ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE MATERIAL

COURSE NAME: WIRELESS TECHNOLOGY

INTRODUCTION

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 radio frequency (RF) as well as infrared (IR) waves.

HISTORY OF WIRELESS TECHNOLOGY

The birth of wireless technology started with the discovery of electromagnetic waves by Heinrich Hertz (1857–1894). Guglielmo Marconi (1874–1937) established the very first commercial RF communications, the wireless telegraph, in the late 1890s—more than fifty years after the first commercial wired telegraph service that was demonstrated in 1832 by Samuel F. B. Morse (1791–1872). Marconi was also the first to transmit radio signals to a mobile receiver on ships in the early 1900s. Wireless technology has always been preceded by wired technology and 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.

Another major thrust 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 STANDARDS

Home and business owners looking to buy networking gear face an array of choices. Many products conform to the *802.11a*, *802.11b/g/n*, and/or *802.11ac* wireless standards collectively known as Wi-Fi technologies(Bluetooth and various other wireless (but not Wi-Fi) technologies also exist, each designed for specific networking applications.

This article describes the Wi-Fi standards and related technologies, comparing and contrasting them to help you better understand the evolution of Wi-Fi technology and make educated network planning and equipment buying decisions.

802.11

In 1997, the Institute of Electrical and Electronics Engineers (IEEE) created the first WLAN standard. They called it

802.11 after the name of the group formed to oversee its development. Unfortunately, 802.11 only supported a maximum network bandwidth of 2 Mbps - too slow for most applications. For this reason, ordinary 802.11 wireless products are no longer manufactured.

802.11b

IEEE expanded on the original 802.11 standard in July 1999, creating the *802.11b* specification. 802.11b supports bandwidth up to 11 Mbps, comparable to traditional Ethernet.802.11b uses the same unregulated radio signaling frequency (2.4 GHz) as the original 802.11 standard. Vendors often prefer using these frequencies to lower their production costs. Being unregulated, 802.11b gear can incur interference from microwave ovens, cordless phones, and other appliances using the same 2.4 GHz range. However, by installing 802.11b gear a reasonable distance from other appliances, interference can easily be avoided.

• Pros of 802.11b - Lowest cost; signal range is good and not easily obstructed

• Cons of 802.11b - Slowest maximum speed; home appliances may interfere on the unregulated frequency band

802.11a

While 802.11b was in development, IEEE created a second extension to the original 802.11 standard called *802.11a*. Because 802.11b gained in popularity much faster than did 802.11a, some folks believe that 802.11a was created after802.11b. In fact, 802.11a was created at the same time. Due to its higher cost, 802.11a is usually found on business networks whereas 802.11b better serves the home market.802.11a supports bandwidth up to 54 Mbps and signals in a regulated frequency spectrum around 5 GHz. This higher frequency compared to 802.11b shortens the range of 802.11a networks. The higher frequency also means 802.11asignals have more difficulty penetrating walls and other obstructions. Because 802.11a and 802.11b utilize different frequencies, the two technologies are incompatible with each other. Some vendors offer hybrid *802.11a/b* network gear, but these products merely implement the two standards side by side (each connected devices must use one or the other).

• Pros of 802.11a - Fast maximum speed; regulated frequencies prevent signal interference from other devices.

• Cons of 802.11a - Highest cost; shorter range signal that is more easily obstructed.

802.11g

In 2002 and 2003, WLAN products supporting a newer standard called ***802.11g*** emerged on the market. 802.11gattempts to combine the best of both 802.11a and 802.11b.802.11g supports bandwidth up to 54 Mbps, and it uses the 2.4 GHz frequency for greater rang[5]e. 802.11g isbackward compatible with 802.11b, meaning that 802.11g access points will work with 802.11b wireless network adapters and vice versa.

• **Pros of 802.11g** - Fast maximum speed; signal range is good and not easily obstructed.

• **Cons of 802.11g** - Costs more than 802.11b; appliances may interfere on the unregulated signal frequency.

802.11n

802.11n (also sometimes known as "Wireless N") was designed to improve on 802.11g in the amount of bandwidth supported by utilizing multiple wireless signals and antennas (called ***MIMO*** technology) instead of one. Industry standards groups ratified 802.11n in 2009 with specifications providing for up to 300 Mbps of network bandwidth.

802.11n also offers somewhat better range over earlier Wi-Fi standards due to its increased signal intensity, and it is backward-compatible with 802.11b/g gear.

• **Pros of 802.11n** - Fastest maximum speed and best signal range; more resistant to signal interference from outside sources.

• **Cons of 802.11n** - Standard is not yet finalized; costs more than 802.11g; the use of multiple signals may greatly interfere with nearby 802.11b/g based networks.

802.11ac

The newest generation of Wi-Fi signaling in popular use, 802.11ac utilizes dual-band wireless technology, supporting simultaneous connections on both the 2.4 GHz and 5 GHz HYPERLINK "https://www.lifewire.com/is-5-ghz-wifibetter-than-2-4-ghz-818293"Wi- HYPERLINK "https://www.lifewire.com/is-5-ghz-wifi-better-than-2-4-ghz-818293"Fi bands. 802.11ac offers backward compatibility to 802.11b/g/n and bandwidth rated up to 1300 Mbps on the5 GHz band plus up to 450 Mbps on 2.4 GHz.

TYPES OF WIRELESS COMMUNICATION

The different types of wireless communication mainly include, IR wireless communication, satellite communication , broadcast radio, Microwave radio, Bluetooth, Zigbee etc.

Satellite Communication

Satellite communication is one type of self-contained wireless communication technology; it is widely spreadall over the world to allow users to stay connected almost anywhere on the earth. When the signal (a beam of modulated microwave) is sent near the satellite then, satellite amplifies the signal and sent it back to the antenna receiver which is located on the surface of the earth. Satellite communication contains two main components like the space segment and the ground segment. The ground segment consists of fixed or mobile transmission, reception and ancillary equipment and the space segment, which mainly is the satellite itself.

Satellite Communication

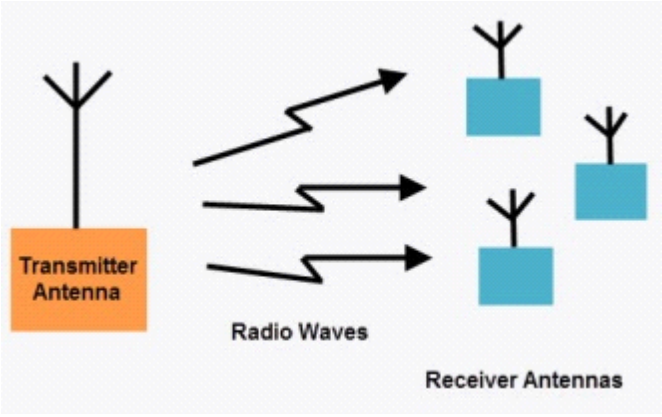
Infrared Communication

Infrared wireless communication communicates information in a device or systems through IR radiation. IR is electromagnetic energy at a wavelength that is longer than that of red light. It is used for security control, TV remote control and short-range communications. In the electromagnetic spectrum, IR radiation lies between microwaves and visible light. So, they can be used as a source of communication

For a successful infrared communication, a photo LED transmitter and a photo diode receptor are required. The LED transmitter transmits the IR signal in the form of non-visible light, that is captured and saved by the photoreceptor. So the information between the source and the target is transferred in this way. The source and destination can be mobile phones, TVs, security systems, laptops etc supports wireless communication.

Broadcast Radio

The first wireless communication technology is the open radio communication to seek out widespread use, and it still serves a purpose nowadays. Handy multichannel radios permit a user to speak over short distances, whereas citizen's band and maritime radios offer communication services for sailors. Ham radio enthusiasts share data and function emergency communication aids throughout disasters with their powerful broadcasting gear, and can even communicate digital information over the radio frequency spectrum.



Mostly an audio broadcasting service, radio broadcasts sound through the air as radio waves. Radio uses a transmitter which is used to transmit the data in the form of radio waves to a receiving

antenna (Different Types of Antennas). To broadcast common programming, stations are associated with the radio N/W's. The broadcast happens either in simulcast or syndication or both. Radio broadcasting may be done via cable FM, the net and satellites. A broadcasts ends information over long distances at up to two megabits/Sec (AM/FM Radio).Radio waves are electromagnetic signals, that are transmitted by an antenna. These waves have completely different frequency segments, and you will be ready to obtain an audio signal by changing into a frequency segment.

current Wireless Systems

- Cellular Systems
- Wireless LANs
- WIMAX
- Satellite Systems
- Paging Systems
- Bluetooth
- Ultrawideband Radios
- Zigbee Radios

Bluetooth Technology

Bluetooth technology allows you to connect a variety of different electronic devices lessly to a system for the transfer and sharing of data and this is the main function of Bluetooth. Cell phones are connected to hands-free earpieces, wireless keyboard, mouse and mike to laptops with the help of Bluetooth as it transmits information from one device to other device. Bluetooth technology has many functions, and it is used most commonly in wireless communications' market.

Features

• Bluetooth technology uses radio waves to communicate between devices. Most of these radio waves have a range of 15-50 feet.

• According to the official Bluetooth website, Bluetooth uses a low-power signal with a maximum range of 50feet with sufficient speed to enable transmission of data.

• The pairing process identifies and connects any two devices to each other. It also prevents interference from other non-paired Bluetooth devices in the area.

• It uses maximum power only when it is required, thus preserving battery life.

ZigBee

ZigBee is a wireless communication standard designed to address the unique needs of low-power, low-cost wireless sensor, and control networks. ZigBee can be used almost anywhere, as it is easy to implement and requires little power to operate. Zigbee has been developed looking into the needs of the communication of data with a simple structure like the data from the sensors.

Features

• ZigBee devices are designed for low-power consumption.

• ZigBee is used in Commercial Applications like sensing and monitoring applications.

• ZigBee uses very low power and extremely long device battery life.

• ZigBee gives flexibility to do more with the reliable wireless performance and battery operation.

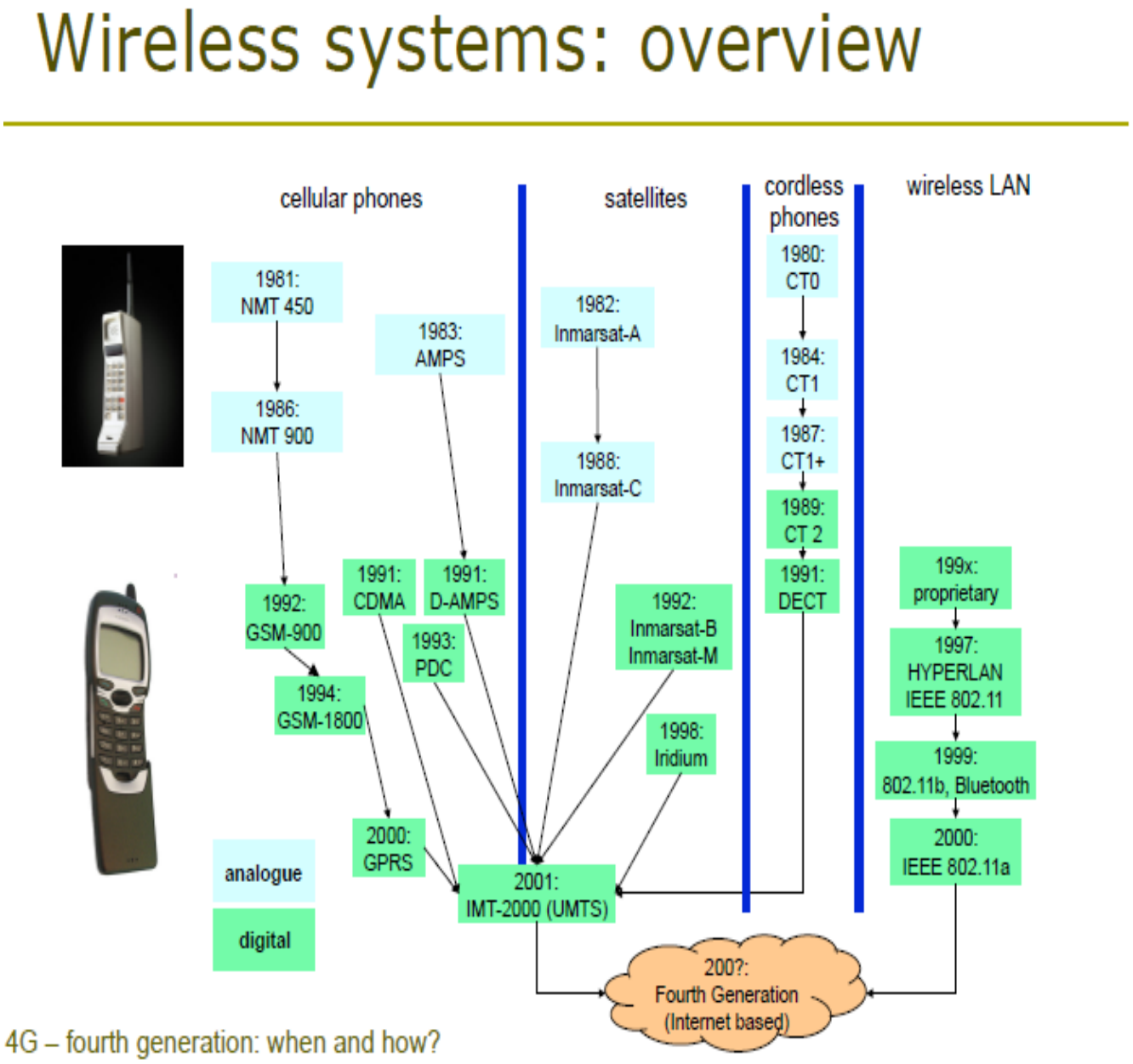
Wireless Networking

Wireless Networking technologies connect multiple computers, systems and devices together without requiring wires or cables: a wireless local area network or WLAN comes under Wi-Fi.

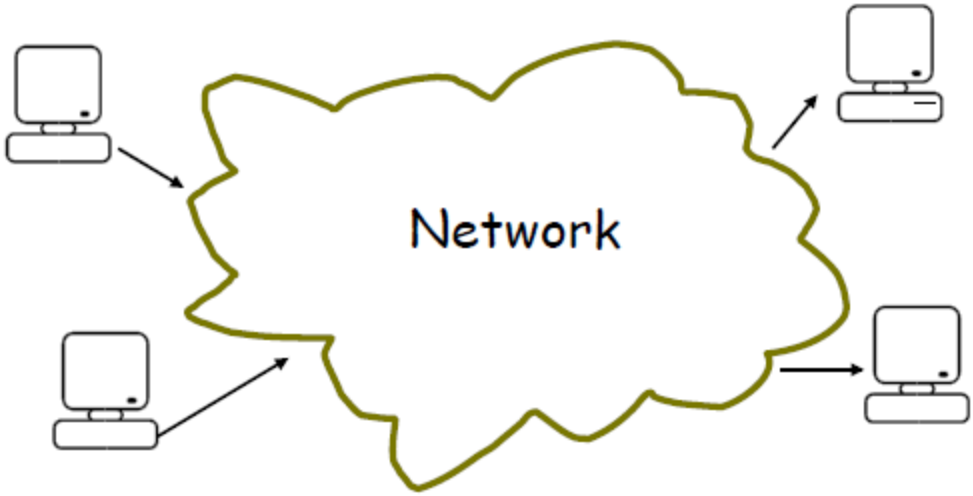
WiMAX

There are wireless broadband systems that offer fast Web surfing without being getting connected through cable or DSL (Example of wireless broadband is WiMAX). Although WiMAX can potentially deliver data rates of more than30 Megabits per second, yet the providers offer average 0 data rates of 6

Mbps and often deliver less, making the service significantly slower than the hard-wired broadband. The actual cost of the data available using WiMAX widely varies with the distance from the transmitter. WiMAX is also one of the versions of 4G wireless available in phones as Sprint's 4G technology.



- A **computer network** is two or more computers connected together using a telecommunication system for the purpose of communicating and sharing resources
- Why they are interesting?
  - Overcome geographic limits
  - Access remote data
  - Separate clients and server
- Goal: Universal Communication (any to any)



The difference between wired and wireless is the physical layer and the data link layer Wired network technology is based on wires or fibers. Data transmission in wireless networks take place using electromagnetic waves which propagates through space (scattered, reflected, attenuated) Data are modulated onto carrier frequencies (amplitude, frequency) The data link layer (accessing the medium ,multiplexing, error correction, synchronization)requiresmorecomplexmechanisms.

CHARACTERISTICS OF WIRELESS TECHNOLOGY

Here is some inherent characteristic of wireless communications that make the networks more efficient in usability to the users of networks nodes (Prashant, Varun, Raj, & Devendra, 2015):

1. Mobility: Users can access files, network resources, and the Internet without having to physically connect to the network with wires. The Wireless users are provided with access to the real time information even when they are away from their home/offices and even from their society.

2. Rapid Installation: The time required for installation is reduced as network connections can be made without moving or adding wires, or pulling them through walls or ceilings, or by making modifications to the infrastructure cable plant.

3. Flexibility: Enterprises can also enjoy the flexibility of installing and taking down wireless devices in locations for temporary needs such as a conference, trade show, or standards meeting. The Wireless users are provided with access to the real time information even when they are away from their nativity.

4. Multihopping: A multi hop network is a network the spot that the path from source to destination traverses' other nodes.

5. Scalability: Wireless network topologies can easily be configured to meet specific application and installation needs and to scale from small peer-to-peer networks to very large enterprise networks that enable roaming in a broader area.

Cost: Networks can be extended at any level with limited cost or almost no cost, no wired system and hence setting up a wireless network is much easy and fast; it eliminates the need for pulling out the cable through walls and ceilings.

7. Self-organization: the ad hoc network must autonomously determine its very own configuration parameters including: addressing, routing, clustering, position identification, power control, and so on.

8. Energy conservation: most ad hoc nodes have limited power supply, no power to generate their particular power. High efficiency protocol design is important for longevity with the mission.

TYPES OF WIRELESS TECHNOLOGY

1. RF Module

This is a band of frequency ranging from 3KHz to 300GHz known as Radio Frequency (RF). RF module is an electronic circuitry which is used to "broadcast" and "receive" real time data from one device to another. The data transfer rate is ranging from 1kbps to 10kbps. It transmits data in the range of 100 meters in open space. It contains a very low-level power consumption and ease of access. There are various signal modulation techniques that can be employed in RF module, such as Amplitude Shift Keying (ASK) (best suitable for digital data), Frequency Shift Keying (FSK), Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS). There are four categories of RF module: Transmitter, Receiver, Transceiver and System On Chip (SoC). It can work for long ranges with no hindrance by other radio modules unlike Infrared modules. It can be applied in various application areas such as vehicle monitoring, telemetry, Remote control, small range wireless network, wireless home security system, robotics, radio tag reading, wireless fire protection system and other countless number of applications (Deepan, Himanshu, & Hardik, 2016).

I BLUETOOTH

Bluetooth is standardized as IEEE 802.15.1 standard, generally used for short range communication. It works on 2.4 to 2.485 GHz frequency of the ISM band having 79 channels separated by 1 MHz. Data transmission is done in the form of packets, which are transmitted by Frequency Hopping Spread Spectrum (FHSS). It consumes very less power, available at very economical price, and it is a very simple yet effective technology (Rajeev & Brent, 2000). Bluetooth technology works on the principle of "Master-Slave". Communication can be established only after the Master device invoke the process. Every device containing its Global ID, which gets exchanged among them and the connection gets established after it. Bluetooth Low Energy (BLE) and Bluetooth 4.0 are the latest version of this technology which consumes much less power than the former version. It is being employed in new applications, such as Healthcare, security, fitness and many more. Sometimes, Bluetooth Technology encounters with pairing error, yet it still has a very wide range of application, such as wireless networking between devices and other wireless peripherals such as mouse, keyboard, headsets, media transfer, wireless control, Data logging equipment, and many more (Deepan, Himanshu, & Hardik, 2016).

2. WIRELESS FIDELITY

Wireless Fidelity (Wi-Fi), IEEE 802.11 standard, is also known as Wireless Local Area Network (WLAN). It is a protocol used to connect devices wirelessly, to provide internet access and also connect different devices to the wired network. Its range is always greater than 100 meters and works on either on 2.4 GHz or 5 GHz. These frequencies are the part of the ISM band and are free to use. Wi-Fi uses radio waves to transmit information for wireless communication between devices or internet access. To establish communication, there are two devices required, namely Wireless adapter and Wireless router. (Deepan, Himanshu, & Hardik, 2016) highlighted three major standards applied for the security purpose of Wi-Fi which are: Wireless Equivalent Privacy (WEP) uses 40- or 104-bit encryption and WPA provides authentication; Wi-Fi Protected Access (WPA); Wi-Fi Protected Access-2 (WPA-2) uses 128-bit encryption methods. Wi-Fi uses 2.4 or 5GHz high frequency so that it can carry more data. Wi-Fi can be used to share internet, to share files, to share resources between devices and much more.

3. ZigBee

In the industrial and medical applications, there is need for low data transfer medium. So, Zigbee alliance presented IEEE 802.15.4 standard. While Bluetooth and Wi-Fi are used to transfer lager data file such as media files, Zigbee is suitable when communication is occasional, smaller packet sizes are used, and power consumption is an issue (Andreas, Kirsten, & Adam, 2005). Zigbee works on radio standards and 2.4 GHz, 900 MHz, 868 MHz unlicensed band frequency. Due to low power and low data rate its range is limited from 10 to 100m. Its having data rate of 250kbps. Due to energy efficiency, it provides long battery life (Fotouhi, Vahabi, Rasid, & Raja, 2008). Zigbee technology works on Direct Sequence Spread Spectrum (DSSS), due to its very low latency. One of the leading features of Zigbee is, it supports mesh networking.

and every node is capable of locating itself. With the help of routing table any node is able to select a best suitable path for communication. With the help of ad-hoc routing and mesh topology, better stability can be provided. Zigbee is it supports 65000 nodes in network topology. It provides various network topologies like point to point, point to multipoint, mesh network topology and "Personal Area Network" (PAN). It provides security and application services which can work on PHY layer and MAC layer (Hu, 2010). Zigbee technology is very much safe and secure, because it provides 128-bit encryption method to get security from data collision, interference, and trespassing. Zigbee is used in various applications such as automation, Automatic meter reading, sensor networking in industrial, Medical devices and applications, lighting control, building automation and many more thanks to a very low cost and long battery life.

4. Infrared

This is the technology through which communication is achieved via infrared radiation. In this technology, an infrared port is required to transmit and receive the data. This technology provides bi-directional communication. Its range is about 1 to 10 meters. It provides data rates about 4 Mbps. Infrared technology features include, very economical, very low power consuming, highly secure, portable, immune from noise yet contains simple circuitry. But it has some limitations too. It requires line of sight communication; any obstacle causes interference and failure in the communication. It is only available for short range communication, which is affected by light, climate and atmospheric conditions. It is usually used in TV remote control and cheap mobile handsets.

Near Field Communication

Near Field Communication (NFC) is the wireless technology that allows mobile devices to vigorously work together with additional mobile devices. NFC is a very short-range communication used to share data between two devices closer within 4 cm. It works at 13.56 MHz, which is an unlicensed ISM radio frequency band. The data transfer rate is ranging from 106 to 424 kbps. NFC makes available flawless medium for the recognition protocols that authenticate the protected transfer of data. Near Field Communication can take place in three modes: Card emulation: smartphone can act like smart card and make payments; Reader/ writer: smartphone can read or write NFC tags; Peer to peer: two NFC device can interact with each other and convey information (Agrawal & Sharad, 2016).

6. Ultra-Wideband

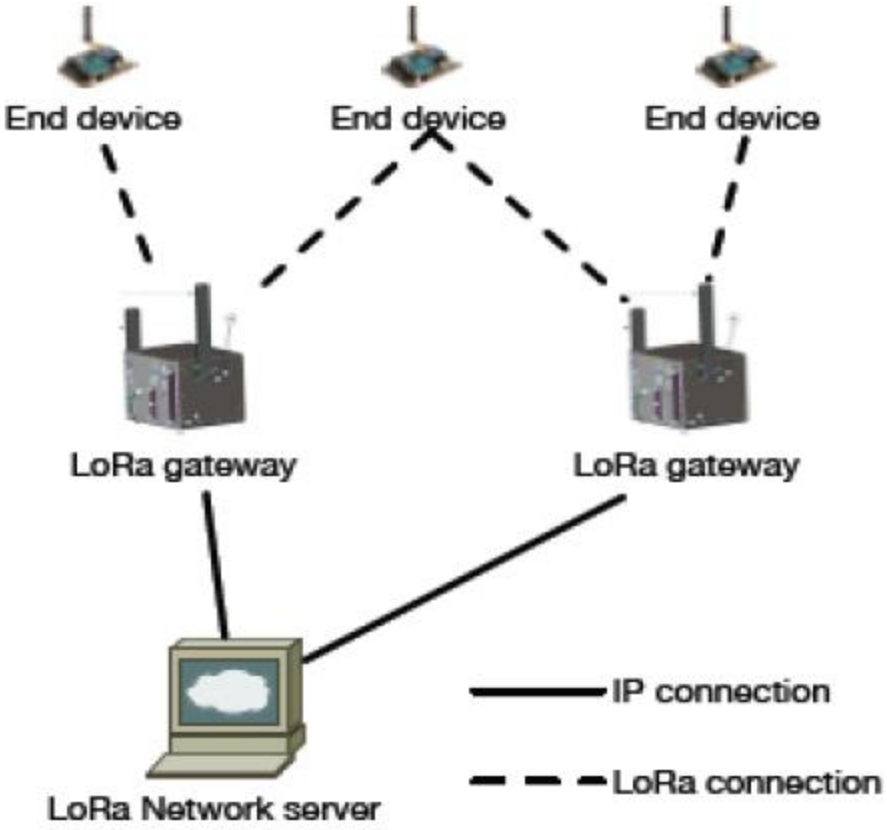
Ultra-Wideband (UWB) technology transmits information over a large spectrum with a high bandwidth and a low power spectral density. Due to low power spectral density it is secured from interference with other radio frequencies, and with the help of high bandwidth which is greater than 500 MHz it can carry large data. UWB uses the 3.1 to 10.6 GHz frequency band. In this technology, we can share spectrum with other users and be used as a high rate personal area network (PAN). It is generally known as pulse radio, transmission is made by increasing or decreasing the level of amplitude, frequency or phase, and transmission takes place by generating radio energy at specific time interval. It is mainly used in radar imaging technique, because it has a very efficient spatial capacity around 1013 bits/m2. It can also be used in short range indoor application (Aiello & Gerald, 2003) (Porcino & Walter, 2003).

Wireless Body Area Network

Wireless Body Area Network (WBAN), IEEE 802.15.6 standard, is mainly created for low power, short range and highly reliable medical and healthcare application. It uses ISM band and other frequency band which is allowed for medical purpose. It provides data transfer rate about 10 Mbps. It can work on a range of about 2-5 meter and allows 256 nodes. It uses star network topology for the communication process. A key layer which is used for data communication is MAC layer (Mohammad, Harneet, Sherratt, & William, 2015). With the help of this technology, notification can be sent before the heart attack occurs from the observations of change in vital signs. Also, it can inject insulin in the diabetic patient's body. The WBAN technology contains three levels of security, such as unsecured communication (level 0), authentication but no encryption (level 1), authentication and encryption (level 2). For the communication, the host and node must be at same security level. Consequently, a temporary key is generated which is used for communication and can

Long Range

Long Range (LoRa) is a long-range wireless communications system, promoted by the LoRa Alliance. It aims at being usable in long-lived battery-powered devices, where the energy consumption is of paramount importance. LoRa can commonly refer to two distinct layers: a physical layer using the Chirp Spread Spectrum (CSS) radio modulation technique; and a MAC layer protocol (LoRaWAN). The LoRa physical layer, allows for long-range, low-power and low-throughput communications. It operates on the 433-, 868- or 915-MHz ISM bands, depending on the region in which it is deployed. The payload of each transmission can range from 2–255 octets, and the data rate can reach up to 50 Kbps when channel aggregation is employed. The modulation technique is a proprietary technology from Semtech. LoRaWAN provides a medium access control mechanism, enabling many end-devices to communicate with a gateway using the LoRa modulation. While the LoRa modulation is proprietary, the LoRaWAN is an open standard being developed by the LoRa Alliance (Aloÿs, Jiazi, Thomas, & William, 2016).



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vehicle-infrastructure integration (IntelliDrive), cooperative intersection collision avoidance system (CICAS), automatic vehicle safety inspection, electronic toll collection, transit or emergency

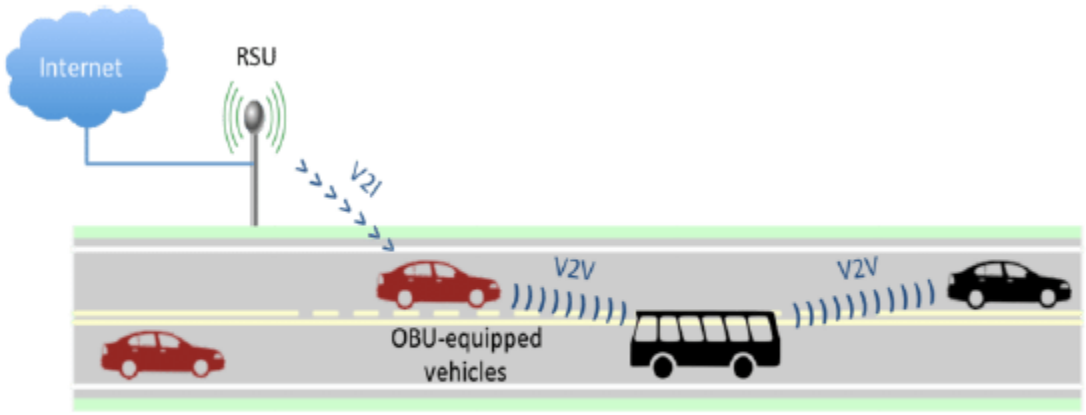

Figure 5 : DSRC-Based Communication

Long Term Evolution

The long-term evolution (LTE) as defined by the 3rd Generation Partnership Project (3GPP) is a highly flexible radio interface. The first release of LTE provides peak rates of 300 Mbps, a radio-network delay of less than 5 ms, a significant increase in spectrum efficiency compared to previous cellular systems, and a new flat radio-network architecture designed to simplify operation and to reduce cost. LTE supports both frequency-division duplex (FDD) and time-division duplex (TDD), as well as a wide range of system bandwidths in order to operate in a large number of different spectrum allocations. The radio link control (RLC) and medium access control (MAC) layers, among other tasks, are responsible for retransmission handling and multiplexing of data flows. In the physical layer, the data that is to be transmitted is turbo coded and modulated using one of the following: quadrature-phase shift keying (QPSK), 16-QAM, or 64-QAM, followed by OFDM modulation. The subcarrier spacing is 15 kHz and two cyclic-prefix lengths are supported in both uplink and downlink, a normal cyclic prefix of 4.7 μs, suitable for most deployments and an extended cyclic prefix of 16.7 μs for highly dispersive environments (David, et al., 2009).

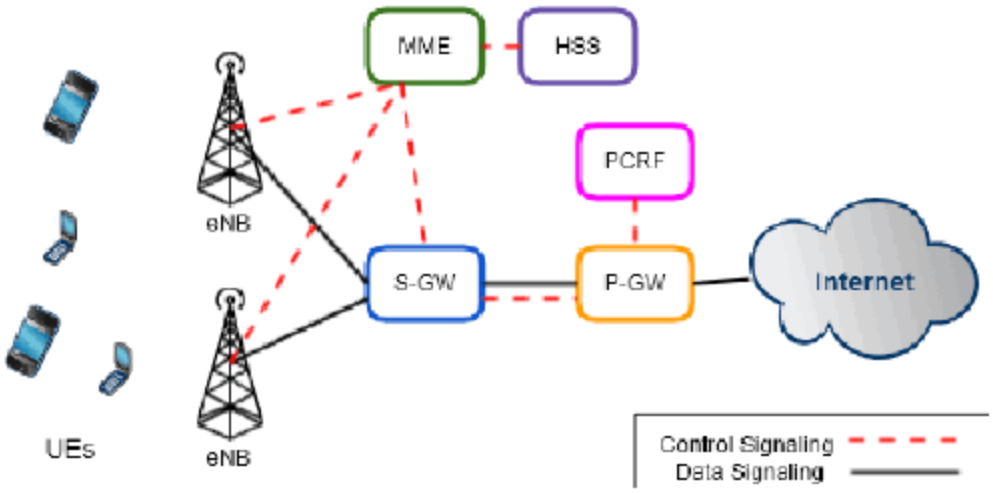

Figure 6 : Main Components of LTE Network

Light Fidelity

Light Fidelity (Li-Fi) is a Visible Light Communication (VLC) technology in which data is transferred through a LED light bulb whose intensity keep on varying at a very high speed. The VLC uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as the optical carrier for data transmission and for illumination. Data rates of greater than 100 Mbps can be achieved by using high speed LEDs with adequate multiplexing. Parallel data transmission using arrays of LEDs where each LED transmits a separate stream of data can be used to increase the VLC data rate. Though the lights have to be kept on in order to transmit data, they can be dimmed to the point that they are not visible to humans but still be capable of transmitting data. This technology offers a large bandwidth which is unlicensed, so it can be used for many application such as streaming of video and music, connection of internet with moving or stationary devices and so on (Anurag, Shalabh, & Asoke, 2015).

This focuses on the applications and improvement of wireless technology. Highlighting some of the possible ways via which wireless technology has been employed in our daily lives. (Tan-Hsu, et al., 2017) presented a new ubiquitous emergency medical service system (UEMS) that consists of a ubiquitous tele-diagnosis interface and a traffic guiding subsystem. The UEMS manages the sensor wires for eliminating inconvenience for both patients and paramedics in an ambulance, providing ubiquitous accessibility of patients' biosignals in remote inaccessible areas using wireless biosensors, and offering availability of real-time traffic information using webcam; can be simultaneously transmitted to an emergency room for pre-hospital treatment via WiMAX/3.5 G networks. Results validates the feasibility of the proposed system for application in real-life scenarios. (Danda, Bassma, & Vijay, 2019) investigated wireless virtualization (WiVi) where wireless resources forvirtual wireless networks are adapted based on availability of leasable RF slices as well as the demands from the users of virtual wireless networks. With the help of software defined network controller, wireless infrastructure providers (WIPs) slice their RF bands to sublease

those slices to mobile virtual network operators (MVNOs). In wireless virtualization, MVNOs work as independent service provides, and thus, the end users negotiate directly to MVNOs regardless of WIPs used behind the scene. WiVi through MVNOs can provide better service to wireless users (higher data rates and with lower outage probability) when MVNOs receive enough RF slices from WIPs to serve their users. (Natasa, et al., 2019) presented and evaluated a mobile monitoring system using various non-intrusive wireless sensors that continuously measure vital parameters of the patient. Results shows high acceptance of the developed system by Electronic Medical professionals. And concluded that the proposed system can be used as a complementary system in Electronic Medical System, allowing continuous real-time monitoring of patients' vital signs and on-scene triage. (Estefania, Adrián, Aarón, Alfonso, & Matilde, 2019) proposed a network and physical layer solution based on LTE-A and future 5G capabilities to improve public safety communications, which are currently conveyed through narrowband private mobile radio (PMR) systems and mainly focused on offering limited voice services. Performance was analyzed in terms of capacity of an amplify-and-forward relay network when massive multiple-input multiple-output (MIMO) textile technology is deployed at the user side. Additionally, the optimal relay location was evaluated, with the purpose of maximizing the achieved capacity in the two-hop network. Results illustrated the viability of the proposed design, specifically for low SNR scenarios where the relay node will allow us to extend the coverage and the MIMO textile technology to improve the capacity. (Bradley, Salil, Yvonne, & Keat, 2020) reviewed and briefly describes some common wireless technologies and modern advancements, as well as their strengths and suitability for use in implantable medical devices. The applications of these wireless technologies in treatments of orthopedic and cardiovascular injuries and disorders are described. Such that, with remote data collection and control of implantable devices, these wireless technologies help researchers and clinicians to better understand diseases and to improve medical treatments. And then concludes with a discussion on the technical challenges and potential solutions of implementing wireless technologies in implantable devices. (Bahaa, Alyani, & Aduwati, 2020) reviewed electro-textile wearable tags involved in the body-centric area particularly examining microstrip patch antennas; since they radiate perpendicularly to the planar structure, of which their ground plane shields the human body efficiently. The crucial features of conductive and non-conductive textile materials used in designing wearable antennas were reviewed. This review can be the benchmark used to choose the materials and techniques to design a textile wearable tag in the Body Area Network. The embroidery textile slotted patch design antenna with specific materials proved in this study to have high performance. (Gordana, Konstantinos, Dragana, & Lazar, 2020) provided an extensive survey on emerging IoT communication standards and technologies suitable for smart healthcare applications. With emphasis on low-power wireless technologies as a key enabler for energy-efficient IoT-based healthcare systems; with challenges in privacy and security. A particular attention is devoted to crowdsourcing/crowdsensing, envisaged as tools for the rapid collection of massive quantities of medical data. (Emanuele & Salvatore, 2020) designed a technology which can reduce the effects of exposure to electromagnetic fields as much as possible is needed.