Unit 2: The Network Infrastructure for E-Commerce

**Contents:**

Introduction to Information Superhighway (I-Way)

- Global network of computers that, potentially, will connect most of world's individuals, firms, and organizations. It is envisioned to provide very high speed access to information in all forms (text, graphics, audio, video) via a telephone or wireless connection. The term was first used in 1985 by Al Gore.
- The Information Superhighway is very much a physical network, an infrastructure of modern High-capacity, interactive electronic pipeline providing integrated services. I-way links everyone at home or office to everything else.
- The Information Superhighway is a physical network, facilitating the broadband, two-way transmission of any type of digital information, within its own virtual space.
- Any e-commerce application will need the I-Way infrastructure in the same manner as any normal business would require the interstate highway network to carry goods from one place to the other.
- I-Way is a network of interconnected data highways of several types:
  1. Cable TV wires
  2. Telephone wires
  3. Optical fibers
  4. Cellular and satellite
  5. Radio and microwave-based wireless

- I-Way is an interactive two-way high-capacity method of transporting information and services. I-Way is applicable in large volume e-commerce applications as it provides traffic-free telecommunication service. I-Way helps organizations, firms and companies in upgrading their network infrastructure.
- It also helps companies and organizations in recognizing the following:
  1. Their infrastructure
  2. Ways to change their business
  3. Transaction strategies (marketing, advertising, etc.)
  4. Ways to sell their products and services
  5. Ways to change their relationship with the customer

Components of the I-Way

Fig: Components of the Information Superhighway infrastructure
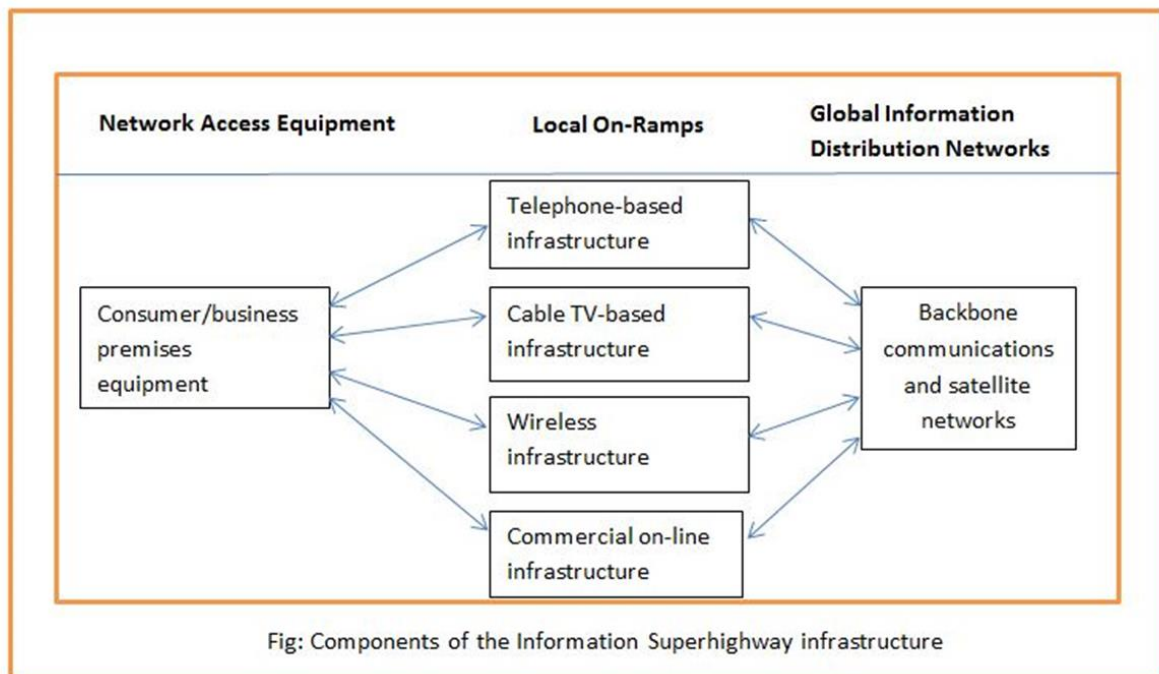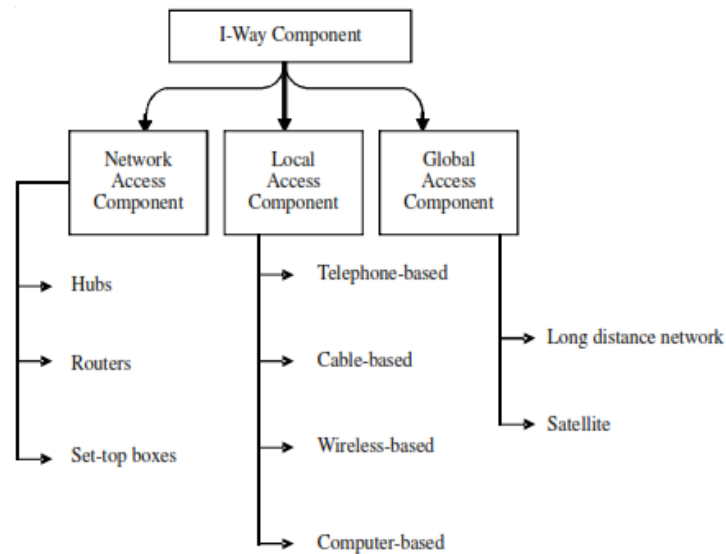
Source: 'Frontiers of Electronic Commerce', Kalakota and Whinston

There are three main components in I-Way:

1. Network Access equipment
2. Local Access components
3. Global Access components

Network access equipment

To access any network, specific equipment is required at the customer and this enables the consumer to access the network. It consists of hardware, such as routers, switches and access devices, such as computers and set-top boxes. Software platforms are browsers and operating systems.

Local access component

Local access component is the link between businesses, homes, schools and organizations to the main communication point also referred to as the 'last mile'. Last mile connection represents a tremendous investment that cannot be easily replaced or overlooked in any network strategy.

It provides the following types of connections:

(a) Telephone-based channel
(b) Cable-based last channel
(c) Electrical-based last channel
(d) Wireless-based last channel

Global access component

Nowadays, e-commerce activities are not limited to any country; and with the world becoming a global village, a proper network infrastructure is required to connect people and businesses across the world. These types of networks include:

(a) Long distance networks (via coaxial cable or fiber-optic cable)
(b) Satellite

Internet as network infrastructure

Backbone

High-bandwidth fiber optic cable that transports data across the Internet

**Network Service Provider (NSP):** Owns and controls one of the major networks comprising the Internet backbone

Bandwidth

Measures how much data can be transferred over a communications medium within a fixed period of time; is usually expressed in bits per second (bps), kilobits per second (Kbps), or megabits per second (Mbps)

Network Access Points and Metropolitan Area Exchanges

- One of the hubs where the backbone intersects with regional and local networks, and where the backbone owners connect with one another.
- Metropolitan Area Exchanges (MAEs) another name for one of the hubs where the backbone intersects with regional and local networks.
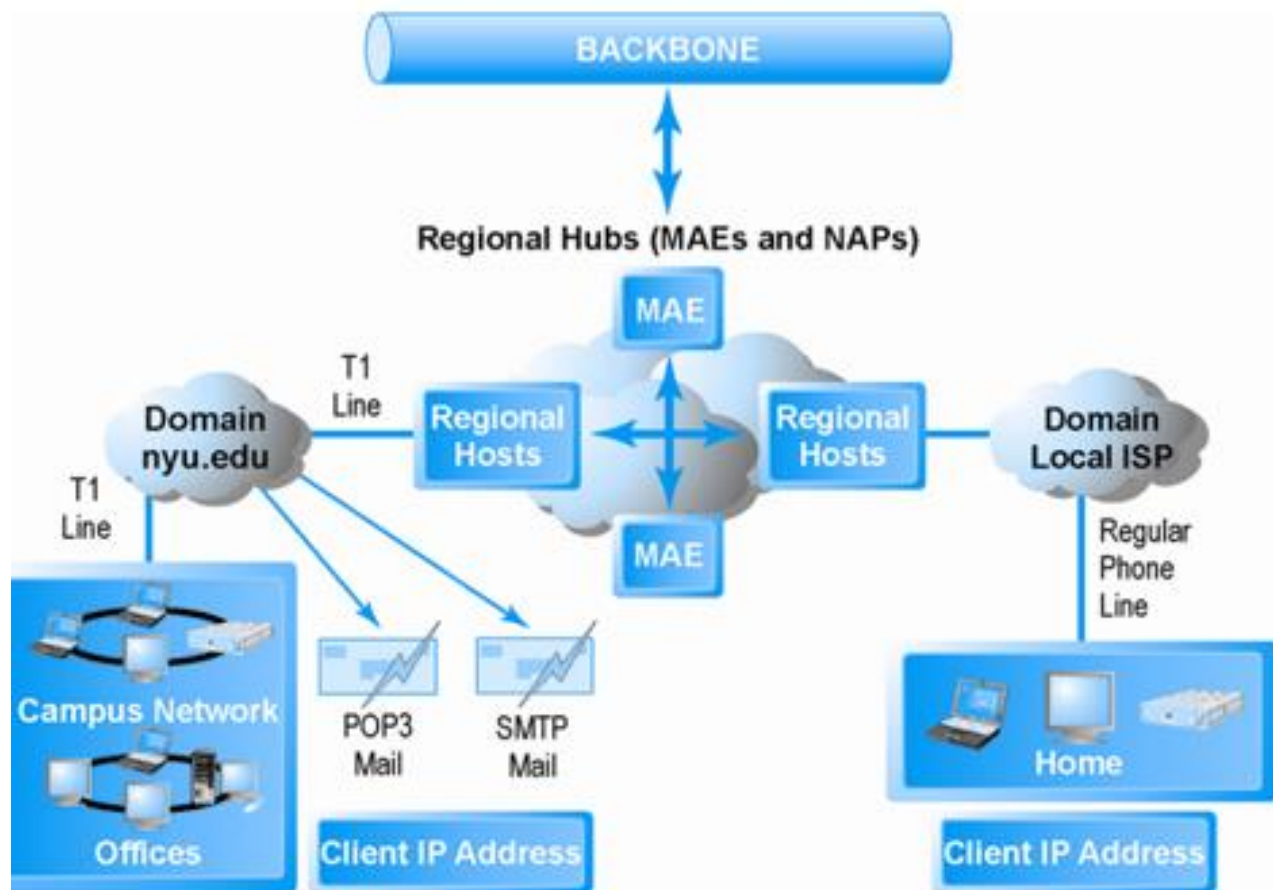
Campus Networks

Generally local area networks operating with a single organization that leases access to the Web directly from regional and national carriers

Internet Service Providers

Firm that provides the lowest level of service in the multi-tiered Internet architecture by leasing Internet access to home owners, small businesses, and some large institutions.

Narrowband

The traditional telephone modem connections, now operating at 56.6 Kbps

Broadband

Refers to any communication technology that permits clients to play streaming audio and video files at acceptable speeds -- generally above 100 Kbps Broadband service is based on DSL, cable modem, telephone (T1 and T3 lines), and satellite technologies.

Cable modem

It refers to a cable television technology that piggybacks digital access to the Internet using the same analog or digital video cable providing television signals to a home. Cable Internet is a major broadband alternative to DSL service, generally providing faster speeds and a "triple play" subscription: telephone, television, and Internet for a single monthly payment.

Digital Subscriber Line (DSL)

It is a telephone technology that provides high-speed access to the Internet through ordinary telephone lines found in a home or business. Service levels range from about 768 Kbps up to 7 Mbps.

T1

An international telephone standard for digital communication that offers guaranteed delivery at 1.54 Mbps

T3

An international telephone standard for digital communication that offers guaranteed delivery at 45Mbps

Satellite

Satellite companies provide high-speed broadband Internet access, primarily to homes and offices located in rural areas where DSL or cable access is not available
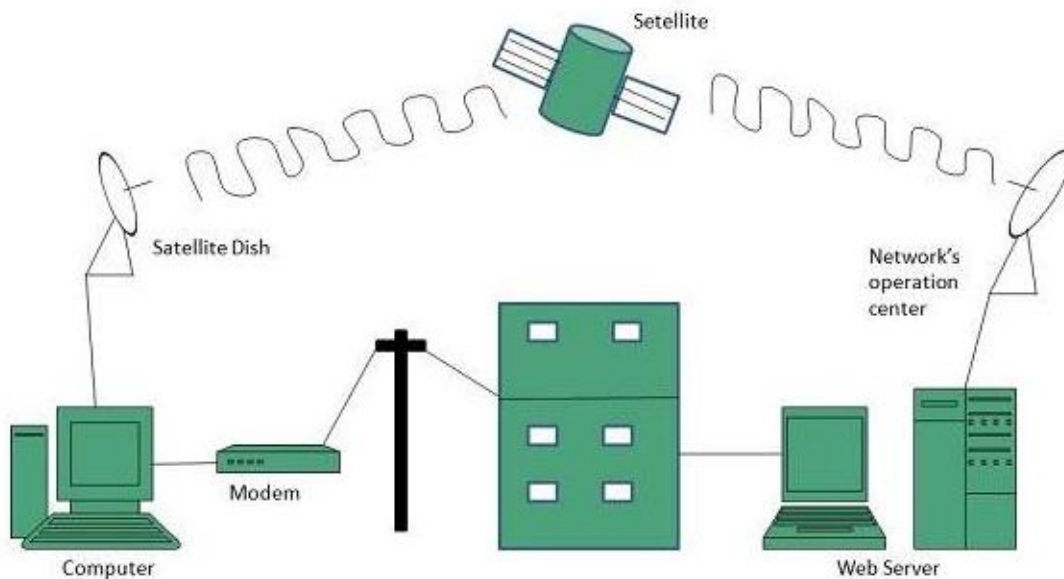
Internet, Intranet and Extranet

Internet

- The internet is the global system of interconnected computer networks that server billions of users worldwide.
- It is the network of networks.
- It allows computers on different kinds of networks to interact with each other.
- It is the most common information super highway.
- It is a public network.

Intranet

Intranet is defined as private network of computers within an organization with its own server and firewall. Intranet is system in which multiple PCs are networked to be connected to each other. PCs in intranet are not available to the world outside of the intranet. Usually each company or organization has their own Intranet network and members/employees of that company can access the computers in their intranet.

Extranet

- It is an Intranet that can be accessed by the permitted users over the Internet in a secure way.

- It is a controlled private network that allows access to partners, vendors and suppliers or an authorized set of customers – normally to a subset of the information accessible from an organization's intranet.

- It can be used for Inter-organization services like suppliers, buyers and distribution management.

Internet vs Intranet

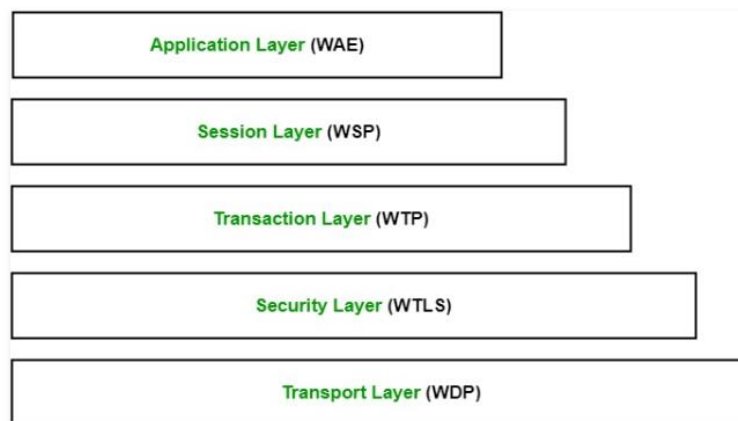| Internet	Intranet
It is a public network.	It is a private network.
It is not owned by particular organization.	It is owned by a particular organization or group of organizations.
It connects large number of computers worldwide.	It connects limited number of computers owned by an organization or group of organizations.
It can be used by any user.	It can be used only by the permitted used such as employee, customer of the organization.
It contains data and information targeted for all the users.	It contains data and information targeted only to the users of the organization.
The security is usually low.	The security is usually higher.

Wireless Application Protocol

- **WAP** stands for **Wireless Application Protocol**.
- It is a protocol designed for micro-browsers and it enables the access of internet in the mobile devices.
- It uses the mark-up language WML (Wireless Markup Language and not HTML), WML is defined as XML 1.0 application.
- It enables creating web applications for mobile devices.
- In 1998, *WAP Forum* was founded by Ericson, Motorola, Nokia and Unwired Planet whose aim was to standardize the various wireless technologies via protocols.
- WAP protocol was resulted by the joint efforts of the various members of WAP Forum.
- In 2002, WAP forum was merged with various other forums of the industry resulting in the formation of **Open Mobile Alliance (OMA)**.

- WAP achieved some popularity in the early 2000s.
- From the 2010s it had been largely outdated by more modern standards.
- Most modern handset internet browsers now fully support HTML, so they do not need to use WAP markup for web page compatibility, and therefore, most are no longer able to render and display pages written in WML, WAP's markup language.
- Most modern handset internet browsers now support full HTML, CSS, and most of JavaScript, and do not need to use any kind of WAP markup for webpage compatibility.
- The list of handsets supporting HTML is extensive, and includes all Android handsets, all versions of the iPhone handset, all Blackberry devices, all devices running Windows Phone, and many Nokia handsets.

Architecture of WAP

WAP is designed in a layered fashion, so that it can be extensible, flexible, and scalable. The WAP protocol stack is divided into five layers –

Application Layer (WAE)
Session Layer (WSP)
Transaction Layer (WTP)
Security Layer (WTLS)
Transport Layer (WDP)

1. **Application Layer:** This layer contains the *Wireless Application Environment (WAE)*. It contains mobile device specifications and content development programming languages like WML and WMLScript

2. **Session Layer:** This layer contains *Wireless Session Protocol (WSP)*. It provides fast connection suspension and reconnection.

3. **Transaction Layer:** This layer contains *Wireless Transaction Protocol (WTP)*. It runs on top of UDP (User Datagram Protocol) and is a part of TCP/IP and offers transaction support. It provide a simplified protocol suitable for low bandwidth wireless stations.

4. **Security Layer:** This layer contains *Wireless Transaction Layer Security (WTLS)*. It incorporates security features that are based upon the established Transport Layer Security (TSL) protocol standard. It offers data integrity, privacy and authentication.

5. **Transport Layer:** This layer contains *Wireless Datagram Protocol*. It presents consistent data format to higher layers of WAP protocol stack.

Working mechanism of WAP
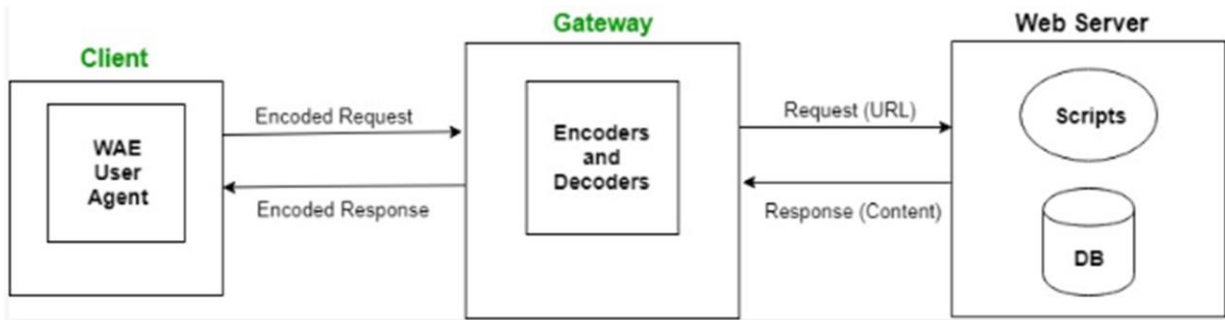
- The user opens the mini-browser in a mobile device. He selects a website that he wants to view.
- The mobile device sends the URL encoded request via network to a WAP gateway using WAP protocol.
- The WAP gateway translates this WAP request into a conventional HTTP URL request and sends it over the internet.
- The request reaches to a specified Web server and it processes the request just as it would have processed any other request and sends the response back to the mobile device through WAP gateway in WML file which can be seen in the micro-browser.

Wireless Technologies

Wireless technology refers to technology that allows us to communicate without using cables or wires. Wireless technology provides the ability to communicate between two or more entities over distances without the use of wires or cables of any sort. This includes communications using electromagnetic waves through the air.

Wireless technology is usually more expensive, but it has provided the additional advantage of mobility, allowing the user to receive and transmit information while on the move.

The major use of wireless technology has been in the area of broadcast communications like radio, television, and direct broadcast satellite. A single wireless transmitter can send signals to several hundreds of thousands of receivers as long as they all receive the same information.

Today, wireless technology encompasses such diverse communication devices as garage-door openers, baby monitors, walkie-talkies, and cellular telephones, as well as transmission systems such as point-to-point microwave links, wireless Internet service, and satellite communications.

Wireless keyboards and mice for computers, wireless speakers and headphones, and wireless smart sensors are now available on the market.

The electromagnetic waves used in wireless technology includes waves like: radio waves, microwaves, infrared waves. These waves transmit data at different frequencies that do not interfere with each other. Frequency bands are either licensed or unlicensed. Licensed bands are owned by certain companies or facilities for specific purposes and cannot be used by anyone else. Unlicensed bands are free and any one can use them, subject to certain protocols.

Some of the characteristics of wireless communications systems which make it attractive for users are:

1. **Mobility** – A wireless communications system allows users to access information beyond their desk and conduct business from anywhere without having a wire connectivity.
2. **Reachability** – Wireless communication systems enable people to be stay connected and be reachable, regardless of the location they are operating from.
3. **Simplicity** – Wireless communication system are easy and fast to deploy in comparison of cabled network. Initial setup cost could be a bit high but other advantages overcome that high cost.
4. **Maintainability** – In a wireless system, you do not have to spend too much cost and time to maintain the network setup.
5. **Roaming Services** – Using a wireless network system, you can provide service anywhere any time including train, buses, airplanes etc.
6. **New Services** – Wireless communication systems provide various smart services like SMS and MMS.

Different technologies used for data communication are:

- ADSL
- WiMAX
- WLAN
- WMAN
- Wi-Fi   — Wireless Technologies
- UMTS (3G)
- LTE (4G)
- NR (5G)

ADSL (Asymmetric Digital Subscriber Line)

- ADSL is a high-speed Internet access service that utilizes existing copper telephones lines to send and receive data at speeds that far exceed conventional dial-up modems.
- ADSL uses standard telephone lines to transmit upstream and downstream data on a digital frequency, which sets these data streams apart from the analog signals telephones and fax machines use.
- ADSL allows data stream speeds from 1.5 to 8 megabits per second (Mbps).
- The "asymmetric" in ADSL refers to the fact that the downstream data rate, or the data coming to your computer from the Internet, is traveling faster than upstream data, or the data traveling from your computer to the Internet.
- Upstream data rates are slower because Web page requests are fairly miniscule data strings that do not require much bandwidth to handle efficiently.

Features:

- Runs through the BT phone line network
- High-quality, reliable broadband connection
- Permits faster data transmission through a single connection
- Allows internet access at the same time as making phone calls
- Minimal installation costs and maintenance

<u>Advantages</u>: Affordable, Large coverage area, does not affect your landline phone calls

<u>Disadvantages</u>: Low speed, Distance-sensitive, Susceptible to electrical noise

<u>DSL (Digital Subscriber Line)</u>

DSL is a communications medium used to transfer digital signals over standard telephone lines. Along with cable Internet, DSL is one of the most popular ways ISPs provide broadband Internet access.

<u>Types of DSL</u>:

1) ADSL - ADSL supports a range of asymmetric (higher downstream than upstream) data speeds that can reach up to 7Mbps downstream and 1.5Mbps upstream. ADSL can deliver simultaneous high-speed data and telephone service over the same line.
2) SDSL (Symmetric Digital Subscriber Line) - SDSL supports symmetric (equal downstream and upstream) data transmissions up to 1.54Mbps.
3) VDSL (Very High Bit-rate Digital Subscriber Line) - VDSL is the fastest of all DSL and provides transmission rates of 13-52Mbps downstream and 1.5-2.3Mbps upstream over a single copper-pair wire, at a distance of 1,000-4,500 feet from the service provider's premises.
4) VDSL2 (Very High Bit-rate Digital Subscriber Line 2) - VDSL2 is faster than VDSL and provides transmission rates up to 100Mbps at longer distances.

WiMAX

- WiMAX stands for **W**orldwide **I**nteroperability for **M**icrowave **A**ccess.
- It is an IP based Wireless Broadband Access Technology.
- It is an alternative to wired broadband, such as DSL and cable modem.
- It is a broadband wireless networks that are based on the IEEE 802.16 standard, which ensures compatibility and interoperability between broadband wireless access equipment.
- It operates similar to Wi-Fi, but at higher speeds over greater distances and for a greater number of users. It has the ability to provide service even in areas that are difficult for wired infrastructure to reach.
- It is expected to offer up to about 40Mbps capacity per wireless channel for both fixed and portable applications, depending on the particular technical configuration chosen enough to support hundreds of businesses with T-1 speed connectivity and thousands of residences with DSL speed connectivity.
- It can support voice and video as well as Internet data.

Nepal Telecom also provides WiMAX Service. It is available throughout the country within the tentative 2 km radius from the base station. It provides Internet speed of 256Kbps to 2Mbps. The service is provided in three options: USB Dongle, In Door Unit (IDU) and Out Door Unit (ODU).

<u>Benefits of using WiMAX</u>

1. It can support high bandwidth solutions that is required for a full range of high-value multimedia services.
2. It can help service providers meet many of the challenges they face due to increasing customer demands without discarding their existing infrastructure investments as it can seamlessly interoperate across various network types.

3. It can provide wide area coverage and quality of service capabilities for applications ranging from VoIP to real-time streaming video and non-real time downloads, ensuring the subscribers obtain the performance they expect for all types of communications.
4. It can integrate with third generation (3G) mobile, wireless and wired networks allowing it to become part of a seamless anytime, anywhere broadband access solution.

Wi-Fi

- Wi-Fi is stands for Wireless Fidelity.
- It is based in IEEE 802.11 standard.
- It is primarily designed for wireless LAN to provide broadband coverage within the building or a compound.
- It uses radio frequency to transmit data through the air.
- It allows you to use your computer or other device to connect to the internet from anywhere there is a Wi-Fi access point (often known as a hot Spot)
- The significant advantage of Wi-Fi is its simplicity and ability to connect large varieties of devices including laptop, smart phone, tablet, printer and many more.

Working concept:

Radio signals: These are the key, which make Wi-Fi networking possible. The radio signals transmitted from Wi-Fi antennas are picked up by Wi-Fi receivers, such as computers and cell phones that are equipped with Wi-Fi cards.

Wi-Fi cards: We can think of Wi-Fi cards as being invisible cords that connect the computer to the antenna for a direct connection to the internet.

Wi-Fi cards can be external or internal. If a Wi-Fi card is not installed in your computer, then we may attach a USB antenna externally or have an antenna-equipped expansion card installed directly to the computer (as shown in the figure given above).

Wi-Fi Hotspots: A Wi-Fi hotspot is created by installing an access point to an internet connection. The access point transmits a wireless signal over a short distance. It typically covers around 300 feet. When a Wi-Fi enabled device such as a smartphone encounters a hotspot, the device can then connect to that network wirelessly.

Most hotspots are located in places that are readily accessible to the public such as airports, coffee shops, hotels, book stores, and campus environments.

Wi-Fi- IEEE Standards

The 802.11 standard is defined through several specifications of WLANs.

There are several specifications in the 802.11 family −

- 802.11 − It relates to wireless LANs and provides 1 - or 2-Mbps transmission in the 2.4-GHz band using either frequency-hopping spread spectrum (FHSS) or direct-sequence spread spectrum (DSSS).
- 802.11a − It is an extension to 802.11 that pertains to wireless LANs and goes as fast as 5.4 Mbps in the 5-GHz band. 802.11a employs the orthogonal frequency division multiplexing (OFDM) encoding scheme as opposed to either FHSS or DSSS.
- 802.11b − The 802.11b high rate Wi-Fi is an extension to 802.11 that pertains to wireless LANs and yields a connection as fast as 11 Mbps transmission (with a fallback to 5.5, 2, and 1 Mbps depending on strength of signal) in the 2.4-GHz band. The 802.11b specification uses only DSSS.
- 802.11g − It relates to wireless LANs and provides 20+ Mbps in the 2.4-GHz band.

Wi-Fi Security

Security has been one of the major deficiencies in Wi-Fi, though better encryption systems are now becoming available. Encryption is optional in Wi-Fi, and different techniques have been defined. These techniques are given here −

1. Wired Equivalent Privacy (WEP): An RC4-based 40-or 104-bit encryption with a static key.
2. Wi-Fi Protected Access (WPA): This is a new standard from the Wi-Fi Alliance that uses the 40 or 104-bit WEP key, but it changes the key on each packet.
3. IEEE 802.11i/WPA2: The IEEE is finalized the 802.11i standard, which is based on a far more robust encryption technique called the Advanced Encryption Standard. However, implementing 802.11i requires a hardware upgrade.
4. IEEE 802.11n-2009 or 802.11n is a wireless-networking standard that uses multiple antennas to increase data rates.

Major Issues in Wi-Fi

There are a few issues in Wi-Fi −

1. Security Problems
2. Compatibility and Interoperability − One of the major problems with Wi-Fi is its compatibility and interoperability. For example, 802.11a products are not compatible with 802.11b products. Due to different operating frequencies, 802.11a hotspots would not help an 802.11b client. Due to lack of standardization, harmonization, and certification, different vendors come out with products that do not work with each other.
3. Billing Issues − Wi-Fi vendors are also looking for ways to solve the problem of back-end integration and billing, which have dogged the roll-out of commercial Wi-Fi hotspots. Some of the ideas under consideration for Wi-Fi billing such as per day, per hour, and unlimited monthly connection fees.

WPAN, WLAN, WMAN and WWAN
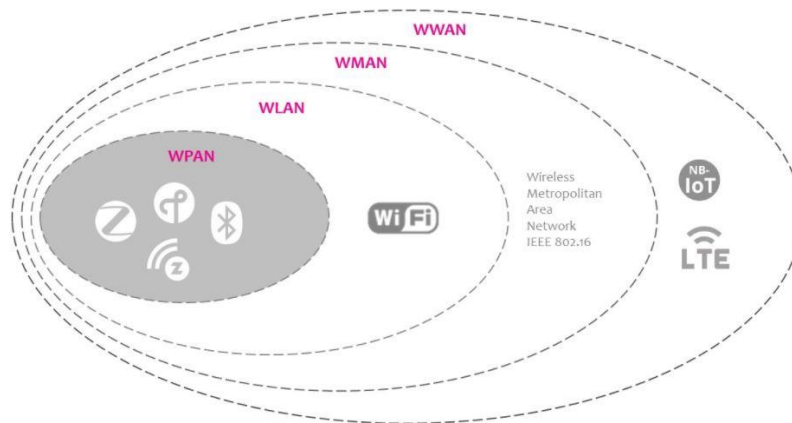
- WPAN refers to Wireless Personal Area Network.
- WLAN refers to Wireless LAN of Wireless Local Area Network.
- WMAN refers to Wireless Metropolitan Area Network
- WWAN refers to Wireless Wide Area Network

WPAN:

It connect devices within a small area, somewhere around within a person's reach. It has a typical range of about 30 feet. It commonly used to interconnect compatible devices near a central location, such as a desk.

With billions of wireless devices on the air already, and many billions more projected to join them in the next few years, many radio frequency bands are becoming crowded, and interference is a growing problem.

Wireless Network Technologies carrying over WPAN: Bluetooth radio, Bluetooth Low Energy, ZigBee, Z-Wave, Thread, infrared.

WLAN:

WLANs allows users to linking of two or more devices using a wireless distribution method that providing a connection through access points to the wider Internet. It provides mobility function to its users to covers local area such as a university campus, library or canteen, small offices or home to maintaining a network or gain access to the internet.

In this technology a temporary network can be formed by a small number of users without the need of an access point (APs); given that they do not need access to network resources. Sometimes it calls a local area wireless network (LAWN).

WLAN are wireless networks that use radio waves. The backbone network usually uses cables, with one or more wireless access points connecting the wireless users to the wired network. The range of a Wireless Local Area Network can be anywhere from a single room to an entire campus.

Wi-Fi is the common technology used in WLAN.

<u>WMAN:</u>

WMAN technology allows connecting several wireless LANs. In this connection of multiple networks includes metropolitan area such as different buildings in a city, which can be an alternative or backup to laying copper or fiber cabling.

WMAN networking technology is also known as Wireless Local Loop (WLL).

It allows communication in between two or more terminals (nodes) with the help of single access point, within a radius up to 40 km.

The most well-known WMAN wireless networking technology includes WiMAX.

<u>WWAN:</u>

Wireless Wide Area Network types of networks can be maintained over large areas, such as neighboring towns, cities or countries, via multiple satellite systems or antenna sites looked after by an ISP.

These types of systems are referred to as 2G (2nd Generation), 3G (3rd Generation), 4G (4th Generation) systems and upcoming generation.

WWAN services are typically delivered to smart phones and other handheld devices sold by cellular service providers. In the family of WWAN technologies includes GSM/UMTS, CDMA One/CDMA2000 etc.

Type	Coverage	Performance	Standards	Applications
Wireless LAN	Within a building or campus	High	IEEE 802.11, Wi-Fi, and HiperLAN	Mobile extension of wired networks
Wireless MAN	Within a city, two or more buildings	High	Proprietary, IEEE 802.16, and WIMAX	Fixed wireless between homes and businesses and the Internet
Wireless WAN	Worldwide	Low	CDPD and Cellular 2G, 2.5G, and 3G	Mobile access to the Internet from outdoor areas
Wireless PAN	Within reach of a person	Moderate	Bluetooth, Zigbee, IEEE 802.15, and IrDa Cable replacement for peripherals	Cable replacement for peripherals

UMTS (3G)

3G is a third generation cellular data technologies.

The first generation (1G) was introduced in 1982, while the second generation of cellular data technologies (2G) became standardized in the early 1990s. 3G technologies were introduced as early as 2001, but did not gain widespread use until 2007.

In order to be labeled "3G," a cellular data transfer standard must meet a set of specifications defined by the International Telecommunications Union, known as IMT-2000.

The Universal Mobile Telecommunications System (UMTS) is a third generation mobile cellular system for networks based on the GSM standard. It is developed and maintained by the 3GPP (3rd Generation Partnership Project). UMTS uses wideband code division multiple access (W-CDMA) radio access technology to provide greater spectral efficiency and bandwidth mobile network operators.

The main idea behind 3G is to prepare a universal infrastructure able to carry existing and also future services. The infrastructure should be so designed that technology changes and evolution can be adapted to the network without causing uncertainties to the existing services using the existing network structure.

3G wireless service has been designed to provide high data speeds, always-on data access, and greater voice capacity.

Some of the features of 3G wireless network are:

- The high data speeds, measured in Mbps, enable full motion video, high-speed internet access and video-conferencing.
- 3G technology standards include UMTS, based on WCDMA technology (quite often the two terms are used interchangeably) and CDMA2000, which is the outgrowth of the earlier CDMA 2G technology.
- UMTS standard is generally preferred by countries that use GSM network. CDMA2000 has various types, including 1xRTT, 1xEV-DO and 1xEV-DV. The data rates they offer range from 144 kbps to more than 2 mbps.
- Data rates of UMTS are:
    - 144 kbps for rural
    - 384 kbps for urban outdoor
    - 2048 kbps for indoor and low range outdoor

Different environments of UMTS

Advantages

- Fast Internet
- Smooth Multimedia Messaging (MMS)
- Enhanced Location based services

- Enhanced Communication (Email, IM, File sharing)
- Increased Capacity compared to 2G

Disadvantages

- Poor Video Experience
- Drains battery
- Expensive that GSM
- Still not full Broadband

LTE (4G)

4G means the fourth generation of data technology for cellular **networks** following 3G, the third generation.

LTE (Long Term Evolution) evolved from an earlier 3GPP system known as the Universal Mobile Telecommunication System (UMTS), which in turn evolved from the Global System for Mobile Communications (GSM).

A rapid increase of mobile data usage and emergence of new applications such as MMOG (Multimedia Online Gaming), mobile TV, Web 2.0, streaming contents have motivated the 3rd Generation Partnership Project (3GPP) to work on the Long-Term Evolution (LTE) on the way towards fourth-generation mobile.

The main goal of LTE is to provide a high data rate, low latency and packet optimized radio access technology supporting flexible bandwidth deployments. Same time its network architecture has been designed with the goal to support packet-switched traffic with seamless mobility and great quality of service.

Features of LTE

- LTE is the successor technology not only of UMTS but also of CDMA 2000.
- LTE is important as it has up to 50 times performance improvement and much better spectral efficiency to cellular networks.
- LTE introduced to get higher data rates, 300Mbps peak downlink and 75 Mbps peak uplink. In a 20MHz carrier, data rates beyond 300Mbps can be achieved under very good signal conditions.
- LTE is an ideal technology to support high date rates for the services such as voice over IP (VOIP), streaming multimedia, videoconferencing or even a high-speed cellular modem.
- LTE uses both Time Division Duplex (TDD) and Frequency Division Duplex (FDD) mode. In FDD uplink and downlink transmission used different frequency, while in TDD both uplink and downlink use the same carrier and are separated in Time.
- All LTE devices have to support (MIMO) Multiple Input Multiple Output transmissions, which allow the base station to transmit several data streams over the same carrier simultaneously.
- All interfaces between network nodes in LTE are now IP based.
- Quality of Service (QoS) mechanism have been standardized on all interfaces to ensure that the requirement of voice calls for a constant delay and bandwidth, can still be met when capacity limits are reached.
- Works with GSM/EDGE/UMTS systems utilizing existing 2G and 3G spectrum and new spectrum. Supports hand-over and roaming to existing mobile networks.

Advantages of LTE

1. **High throughput**: High data rates can be achieved in both downlink as well as uplink. This causes high throughput.
2. **Low latency**: Time required to connect to the network is in range of a few hundred milliseconds and power saving states can now be entered and exited very quickly.
3. **FDD and TDD in the same platform**: Frequency Division Duplex (FDD) and Time Division Duplex (TDD), both schemes can be used on same platform.
4. **Superior end-user experience**: Optimized signaling for connection establishment and other air interface and mobility management procedures have further improved the user experience. Reduced latency (to 10 ms) for better user experience.
5. **Seamless Connection**: LTE will also support seamless connection to existing networks such as GSM, CDMA and WCDMA.
6. **Plug and play**: The user does not have to manually install drivers for the device. Instead system automatically recognizes the device, loads new drivers for the hardware if needed, and begins to work with the newly connected device.
7. **Simple architecture**: Because of Simple architecture low operating expenditure (OPEX).

5G NR

5G is the Fifth Generation technology.

It has many advanced features potential enough to solve many of the problems of our everyday life. It is beneficial for the government, as it can make the governance easier; for the students, as it can make available the advanced courses, classes, and materials online; it is easier for the common people as well, as it can facilitate them the internet everywhere.
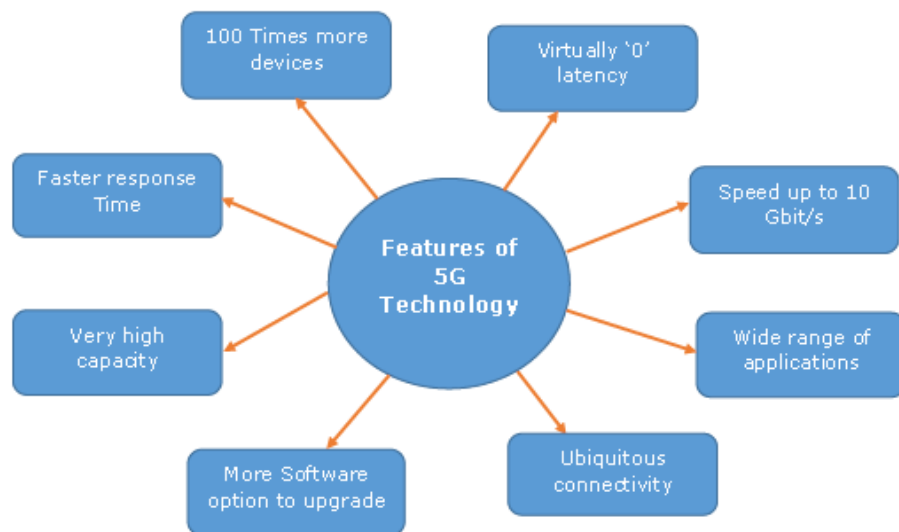
5G NR is a new radio access technology developed by 3GPP for the 5G mobile network. It is designed to be the global standard for the air interface of 5G networks.

Features of 5G

With a huge array of innovative features, now your smart phone would be more parallel to the laptop.

- You can use broadband internet connection
- More gaming options,
- Wider multimedia options,
- Connectivity everywhere,
- Zero latency,
- Faster response time, and
- High quality sound and HD video can be transferred on other cell phone without compromising with the quality of audio and video.

Distinct features of 5G from 4G

- High increased peak bit rate
- Larger data volume per unit area (i.e. high system spectral efficiency)
- High capacity to allow more devices connectivity concurrently and instantaneously
- Lower battery consumption
- Better connectivity irrespective of the geographic region, in which you are
- Larger number of supporting devices
- Lower cost of infrastructural development
- Higher reliability of the communications

Advanced Features

In comparison to previous radio technologies, 5G has following advancement –

- Practically possible to avail the super speed i.e. 1 to 10 Gbps.
- Latency will be 1 millisecond (end-to-end round trip).
- 1,000x bandwidth per unit area.
- Feasibility to connect 10 to 100 number of devices.
- Worldwide coverage.
- About 90% reduction in network energy usage.
- Battery life will be much longer.
- Whole world will be in Wi-Fi zone.

Applications of 5G

Some of the applications of 5G are –

1. It will make unified global standard for all.
2. Network availability will be everywhere and will facilitate people to use their computer and such kind of mobile devices anywhere anytime.
3. Because of the IPv6 technology, visiting care of mobile IP address will be assigned as per the connected network and geographical position.
4. Its application will make world real Wi-Fi zone.

5. Its cognitive radio technology will facilitate different version of radio technologies to share the same spectrum efficiently.
6. Its application will facilitate people to avail radio signal at higher altitude as well.

Some Applications of 5G for the Common People:

1. Parallel multiple services, such as you can know weather and location while talking with other person.
2. You can control your PCs by handsets.
3. Education will become easier – A student sitting in any part of world can attend the class.
4. Medical Treatment will become easier & frugal – A doctor can treat the patient located in remote part of the world.
5. Monitoring will be easier – A governmental organization and investigating offers can monitor any part of the world. Possible to reduce the crime rate.
6. Visualizing universe, galaxies, and planets will be possible.
7. Possible to locate and search the missing person.
8. Possible, natural disaster including tsunami, earthquake etc. can be detected faster.

Disadvantages of 5G Technology

Though, 5G technology is researched and conceptualized to solve all radio signal problems and hardship of mobile world, but because of some security reason and lack of technological advancement in most of the geographic regions, it has following shortcomings –

1. Technology is still under process and research on its viability is going on.
2. The speed, this technology is claiming seems difficult to achieve (in future, it might be) because of the incompetent technological support in most parts of the world.
3. Many of the old devices would not be competent to 5G, hence, all of them need to be replaced with new one — expensive deal.
4. Developing infrastructure needs high cost.
5. Security and privacy issue yet to be solved.
6. With the increase in speed, cybercrime and fraud may also increase.

2G vs 3G vs 4G vs 5G

Comparison	2G	3G	4G	5G
Introduced in year	1993	2001	2009	2018
Technology	GSM	WCDMA	LTE, WiMAX	MIMO, mm Waves
Access system	TDMA, CDMA	CDMA	CDMA	OFDM, BDMA
Switching type	Circuit switching for voice and packet switching for data	Packet switching except for air interference	Packet switching	Packet switching
Internet service	Narrowband	Broadband	Ultra broadband	Wireless World Wide Web
Bandwidth	25 MHz	25 MHz	100 MHz	30 GHz to 300 GHz
Advantage	Multimedia features (SMS, MMS), internet access and SIM introduced	High security, international roaming	Speed, high speed handoffs, global mobility	Extremely high speeds, low latency
Applications	Voice calls, short messages	Video conferencing, mobile TV, GPS	High speed applications, mobile TV, wearable devices	High resolution video streaming, remote control of vehicles, robots, and medical procedures

Security Issues related to Wireless Communications

Wireless communication transmits and receive data using radio waves rather than wires. This lack of physical barrier makes it vulnerable for wide range of cyber security issues. In addition, due to increased usage of wireless mobile networks and communications in our everyday life, the society has become extremely exposed to cyber security attacks and threats in this environment.

DENIAL OF SERVICE

- Denial of service is a simple attack that relies on limiting access to services on a **wired or wireless** network.
- This hack is commonly accomplished by routing a tremendous amount of traffic at a specified target.
- With this approach, the high volume of traffic overwhelms the target machine and disrupts service.
- It is also possible for hackers to launch a denial of service attack by simply disrupting the signal on the network.
- This can be achieved by causing enough interference on one channel to interrupt the service.

ROGUE ACCESS

- A common method of attack used by hackers is the use of a rogue access point that is setup within range of your existing **wireless** network.
- The concept behind a rogue access point is simple. Hackers establish these false networks to fool people and devices in range to use those access points.
- This allows hackers to access data and information on legitimate devices that should be secure.

PASSIVE CAPTURING

- Passive capturing is another threat to security on your **wireless** network.
- Passive capturing is accomplished by setting up devices within range of the network and "listening" to the data traffic traveling along your network and capturing that information.
- What hackers do with that information differs depending upon the goal of the hacker.
- Some attempt to breakthrough your existing security settings by analyzing network traffic, while others simply look through the non-secured traffic to potentially access sensitive information regarding business operations.

Practice Questions

1. What is role of information superhighway in e-commerce? List the components of information superhighway. [TU-BCA-2020] [2+3]
2. What do you mean by Wireless Application Protocol (WAP)? How it works? Discuss the layered architecture of WAP. [TU-BCA-2020] [2+2+6]
3. Explain Internet as the network infrastructure.
4. Explain the terms Internet, Intranet and Extranet.
5. Present the comparative study between WPAN, WLAN, WMAN and WWAN.
6. Explain ADSL communication technology with its applications, advantages and disadvantages.
7. What is WiMAX? Explain.

8. What are the features of Wi-Fi that has made it popular in present scenario?
9. Describe 3G wireless communication in detail.
10. What is 4G cellular communication? Explain with its advantages and disadvantages.
11. Differentiate between UTMS and LTE wireless data communication.
12. Explain 5G NR concept with its features, applications, advantages and disadvantages.
13. Explain wireless security issues.