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## The wireless technology applications and evolution: A review

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### Abstract

The term wireless refers to the communication or transmission of information over a distance without requiring wires, cables or any other electrical conductors. Today, the term wireless refers to a variety of devices and technologies ranging from smart phones to laptops, tabs, computers, printers, Bluetooth, etc. On the other hand, Wireless Communication doesn't require any physical medium but propagates the signal through space. Since, space only allows for signal transmission without any guidance, the medium used in Wireless Communication is called Unguided Medium. In the present days, wireless communication system has become an essential part of various types of wireless communication devices, that permits user to communicate even from remote operated areas. There are many devices used for wireless communication like mobiles, Cordless telephones, GPS, Wi-Fi, satellite television and wireless computer parts. Current wireless phones include 3G,4G and 5G networks, Bluetooth and Wi-Fi technologies. This paper is focused on elements of Wireless Communication system, Types of Wireless Communication, Advantage & Disadvantage of it and Review of few works done so far.

**Keywords:** Wireless; Bluetooth; GPS; Wi-Fi; Wivi

### 1. Introduction

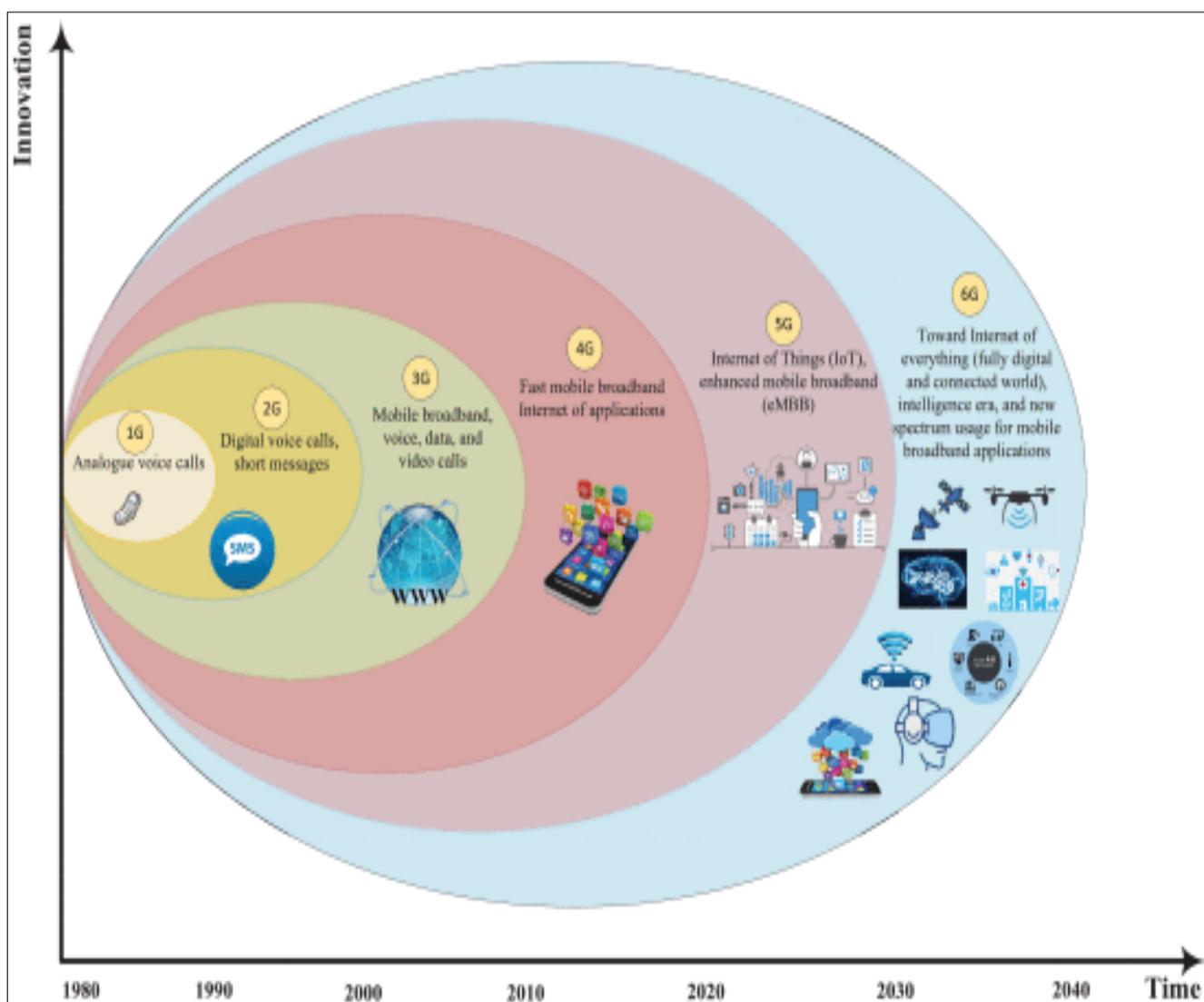
Wireless communication plays a significant role in day to day life. Besides communication, wireless technology has become an integral part of our daily activities. At the end of the 19th century, the first wireless communication systems were introduced and the technology has significantly been developed over the intervening and subsequent years. The transmission of data or information from one place to another witlessly is referred as wireless communication. Wireless communication is one of the important mediums of transmission of data or information to other devices. The Communication is set and the information is transmitted through the air, without requiring any cables, by using electromagnetic waves like radio frequencies, infrared, satellite, etc. This provides an exchange of data without any conductor through RF and radio signals. The information is transmitted across the devices over some meters to hundreds of kilometres through well-defined channels. In order to transmit information (voice or data) using wireless communication we need antenna. The antenna is the device which couples RF energy from one medium (i.e. wave guide, transmission line etc.) to the other medium (i.e. air). We require two systems viz. transmitter and receiver to complete end to end wireless link [1].

The wireless communication revolution is bringing fundamental changes to data networking, telecommunication, and is making integrated networks a reality. By freeing the user from the cord, personal communications networks, wireless LAN's, mobile radio networks and cellular systems promise of fully distributed mobile computing and communications, anytime, anywhere. Focusing on the networking and user aspects of the field, Wireless Networks provides a global forum for archival value contribution documenting these fast-growing areas of interest. The primary and important benefit of wireless communication is mobility. Apart from mobility, wireless communication also offers flexibility and

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ease of use, which makes it increasingly popular day – by – day. Wireless Communication like mobile telephony can be made anywhere and anytime with a considerably high throughput performance [2, 3]. Another important point is infrastructure. The setup and installation of infrastructure for wired communication systems is an expensive and time-consuming job. The infrastructure for wireless communication can be installed easily and low cost.

Though wireless communication has been around since 1876, the technology is now being broadly used to convey information from one node to another, using radio waves, microwaves, or infrared waves. Figure 1 shows the growth of wireless technology from 1G to 5G and evolving 6G. A key benefit of wireless technology, information can send out data across long distances without any kind of hindrance; thus, more trustworthy and convenient compared to wired technology. Consequently, devices like sensors and actuators, can be monitored and controlled with ease, making the device more portable and flexible. In industry, various devices, sensors, and actuators are connected in diverse ways through various protocols, if done using wireless technology, can replace all the physical limits of wired technology [4]. A variety of IEEE standards and protocols, such as like Bluetooth, Zigbee, RF modules, infrared and many more, are used for wireless communication. It is used in many areas like industrial, commercial, home use, health care, Smartphone, laptops and many others. Each wireless standard is being chosen as per the requirement and specification. For example, Bluetooth is used in Smartphone, laptops, home automations, music players, and so on. where several meters of range and data transfer in tens to hundreds of MBs are required.



**Figure 1** Growing of Wireless Technology along with the time from 1G to Evolving 6G

## 2. 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 [5]:

- **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.
- **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.
- **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.
- **Multi-hopping:** A multi-hop network is a network the spot that the path from source to destination traverses' other nodes.
- **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.
- **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.
- **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.

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## 3. Types of Wireless Technology

- **Satellite Communication:** Satellite communication is one type of self contained wireless communication technology; it is widely spread all 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.
- **Infrared Communication:** Infrared 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.
- **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 broadcast sends information over long distances at up to two megabits/Sec (AM/FM Radio) [6].
- **Microwave Communication:** Microwave wireless communication is an effective type of communication, mainly this transmission uses radio waves, and the wavelengths of radio waves are measured in centimetres. In this communication, the data or information can be transfers using two methods. One is satellite method and another one is terrestrial method. Wherein satellite method, the data can be transmitted though a satellite, that orbit 22,300 miles above the earth. Stations on the earth send and receive data signals from the satellite with a frequency ranging from 11GHz-14GHz and with a transmission speed of 1Mbps to 10Mbps.

- **Wi-Fi:** Wi-Fi is a low power wireless communication, that is used by various electronic devices like smart phones, laptops, etc. In this setup, a router works as a communication hub wirelessly. These networks allow users to connect only within close proximity to a router. Wi-Fi is very common in networking applications which affords portability wirelessly. These networks need to be protected with passwords for the purpose of security, otherwise it will access by others.
- **Mobile Communication Systems:** The advancement of mobile networks is enumerated by generations. Many users communicate across a single frequency band through mobile phones. Cellular and cordless phones are two examples of devices which make use of wireless signals. Typically, cell phones have a larger range of networks to provide a coverage. But, Cordless phones have a limited range. Similar to GPS devices, some phones make use of signals from satellites to communicate [7].
- **Bluetooth Technology:** The main function of the Bluetooth technology is that permits you to connect to various electronic devices wirelessly to a system for the transferring of data. Cell phones are connected to hands free earphones, mouse, wireless keyboard. By using Bluetooth device the information from one device to another device, this technology has various functions and it is used commonly in the wireless communication market.

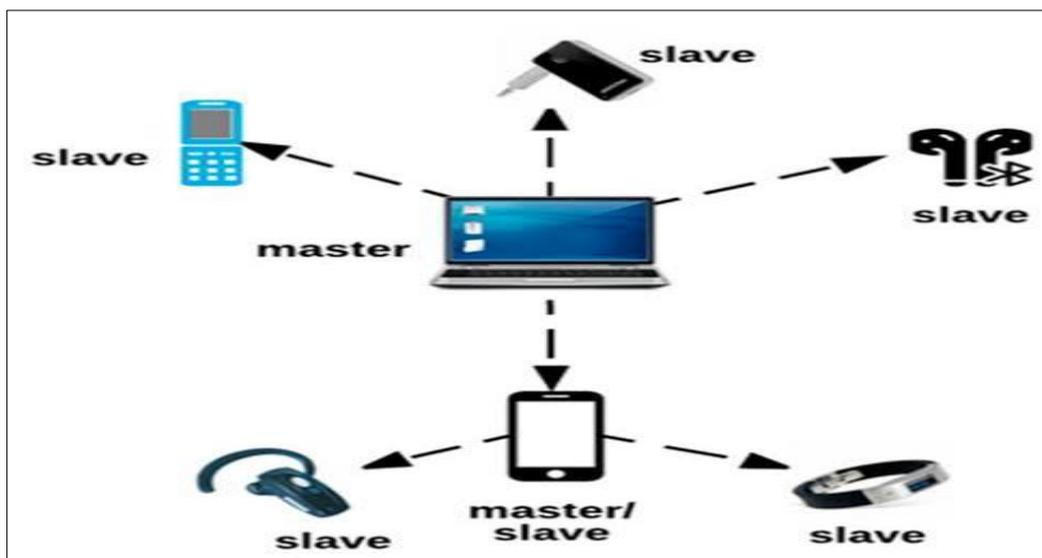


Figure 2 Bluetooth Network Architecture

#### 4. Advantages of Wireless Technology

There are numerous advantages of Wireless Communication Technology, Wireless Networking and Wireless Systems over Wired Communication such as [8]:

- **Cost:** The cost of installing wires, cables and other infrastructure is eliminated in wireless communication and hence lowering the overall cost of the system compared to wired communication system. Installing wired network in building, digging up the Earth to lay the cables and running those wires across the streets is extremely difficult, costly and time-consuming job. Thus, wireless communication such as Wi-Fi or Wireless LAN is the only option.
- **Mobility:** This is the main advantage of wireless technology system. It offers the freedom to move around while still connected to network.
- **Ease of Installation:** The setup and installation of wireless technology network's equipment and infrastructure is very easy compared to wired technology. Also, the time required to setup a wireless system like a Wi-Fi network for example, is very less when compared to setting up a full cabled network.
- **Reliability:** Since no cables and wires involved, no chance of communication failure due to damage of these cables which may be caused by environmental conditions, cable splice and natural diminution of metallic conductors.
- **Disaster Recovery:** In case of accidents due to fire, floods or other disasters, the loss of communication infrastructure in wireless communication system can be minimal.

## 5. Disadvantages of Wireless Technology

Even though wireless communication has a number of advantages over wired communication, there are a few disadvantages such as

- **Interference:** Wireless technology systems use open space as the medium for transmitting signals. Therefore, there is a huge chance that radio signals from one wireless technology system might interfere with other signals. For example, Bluetooth and Wi-Fi (WLAN) uses the 2.4GHz frequency for communication, when both are active simultaneously, there is a chance of interference.
  - **Security:** Since the signals are transmitted in open space, it is possible that an intruder can intercept the signals and copy sensitive information. This is a major concern in wireless technology.
  - **Health Concerns:** Continuous exposure to any type of radiation can be hazardous. Even though the levels of Radio Frequency energy that can cause the damage are not accurately established, it is advised to avoid Radio Frequency radiation to the maximum.
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## 6. Literature Review

This review of literature focuses on the applications and improvement of wireless technology. This highlights some of the possible ways in which wireless technology has been employed in our daily lives.

[9] 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' bio-signals 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/3.5G networks. Results validate the feasibility of the proposed system for application in real-life scenarios.

[10] investigated wireless virtualization (WiVi) where wireless resources for virtual 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 providers, 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.

[11] presented and evaluated a mobile monitoring system using various non-intrusive wireless sensors that continuously measure vital parameters of the patient. Results show high acceptance of the developed system by Electronic Medical professionals. And concluded that the proposed system can be used as a complementary system in the Electronic Medical System, allowing continuous real-time monitoring of patients' vital signs and on-scene triage.

[12] 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 analysed 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, to maximize 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.

[13] 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 orthopaedic 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.

[14] reviewed electro-textile wearable tags involved in the body-centric area, particularly examining micro-strip 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.

[15] 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/crowd sensing, envisaged as tools for the rapid collection of massive quantities of medical data.

[16] analysed of the idea of IoT in the field of agriculture. In the near future, sensors, actuators, and devices will rule the agricultural world by connecting to the internet alongside the basic aim of intercommunication and decision making. By providing innumerable profits to the end user with a variety of services such as supervise pests, build intelligent seeds, monitor crop yield, weed detection, water management and so on, for improving the result of production in agriculture. By using wireless technologies such as Wi-Fi, Zigbee, Z-Wave, GSM and automation, helps to improve the crop yield by perfect monitoring and detection of disease affected crops. Hence better usage of automation in agriculture helps to improve the yield of the crops.

[17] designed a technology which can reduce the effects of exposure to electromagnetic fields as much as possible is needed. By applying resonance theory to search non-resonant frequencies in the mechanism of ions flux across cellular membrane channels, that minimize harmful effects of high-frequency electromagnetic radiation, using spectroscopic and biochemical techniques. The development of new emerging 5G technology at non-resonant frequency should induce a decreasing of harmful effects on human health, without giving up advantages of this advanced technology.

**Table 1** Applications and Improvement of Wireless Technologies and Systems

Author(s)/Year	Applications/Improvement	Wireless Technologies	Wireless Systems
[9]	A new ubiquitous emergency medical service system (UEMS) that consists of a ubiquitous tele-diagnosis interface and a traffic guiding subsystem	WiMAX/3.5 G	Wireless biosensors, Webcam
[10]	Wireless Virtualization (WiVi)	Radio Frequency	
[11]	Mobile monitoring system		Non-intrusive wireless sensors
[12]	A network and physical layer solution improve public safety communications	LTE-A and future 5G	
[13]	Implantable medical devices	Bluetooth Low Energy, Zigbee, Wi-Fi	
[14]	An electro-textile wearable tag	Microstrip patch antennas	Wireless Body Area Network
[15]	Smart healthcare applications		IoT communication standards and technologies
[16]	IoT in Agriculture	Wi-Fi, Zigbee, Z-Wave, GSM	Sensors, Actuators, and Automation devices
[17]	A technology which can reduce the effects of exposure to electromagnetic fields	New emerging 5G technology at non-resonant frequency	

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## 7. Conclusion

In the world we live in today, communication and Wireless technology are a key part of our daily lives. Some of the commonly used Wireless technology systems in our daily life are: Mobile Phones, GPS Receivers, Remote Controls, Bluetooth Audio and Wi-Fi and so on. This paper is focused on elements of wireless technology, types, advantage and disadvantage, as well as literature review on various applications and improvements of wireless technology and systems. Additionally, a comparative analysis between the various types of wireless technology based on different aspects and their characteristics was discussed. With more research and experimentation, the challenges faced by wireless technology can be reduced. Wireless technology will be very important in the near future where the need for wires connecting individual devices seems to be coming to an end.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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