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An Analysis of the 1G–6G Mobile Wireless Communication Network Evolution

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Abstract-

Over the past few decades, there has been a significant breakthrough in mobile wireless communication. This progress spans multiple generations and continues to this day. 1G marked the start of the mobile wireless communication adventure, which was followed by 3G, 2G, 4G, and, pending more study, 5G, 6G, and 7G. By contrasting the difficulties and characteristics that have changed with each generation and outlining the advancements made from one to the next, this study aims to give a general overview of the development of mobile generations.

Keywords-

Wireless Communication, 6G, World Wide Web, FDMA, WCDMA Network.

Introduction

Mobile networks for communication have seen significant transformation in the previous several decades. The term "cellular wireless generation" (G) often describes a shift in the system's technology,speed,nature, and frequency. Every generation differs from the one before it in a few ways, including standards, abilities, methodologies, and new features. The next step is the generational evolution of wireless mobile communication. The first generation (1G) of mobile wireless networks was analogue and was limited to voice calls. Text messaging is supported by digital technology known as second generation, or 2G. The next technology was 3G, which supported multimedia and offered faster and more capacityful data transmission speeds. In an effort to get beyond 3G's restrictions, the fourth generation (4G) combines 3G with fixed internet to enable wireless mobile internet. It also improves QoS, expands capacity, and lowers resource costs. While 6G is intended to combine 5G with satellite networks for worldwide coverage, 5G offers the Wireless World Wide Web (WWW). Space roaming is covered in 7G.

Fifth Generation Mobile Technology is referred to as 5G technology. With the advent of 5G technology, smartphones can now consume extremely high bandwidth. 5G is a high throughput, broad area coverage packet switched wireless technology. In order to offer seed speeds more than 100Mbps at full mobility and higher than 1Gbps at low mobility, 5G technologies use millimetre wireless, CDMA, and

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BDMA. Because 5G technology has so many cutting-edge characteristics, it will soon be the most powerful and in high demand. Such a vast array of technologies packed into such a tiny package is not remarkable. Users of mobile phones can access additional features and efficiency thanks to 5G technology. A cell phone user may link their 5G device to a tablet or laptop with ease in order to have broadband internet access. The following 5G technology features have emerged thus far: 5G provides extreme mobile customers with high image quality, bidirectional massive bandwidth, greater speeds for data, and the best Quality of Service (QoS).

1G technology (analog)

In the 1980s, analogue technology was used to create the first wireless mobile system for communication. [1] This technology, known as the AMPS, was utilised for voice services. A frequency spectrum of 824-894MHz and a channel capacity of 30KHz were utilised by the frequency modulated AMPS system, which employed FDMA. [2] A maximum speed of 2.4 kbps is supported. Expanded Spectrum, which was originally used in Chicago and included a 2100 square mile service area, was a 10MHz bandwidth allotment given to AMS in 1988. The US introduced AMPS for the first time in 1982.

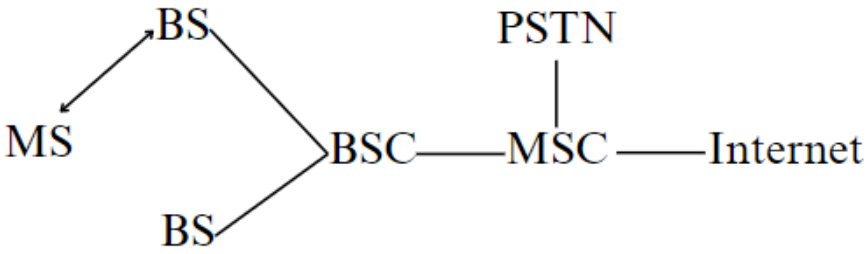

Figure 1. The architecture of AMPS

2G generation technology (digital)

Introduced in the late 1980s, the 2nd generation wireless mobile messaging system is a digital technology.It transmits voice at a speed of 64 kbps using digital signals. [3] 2G has a bandwidth of 30-200 KHz. SMS, image messaging, and MMS are among the services offered by 2G.It makes use of digital modulation techniques like CDMA and TDMA.Signals can be divided into time slots using TDMA. [4] For the purpose of communicating over a multiplex physical channel, CDMA assigns a unique code to each user. [5] There is use of CDMA technology such as IS-95 and TDMA technologies such as PDC, GSM, IS-136, and iDEN. The most popular 2G mobile standard is called GSM .In 1991, Finland introduced 2G on the GSM network for commercial use. [6] The first technology to enable worldwide roaming was GSM. As a result, mobile users were able to use their connections with greater capacity and quality in many nations across the globe.

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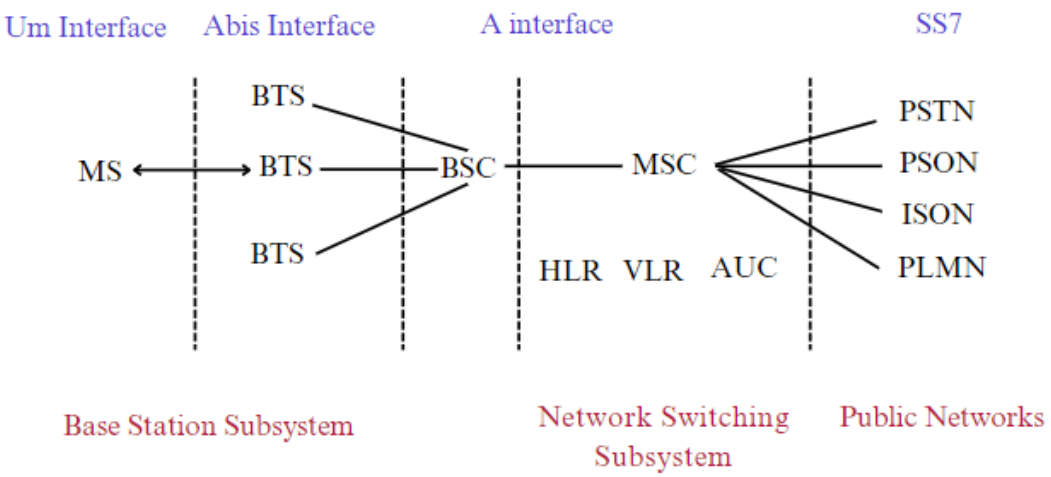

Figure 2. Architecture of the GSM System

2.5G Technology

In order to deliver better services, GSM technology was constantly enhanced, which prompted the creation of sophisticated systems known as 2.5 Generation, or 2.5G, systems.Between 3G and 2G technologies is 2.5G. 2.5G adds a packet controlled domain to the 2G system's circuit switched realm and offers a 144 kbps data rate. [7] GPRS and EDGE were among the technologies employed by 2G.Packet switching protocols, quick ISP connection setup times, and the ability to bill users based on data transferred rather than connection duration are all features of GPRS. [8] GPRS offers a persistent connection to the network and adjustable transfer of data rates. The important first step towards 3G is GPRS.

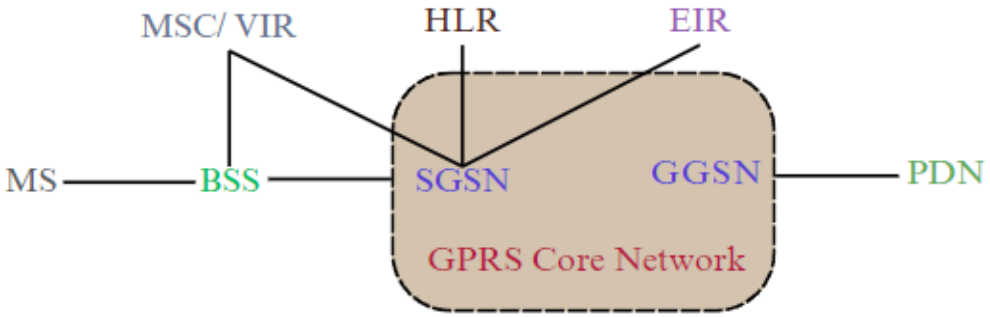

Figure 3. GPRS Architecture

3G third generation technology

In 2000, the third generation of wireless mobile communication technology was unveiled.Increasing data rates from 144 kbps to 384 kbps in broad coverage regions and 2 Mbps in small coverage areas was the aim of 3G systems

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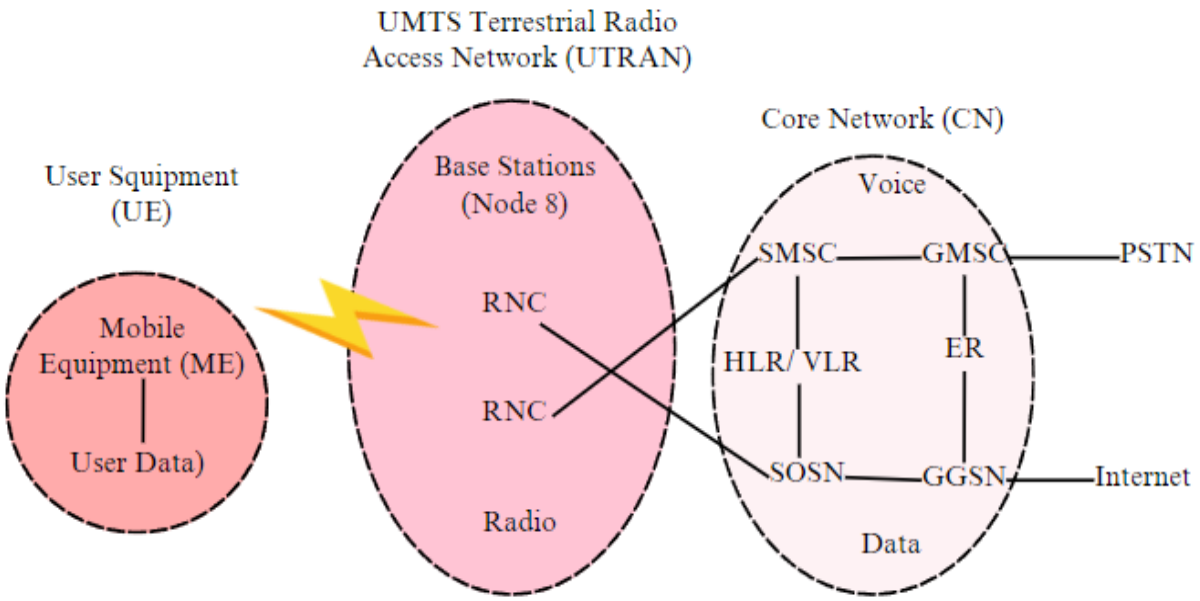

Figure 4. Diagram of the WCDMA Network

.In comparison to 1G and 2G, 3G provides consumers with more advanced services.It offers voice communication as well as access to data services,video and TV , Web browsing, email, video conferencing, paging, navigational maps, and fax. [9] Its 15-20MHz bandwidth is utilised for video conferencing, high-speed internet, and other purposes. [10] An organisation known as 3GPP defined a 3G mobile system that complies with IMT-2000 specifications. In Europe, it was referred to as UMTS and is driven by TSI.The third generation technology is referred to by the ITU-T as IMT2000, but the American 3G form is called CDMA2000. [11] Additionally, the IMT2000 has adopted TD-SCDMA, a new 3G technology from China.UMTS uses WCDMA as its air interface technology. [12] NTT Do co mo introduced the first 3G network for commerce in Japan in 2001.

4G generation technology

In order to provide mobility and seamless roaming between various wireless technologies, 4G technology integrates a variety of current and upcoming wireless technologies.WiMAX and LTE are regarded as 4G technologies. [13] In India, the first field test of 4G was carried out successfully in 2005.

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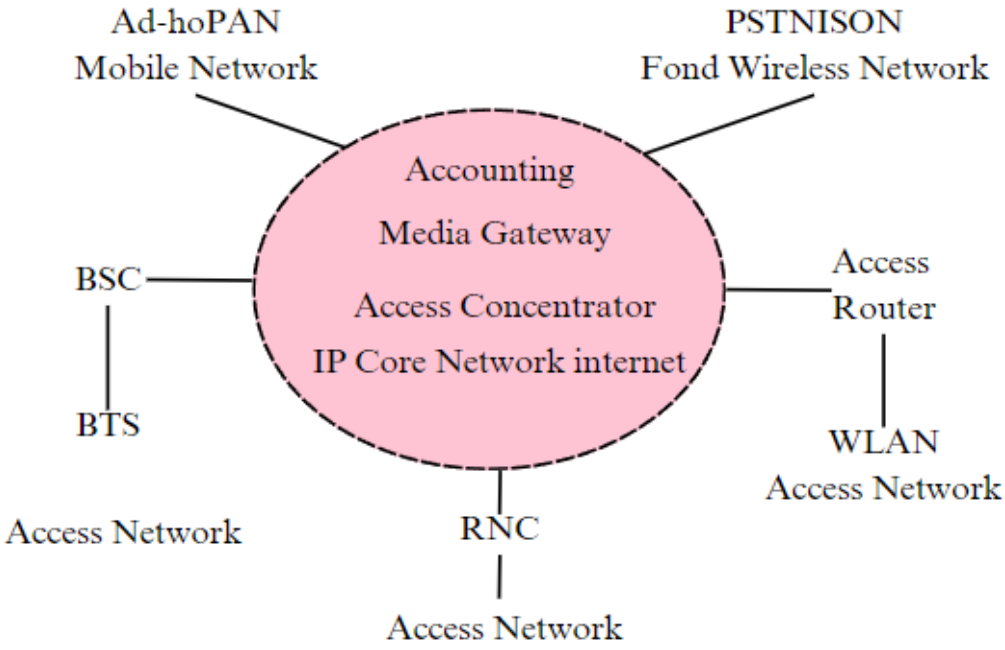

Figure 5. Architecture of 4G Networks

LTE advanced

It is said that LTE release 10, often known as LTE-Advanced, represents the real 4G progression step. LTE release 10 incorporates previous LTE releases as integrated components, offering simpler backwards compatibility and support for legacy terminals, among other benefits. According to [14], the primary requirements for LTE advanced are as follows:

1. 500 Mbps for peak uplink and 1 Gbps for peak downlink data rates.
2. Transmission bandwidth: Greater than 40 MHz in UL and roughly 70 MHz in DL.
3. Two times the user throughput at the cell edge compared to LTE.
4. Three times as many users throughput on average as in LTE.
5. Peak spectrum efficiency downlink is 30 bps/Hz, and uplink is 15 bps/Hz. This is three times higher than that of LTE.
6. Mobility: Exact same as LTE.
7. Coverage should be deployed in micro cell environments or local areas with an Inter Site Distance (ISD) of no more than one kilometre.

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5G generation technology

The real wireless world, which is supported by the fifth generation mobile and wireless communication network and is limitless, is also known as the perfect real wireless world, or WWWW. IPv6 is the fundamental protocol that runs on both 4G and 5G networks.The goal of 5G is to give everyone, everywhere, at any time, limitless access to knowledge and the capacity to share it for the good of all.With all of its sophisticated features, 5G mobile technology is the most potent and will likely be in high demand in the future. All-IP based mobile and wireless network interoperability underpins 5G mobile. This year has seen the beginning of 5G standardisation efforts, which could result in commercial availability by 2020.

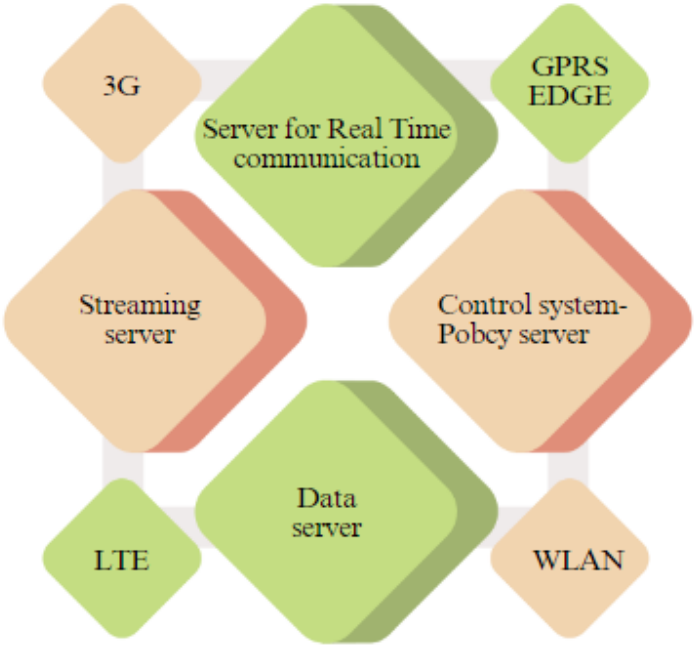

Figure 6. Architecture of the 5G Mobile Network

There is currently no 5G wireless communication system in use. As suggested features and architecture will boost system capacity and quality within the constrained available frequency spectrum, whose frequency band and Data Bandwidth will be greater progressively, the major issue for the design and deployment of 5G wireless systems may be readily overcome. The amazing thing about 5G is that it will not have any restrictions on user requests for the next 200 years. The entire wireless world will be connected with 5G, together with extremely fast data rates for Quality of Service (QoS) applications.

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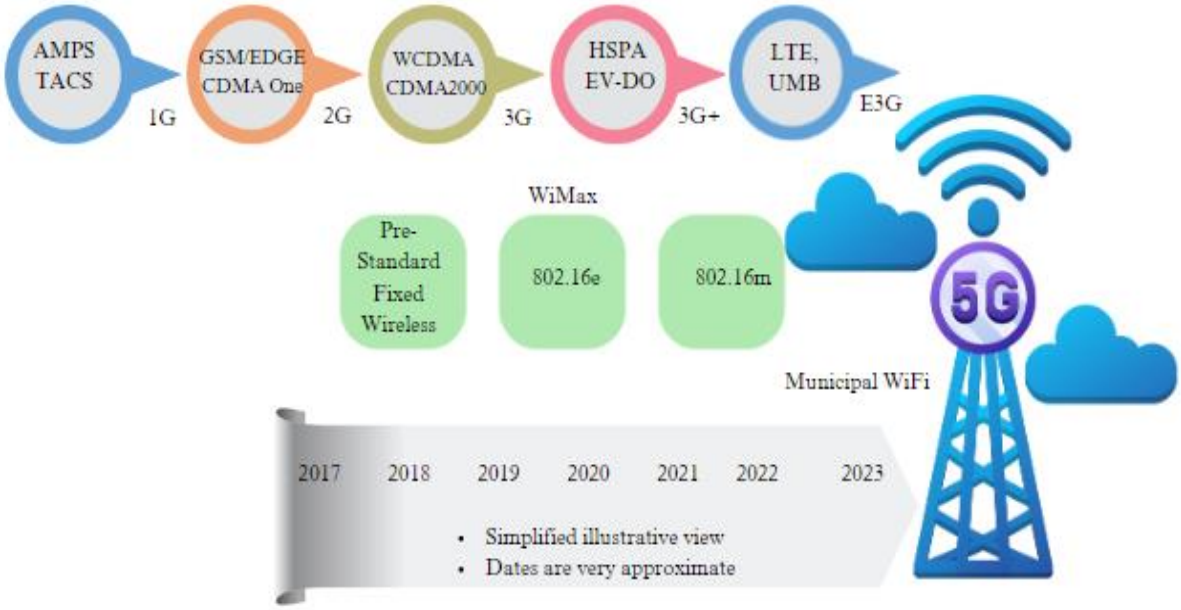

Figure 7: Developments in Mobile Technology

The 5G wireless technology is defined by the Physical and Data Link layers of the network, designating it as an OWA.Multi-wireless virtual networks are also maintained by 5G technology. The network layer is split into two layers to do this: the lower network layer for interfaces and the upper network layer for mobile terminals. Here, every routing decision will be made using IP addresses, which vary among IP networks globally. Open Transport Protocol is used in 5G technology to mitigate the greater bit rate loss (OTP).Session layer and Transport layer support OTP. The management of quality of service across different kinds of networks is done at the application layer..

The majority of the current communication infrastructures will be connected by 5G, a new technology that will offer all potential applications with a single universal device. The 5G terminals will have cognitive radio functionality and be multimode, upgradeable devices. Radio modulation techniques defined by software will be included. It is recommended that all necessary software updates be downloaded immediately from the Internet. The design of user terminals, which will combine several flows from different technologies and allow the terminals to access multiple wireless technologies simultaneously, will be the main emphasis of 5G mobile networks. Additionally, for a particular service, the terminal will select the best option from among many wireless/mobile access network providers.

Quality of Service (QoS)

The term "Next Generation Networks" (NGN) refers to a set of functionalities that facilitate applications and services in addition to data and control transfer. One of the fundamental control actions required to deliver Quality of Service is traffic measurement [5]. Furthermore, the best Quality of Service was used in the design of the 5G communication system (QoS). The ability of a network to handle various network performance factors including latency, error rate, and uptime, as well as to

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reach maximum bandwidth, is known as quality of service, or QoS. Setting priority for particular data kinds (files, audio, and video) on the network is another way that quality of service involves managing and controlling network resources. Only network traffic produced for online gaming, video on demand, VoIP, IPTV, streaming media, and video conferences is subject to QoS. Providing networks with priority, including dedicated bandwidth, managed jitter, minimal latency, and enhanced loss characteristics, is the main objective of quality of service. The fundamental building blocks required for upcoming business applications across campus, wide area, and service provider networks are provided by its technologies. Three essential elements are needed for a simple implementation of QoS: • Methods for identifying and labelling network nodes to enable end-to-end QoS coordination. • QoS in a solitary network component. • Functions for accounting, management, and QoS policy to oversee and manage end-to-end network traffic.

6G generation technology

Global coverage can be achieved by integrating satellite networks for communication and 5G into the 6th generation mobile and wireless data network. The satellite networks used for earth imaging, communications, and navigation could make up the satellite communication network. The integration of several satellite networks is the aim of 6G, which aims to offer mobile consumers digital media, connectivity to the internet, network location identification, and weather data services..

Table 2: A comparative analysis across all generations

Features	Generation					
	1G	2G	3G	4G	5G	**6G**
Core Network	PSTN	PSTN and Packet network	Packet Network	Internet	Internet	**Internet**
Handoff	Horizontal	Horizontal	Horizontal & Vertical	Horizontal & Vertical	Horizontal & Vertical	**Horizontal & Vertical**
Multiplexing	FDMA	TDMA,CDMA	CDMA	CDMA	CDMA	**CDMA**
Services	Voice only	Digital voice and short	Integrated high Quality audio, video	Dynamic information access,	Dynamic information access,	**Ultra Internet access**

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		messaging, packetized data	and data	wearable devices	wearable devices with AI capabilities	**fast**
Speed	2.4Kbps	64Kbps	2Mbps	200Mbps to 1Gbps	1Gbps and Higher	**10 to 11Gbps**
Standard	AMPS	GSM,PDC,IS-95,IS-136, EDGE,GPRS	CDMA 2000, UMTS, TD-SCD MA, WCDMA	LTE, WiMAX	LAS-CDMA, OFDM, MC-CDMA, UWB, Network-LMDS, IPv6	**GPS,COMPASS, GLONASS, Galileo systems**
Switching	Circuit	Circuit & Packet	Packet except circuit for air interface	Packet	Packet	**Packet**
Technology	Analog Cellular	Digital Cellular	Broadband CDMA, IP	Unified IP & seamless combination of broad band LAN, WAN, WLAN, PAN	4G+WWW	**5G+satellite**
Year	**1980-1990**	**1990-2000**	**2000-2010**	**2010-2020s**	**2022 onwards**	**After 5G**

Conclusion

The field of wireless mobile communication is expanding quickly. The cellular business has grown remarkably over the past few years. 5G, 6G, and 7G are the products of attempts to consolidate the many technologies into a single worldwide standard. Whereas 6G combines 5G with satellite networks, 5G seeks to create a truly limitless wireless society. There will be problems with handoff and roaming with 6G due to different technologies and standards. This is the motivation for the 7G mobile wireless networks, which seek to obtain space roaming. 5G trials have already begun, and commercial availability is anticipated by 2020.The world is working towards become entirely wireless, and as a

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result, people want constant, high-speed, higher-quality, more affordable, and more bandwidth when accessing information at any time and from any location.

Abbreviation

5G - fifth generation

BAN - Body Area Networks

IoT - Internet of Things

RFID - Radio Frequency Identification

VLC - Visible Light Communication

PLC - Power Line Communication

Competing interests

The authors declare that they have no competing interests.

Consent for publication

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Ethics approval and consent to participate

Not applicable

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Authors' contribution

Author A supports to find materials and results part in this manuscript. Author B helps to develop literature part.

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