Sub Code: MTCS202

M. TECH.
(SEM II) THEORY EXAMINATION 2022-23

WIRELESS MOBILE NETWORKS SOLUTION

Time: 3 Hours ***Total Marks: 70***

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

(a) **Discuss features of wireless networks.**

Ans: 1. High Capacity Load Balancing

2. Scalability

3. Network Management System

4. Role Based Access Control

5. Indoor as well as Outdoor coverage options

6. The Ability to Measure Performance

(b) **Explain Handover in GSM.**

Ans: Handover/Handoff is a process typical to and of significant importance in cellular systems. The goal of proper handover is to ensure undisrupted calls and seamless services. It is a key performance indicator of any cellular network and customer satisfaction. Handover is a mechanism by which the call or data service is transferred from one base to other or from one channel to another in order to maintain seamless connectivity. It is often triggered by various factors like low signal strength due movement of the wireless device away from existing base station or environmental conditions, and load balancing. A handover can be hard handover as in case of GSM or soft handover as in CDMA.

(c) **Discuss about signal propagation.**

Ans: Signal propagation is the movement of radio waves from a transmitter to a receiver. When the waves travel (propagate) from one point to another, they are, like light waves, affected by different phenomena such as light reflection, absorption, or scattering.

(d) **Explain TDMA in brief.**

Ans: Time-division multiple access (TDMA) is a 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.

(e) **Discuss about RFID in brief.**

Ans: Radio Frequency Identification (RFID) refers to a wireless system comprised of two components: tags and readers. The reader is a device that has one or more antennas that emit radio waves and receive signals back from the RFID tag.

(f) **Describe the problems of IP in wireless networks.**

Ans: Problems in wireless transmission of TCP/IP packets are bit errors(change in bits), handoff errors(failed transfer of data), congestion(increased traffic), re-ordering errors(re-ordering of received data packets), errors caused by delays(delay in transmission, processing, etc.)

(g) **Explain Database systems for mobile communication in brief.**

Ans: Mobile databases make data from database applications available to mobile users, and they support applications that involve data processing. In general, a mobile database enables a connection between computing devices across a wireless mobile network.

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

(a) **Explain various antennas types and also discuss antenna gain.**

Ans: Antennas have to be classified to understand their physical structure and functionality more clearly. There are many types of antennas depending upon the applications applications.

Type of antenna	Examples	Applications
Wire Antennas	Dipole antenna, Monopole antenna, Helix antenna, Loop antenna	Personal applications, buildings, ships, automobiles, space crafts
Aperture Antennas	Waveguide (opening), Horn antenna	Flush-mounted applications, air-craft, space craft
Reflector Antennas	Parabolic reflectors, Corner reflectors	Microwave communication, satellite tracking, radio astronomy
Lens Antennas	Convex-plane, Concave-plane, Convex-convex, Concaveconcave lenses	Used for very highfrequency applications
Micro strip Antennas	Circular-shaped, Rectangularshaped metallic patch above the ground plane	Air-craft, space-craft, satellites, missiles, cars, mobile phones etc.
Array Antennas	Yagi-Uda antenna, Micro strip patch array, Aperture array, Slotted wave guide array	Used for very high gain applications, mostly when needs to control the radiation pattern

(b) **Explain GSM system architecture with diagram.**

Ans:

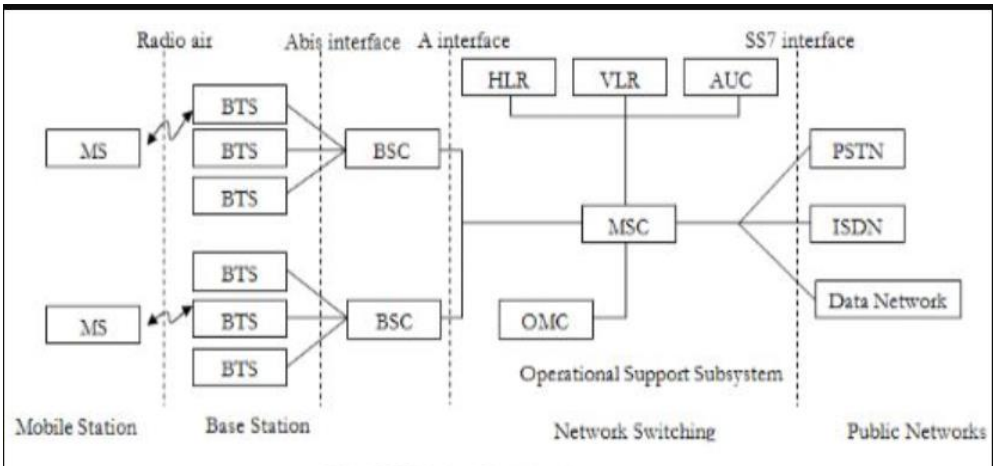


Fig: GSM Architecture

The GSM architecture consists of three major interconnected subsystems that interact with themselves and with users through certain network interface. The subsystems are Base Station Subsystem (BSS), Network Switching Subsystem (NSS) and Operational Support Subsystem (OSS). Mobile Station (MS) is also a subsystem but it is considered as a part of BSS.

1. Mobile Station (MS): Mobile Station is made up of two entities.

A. Mobile equipment (ME):

- It is a portable, vehicle mounted, hand held device.
- It is uniquely identified by an IMEI number.
- It is used for voice and data transmission. It also monitors power and signal quality of surrounding cells foe optimum handover. 160 characters long SMS can also be sent using Mobile Equipment.

B. Subscriber Identity module (SIM):

- It is a smart card that contains the International Mobile Subscriber Identity (IMSI) number.
- It allows users to send and receive calls and receive other subscriber services. - It is protected by password or PIN.
- It contains encoded network identification details. it has key information to activate the phone.
- It can be moved from one mobile to another.

2. Base Station Subsystem (BSS): It is also known as radio subsystem, provides and manages radio transmission paths between the mobile station and the Mobile Switching Centre (MSC). BSS also manages interface between the mobile station and all other subsystems of GSM. It consists of two parts.

A. Base Transceiver Station (BTS):

- It encodes, encrypts, multiplexes, modulates and feeds the RF signal to the antenna.
- It consists of transceiver units.
- It communicates with mobile stations via radio air interface and also communicates with BSC via Abis interface.

B. Base Station Controller (BSC):

- It manages radio resources for BTS. It assigns frequency and time slots for all mobile stations in its area.
- It handles call set up, transcoding and adaptation functionality handover for each MS radio power control.
- It communicates with MSC via A interface and also with BTS.

3. Network Switching Subsystem (NSS): it manages the switching functions of the system and allows MSCs to communicate with other networks such as PSTN and ISDN. It consist of

A. Mobile switching Centre:

- It is a heart of the network. It manages communication between GSM and other networks.
- It manages call set up function, routing and basic switching.
- It performs mobility management including registration, location updating and inter BSS and inter MSC call handoff.
- It provides billing information.
- MSC does gateway function while its customers roam to other network by using HLR/VLR.

B. Home Location Registers (HLR): - It is a permanent database about mobile subscriber in a large service area. - Its database contains IMSI, IMSISDN, prepaid/post-paid, roaming restrictions, supplementary services.

C. Visitor Location Registers (VLR): - It is a temporary database which updates whenever new MS enters its area by HLR database. - It controls mobiles roaming in its area. It reduces number of queries to HLR. - Its database contains IMSI, TMSI, IMSISDN, MSRN, location, area authentication key.

D. Authentication Centre: - It provides protection against intruders in air interface. - It maintains authentication keys and algorithms and provides security triplets (RAND, SRES, Ki).

E. Equipment Identity Registry (EIR):

- It is a database that is used to track handset using the IMEI number.
- It is made up of three sub classes- the white list, the black list and the gray list.

4. Operational Support Subsystem (OSS): It supports the operation and maintenance of GSM and allows system engineers to monitor, diagnose and troubleshoot all aspects of GSM system. It supports one or more Operation Maintenance Centres (OMC) which are used to monitor the performance of each MS, Bs, BSC and MSC within a GSM system. It has three main functions:

- To maintain all telecommunication hardware and network operations with a particular market.
- To manage all charging and billing procedures
- To manage all mobile equipment in the system.

Interfaces used for GSM network : (ref fig 2)
1)UM Interface –Used to communicate between BTS with MS
2)Abis Interface— Used to communicate BSC TO BTS
3)A Interface-- Used to communicate BSC and MSC
4) Singling protocol (SS 7)- Used to communicate MSC with other network .

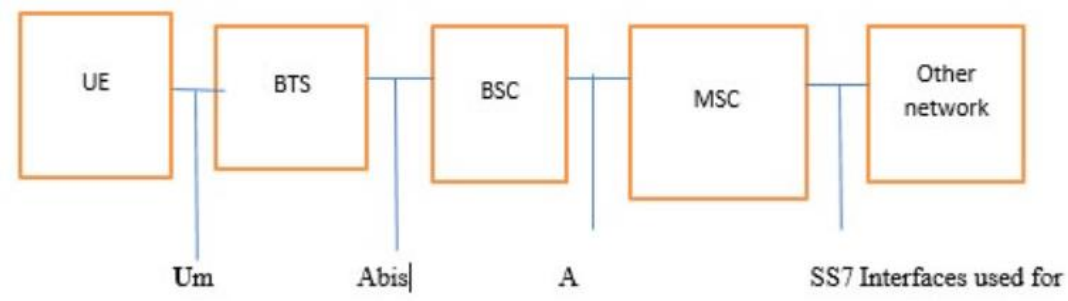


Fig 2 GSM network Interfaces

(c) **Explain BSS and ESS configuration of IEEE 802.11.**

Ans: 1. Basic Service Set (BSS) : Basic Service Set (BSS), as name suggests, is a group or set of all stations that communicate with each together. Here, stations are considered as computers or components connected to wired network.

Advantages of BSS:

- Simplicity: A BSS is a simple and cost-effective way to provide wireless connectivity for a small area, such as a home or office.
- Easy to set up: Setting up a BSS is straightforward, as it only requires a single Access Point (AP) and a set of client devices.
- Lower latency: A BSS can provide lower latency than an ESS, as there is no need to communicate with other APs or a central controller.

- Easier to manage: A BSS is easier to manage than an ESS, as there is only one AP to configure and maintain.

Disadvantages of BSS:

- Limited coverage: A BSS has limited coverage, typically ranging from a few meters to a few hundred meters.
- Limited scalability: A BSS is not scalable beyond a certain point, as adding more users or devices can cause congestion and slow down the network.
- Limited mobility: Clients within a BSS can move around within its coverage area without losing connectivity, but cannot roam between different BSSs.

2. Extended Service Set (ESS) : Extended Service Set (ESS), as name suggests, is a group of BSSs or one or more interconnected BSS along with their wired network.

Advantages of ESS:

- Scalability: An ESS can be scaled to cover a much larger area by interconnecting multiple BSSs.
- Greater coverage: An ESS can provide coverage over a large area, such as a campus or an entire building.
- Mobility: Clients within an ESS can roam between different BSSs without losing connectivity, allowing for greater mobility.
- Centralized management: An ESS can be managed centrally, making it easier to configure and maintain.

Disadvantages of ESS:

- Complexity: An ESS is more complex than a BSS, as it requires multiple APs and a central controller.
- Higher cost: An ESS can be more expensive to set up and maintain than a BSS, due to the need for multiple APs and a central controller.
- Higher latency: An ESS can have higher latency than a BSS, as there is more communication involved between APs and the central controller.

(d) **Describe the goals of mobile IP in mobile network and explain its working.**

Ans: Mobile IP is a communication protocol (created by extending Internet Protocol, IP) that allows the users to move from one network to another with the same IP address. It ensures that the communication will continue without the user's sessions or connections being dropped.

Mobile Node (MN) is the hand-held communication device that the user carries e.g. Cell phone.

Home Network is a network to which the mobile node originally belongs as per its assigned IP address (home address).

Home Agent (HA) is a router in-home network to which the mobile node was originally connected

Home Address is the permanent IP address assigned to the mobile node (within its home network).

Foreign Network is the current network to which the mobile node is visiting (away from its home network).

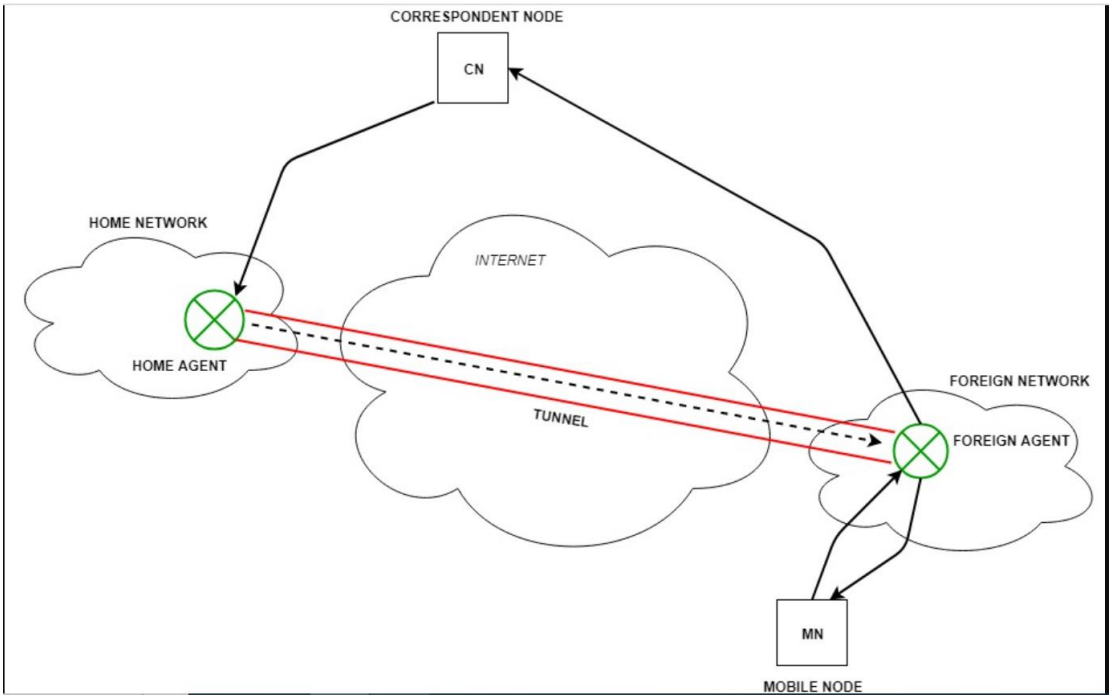
Foreign Agent (FA) is a router in a foreign network to which the mobile node is currently connected. The packets from the home agent are sent to the foreign agent which delivers them to the mobile node.

Correspondent Node (CN) is a device on the internet communicating to the mobile node.

Care-of Address (COA) is the temporary address used by a mobile node while it is moving away from its home network.

Foreign agent COA, the COA could be located at the FA, i.e., the COA is an IP address of the FA. The FA is the tunnel end-point and forwards packets to the MN. Many MN using the FA can share this COA as a common COA.

Co-located COA, the COA is co-located if the MN temporarily acquired an additional IP address which acts as COA. This address is now topologically correct, and the tunnel endpoint is at the MN. Co-located addresses can be acquired using services such as DHCP.



Working:

The correspondent node sends the data to the mobile node. Data packets contain the correspondent node's address (Source) and home address (Destination). Packets reach the home agent. But now mobile node is not in the home network, it has moved into the foreign network. The foreign agent sends the care-of-address to the home agent to which all the packets should be sent. Now, a tunnel will be established between the home agent and the foreign agent by the process of tunneling.

Tunneling establishes a virtual pipe for the packets available between a tunnel entry and an endpoint. It is the process of sending a packet via a tunnel and it is achieved by a mechanism called encapsulation.

Now, the home agent encapsulates the data packets into new packets in which the source address is the home address and destination is the care-of-address and sends it through the tunnel to the foreign agent. Foreign agent, on another side of the tunnel, receives the data packets, decapsulates them, and sends them to the mobile node. The mobile node in response to the data packets received sends a reply in response to the foreign agent. The foreign agent directly sends the reply to the correspondent node.

(e) **What is Wireless Application Protocol and also explain its goals.**

Ans: Wireless Application Protocol (WAP) was a technical standard for accessing information over a mobile wireless network. It provided a framework for delivering web content and services to mobile devices, such as mobile phones, PDAs, and other handheld devices, with limited display and processing capabilities. WAP aimed to enable these devices to access and display content from the internet in a format suitable for their small screens and constrained resources.

The goals of Wireless Application Protocol (WAP) were:

Universal Access: WAP aimed to create a standard that would allow users to access internet content and services from their mobile devices, regardless of the underlying network technology or device manufacturer.

Interoperability: WAP intended to ensure that mobile devices and network infrastructure from different manufacturers could work seamlessly together. This was important to create a consistent user experience across various devices and networks.

Efficiency: Since mobile devices had limited processing power, memory, and bandwidth, WAP focused on optimizing data transmission and rendering of content. It aimed to reduce the amount of data transferred and optimize the display of information on small screens.

Portability: WAP protocols were designed to be platform-independent, making it possible to develop applications that could run on various types of devices and operating systems.

Security: Security was a significant concern when accessing the internet from mobile devices. WAP aimed to provide secure communication between the mobile device and the content server, protecting sensitive information and ensuring user privacy.

Adaptability: WAP aimed to support different markup languages, such as Wireless Markup Language (WML), which was designed to be more lightweight and suitable for mobile devices compared to HTML.

Cost-Effectiveness: WAP recognized that mobile data transmission was relatively expensive and limited at the time. Therefore, it aimed to minimize the data exchanged between the server and the mobile device, thus reducing costs for both users and network operators.

Ease of Use: WAP focused on creating user-friendly interfaces that were adapted to the limitations of mobile devices, allowing users to navigate and interact with content more easily.

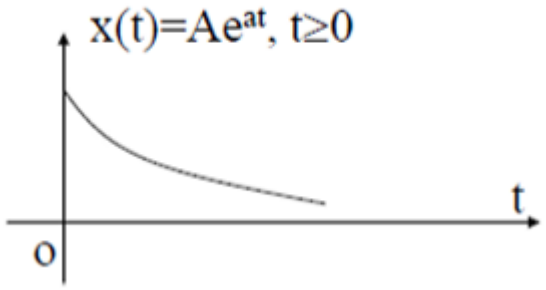
However, despite its initial popularity, WAP faced limitations such as slow data speeds, inconsistent user experiences, and advancements in mobile technology that quickly made it obsolete. As faster mobile networks and more capable devices emerged, full internet browsing became feasible on mobile devices using standard web technologies like HTML, CSS, and JavaScript. This shift led to the decline of WAP and the adoption of modern mobile web browsing practices.

SECTION C 3. Attempt any *one* part of the following: 7 x 1 = 7

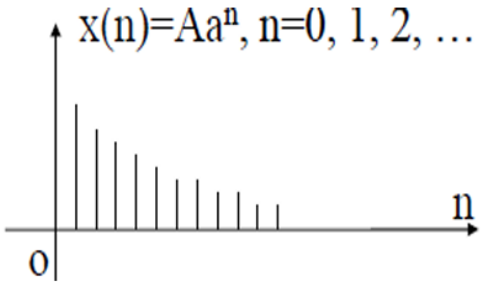
(a) **Explain various representations of signals.**

Ans: A Signal is the function of one or more independent variables that carries some information to represent a physical phenomenon.

A continuous-time signal, also called an analog signal, is defined along a continuum of time.



A discrete-time signal is defined at discrete times.



Elementary Signals

Sinusoidal & Exponential Signals

Sinusoids and exponentials are important in signal and system analysis because they arise naturally in the solutions of the differential equations.

Sinusoidal Signals can expressed in either of two ways : cyclic frequency form- A sin 2Πfot = A sin(2Π/To)t radian frequency form- A sin ωot

ωo = 2Πfo = 2Π/To

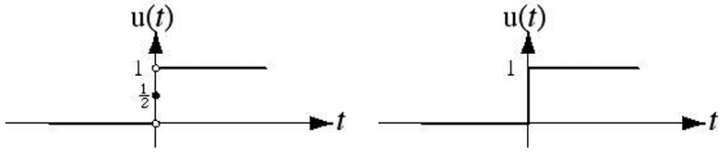
To = Time Period of the Sinusoidal Wave

x(t) = A sin (2Πfot+ θ) = A sin (ωot+ θ) x(t) = Aeat Real Exponential = Aejω̥t = A[cos (ωot) +j sin (ωot)] Complex Exponential θ = Phase of sinusoidal wave A = amplitude of a sinusoidal or exponential signal fo = fundamental cyclic frequency of sinusoidal signal ωo = radian frequency

Unit Step Function

$$u(t)=\begin{cases}1 & , \ t>0\\ 1/2 & , \ t=0\\ 0 & , \ t<0\end{cases}$$

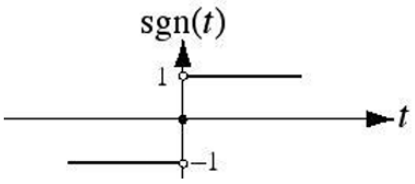
Precise Graph Commonly-Used Graph



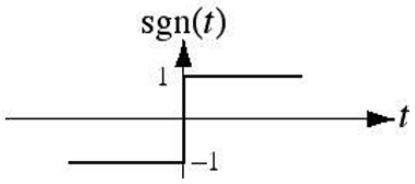
Signum Function

$$\operatorname{sgn}(t) = \left\{ \begin{array}{l} 1 \quad , \ t > 0 \\ 0 \quad , \ t = 0 \\ -1 \ , \ t < 0 \end{array} \right\} = 2\,\mathrm{u}(t) - 1$$

Precise Graph

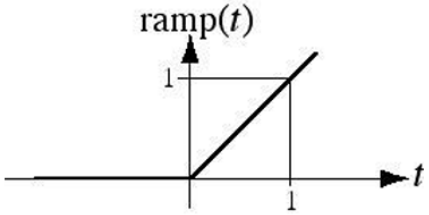


Commonly-Used Graph



The signum function, is closely related to the unit-step function.

Unit Ramp Function



$$\operatorname{ramp}(t) = \left\{ \begin{array}{l} t \quad , \ t > 0 \\ 0 \quad , \ t \le 0 \end{array} \right\} = \int_{-\infty}^{t} \mathrm{u}(\lambda)\, d\lambda = t\,\mathrm{u}(t)$$

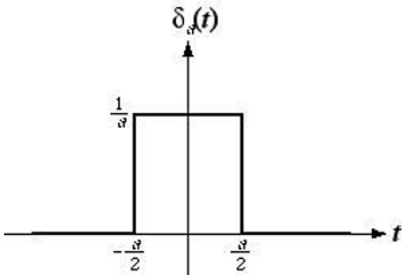
The unit ramp function is the integral of the unit step function.

It is called the unit ramp function because for positive t, its slope is one amplitude unit per time.

Rectangular Pulse Or Gate Function

Rectangular pulse,

$$\delta_a(t) = \left\{ \begin{array}{l} 1/a \quad , \ |t| < a/2 \\ 0 \quad\quad , \ |t| > a/2 \end{array} \right.$$



(b) **Explain spread spectrum with suitable example also explain its types.**

Ans: Spread spectrum is a communication technique used in wireless communications to spread the signal over a larger bandwidth than is technically required. This process provides several benefits, including increased resistance to interference, improved security, and the ability to share a frequency band with multiple

users. Spread spectrum is particularly useful in environments with high levels of noise, interference, and the need for reliable and secure communication.

The basic idea behind spread spectrum is to transmit the data signal using a specific spreading code, which is a sequence of values that modifies the signal's frequency, phase, or amplitude. This spreading code spreads the original signal across a wider frequency band, making it more resilient to external disturbances. At the receiver end, a compatible code is used to despread the received signal, effectively recovering the original data.

There are two main types of spread spectrum techniques: Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS).

1. Frequency Hopping Spread Spectrum (FHSS):
In FHSS, the signal's carrier frequency changes rapidly and unpredictably according to a predetermined hopping sequence. Both the transmitter and the receiver follow the same hopping pattern. This technique helps combat narrowband interference because the signal's frequency is constantly changing, making it difficult for external sources of interference to disrupt the communication.

Example: Consider a scenario where two devices are communicating using FHSS. The devices share a hopping sequence, and at any given time, they transmit and receive data on the same frequency within the hopping sequence. If one frequency becomes noisy due to interference, the devices will quickly hop to another frequency within the sequence to maintain a stable connection.

2. Direct Sequence Spread Spectrum (DSSS):
DSSS spreads the data signal by multiplying it with a higher-rate spreading code, often referred to as a "chip sequence." This process increases the signal's bandwidth significantly. The receiver, knowing the same spreading code, can then despread the signal to recover the original data.

Example: Imagine two devices using DSSS to communicate. The transmitter multiplies the original signal with a chip sequence, which changes the signal's properties. The receiver, aware of the same chip sequence, performs the reverse process, effectively extracting the original data from the spread signal. This technique provides resilience against interference as well as security due to the complexity of the spread signal.

Spread spectrum techniques have found applications in various fields, including military communications, wireless networks, and even consumer devices like Wi-Fi routers. They offer robustness against interference, improved security through obscurity, and the ability to accommodate multiple users within the same frequency band without excessive interference.

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) **Describe the network architecture of UMTS with diagram.**

Ans: i. A UMTS system can be divided into a set of domains and the reference points that interconnect them.

ii. The UMTS network architecture is partly based on existing 2G network components and some new 3G network components. It inherits the basic functional elements from the GSM architecture on the core network (CN) side.

iii. The MS of GSM is referred as user equipment (UE) in UMTS. The MSC has quite similar functions both in GSM and UMTS. Instead of circuit-switched services for packet data, a new packet node SGSN is introduced. This SGSN is capable of supporting data rates of up to 2 Mbps.

iv. The core-network elements are connected to the radio network via the Iu interface, which is very similar to the A-interface used in GSM.

v. The major changes in the UMTS architecture are in the Radio Access Network (RAN), which is also called UMTS terrestrial RAN (UTRAN). There is a totally new interface called Iur,which connects two neighbouring Radio Network Controllers (RNCs).BSs are connected to the RNC via the Iub interface.

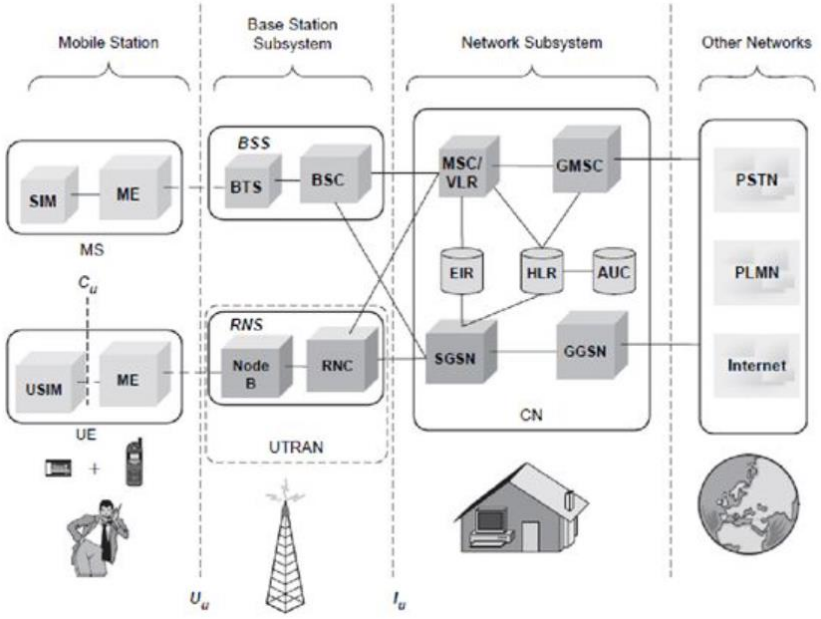
UMTS terrestrial RAN (UTRAN)

i. UTRAN consist of Radio Network Subsystems (RNSs). The RNS has two main elements: Node B and a Radio Network Controllers (RNC). ii. Radio network controller (RNC):

- The RNC is responsible for control of the radio resources in its area. One RNC controls multiple nodes B.
- The RNC in UMTS provides functions equivalent to the Base Station Controller (BSC) functions in GSM/GPRS networks.
- The major difference is that RNCs have more intelligence built-in than their GSM/GPRS counterparts. For example, RNCs can autonomously manage handovers without involving MSCs and SGSNs.

iii. Node B:

- The Node B is responsible for air-interface processing and some radio-resource management functions.
- The Node B in UMTS networks provides functions equivalent to the base transceiver station (BTS) in GSM/GPRS networks. UMTS operates at higher frequencies than GSM/GPRS and therefore the signal coverage range is less.



Features of UMTS interfaces:

i. The UMTS interfaces can be categorized as follows:

a. Uu :

- This is the interface between the user equipment and the network. That is, it is the UMTS air interface.
- The equivalent interface in GSM/GPRS networks is the um interface.

b. The Iuis split functionally into two logical interfaces, Iupsconnecting the packet switched domain to the access network and the Iucsconnecting the circuit switched domain to the access network. The standards do not dictate that these are physically separate, but the user plane for each is different and the control plane may be different.

c. Iu –CS :

- This is the circuit-switched connection for carrying (typically) voice traffic and signaling between the UTRAN and the core voice network.
- The main signaling protocol used is Radio Access Network Application Part (RANAP).
- The equivalent interface in GSM/GPRS networks is the A-interface.

d. Iub :

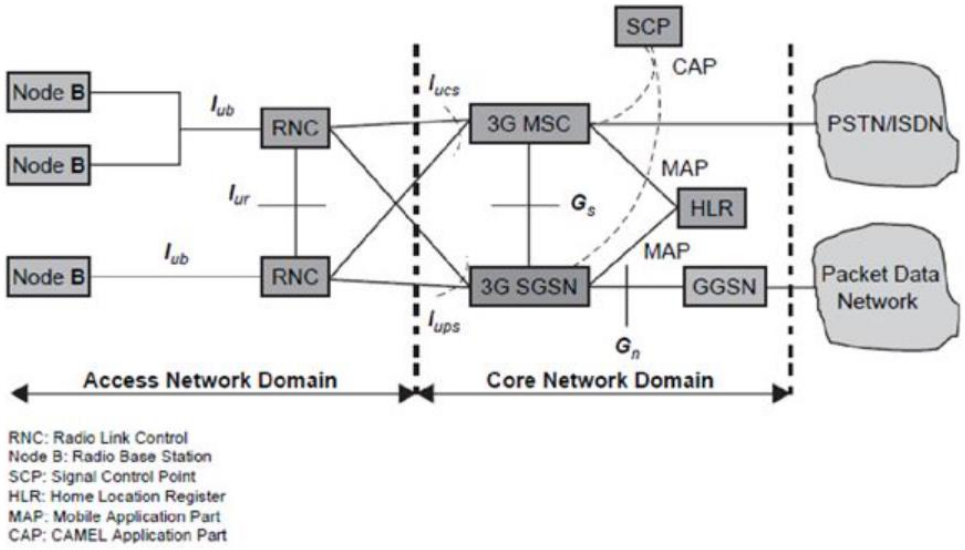
- This is the interface used by an RNC to control multiple Node Bs.
- The main signaling protocol used is Node B Application Part (NBAP).
- The equivalent interface in GSM/GPRS networks is the A-bis interface.
- The Iubinterface is the main standardized and open, unlike the A-bis interface.

e. Iu –PS :

- This is the packet-switched connection for carrying (typically) data traffic and signaling between the UTRAN and the core data GPRS network.
- The main signaling protocol used is RANAP.
- The equivalent interface in GSM/GPRS networks is the Gb-interface.

f. Iur :

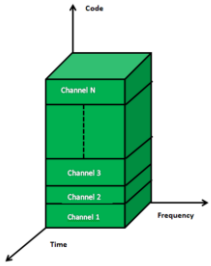
- The primary purpose of the Iur interface is to support inter-MSC mobility. When a mobile subscriber moves between areas served by different RNCs, the mobile subscriber’s data is now transferred to the new RNC via Iur.
- The original RNC is known as the serving RNC and the new RNC is known as the drift RNC.
- The main signaling protocol used is Radio Network Subsystem Application Part (RNSAP).
- There is no equivalent interface in GSM/GPRS networks.



(b) **Discuss about CDMA with neat diagrams.**

Ans: CDMA stands for Code Division Multiple Access. It is basically a channel access method and is also an example of multiple access. Multiple access basically means that information by several transmitters can be sent simultaneously onto a single communication channel.

There are multiple users which are provided or assigned variant CDMA codes and thus the users can access the entire band of frequencies or the whole bandwidth. This method does not limit the frequency range of the user. Hence, with the help of CDMA, multiple users can share a band of frequencies without any kind of undue interference between them. CDMA makes the use of spectrum technology along with analog to digital conversion(ADC). It is thus used by various radio communication technologies. Mainly, it is used for mobile communication.



Characteristics of CDMA

It allows more users to connect at a given time and thus provides improved data and voice communication capacity.

A full spectrum is used by all the channels in CDMA.

CDMA systems make the use of power control to eliminate the interference and noise and to thus improve the network quality.

CDMA encodes the user transmissions into distinct and unique codes in order to secure its signals.

In CDMA systems all the cells can thus use the same frequency.

CDMA systems have a soft capacity. Thus there is no particular limit to the number of users in a CDMA system but with increase in the number of users the performance degrades.

5. Attempt any *one* part of the following: 7 x 1 = 7

(a) **Explain Satellite architecture with suitable diagram.**

Ans: A satellite definition is a small object that rotates in the region of a larger object within space. The best example of a natural satellite of the globe is the moon. We know that communication is nothing but the sharing

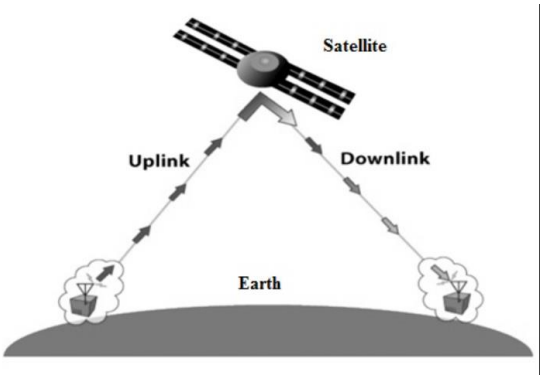
of data among two or more entities using any transmission channel or medium. Alternatively, communication can also be defined as transmitting, receiving & processing the data.

So, if communication occurs between any two stations on the earth with a satellite, then it is known as satellite communication. In this kind of communication, electromagnetic waves are utilized like carrier signals to carry the data like audio, voice, video among space and ground.

Need of Satellite Communication

In earlier communication, there are two types of propagation is used up to some distance like ground wave propagation and skywave propagation. The bandwidth used by Ground wave propagation is up to 30MHz frequencies. This kind of communication uses the conditions of the troposphere of the globe.

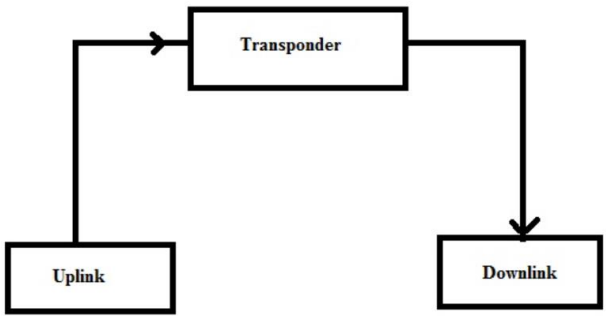
The bandwidth used by skywave propagation mainly ranges from 30 to 40 MHz with the properties of the ionosphere of the earth. The highest station distance is restricted to 1500KM simply in both the propagations. So, satellite communication conquers this drawback. By providing long-distance communication.



As the satellites situate at a certain height from the earth, then communication occurs in between two earth stations simply through satellite. So, it conquers the drawback of communication between two stations on the earth because of the curvature of the earth.

Block Diagram

Satellite communications are related to the space mirrors because they assist us in activating the signals like internet data, radio & TV from one face of the earth to another face.



The block diagram of the satellite communication system includes the following. This satellite communication system can be explained through three blocks namely uplink, transponder, and downlink where these components of the satellite communication system & their working are discussed below.

Types of Satellite Communication

The classification of satellites can be done based on their functions because they are mainly launched into space to perform a specific task. So its design must fulfill its role. There are different types of satellite communication systems like communication, remote sensing, navigation, geocentric orbit type like LEO, HEO, MEO, GPS (global positioning system), GEOs(geostationary satellites), polar, ground, drone, smallsats, CubeSats, nanosats.

(b) **Discuss the deficiencies of existing GEO/MEO/LEO Satellite Systems.**

Ans: Existing satellite systems, whether they are in Geostationary Earth Orbit (GEO), Medium Earth Orbit (MEO), or Low Earth Orbit (LEO), each come with their own set of deficiencies and limitations. Let's discuss some of the shortcomings associated with each of these satellite systems:

1. Geostationary Earth Orbit (GEO) Satellites:

High Latency: GEO satellites are positioned at a fixed point above the equator, resulting in high latency for communication. The time it takes for signals to travel from Earth to the satellite and back can introduce noticeable delays, making real-time applications like video conferencing or online gaming challenging.
Limited Coverage at High Latitudes: GEO satellites have limited coverage at high latitudes due to their fixed position above the equator. This can lead to coverage gaps for users in polar regions.
Limited Frequency Spectrum: The available frequency spectrum for GEO satellites is limited and can become congested, especially as more satellites are launched into this orbit.
Costly Deployment and Maintenance: Launching satellites into GEO is expensive, and maintaining their positions requires continuous fuel consumption for station-keeping maneuvers.
2. Medium Earth Orbit (MEO) Satellites:

Moderate Latency: MEO satellites offer lower latency compared to GEO satellites but still have noticeable delays due to their higher altitudes. While latency is reduced compared to GEO, it might still be an issue for certain real-time applications.
Limited Coverage and Handovers: MEO satellites cover a larger area compared to LEO satellites, but they still require handovers as users move across different satellite footprints. These handovers can result in temporary disruptions in communication.
Complex Constellation Management: Maintaining and managing a MEO satellite constellation involves complex orbital dynamics and precise timing to ensure continuous coverage.
3. Low Earth Orbit (LEO) Satellites:

High Satellite Constellation Density: LEO satellite systems require a large number of satellites to provide global coverage due to their lower altitudes. This high density can lead to challenges related to satellite collision avoidance and space debris mitigation.
Short Satellite Lifespan: LEO satellites experience more atmospheric drag and are subject to faster orbital decay. This results in shorter operational lifespans, requiring more frequent satellite launches to maintain the constellation.
Frequent Handovers: LEO satellites have rapid orbital motion, leading to frequent handovers as satellites move across the sky. This can result in potential disruptions during handover transitions.
Complex Network Management: Managing a large and dynamic constellation of LEO satellites involves complex networking and communication protocols to ensure seamless connectivity.

6. Attempt any *one* part of the following: 7 x 1 = 7

(a) **What is Wireless Sensor Network? How it is different from Traditional Network?**

Ans: A Wireless Sensor Network (WSN) is a collection of small, autonomous devices called sensors that are equipped with various types of sensors, computational capabilities, and wireless communication capabilities. These sensors work together to monitor and collect data from the surrounding environment, such as temperature, humidity, light, sound, motion, and more. The data collected by the sensors can be processed,

aggregated, and transmitted wirelessly to a central node or base station for further analysis, storage, and decision-making.

Key characteristics of Wireless Sensor Networks include:

Wireless Communication: Sensors communicate with each other and the base station wirelessly, often using radio frequency (RF) communication protocols. This eliminates the need for physical wired connections and enables flexible deployment in remote or hard-to-reach locations.

Distributed and Autonomous: Each sensor node in a WSN operates autonomously, making its own decisions about data collection and communication. This decentralized approach allows the network to adapt to changes in the environment and operate even if some nodes fail.

Energy Constraints: Sensors in WSNs are usually powered by batteries or energy harvesting mechanisms. Due to limited energy resources, energy efficiency is a critical concern, and techniques to optimize energy consumption are essential.

Data Aggregation: Data collected by sensors are often aggregated before being transmitted to the base station. This helps reduce the amount of data transmitted, saving energy and bandwidth.

Scalability: WSNs can consist of a large number of sensors, allowing them to cover large areas and collect extensive data.

Now, let's discuss the differences between a Wireless Sensor Network (WSN) and a Traditional Network:

1. Purpose and Application:

WSN: Designed for monitoring and collecting data from the physical environment. Common applications include environmental monitoring, industrial automation, agriculture, healthcare, and smart cities.

Traditional Network: Designed for general communication purposes, such as sending emails, browsing the internet, making voice and video calls, and accessing online services.

2. Node Characteristics:

WSN: Sensor nodes are small, resource-constrained devices with limited processing power, memory, and energy. They are optimized for data sensing and communication.

Traditional Network: Devices in a traditional network, such as computers, smartphones, and servers, are more powerful with greater computational capabilities.

3. Communication Patterns

WSN: Communication in WSNs is often event-driven, where sensors transmit data when specific events or thresholds are met. The focus is on efficient transmission of relevant data.

Traditional Network: Communication in traditional networks is typically user-driven and involves continuous data exchange for various applications like browsing, streaming, and chatting.

4. Coverage and Deployment:

WSN: Sensors are often deployed in a spatially distributed manner to cover a specific physical area for data collection.

Traditional Network: Traditional networks provide connectivity for users to access online services and content from various locations.

5. Energy Efficiency:

WSN: Energy efficiency is a critical concern in WSNs due to the limited energy resources of sensor nodes.

Traditional Network: Energy efficiency is also important, but devices in traditional networks usually have more consistent and higher power sources.

(b) **Explain the routing principle of Ad-hoc Networks.**

Ans: Ad hoc networks, also known as mobile ad hoc networks (MANETs), are wireless networks formed by a collection of mobile devices or nodes that communicate directly with each other without relying on any fixed infrastructure or centralized control. In ad hoc networks, nodes act as both hosts and routers, relaying data packets for each other to enable communication. The routing principle in ad hoc networks revolves around how these nodes cooperate to forward data packets from source nodes to destination nodes.

There are several routing protocols designed for ad hoc networks, each with its own approach to managing routing information and selecting paths for data transmission. Two common categories of ad hoc routing protocols are proactive (table-driven) and reactive (on-demand) routing protocols.

Proactive Routing Protocols:

Proactive routing protocols maintain up-to-date routing tables for all nodes in the network. These tables contain information about routes to all possible destinations. Examples of proactive routing protocols include:

Destination-Sequenced Distance Vector (DSDV): This protocol is an extension of the classic distance vector algorithm. Nodes periodically exchange routing tables to ensure they have current routing information. Each entry in the table includes a sequence number to indicate the freshness of the route.

Optimized Link State Routing (OLSR): OLSR minimizes overhead by dividing nodes into different sets and only a subset of nodes participating in route discovery. It uses multipoint relays to reduce control message overhead while maintaining routes to all nodes.

Reactive Routing Protocols:

Reactive routing protocols establish routes only when needed. When a source node wants to send data to a destination, it initiates a route discovery process to find a path. Examples of reactive routing protocols include:

Ad Hoc On-Demand Distance Vector (AODV): AODV uses route discovery and route maintenance mechanisms. When a node wants to communicate with a destination and has no route, it broadcasts a route request (RREQ) message. Intermediate nodes process the RREQ and either reply with a route reply (RREP) if they have a valid route or forward the RREQ further.

Dynamic Source Routing (DSR): DSR also relies on route discovery and route maintenance. When a source node wants to send data, it attaches a list of nodes (route) to the packet. Intermediate nodes use this route information to forward the packet.

Hybrid Routing Protocols:

Hybrid routing protocols combine aspects of both proactive and reactive approaches to achieve a balance between routing overhead and route setup latency. One example is the Zone Routing Protocol (ZRP), which divides the network into zones. Inside each zone, a proactive routing protocol is used, while between zones, a reactive approach is employed.

In summary, the routing principle in ad hoc networks involves the establishment and maintenance of routes between nodes to facilitate data transmission. Proactive protocols maintain routing tables at all times, while reactive protocols initiate route discovery only when needed. The choice of routing protocol depends on factors such as network size, node mobility, overhead tolerance, and application requirements.

7. Attempt any *one* part of the following: 7 x 1 = 7

(a) **Discuss the effect of mobility in TCP.**

Ans: The Transmission Control Protocol (TCP) is a widely used transport layer protocol that provides reliable, connection-oriented communication between devices over a network. Mobility refers to the ability of a device to move within a network or switch between different networks while maintaining its ongoing connections. Mobility can have a significant impact on TCP's performance and behavior. Let's explore the effects of mobility on TCP:

Packet Loss and Retransmissions:

When a mobile device moves between different networks or experiences handovers, there is a possibility of packet loss due to network disruptions, latency spikes, or other factors. TCP perceives packet loss as congestion and invokes its congestion control mechanisms, including retransmission of lost packets. Frequent handovers or network changes can lead to higher retransmission rates, affecting overall throughput and latency.

Out-of-Order Delivery:

As a mobile device switches between networks, the routing paths and network conditions may vary. This can result in packets arriving out of order at the receiver. TCP is designed to handle out-of-order packets using its sequence number mechanism, but excessive reordering can increase the need for retransmissions and impact the efficient use of available bandwidth.

TCP Timeout and Retransmission Timer Adjustment:

TCP uses retransmission timers to determine when to retransmit a packet that hasn't been acknowledged. Mobility-related delays, such as handovers or changes in network characteristics, can lead to inaccuracies in estimating round-trip times, affecting the optimal setting of retransmission timers. A mismatch between timers and actual round-trip times can lead to inefficient retransmissions.

Congestion Control and Performance:

TCP's congestion control mechanisms aim to maintain a balance between network utilization and fairness among different connections. Mobility-induced packet loss can falsely trigger congestion control mechanisms, leading to reduced throughput and inefficient bandwidth utilization. Additionally, frequent handovers can cause TCP to interpret network changes as congestion, causing congestion avoidance actions that are not necessary.

Buffering and Buffer Overflows:

Mobile devices may experience interruptions or delays in communication during handovers or network changes. If a receiving device's buffer becomes full during these moments, it may lead to buffer overflows and packet drops. TCP's window-based flow control mechanisms may be affected, impacting the overall communication efficiency.

Interaction with Mobility Management Protocols:

Mobility management protocols, such as Mobile IP or Proxy Mobile IPv6, are used to maintain connectivity as a device moves across networks. Interaction between these protocols and TCP can introduce additional delays and complexities in maintaining ongoing connections during handovers.

To mitigate the effects of mobility on TCP, various mechanisms have been proposed and implemented. These include modifications to TCP's congestion control algorithms, dynamic adjustment of retransmission timers based on mobility patterns, and integration with mobility management protocols to enhance seamless handover capabilities. However, it's important to note that achieving optimal TCP performance in highly mobile environments remains a challenge due to the unpredictable nature of network changes and handovers.

(b) **Write short notes on**

(i) **File System :** A file system is a process of managing how and where data on a storage disk, which is also referred to as file management or FS. It is a logical disk component that compresses files separated into groups, which is known as directories. It is abstract to a human user and related to a computer; hence, it manages a disk's internal operations. Files and additional directories can be in the directories. Although there are various file systems with Windows, NTFS is the most common in modern times. It would be impossible for a file with the same name to exist and also impossible to remove installed programs and recover specific

files without file management, as well as files would have no organization without a file structure. The file system enables you to view a file in the current directory as files are often managed in a hierarchy.

A disk (e.g., Hard disk drive) has a file system, despite type and usage. Also, it contains information about file size, file name, file location fragment information, and where disk data is stored and also describes how a user or application may access the data. The operations like metadata, file naming, storage management, and directories/folders are all managed by the file system.

On a storage device, files are stored in sectors in which data is stored in groups of sectors called blocks. The size and location of the files are identified by the file system, and it also helps to recognize which sectors are ready to be used. Other than Windows, there are some other operating systems that contain FAT and NTFS file system. But Apple product (like iOS and macOS) uses HFS+ as operating system is horizon by many different kinds of file systems.

File system Examples include FAT (FAT12, FAT16, FAT32), exFAT, NTFS, ReFS, HFS and HFS+, HPFS, APFS, UFS, ext2, ext3, ext4, XFS, btrfs, Files-11, Veritas File System, VMFS, ZFS, ReiserFS, NSS and ScoutFS. Some disk file systems are journaling file systems or versioning file systems.

(ii) **WWW**

Ans: World Wide Web, which is also known as a Web, is a collection of websites or web pages stored in web servers and connected to local computers through the internet. These websites contain text pages, digital images, audios, videos, etc. Users can access the content of these sites from any part of the world over the internet using their devices such as computers, laptops, cell phones, etc. The WWW, along with internet, enables the retrieval and display of text and media to your device.

The building blocks of the Web are web pages which are formatted in HTML and connected by links called "hypertext" or hyperlinks and accessed by HTTP. These links are electronic connections that link related pieces of information so that users can access the desired information quickly. Hypertext offers the advantage to select a word or phrase from text and thus to access other pages that provide additional information related to that word or phrase.

A web page is given an online address called a Uniform Resource Locator (URL). A particular collection of web pages that belong to a specific URL is called a website, e.g., www.facebook.com, www.google.com, etc. So, the World Wide Web is like a huge electronic book whose pages are stored on multiple servers across the world.

Small websites store all of their WebPages on a single server, but big websites or organizations place their WebPages on different servers in different countries so that when users of a country search their site they could get the information quickly from the nearest server.

So, the web provides a communication platform for users to retrieve and exchange information over the internet. Unlike a book, where we move from one page to another in a sequence, on World Wide Web we follow a web of hypertext links to visit a web page and from that web page to move to other web pages. You need a browser, which is installed on your computer, to access the Web.