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Exp 1 : Study of different types of physical layer wired/wireless connections

In the seven-layer OSI model of computer networking, the physical layer or layer 1 is the first and lowest layer. The physical layer defines the means of transmitting raw bits over a physical data link connecting network nodes. The bitstream may be grouped into code words or symbols and converted to a physical signal that is transmitted over a transmission medium.

Functions of Physical Layer :

- Physical Layer is the lowest layer of the OSI Model.
- It activates, maintains and deactivates the physical connection.
- It is responsible for transmission and reception of the unstructured raw data over network.
- Voltages and data rates needed for transmission is defined in the physical layer.
- It converts the digital/analog bits into electrical signal or optical signals.
- Data encoding is also done in this layer.

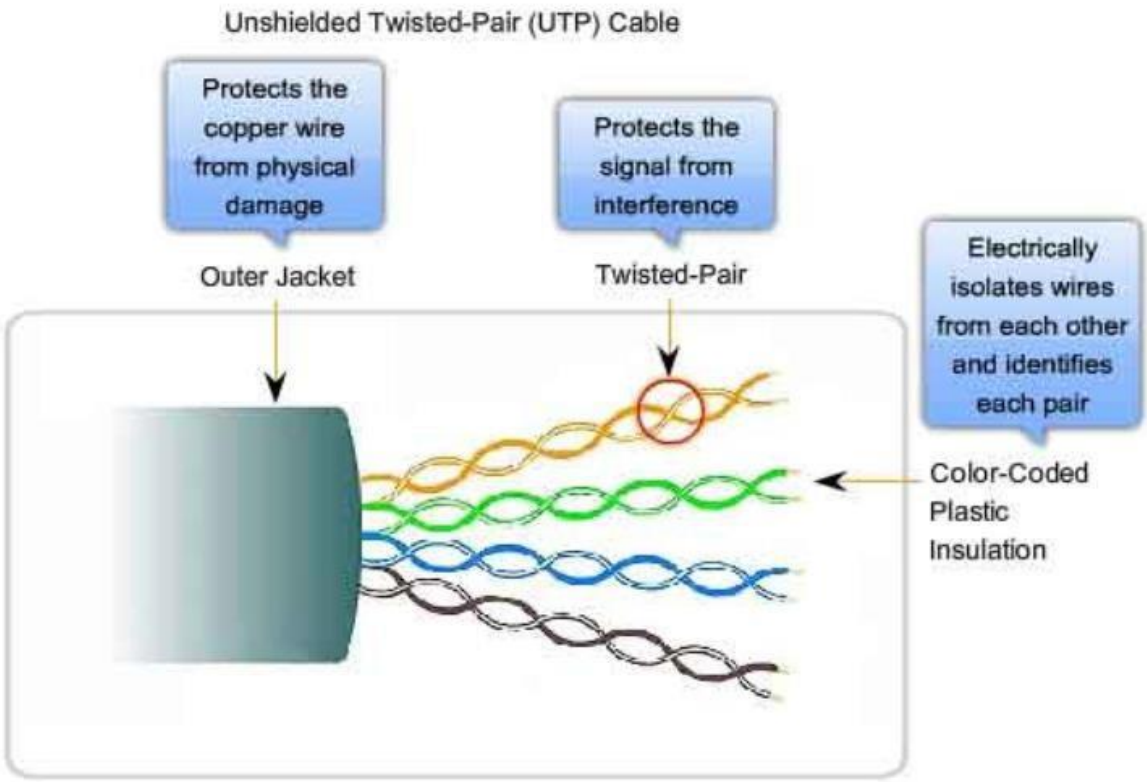
The media carries signals, one at a time, to represent the bits that make up the frame. There are three basic forms of network media on which data is represented also The representation of the bits - that is, the type of signal - depends on the type of media :

- For **Copper cable** media, the signals are patterns of electrical pulses.
- For **Fiber**, the signals are patterns of light.
- For **Wireless Media,** the signals are patterns of radio transmissions.

Copper Media :
The most commonly used media for data communications is cabling that uses copper wires to signal data and control bits between network devices

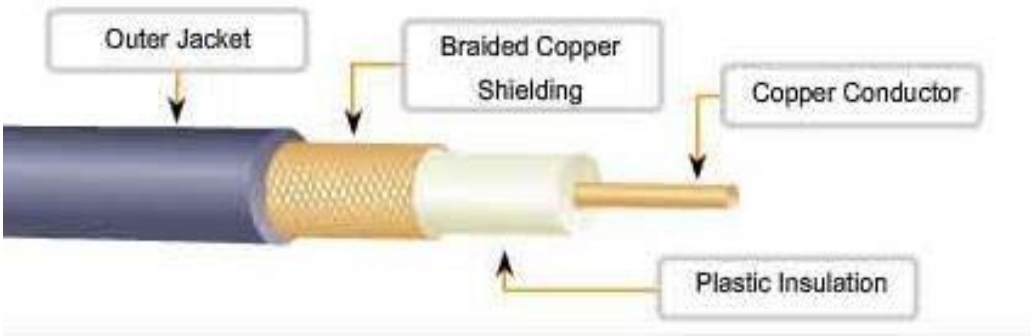
Unshielded Twisted Pair (UTP) Cable

Unshielded twisted-pair (UTP) cabling, as it is used in Ethernet LANs, consists of four pairs of color-coded wires that have been twisted together and then encased in a flexible plastic sheath. When electrical current flows through a wire, it creates a circular magnetic field around the wire. With the current flowing in opposite directions in the two wires in a pair, the magnetic fields - as equal but opposite forces - have a cancellation effect on each other. Additionally, the different pairs of wires that are twisted in the cable use a different number of twists per meter



Two other types of copper cable are used:

1 . Coaxial Cable

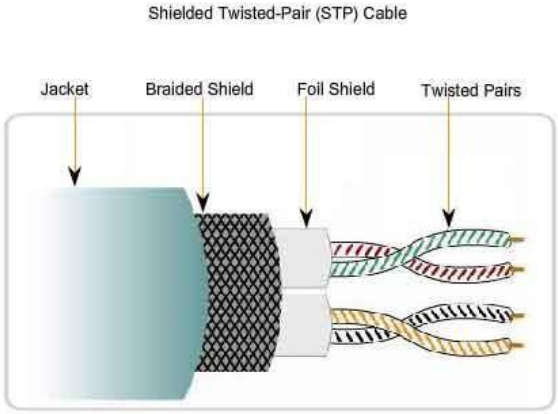


Coaxial cable consists of a copper conductor surrounded by a layer of flexible insulation, as shown in the figure. Over this insulating material is a woven copper braid, or metallic foil, that acts as the second wire in the circuit and as a shield for the inner conductor. This second layer, or shield, also reduces the amount of outside electromagnetic interference. Covering the shield is the cable jacket. All the elements of the coaxial cable encircle the center conductor. Because they all share the same

axis, this construction is called coaxial, or coax for short. Coax cables are used to attach antennas to wireless devices. This combined use of fiber and coax is referred to as hybrid fiber coax (HFC). In the past, coaxial cable was used in Ethernet installations. Today UTP offers lower costs and higher bandwidth than coaxial and has replaced it as the standard for all Ethernet installations.

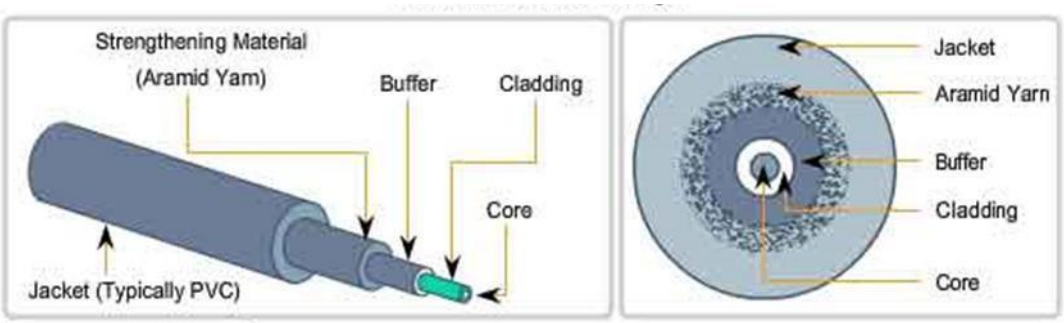
2 . Shielded Twisted-Pair (STP) Cable :

Another type of cabling used in networking is shielded twisted-pair (STP). As shown in the figure, STP uses two pairs of wires that are wrapped in an overall metallic braid or foil. STP cable shields the entire bundle of wires within the cable as well as the individual wire pairs.



STP provides better noise protection than UTP cabling, however at a significantly higher price. For many years, STP was the cabling structure specified for use in Token Ring network installations. With the use of Token Ring declining, the demand for shielded twisted-pair cabling has also waned. The new 10 GB standard for Ethernet has a provision for the use of STP cabling. This may provide a renewed interest in shielded twisted-pair cabling.

Fiber Media :



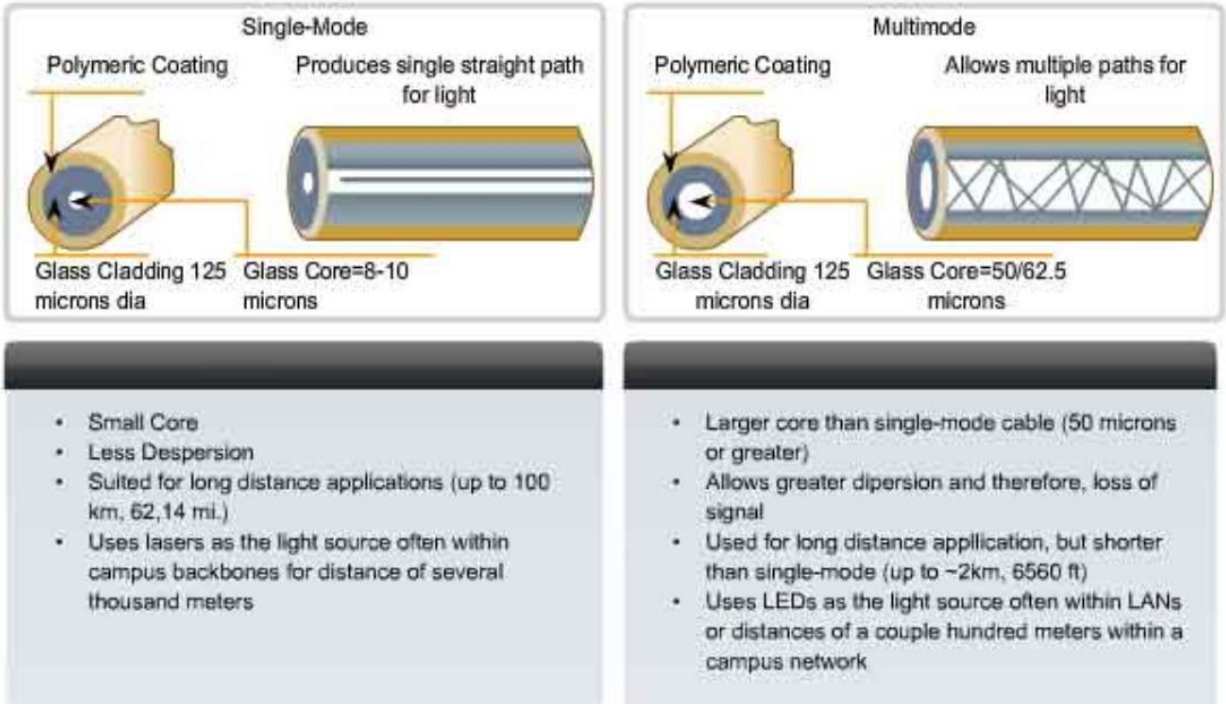
Fiber-optic cabling uses either glass or plastic fibers to guide light impulses from source to destination. The bits are encoded on the fiber as light impulses. Optical fiber cabling is capable of very large raw data bandwidth rates. Most current transmission

standards have yet to approach the potential bandwidth of this media. At present, in most enterprise environments, optical fiber is primarily used as backbone cabling for high-traffic point-to-point connections between data distribution facilities and for the interconnection of buildings in multi-building campuses. Because optical fiber does not conduct electricity and has low signal loss, it is well suited for these uses.

Single-mode and Multimode Fiber :

Fiber optic cables can be broadly classified into two types: single-mode and multimode.

Single-mode optical fiber carries a single ray of light, usually emitted from a laser. Because the laser light is uni-directional and travels down the center of the fiber, this type of fiber can transmit optical pulses for very long distances. **Multimode** fiber typically uses LED emitters that do not create a single coherent light wave. Instead, light from an LED enters the multimode fiber at different angles.



Ethernet :

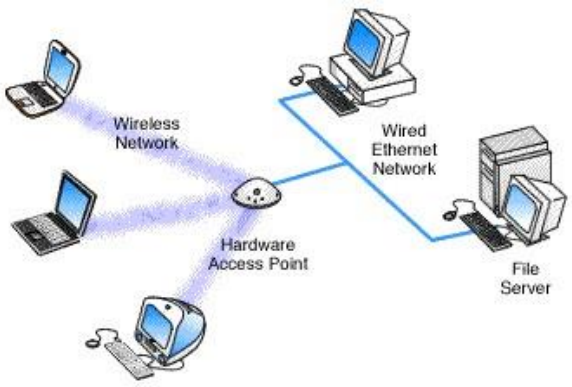
Ethernet was originally based on the idea of computers communicating over a shared coaxial cable acting as a broadcast transmission medium. The method used was similar to those used in radio systems, with the common cable providing the communication channel likened to the Luminiferous aether in 19th century physics, and it was from this reference that the name "Ethernet" was derived . The original 10BASE5 Ethernet uses coaxial cable as a shared medium, while the newer Ethernet variants use twisted pair and fiber optic links in conjunction with switches. Over the course of its history, Ethernet data transfer rates have been increased from the original 2.94 megabits per second (Mbit/s) to the latest 400 gigabits per second (Gbit/s).

The Ethernet standards comprise several wiring and signaling variants of the OSI physical layer in use with Ethernet. Ethernet is widely used in homes and industry, and interworkswell with Wi-Fi. The Internet Protocol is commonly carried over Ethernet and so it is considered one of the key technologies that make up the Internet.

Older Ethernet equipment.

Wireless Media :

Wireless media carry electromagnetic signals at radio and microwave frequencies that represent the binary digits of data communications. As a networking medium, wireless is not restricted to conductors or pathways, as are copper and fiber media. Wireless data communication technologies work well in open environments. However, certain construction materials used in buildings and structures, and the local terrain, will limit the effective coverage. As there is no access to a physical strand of media, devices and users who are not authorized for access to the network can gain access to the transmission. Therefore, network security is a major component of wireless network administration.



WHAT DIFFERENTIATES ONE KIND OF NETWORK FROM ANOTHER?

For the most part, the differentiating factor in the types of networks is how large of a system it is, or how many devices are included in the network's area, as well as how those devices are connected to one another.

LAN

The most basic and common type of network, a LAN, or local area network, is a network connecting a group of devices in a “local” area, usually within the same building The defining characteristics of a LAN, in contrast to a wide area network (WAN), include higher data transfer rates, limited geographic range, and lack of reliance on leased lines to provide connectivity. Current Ethernet or other IEEE 802.3 LAN technologies operate at data transfer rates up to 100 Gbit/s

A WLAN, or wireless LAN, is a subtype of LAN. It uses WiFi to make the LAN wireless through the use of a wireless router.

HAN

A HAN, or home area network, is a network connecting devices within a home. These networks are a type of LAN. All the devices inside the household, including computers, smartphones, game consoles, televisions, and home assistants that are connected to the router are a part of the HAN.

CAN

A CAN, or campus area network, usually comprises several LANs. They cover a campus, connecting several buildings to the main firewall. A university could use a CAN, as could a corporate headquarters.

MAN

Even larger than a CAN, a MAN is a metropolitan area network. These can cover an area as large as a city, linking multiple LANs through a wired backhaul. An example of a MAN would be a citywide WiFi network.

WAN

In contrast to the smaller LAN and HANs, a WAN is a wide area network, covering any distance necessary. The Internet could be considered a WAN that covers the entire Earth.

Major Types of Wireless Networks :

Standard IEEE 802.11 - Commonly referred to as Wi-Fi, is a Wireless LAN (WLAN) technology that uses a contention or non-deterministic system with a Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) media access process.

Standard IEEE 802.15 - Wireless Personal Area Network (WPAN) standard, commonly known as "Bluetooth", uses a device pairing process to communicate over distances from 1 to 100 meters.

Standard IEEE 802.16 - Commonly known as WiMAX (Worldwide Interoperability for Microwave Access), uses a point-to-multipoint topology to provide wireless broadband access.

Global System for Mobile Communications (GSM) - Includes Physical layer specifications that enable the implementation of the Layer 2 General Packet Radio Service (GPRS) protocol to provide data transfer over mobile cellular telephony networks.

The Wireless LAN :

A common wireless data implementation is enabling devices to wirelessly connect via a LAN. In general, a wireless LAN requires the following network devices:

Wireless Access Point (AP) - Concentrates the wireless signals from users and connects, usually through a copper cable, to the existing copper-based network infrastructure such as Ethernet.

Wireless NIC adapters - Provides wireless communication capability to each network host.
As the technology has developed, a number of WLAN Ethernet-based standards have emerged. Care needs to be taken in purchasing wireless devices to ensure compatibility

Standards include:

IEEE 802.11a - Operates in the 5 GHz frequency band and offers speeds of up to 54 Mbps
IEEE 802.11b - Operates in the 2.4 GHz frequency band and offers speeds of up to 11 Mbps..
IEEE 802.11g - Operates in the 2.4 GHz frequency band and offers speeds of up to 54 Mbps.
IEEE 802.11n – is standard is currently in draft form. The proposed standard defines frequency of 2.4 Ghz or 5 GHz. The typical expected data rates are 100 Mbps to 210 Mbps with a distance range of up to 70 meters.

The benefits of wireless data communications technologies are evident, especially the savings on costly premises wiring and the convenience of host mobility. However, network administrators need to develop and apply stringent security policies and processes to protect wireless LANs from unauthorized access and damage. These wireless standards and Wireless LAN implementations will be covered in more detail in the LAN Switching and Wireless course.

Other Types of Wireless Media :

1. BLUETOOTH:

Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.402 GHz to 2.480 GHz, and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables.Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents apply to the technology, which are licensed to individual qualifying devices. As of 2009, Bluetooth integrated circuit chips ship approximately 920 million units annually.Bluetooth is a standard wire-replacement communications protocol primarily designed for low power consumption, with a short range based on low-cost transceiver microchips in each device.

2. NEAR FIELD COMMUNICATION (NFC):

Near-Field-Communication (NFC) is a set of communication protocols for communication between two electronic devices over a distance of 4 cm (1 1⁄2 in) or less. NFC offers a low-speed connection with simple setup that can be used to bootstrap more-capable wireless connections.

NFC devices can act as electronic identity documents and keycards. They are used in contactless payment systems and allow mobile payment replacing or supplementing systems such as credit cards and electronic ticket smart cards. This is sometimes called NFC/CTLS or CTLS NFC, with contactless abbreviated CTLS. NFC can be used for sharing small files such as contacts, and bootstrapping fast connections to share larger media such as photos, videos, and other files.

NFC is based on inductive coupling between two so-called antennas present on NFC-enabled devices—for example a smartphone and a printer—communicating in

one or both directions, using a frequency of 13.56 MHz in the globally available unlicensed radio frequency ISM band using the ISO/IEC 18000-3 air interface standard at data rates ranging .

3. CELLULAR NETWORK:

A cellular network or mobile network is a communication network where the last link is wireless. The network is distributed over land areas called cells each served by at least one fixed-location transceiver, but more normally, three cell sites or base transceiver stations. These base stations provide the cell with the network coverage which can be used for transmission of voice, data, and other types of content. A cell typically uses a different set of frequencies from neighbouring cells, to avoid interference and provide guaranteed service quality within each cell. When joined together, these cells provide radio coverage over a wide geographic area. This enables numerous portable transceivers (e.g., mobile phones , tablets and laptops equipped with mobile broadband modems, pagers, etc.) to communicate with each other and with fixed transceivers and telephones anywhere in the network, via base stations, even if some of the transceivers are moving through more than one cell during transmission. A cellular network is used by the mobile phone operator to achieve both coverage and capacity for their subscribers. Large geographic areas are split into smaller cells to avoid line-of-sight signal loss and to support a large number of active phones in that area. All of the cell sites are connected to telephone exchanges (or switches), which in turn connect to the public telephone network.

4. ZIGBEE:

Zigbee is a low-cost, low-power, wireless mesh network standard targeted at battery-powered devices in wireless control and monitoring applications. Zigbee delivers low-latency communication. Zigbee chips are typically integrated with radios and with microcontrollers. Zigbee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide; though some devices also use 784 MHz in China, 868 MHz in Europe and 915 MHz in the US and Australia, however even those regions and countries still use 2.4 GHz for most commercial Zigbee devices for home use. Data rates vary from 20 kbit/s (868 MHz band) to 250 kbit/s (2.4 GHz band).

Zigbee builds on the physical layer and media access control defined in IEEE standard 802.15.4 for low-rate wireless personal area networks (WPANs). The specification includes four additional key components: network layer, application layer, Zigbee Device Objects (ZDOs) and manufacturer-defined application objects. ZDOs are responsible for some tasks, including keeping track of device roles, managing requests to join a network, as well as device discovery and security.

The Zigbee network layer natively supports both star and tree networks, and generic mesh networking. Every network must have one coordinator device. Within star networks, the coordinator must be the central node. Both trees and meshes allow the use of Zigbee routers to extend communication at the network level. Another defining feature of Zigbee is facilities for carrying out secure communications, protecting

establishment and transport of cryptographic keys, ciphering frames, and controlling device. It builds on the basic security framework defined in IEEE 802.15.4.

5. WiMAX (Worldwide Interoperability for Microwave Access.) :

WiMAX is one of the hottest broadband wireless technologies around today. WiMAX systems are expected to deliver broadband access services to residential and enterprise customers in an economical way.

Loosely, WiMax is a standardized wireless version of Ethernet intended primarily as an alternative to wire technologies (such as Cable Modems, DSL and T1/E1 links) to provide broadband access to customer premises.

More strictly, WiMAX is an industry trade organization formed by leading communications, component, and equipment companies to promote and certify compatibility and interoperability of broadband wireless access equipment that conforms to the IEEE 802.16 and ETSI HIPERMAN standards.

WiMAX would operate similar to WiFi, but at higher speeds over greater distances and for a greater number of users. WiMAX has the ability to provide service even in areas that are difficult for wired infrastructure to reach and the ability to overcome the physical limitations of traditional wired infrastructure.

WiMAX was formed in April 2001, in anticipation of the publication of the original 10-66 GHz IEEE 802.16 specifications. WiMAX is to 802.16 as the WiFi Alliance is to 802.11.

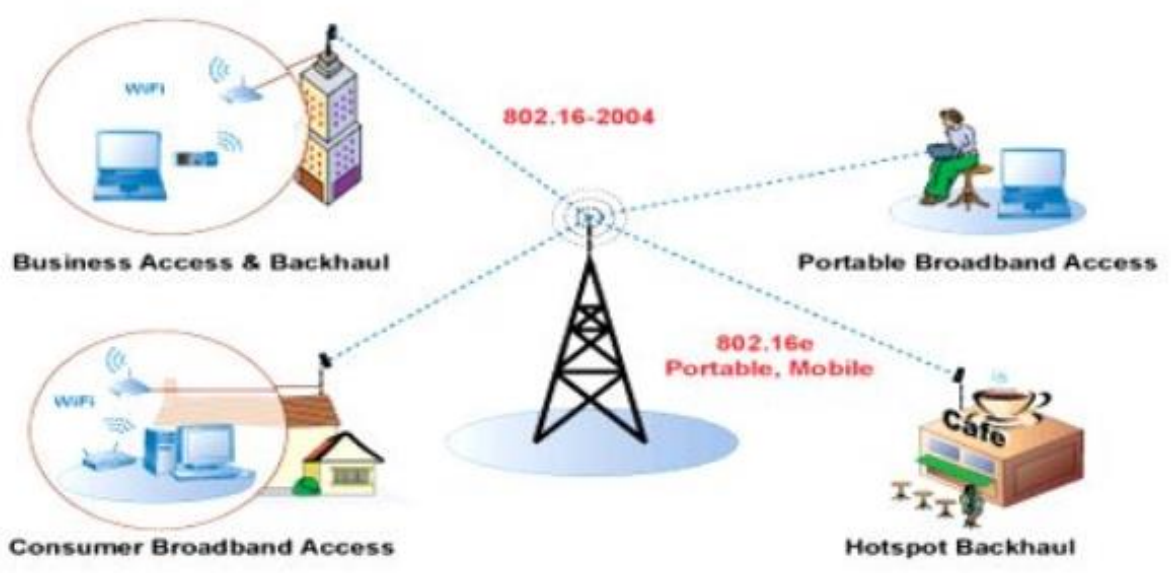
IEEE 802.16e also known as “Mobile WiMAX”, and should not be confused with IEEE 802.20 — the planned standard for Mobile Broadband Wireless Access (MBWA) itself probably some years away. The 802.16e amendment was concluded in 2005 and perhaps not completely settled yet. Whilst conserving the technical updates of the Fixed WiMAX, 802.16e proceeds with support for robust mobile broadband. Its chosen physical layer protocol is OFDMA flexible FFT but does also support OFDM 256-FFT. Further amendments are in development including:

IEEE 802.16f — Management Information Base

IEEE 802.16g — Management Plane Procedures and Services Amendments at pre-draft stage:

IEEE 802.16h — Improved Coexistence Mechanisms for License-Exempt Operation

IEEE 802.16i — Mobile Management Information Base



Network Applications

Computer systems and peripherals are connected to form a network.They provide numerous advantages:

- Resource sharing such as printers and storage devices
- Exchange of information by means of e-Mails and FTP
- Information sharing by using Web or Internet
- Interaction with other users using dynamic web pages
- IP phones
- Video conferences
- Parallel computing
- Instant messaging
- Smart Homes

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