Propogation of Radio Signal Lec. 5

Radio Wave Propagation. Propagation characteristics of EM wave: Transverse waves are waves that are oscillating perpendicularly to the direction of

1- How do radio signals propagate ?

Radio waves can propagate from transmitter to receiver in four ways: through ground waves, sky waves, free space waves, and open field waves. Ground waves exist only for vertical polarization, produced by vertical antennas, when the transmitting and receiving antennas are close to the surface of the earth.

2- What are the 5 basic propagation mechanisms of radio waves

The line of sight (LOS) propagation. Ground wave propagation

Home work : What are the methods of Propagation of a Radio Wave?

3- What are the three types of radio wave propagation

These modes are t

Free space propagation, where radio waves are not influenced by the earth or its .atmosphere

.Ground wave propagation, where radio waves follow the surface of the earth

Ionospheric propagation, where radio waves are refracted by ionised layers in the .atmosphere

4-What is signal propagation -

Wireless signal propagation is the movement of these radio waves (which move at the speed of light) to and from these sites and devices.

5- What is radio propagation model

A radio propagation model describes the behavior of the signal while it is transmitted from the transmitter towards the receiver. It gives a relation between the distance of transmitter & receiver and the path loss. From this relation, one can get an idea about the allowed path .loss and the maximum cell range

6-What are the various propagation methods in networking

Wireless transmissions propagate in three modes: ground-wave, sky-wave, and line-of-sight. Ground wave propagation follows the contour of the earth, while sky wave propagation uses .reflection by both earth and ionosphere

-٧What is antenna and wave propagation

Typically an antenna consists of an arrangement of metallic conductors ("elements"), electrically connected (often through a transmission line) to the receiver or transmitter. Antennas act as transformers between conducted waves and electromagnetic waves propagating freely in space.

٨-How do radio waves propagate through space

Radio waves can travel through space. ... Electromagnetic waves can transmit energy through a vacuum. Once your radio receives the signal, it can convert the signal into sound, which will travel through the air in your space suit without a problem.

٩- What is main problem of signal propagation

Ans: Problems: attenuation, scattering, diffraction, reflection, refraction. Except for attenuation all other effects can divert the waves from a straight line.

١٠- How many types of propagation models are there

The two basic propagation models (Free-Space and Plane Earth Loss) have all the mechanisms which are encountered in macrocell prediction. Many researchers use these models and predict the total signal loss.

١١-What is propagation and types

Plant propagation is the process of creating new plants. There are two types of propagation: sexual and asexual. Sexual reproduction is the union of the pollen and egg, drawing from the genes of two parents to create a new, third individual. Sexual propagation involves the floral parts of a plant.

١٢-What is mobile radio propagation

Mobile radio propagation is divided into four categories: land mobile radio, aviation mobile radio, maritime mobile radio, and satellite mobile radio. The propagation characteristics of each vary substantially depending on the type of the mobile unit and the condition of the propagation path.

١٣What are the two main forms of wave propagation

Waves come in two kinds, longitudinal and transverse. Transverse waves are like those on water, with the surface going up and down, and longitudinal waves are like of those of sound, consisting of alternating compressions and rarefactions in a medium.

١٤ -What is propagation in antenna

This involves the use of antennas or aerials to radiate the signal as an electromagnetic wave, and then there is the way that the electromagntic wave travels or propagates between the transmitting antenna and the receiving one. Thus antennas and propagation are key areas for any radio system.

١٥-What are the three types of antennas

There are several different types of antennas in three broad categories: omni-directional, directional, and semi-directional.

١٦-What is microwave frequency

Microwaves range in frequencies from 100's of MHz to 100's of GHz. Presently the frequency bands used for 5G (between 3GHz to 28GHz) fall within this spectrum.

١٧- How far can radio signals travel in space

The greatest distance for a transmission by a human-built device is currently about 13,482,762,800 miles, and growing by the minute. The greatest distance over which radio signals can be received is some hundreds of millions of lightyears; radio astronomers do that regularly.

١٨- How signal propagation is affected in wireless communication

The wireless channel causes the transmitted signal to lose power as it propagates from the transmitter to the receiver. ... The net result is that wireless propagation leads to a loss of received signal power as well as the presence of multipath, which creates frequency selectivity in the channel.

١٩-What are the 7 types of waves

The EM spectrum is generally divided into seven regions, in order of decreasing wavelength and increasing energy and frequency. The common designations are: radio waves, microwaves, infrared (IR), visible light, ultraviolet (UV), X-rays and gamma rays.

٢٠- What is 5G frequency band

The 5G spectrum is a range of radio frequencies in the sub-6 GHz range and the millimeter-wave (mmWave) frequency range that is 24.25 GHz and above. The 5G spectrum refers to the radio frequencies that carry data from user equipment (UE) to cellular base stations to the data's endpoint.

As with previous cellular technologies, 5G networks rely on signals carried by radio waves - part of the electromagnetic spectrum - transmitted between an antenna or mast and your phone.

-٢١ What are the 6 types of waves

Based on the orientation of particle motion and direction of energy, there are three categories: Mechanical waves. Electromagnetic waves. Matter waves.

Electromagnetic Wave

Microwaves.

X-ray.

.Radio waves

.Ultraviolet waves

٢٢-What frequency will 6G use

.G radio frequency will work in the wavelength ranges above 95GHz٦

G Radio Frequency – What is 6G

Band	Frequency	WR-Size
D	١١٠ GHz to 170 GHz	WR-6
G	١٤٠ GHz to 220 GHz	WR-5
G	١٧٠ GHz to 260 GHz	WR-4
G	٢٢٠ GHz to 325 GHz	WR-

٢٣- What are the 3 main types of waves

Categorizing waves on this basis leads to three notable categories: transverse waves, longitudinal waves, and surface waves. A transverse wave is a wave in which particles of the medium move in a direction perpendicular to the direction that the wave moves

٢٤-How fast is LTE data

Verizon 4G LTE wireless broadband is 10 times faster than 3G — able to handle download speeds between 5 and 12 Mbps (Megabits per second) and upload speeds between 2 and 5 Mbps, with peak download speeds approaching 50 Mbps. Cable speeds vary, but 4 to 12 .Mbps are common

Which is the correct sequence of time arrival of seismic waves to seismograph stations

٢٥ -What mean 4G+

G+ is another name for LTE-A, LTE-Advanced or 4.5G and it's basically a faster version of ٤ 4G. It works through carrier aggregation, which allows 4G phones to receive data from multiple bands in the 4G spectrum. So while standard 4G only uses one band at a time, 4G+ can combine two bands for increased speeds.0

٢٦-What is the top speed of 4G

Mbps ٣٠٠

G offers maximum real-world download speeds up to around 100Mbps, making it over 20 ٤ times faster than 3G. Theoretical maximum 4G speeds are significantly higher at 300Mbps, .although such speeds are only achievable in controlled laboratory environments

٢٢- When 5G was made ?

The 5GTF work helped accelerate the release of the 3GPP 5G New Radio (NR) standard in December of 2017. On April 3, 2019, of we introduced 5G mobile service in parts of Chicago and Minneapolis. Customers in those cities were the first in the world to have a 5G-enabled .smartphone connected to a 5G network

Lecture 6\ Fiber optic

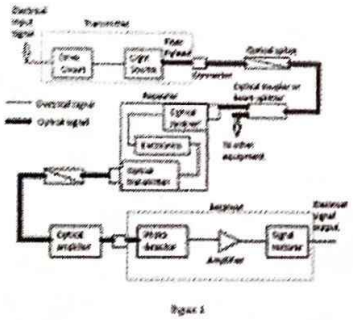
1- What is fiber optic communication system?

Fiber-optic communication is **a method of transmitting information from one place to another by sending pulses of infrared light through an optical fiber**. ... Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication, and cable television signals.

2- What is optical fibre?

• An optical Fiber is a **thin, flexible, transparent Fiber**. that acts as a waveguide, or "light pipe", to transmit. light between the two ends of the Fiber. • Optical fibers are widely used in Fiber-optic. communications, which permits transmission over.

What is optical fibre communication explain its working with diagram?

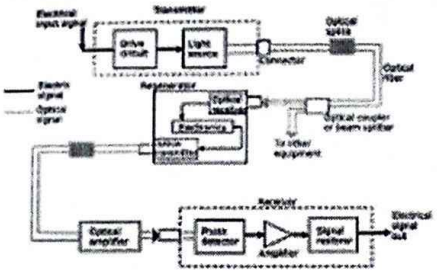


Transmitter: An electric signal is applied to the optical transmitter. The optical transmitter consists of driver circuit, light source and fiber flylead. Driver circuit drives the light source. Light source converts electrical signal to optical signal. Fiber flylead is used **to connect** optical signal to optical fiber.

Home work : <u>What is optical fibre communication explain its working with diagram?</u>

3- What are the basic elements of a fiber optic communication system illustrate the transmission of a light ray in an optical fiber?

Lecture 6\ Fiber optic



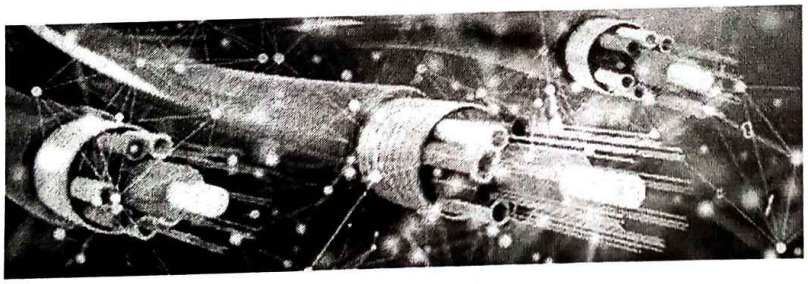
The basic components are **light signal transmitter, the optical fiber, and the photo detecting receiver**. The additional elements such as fiber and cable splicers and connectors, regenerators, beam splitters, and optical amplifiers are employed to improve the performance of the communication system.

4- What are the different types of optical Fibres?

There are four types of optic fibres depending on their mode of propagation and refractive index, which are as follows:

- Step index-single mode fibres.
- Graded index-Single mode fibres.
- Step index-Multimode fibres.
- Graded index-Multimode fibres.

5- What are the advantages of optical fiber communication?



Four Advantages of Fiber Optic Communications

- Secure Communication: Fiber optic cabling is considered one of the most secure means of communication. ...
- Electromagnetic Compatibility: Fiber optic cabling is resistant to many of the outside forces that degrade copper cabling. ...
- Speed: ...
- Distance:

6- What is optical communication basics?

Lecture 6\ Fiber optic

Optical communication, also known as optical telecommunication, is **communication at a distance using light to carry information**. It can be performed visually or by using electronic devices. ... This article provides a basic introduction to different forms of optical communication. Home work: What is optical communication basics?

7- Where is optical fibre used?

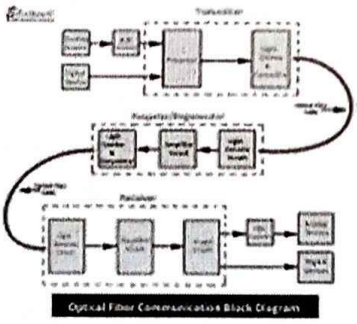
Optical Fibres are used in Industries

They **transmit information in lightning speed** and are used in airbags and traction control. They are also used for research and testing purposes in industries.

8- What are factors affecting optical communication?

According to the above statement, the optical transmission distance is affected by various factors including the **fiber type, light source of transceiver, frequency of transmission, bandwidth as well as splices and connectors**.

9- What is optical communication block diagram?



Optical Fiber Communication is the latest and widely used method to transmit information through inferred light and these lights are transmitted through the fiber optic cables. There are mainly two types of optic cables are used - 1.

10- What are the elements of optical fiber?

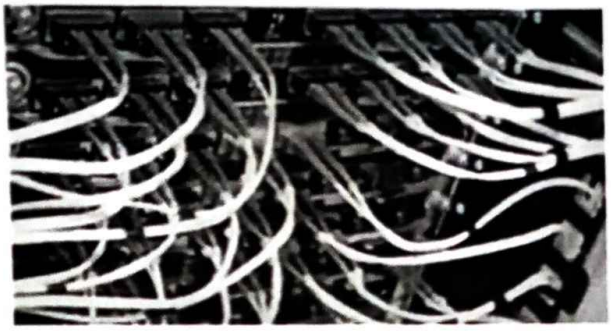
Lecture 6\ Fiber optic

The three basic elements of a fiber optic cable are **the core, the cladding and the coating**. Core: This is the light transmission area of the fiber, either glass or plastic. The larger the core, the more light that will be transmitted into the fiber.

11- Which light is used in optical fiber?

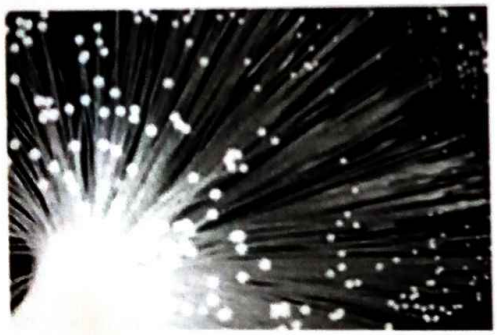
For fiber optics with glass fibers, we use **light in the infrared region** which has wavelengths longer than visible light, typically around 850, 1300 and 1550 nm. Why do we use the infrared? Because the attenuation of the fiber is much less at those wavelengths.

12- What are the advantages and disadvantages of optical fiber communication?



- Advantages of Optical Fiber Cable.
- Bandwidth. Fiber optic cables have a much greater bandwidth than metal cables. ...
- Low Power Loss. An optical fiber offers low power loss, which allows for longer transmission distances. ...
- Interference. ...
- Size. ...
- Weight. ...
- Security. ...
- Flexibility.

13- What are the limitations of optical fiber communication systems?



Lecture 6\ Fiber optic

Typically made of glass, fiber cables are thinner and lighter than metallic wiring, and this makes them more prone to damage. **Exposure to chemicals or radiation can damage a fiber optic network**, and its fragile cables can easily be cut during building renovations or rewiring.

14- What is the bandwidth of optical Fibre?

	Optical fiber	Copper wire
Safety	✓	✗
Weight	✓	✗
RF effects	✓	✗
Data bandwidth	✓	✗
Durability	✓	✓
Cost	✗	✓

The main advantages of optical fiber communication over electrical cable transmission is its high bandwidth capability (**almost 10Gps**) over long distances due to the extremely low loss at same specific wavelengths (e.g. 1.3 um and 1.55 um).
What are 3 uses of optical Fibres?

15- What are three uses of optical fiber?

Some uses of fiber optic cables include:

- Medical. Used as light guides, imaging tools and also as lasers for surgeries.
- Defense/Government. ...
- Data Storage. ...
- Telecommunications. ...
- Networking. ...
- Industrial/Commercial. ...
- Broadcast/CATV.

How work: is optical Fibre made?

16- Is fiber optic affected by weather?

Due to fiber optics sending light beams down the thin strands of glass rather than electrical signals, these **cables are not affected by weather changes**. Rain, cold and extreme heat can affect traditional electrical signals but do not have any affect on fiber optics.

17- Can water damage fiber optic cable?

Lecture 6\ Fiber optic

When indoor-rated cable becomes wet, you should consider it permanently damaged and remove it from the site. ... Water permeates the jacket material and permanently affects the data transmission characteristics of the cable. Water damage to fiber optic cables **results in high attenuation, and degradation of the data signal.**

18- What can destroy fiber?

5 Cable Killers That Destroy Buried Fiber Cable

- Water. We learned early on that water is very detrimental to fiber optic strands. ...
- Rodents. Since they have a life-long drive to gnaw, rodents are often responsible for extensive damage to fiber optic cable. ...
- Lightning or Incidental Voltage. ...
- Construction. ...
- Ice crush. Can fiber be installed in the rain?

  No, rain is generally not an impediment to installation.

  Home work : Can fiber be installed in the rain?

Chapter 7

تقنيات الوصول المتعدد

Multiple Access Techniques

Multiple access techniques are used to allow a large number of mobile users to share the allocated spectrum in the most efficient manner. As the spectrum is limited, so the sharing is required to increase the capacity of cell or over a geographical area by allowing the available bandwidth to be used at the same time by different users. And this must be done in a way such that the quality of service doesn't degrade within the existing users.

8.1 Multiple Access Techniques for Wireless Communication

In wireless communication systems it is often desirable to allow the subscriber to send simultaneously information to the base station while receiving information from the base station.

A cellular system divides any given area into cells where a mobile unit in each cell communicates with a base station. The main aim in the cellular system design is to be able to increase the capacity of the channel i.e. to handle as many calls as possible in a given bandwidth with a sufficient level of quality of service. There are several different ways to allow access to the channel. These includes mainly the following:

1) Frequency division multiple-access (FDMA)

2) Time division multiple-access (TDMA)

3) Code division multiple-access (CDMA)

Table 8.1: MA techniques in different wireless communication systems

Advanced Mobile Phone Systems:	FDMA/FDD
Global System for Mobile:	TDMA/FDD
U.S. Digital Cellular:	TDMA/FDD
Japanese Digital Cellular:	TDMA/FDD
CT2 Cordless Telephone:	FDMA/TDD
Digital European Cordless Telephone:	FDMA/TDD
U.S. Narrowband Spread Spectrum (IS-95):	CDMA/FDD

4) Space Division Multiple access (SDMA)

FDMA,TDMA and CDMA are the three major multiple access techniques that are used to share the available bandwidth in a wireless communication system. Depending on how the available bandwidth is allocated to the users these techniques can be classified as narrowband and wideband systems.

8.1.1 Narrowband Systems

The term narrowband is used to relate the bandwidth of the single channel to the expected coherence bandwidth of the channel. The available spectrum is divided in to a large number of narrowband channels. The channels are operated using FDD. In narrow band FDMA, a user is assigned a particular channel which is not shared by other users in the vicinity and if FDD is used then the system is called FDMA/FDD. Narrow band TDMA allows users to use the same channel but allocated a unique time slot to each user on the channel, thus separating a small number of users in time on a single channel. For narrow band TDMA, there generally are a large number of channels allocated using either FDD or TDD, each channel is shared using TDMA. Such systems are called TDMA/FDD and TDMA/TDD access systems.

8.1.2 Wideband Systems

In wideband systems, the transmission bandwidth of a single channel is much larger than the coherence bandwidth of the channel. Thus, multipath fading doesnt greatly affect the received signal within a wideband channel, and frequency selective fades occur only in a small fraction of the signal bandwidth

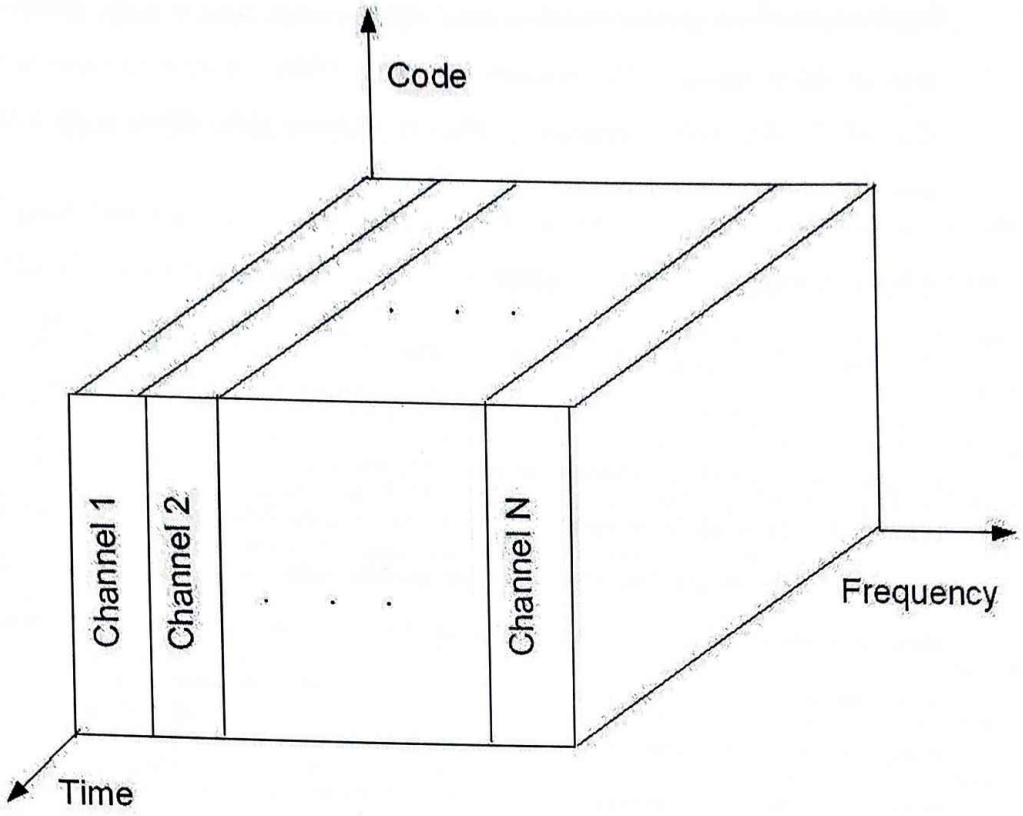


Figure 8.1: The basic concept of FDMA.

8.2 Frequency Division Multiple Access

This was the initial multiple-access technique for cellular systems in which each individual user is assigned a pair of frequencies while making or receiving a call as shown in Figure 8.1. One frequency is used for downlink and one pair for uplink. This is called frequency division duplexing (FDD). That allocated frequency pair is not used in the same cell or adjacent cells during the call so as to reduce the co channel interference. Even though the user may not be talking, the spectrum cannot be reassigned as long as a call is in place. Different users can use the same frequency in the same cell except that they must transmit at different times.

The features of FDMA are as follows: The FDMA channel carries only one phone circuit at a time. If an FDMA channel is not in use, then it sits idle and it cannot be used by other users to increase share capacity. After the assignment of the voice channel the BS and the MS transmit simultaneously and continuously. The bandwidths of FDMA systems are generally narrow i.e. FDMA is usually

implemented in a narrow band system The symbol time is large compared to the average delay spread. The complexity of the FDMA mobile systems is lower than that of TDMA mobile systems. FDMA requires tight filtering to minimize the adjacent channel interference.

8.2.1 FDMA/FDD in AMPS

The first U.S. analog cellular system, AMPS (Advanced Mobile Phone System) is based on FDMA/FDD. A single user occupies a single channel while the call is in progress, and the single channel is actually two simplex channels which are frequency duplexed with a 45 MHz split. When a call is completed or when a handoff occurs the channel is vacated so that another mobile subscriber may use it. Multiple or simultaneous users are accommodated in AMPS by giving each user a unique signal. Voice signals are sent on the forward channel from the base station to the mobile unit, and on the reverse channel from the mobile unit to the base station. In AMPS, analog narrowband frequency modulation (NBFM) is used to modulate the carrier.

8.2.2 FDMA/TDD in CT2

Using FDMA, CT2 system splits the available bandwidth into radio channels in the assigned frequency domain. In the initial call setup, the handset scans the available channels and locks on to an unoccupied channel for the duration of the call. Using TDD(Time Division Duplexing), the call is split into time blocks that alternate between transmitting and receiving.

8.2.3 FDMA and Near-Far Problem

The near-far problem is one of detecting or filtering out a weaker signal amongst stronger signals. The near-far problem is particularly difficult in CDMA systems where transmitters share transmission frequencies and transmission time. In contrast, FDMA and TDMA systems are less vulnerable. FDMA systems offer different kinds of solutions to near-far challenge. Here, the worst case to consider is recovery of a weak signal in a frequency slot next to strong signal. Since both signals are present simultaneously as a composite at the input of a gain stage, the gain is set according to the level of the stronger signal; the weak signal could be lost in the

noise floor. Even if subsequent stages have a low enough noise floor to provide

8.3 Time Division Multiple Access

In digital systems, continuous transmission is not required because users do not use the allotted bandwidth all the time. In such cases, TDMA is a complimentary access technique to FDMA. Global Systems for Mobile communications (GSM) uses the TDMA technique. In TDMA, the entire bandwidth is available to the user but only for a finite period of time. In most cases the available bandwidth is divided into fewer channels compared to FDMA and the users are allotted time slots during which they have the entire channel bandwidth at their disposal, as shown in Figure 8.2.

TDMA requires careful time synchronization since users share the bandwidth in the frequency domain. The number of channels are less, inter channel interference is almost negligible. TDMA uses different time slots for transmission and reception. This type of duplexing is referred to as Time division duplexing(TDD).

The features of TDMA includes the following: TDMA shares a single carrier frequency with several users where each users makes use of non overlapping time slots. The number of time slots per frame depends on several factors such as modulation technique, available bandwidth etc. Data transmission in TDMA is not continuous but occurs in bursts. This results in low battery consumption since the subscriber transmitter can be turned OFF when not in use. Because of a discontinuous transmission in TDMA the handoff process is much simpler for a subscriber unit, since it is able to listen to other base stations during idle time slots. TDMA uses different time slots for transmission and reception thus duplexers are not required. TDMA has an advantage that is possible to allocate different numbers of time slots per frame to different users. Thus bandwidth can be supplied on demand to different users by concatenating or reassigning time slot based on priority.

8.3.1 TDMA/FDD in GSM

As discussed earlier, GSM is widely used in Europe and other parts of the world. GSM uses a variation of TDMA along with FDD. GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its

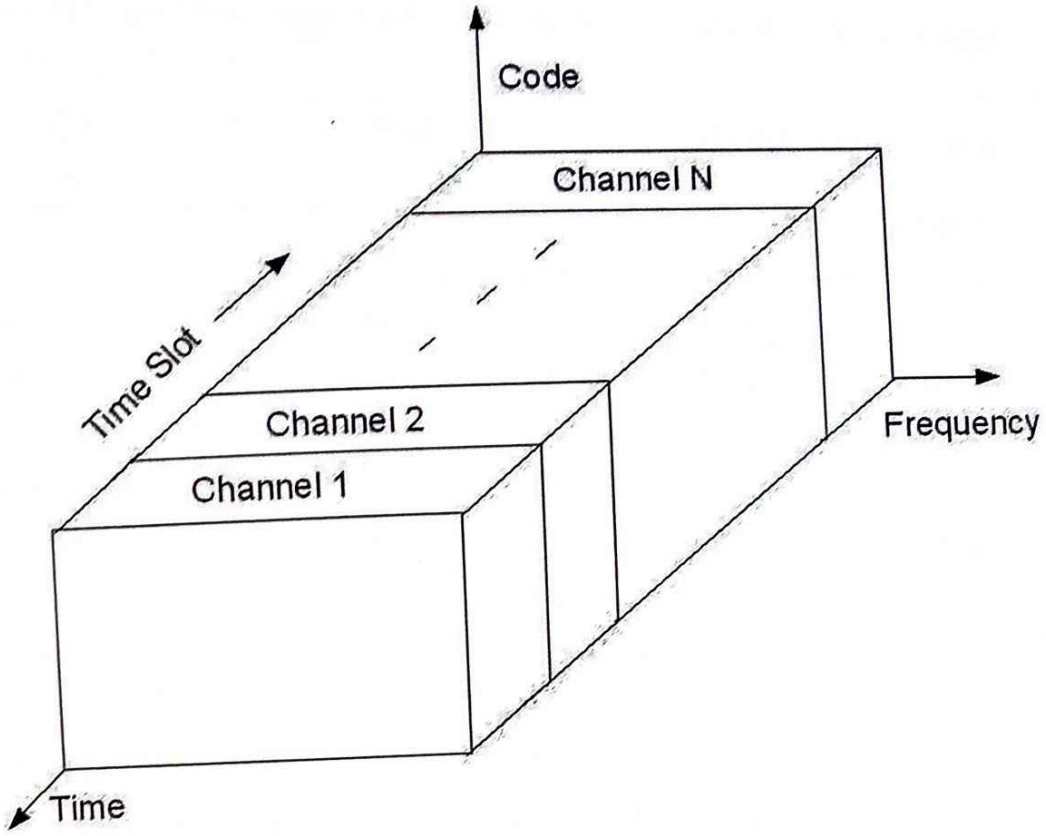


Figure 8.2: The basic concept of TDMA.

own time slot. It operates at either the 900 MHz or 1800 MHz frequency band. Since many GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries.

8.3.2 TDMA/TDD in DECT

DECT is a pan European standard for the digitally enhanced cordless telephony using TDMA/TDD. DECT provides 10 FDM channels in the band 1880-1990 Mhz. Each channel supports 12 users through TDMA for a total system load of 120 users. DECT supports handover, users can roam over from cell to cell as long as they remain within the range of the system. DECT antenna can be equipped with optional spatial diversity to deal with multipath fading.

8.4 Spread Spectrum Multiple Access

Spread spectrum multiple access (SSMA) uses signals which have a transmission bandwidth whose magnitude is greater than the minimum required RF bandwidth. A pseudo noise (PN) sequence converts a narrowband signal to a wideband noise like signal before transmission. SSMA is not very bandwidth efficient when used by a single user. However since many users can share the same spread spectrum bandwidth without interfering with one another, spread spectrum systems become bandwidth efficient in a multiple user environment.

There are two main types of spread spectrum multiple access techniques: Frequency hopped multiple access (FHMA)
Direct sequence multiple access (DSMA) or
Code division multiple access (CDMA).

8.4.1 Frequency Hopped Multiple Access (FHMA)

This is a digital multiple access system in which the carrier frequencies of the individual users are varied in a pseudo random fashion within a wideband channel. The digital data is broken into uniform sized bursts which is then transmitted on different carrier frequencies.

8.4.2 Code Division Multiple Access

In CDMA, the same bandwidth is occupied by all the users, however they are all assigned separate codes, which differentiates them from each other (shown in Figure 8.3). CDMA utilize a spread spectrum technique in which a spreading signal (which is uncorrelated to the signal and has a large bandwidth) is used to spread the narrow band message signal.

Direct Sequence Spread Spectrum (DS-SS)

This is the most commonly used technology for CDMA. In DS-SS, the message signal is multiplied by a Pseudo Random Noise Code. Each user is given his own codeword which is orthogonal to the codes of other users and in order to detect the user, the receiver must know the codeword used by the transmitter. There are, however, two problems in such systems which are discussed in the sequel.

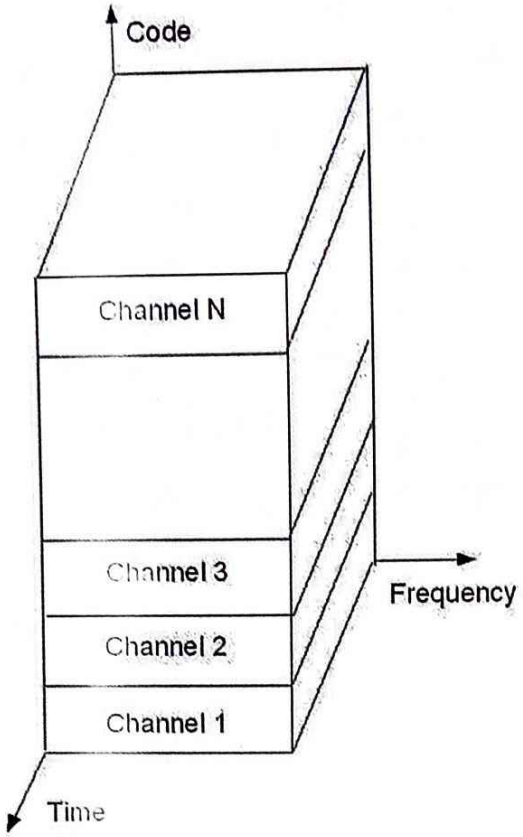


Figure 8.3: The basic concept of CDMA.

CDMA/FDD in IS-95

In this standard, the frequency range is: 869-894 MHz (for Rx) and 824-849 MHz (for Tx). In such a system, there are a total of 20 channels and 798 users per channel. For each channel, the bit rate is 1.2288 Mbps. For orthogonality, it usually combines 64 Walsh-Hadamard codes and a m-sequence.

8.4.3 CDMA and Self-interference Problem

In CDMA, self-interference arises from the presence of delayed replicas of signal due to multipath. The delays cause the spreading sequences of the different users to lose their orthogonality, as by design they are orthogonal only at zero phase offset. Hence in despreading a given user's waveform, nonzero contributions to that user's signal arise from the transmissions of the other users in the network. This is distinct from both TDMA and FDMA, wherein for reasonable time or frequency guardbands, respectively, orthogonality of the received signals can be preserved.

8.4.4 CDMA and Near-Far Problem

The near-far problem is a serious one in CDMA. This problem arises from the fact that signals closer to the receiver of interest are received with smaller attenuation than are signals located further away. Therefore the strong signal from the nearby transmitter will mask the weak signal from the remote transmitter. In TDMA and FDMA, this is not a problem since mutual interference can be filtered. In CDMA, however, the near-far effect combined with imperfect orthogonality between codes (e.g. due to different time shifts) leads to substantial interference. Accurate and fast power control appears essential to ensure reliable operation of multiuser DS-CDMA systems.

8.4.5 Hybrid Spread Spectrum Techniques

The hybrid combinations of FDMA, CDMA and SSMA result in hybrid spread spectrum techniques that provide certain advantages. These hybrid techniques are explained below,

Hybrid FDMA/CDMA (FCDMA):

An alternative to the CDMA technique in which the available wideband spectrum is divided into a smaller number of sub spectra with smaller bandwidths. The smaller sub channels become narrowband CDMA systems with processing gain lower than the original CDMA system. In this scheme the required bandwidth need not be contiguous and different users can be allotted different sub spectrum bandwidths depending on their requirements. The capacity of this hybrid FCDMA technique is given by the sum of the capacities of a system operating in the sub spectra.

Hybrid Direct Sequence/Frequency Hopped Multiple Access Techniques (DS/FHMA):

A direct sequence modulated signal whose center frequency is made to hop periodically in a pseudo random fashion is used in this technique. One of the advantages using this technique is they avoid near-far effect. However, frequency hopped CDMA systems are not adaptable to the soft handoff process since it is difficult to synchronize the frequency hopped base station receiver to the multiple hopped signals. Time and Code Division Multiple Access (TCDMA):

In this TCDMA method different cells are allocated different spreading codes. In each cell, only one user in a cell is allotted a particular time slot. Thus at any