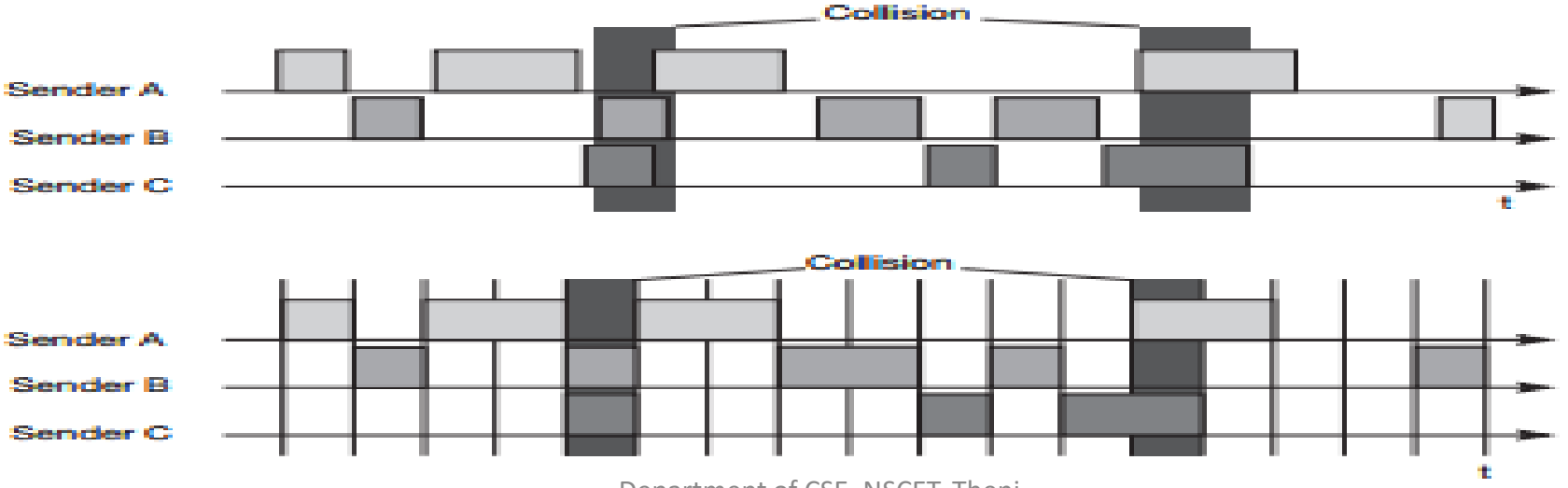
- Fixed TDM
- Classical Aloha
- Slotted Aloha
- Carrier sense multiple access
- Demand assigned multiple access
- PRMA packet reservation multiple access
- Reservation TDMA
- Multiple access with collision avoidance
- Polling
- Inhibit sense multiple access

TDMA

(i)Fixed TDM

The simplest algorithm for using TDM is allocating time slots for channels in a fixed pattern

(ii)Classical Aloha & Slotted Aloha



TDMA

(iv)Carrier sense multiple access

Sensing the carrier and accessing the medium only if the carrier is idle decreases the probability of a collision

(v)Demand assigned multiple access

- One basic scheme is demand assigned multiple access (DAMA) also called reservation Aloha, a scheme typical for satellite systems
- DAMA is an explicit reservation scheme. Each transmission slot has to be reserved explicitly.

TDMA

(vi)PRMA packet reservation multiple access

- An implicit reservation scheme is packet reservation multiple access (PRMA).
- Here, slots can be reserved implicitly according to the following scheme.

(vii) Reservation TDMA

An even more fixed pattern that still allows some random access is exhibited by reservation TDMA. Each station is allotted its own mini-slot and can use it to reserve up to k data-slots

TDMA

(viii)Multiple access with collision avoidance (MACA)

This presents a simple scheme that solves the hidden terminal problem, does not need a base station,and is still a random access Aloha scheme – but with dynamic reservation.

(ix)Polling

Polling is a strictly centralized scheme with one master station and several slave stations

TDMA

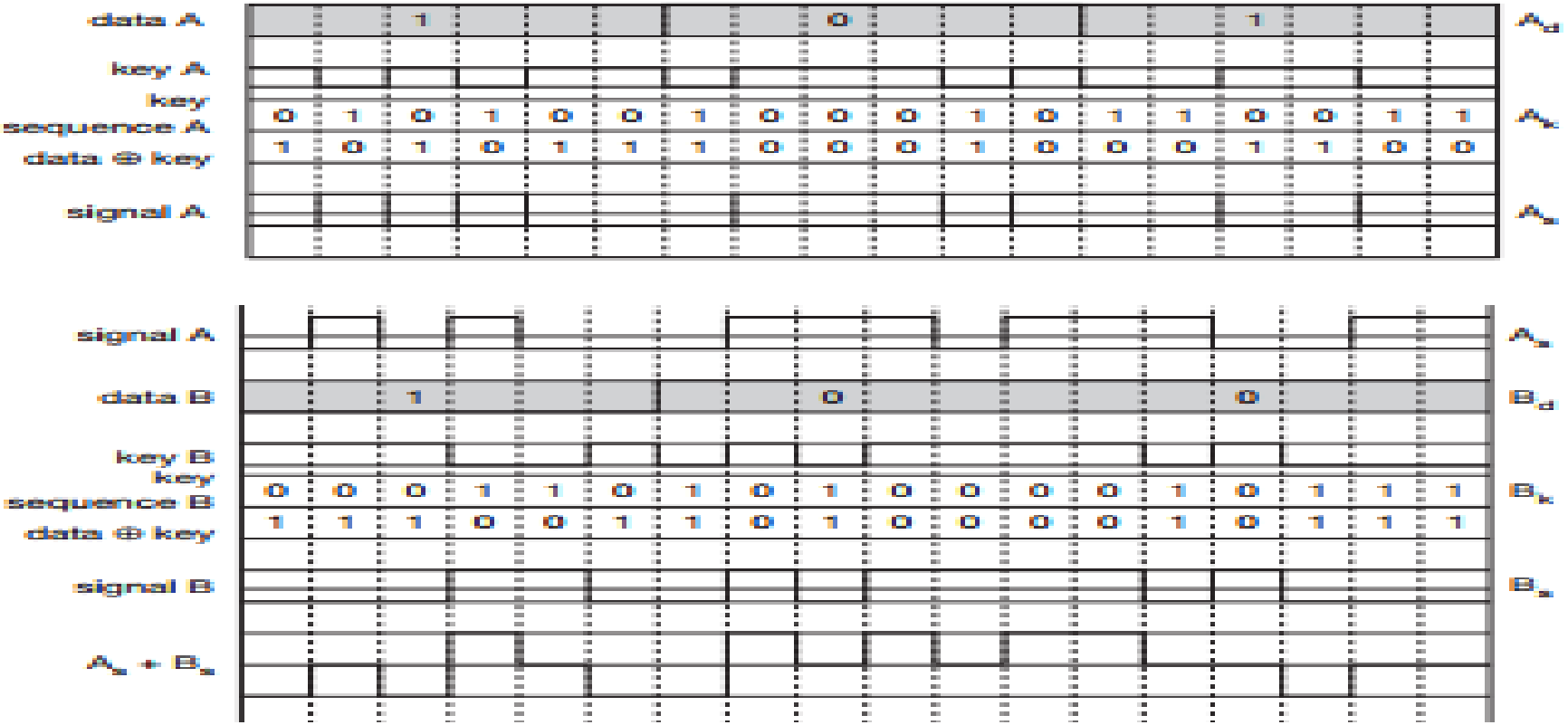
(x)Inhibit sense multiple access

- This scheme, which is used for the packet data transmission service Cellular Digital Packet Data (CDPD) in the AMPS mobile phone system, is also known as digital sense multiple access (DSMA).

CDMA

- Finally, codes with certain characteristics can be applied to the transmission to enable the use of code division multiplexing (CDM).
- Code division multiple access (CDMA) systems use exactly these codes to separate different users in code space and to enable access to a shared medium without interference.

Coding and spreading of data from sender A and B



LECTURE-07

Comparison of SDMA,FDMA,TDMA,CDMA

Approach	SDMA	TDMA	FDMA	CDMA
Idea	Segment space into cells/sectors	Segment sending time into disjoint time-slots, demand driven or fixed patterns	Segment the frequency band into disjoint sub-bands	Spread the spectrum using orthogonal codes
Terminals	Only one terminal can be active in one cell/one sector	All terminals are active for short periods of time on the same frequency	Every terminal has its own frequency, uninterrupted	All terminals can be active at the same place at the same moment, uninterrupted
Signal separation	Cell structure, directed antennas	Synchronization in the time domain	Filtering in the frequency domain	Code plus special receivers
Advantages	Very simple, increases capacity per km^2	Established, fully digital, very flexible	Simple, established, robust	Flexible, less planning needed, soft handover
Disadvantages	Inflexible, antennas typically fixed	Guard space needed (multi-path propagation), synchronization difficult	Inflexible, frequencies are a scarce resource	Complex receivers, needs more complicated power control for senders
Comment	Only in combination with TDMA, FDMA or CDMA useful	Standard in fixed networks, together with FDMA/SDMA used in many mobile networks	Typically combined with TDMA (frequency hopping patterns) and SDMA (frequency reuse)	Used in many 3G systems, higher complexity, lowered expectations; integrated with TDMA/FDMA

THANK YOU