# An Analytical Review on Different types of Antenna used in Wireless Communication

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**Abstract -** The most dynamic and rapidly expanding technology area in the communication sector is transmission technology. Sixth-generation (6 G) mobile communication systems have been developed in response to the growing demand for larger data rates and ultra-high-speed connectivity. Around 2030, the 6G mobile communication system is anticipated to launch. An antenna is crucial for every type of communication, including radio, LAN, and other types. The main job of the antenna is to send and receive crystal-clear signals between different wireless locations. It is safe to state that antennas are necessary for a powerful and effective wireless network to function effectively. Therefore, choosing the appropriate antenna is crucial to improve data communication in wireless systems. In this essay, various mobile communication antenna types have been reviewed.

Keywords – wireless communication, antenna, smart antenna, 5G, 6G, Ultra wide band,

## I. INTRODUCTION

The most dynamic and rapidly expanding technology area in the communication industry is wireless communication. Information can be transmitted wirelessly from one location to another without the use of physical mediums like wires or cables or other connections. In a communication system, information is typically sent across a short distance from a sender to a receiver. The transmitter and receiver can be located anywhere between a few meters and several million british kilometers with the use of mobile communications.

In addition to mobility, wireless communication offers ease and convenience of use, which is why it is growing in popularity day by day. Wireless communication, like mobile telephone, enables extremely high network throughput anywhere and at any time. The infrastructure is a further crucial point. Wired communication network infrastructure architecture and installation is a costly and time-consuming operation. Infrastructure for mobile communications is cheap to install and simple to use. In isolated areas and emergency situations, telecommunications is a suitable substitute where setting up cable communication is challenging.

The confluence of digital wireless technologies and the Internet [1] shows that there has been a shift toward wireless multimedia applications in recent years. High bit rates and a decent error management are both necessary to ensure a specific quality level of service. It is difficult to achieve both of these objectives at once due to the disruptive properties of wireless channels, which are primarily brought on by multipath multipath propagation (produced by reflective surfaces as well as scattering) and fading effects. Since wireless communication has advanced so quickly recently, multiband communication is now supported by compact equipment. Radiation pattern is one of the most important design concerns since it is a crucial component of the communication system. We need antennas that are compact and lightweight since we care about computers and portable [2].

An antenna is a signal-transmitting and -receiving device. Therefore, the send and receive process' speed presents a challenging challenge, particularly given the rapid advancement of telecommunications. However, because to the rapid expansion of network users and the need for a larger coverage area, high data rate transition was necessary for communication systems that are both fixed and portable [3]. They therefore required a broad bandwidth (BW) to cover all data broadband, including mobile. Wideband and ultra-wideband (UWB) antennas with low profile can be used for this in order to simplify the design and lower the cost of manufacture.

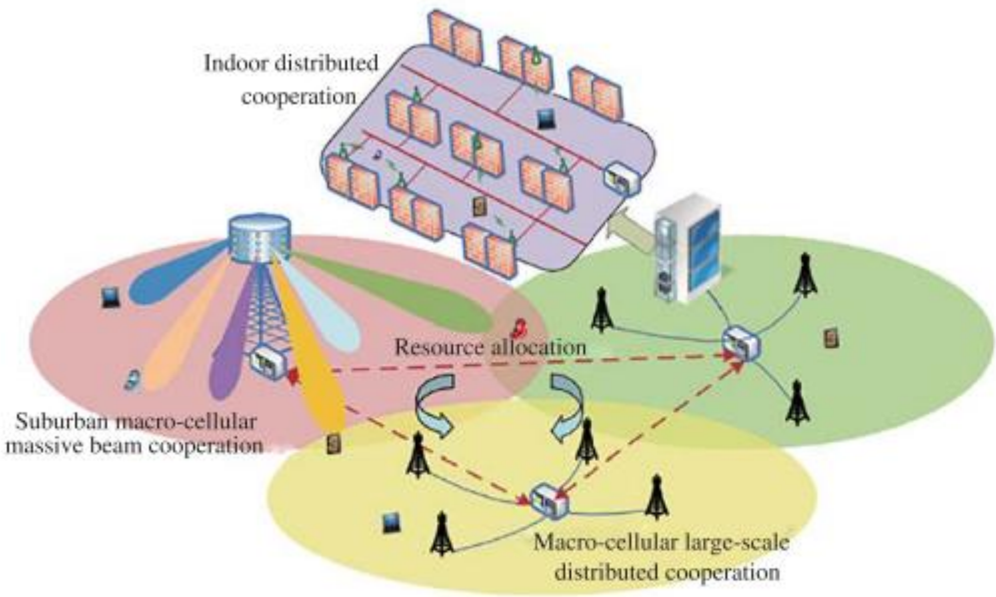


**Figure 1 Large-scale cooperative wireless communications [4]**

In order to satisfy future demand for the mobile data service, one of the primary objectives of 5G mobile networks is to further boost spectral and energy efficiency by an enormous margin more than those in 4G mobile communications. To significantly address the issue of the spectrum and energy efficiency both of mobile communication systems and to meet the aims of faster data rates and greener wireless communications, this calls for a new revolution in network technology and radio communication technologies [4].

### *A. SMART Antennas for Wireless Communication*

In reality, no antenna is intelligent; nonetheless, a wireless system is intelligent. In order to broadcast and receive incoming signals in a spatially sensitive and adaptable manner, a "smart antenna" combines an array of base station with signal computational resources [5].Steven Weber [6] trans- mission capacity is a statistic for decentralized wireless network research that examines and integrates a number of recent contributions. The transmission capacity (TC) framework, which focuses on a simplified physical/MAC-layer model, enables the determination of feasible single-hop rates despite the fact that it is notoriously challenging to derive general end-to-end capacity conclusions for multi-terminal or ad hoc network speeds. T. Rappaport [7] outlines several intriguing discoveries, novel theories, and current results that will help with the creation and integration of wireless networks' sixth generation (6G) and beyond. highlights many of the technological issues and possibilities for optical sensors and mobile communications above 100 GHz.

In order to meet customer demand for Future applications requiring higher data rates and ultra-fast connection, The 6G wireless communication system will use the Terahertz (THz) frequency band (0.1–10 THz). These applications' 6G antenna requirements are indicated. Zahraa R.M. Hajiyat presents a thorough analysis of recent relevant research on THz band antenna, manufacturing, and measurement [8]. In order to meet the expectations, modern advanced telecommunication applications like cognitive radio systems have spurred the growth of reconfiguration antenna systems. In comparison to traditional wideband antennas and multiband antennas, bandwidth enhancement antennas provide the next-generation wireless communication system a number of advantages [9]. Additionally, the communications of today need the use of several switching frequencies, which calls for the use of multiband antennas. It is determined that the microstrip patch antenna is a good choice to meet these RF communication software requirements. Microstrip patch antennas have a short bandwidth, low strength, and disordered radiation patterns, however [10].In [11], A. Pellegrini provides an overview of current advancements and body-centric language problems at 60 GHz and 94 GHz with open questions. However, there are a number of design difficulties that need to be carefully considered in order to raise the working frequency and construct the communication link in the THz range. To overcome path loss, It is necessary to have high power sources, efficient detectors, high gain antennas, and low-loss interconnects. Additionally, according to Kumud Ranjan Jha in [12], communication linkages must be created in low transmission atmospheric windows.

## II. MICROSTRIP PATCH ANTENNA in Wireless Communication

A class of planar antennas known as microstrip patch antennas (MPA) has undergone substantial research and development over the past forty years. Their widespread use in cellular systems both the governmental and the commercial spheres—has made them a favorite among antenna designers. The ability to print metamaterial or patch antennas directly onto a circuit board makes them more and more practical. The use of microstrip antennas in mobile phones is expanding rapidly. Patch antennas are inexpensive, have a small profile, and are simple to make. Due of its various benefits [13] over traditional microwave antennas, the microstrip line has been shown to be a great radiator for many applications. As a result, it has numerous uses across a wide frequency range, from about 100 MHz to 100 GHz. Although the size of a dielectric resonator has both benefits and drawbacks, there are some circumstances where the size is excessive. A microstrip antenna's frequency is inversely correlated with its size. Due to the sizes needed, microstrip patchwork are useless at frequencies below microwave. One of these antennas' primary limitations is their limited bandwidth.

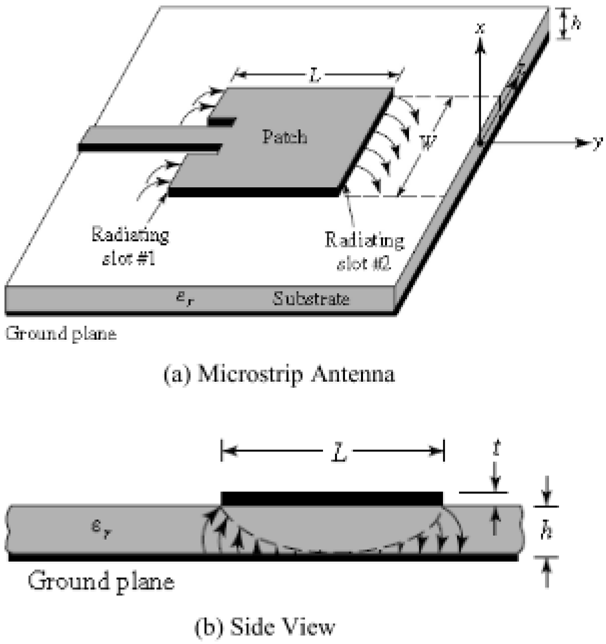


**Figure 2 Microstrip patch antenna with patch in the shape of a rectangle [14]**

techniques using coaxial, stripline, aperture-coupling, or proximity-coupling can all be used to feed this transmitter. Twenty years after its conception in the early 1950s, the patch antenna concept began to draw interest from the antenna community. According to M. Nawaz in [14], microstrip antenna are particularly helpful due to their light weight, capacity to adapt to any geometric shape, ease of incorporation with HMICs and MMICs, and low cost of manufacture.

Additionally, a lot of the designs did not explicitly state how the reduction in size would affect connectivity or efficiency. M. Khan has emphasized the critical requirement to understand how each parameter affects the antenna's ability to perform for a particular miniaturization process in [15]. To evaluate the effectiveness of the suggested miniaturization approach, it would be helpful to compare the antenna Q with the hypothetical lower bound of Q for ESA. There is also a need for miniaturization techniques that offer a clearer view of the methodology's physics and a process for creating miniature MPA for different bands through using suggested method.

### *A) Circular shaped patch Antenna*

Patch antennas with a circular shape are frequently used and have a wide range of uses. Numerous scholarly teams have been working on various forms. M. Kaur uses a customized circular antenna that operates across many bands in [16]. Few changes are made to the circular patch with the main goal of achieving wideband performance and wireless utilities. Ansoft's high-frequency structure simulator (HFSS) program, an electromagnetic three-dimensional simulator, is used to estimate the features between 3 and 21 GHz.R. Tiwari adopted the microscopic patch antenna as an originally generated in [17] for working to improve the various characteristics of microwave circuits, such as narrow bandwidth, cross antagonism, low gain and other things. Other techniques used with the microscopic patch antenna include Slot loaded, CPW-fed, and DGS arrangements with CPW-fed flaws implanted in the antenna antenna array (DGS). The circular patch antenna with a 5mm radius was proposed by N. Thaker. This design's dielectric material was chosen with r=2.4 and a substrate height of 1.6 mm. The formation of an L-slit with radius 0.2 mm, coaxial probe-feed location, and dimensions. At 5.769GHz and 9.74GHz, two resonance frequencies for the proposed antenna are found. In [18], several slit dimensions are analyzed.

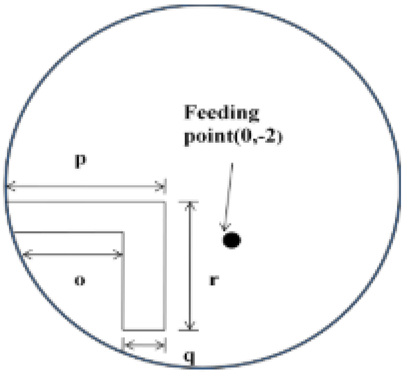


**Figure 3 Circular Patch Antenna with L-slit [18]**

### *B) Feeding Techniques of Microstrip Antenna*

The next crucial step after designing the appropriate patch is to supply the antenna with the communications that must be delivered as electromagnetic waves in free space. There have been many different feeding methods introduced in the past. Co-axial line feed, aperture quarter wavelength feed, proximity coupling feed, microstrip-line feed, waveguide inset line feed, etc. are a few of the most used feeding methods [19].

**1. Microstrip Line Feed**– It is the most basic feeding technique currently in use. In this, a port is connected to the other end of the newly disclosed supplementary Microstrip line, and a patch is connected to a Microstrip line with a susceptibility of 50 Ohms. The additional Microstrip line functions as the feeding point for the circular Microstrip patch antennas.

**2.Microstrip Inset Feed**– It is an improvement on the Microstrip lines that was first presented. In this method of feeding, a supply point is identified on the surface of the dielectric substrate where the patch's capacitance equals that of the 50 ohm Microstrip feed line. The feed cable is then fastened to that specific antenna position.

**3.Coaxial Feed Lines**– The patch antenna is attached to it via a coaxial adapter at a location where the printed substrate's resistance is roughly 50 Ohms. At this specific location, The patch surface is joined perpendicularly with a coaxial connector, allowing the patch antenna to be supplied from there.

A patch along one side of a dielectric substrate and an input impedance on the other make up the fundamental design of a conventional MPA, both of which are fed by coaxial or microstrip lines [20]. Over other patch antennas, MPAs have a variety of advantages, including low profile, lightweight, ease of fabrication, low cost, and simplicity of integration with monolithic microwave integrated circuits (MMICs). Additionally, they exhibit effective narrow bandwidth operation and intrinsic resonant performance [20]. Additionally, because to its multiple advantages over conventional antenna elements like reflectors, horns, slots, or wire antennas, ultra-wideband (UWB) MPAs have drawn increased attention in recent years.

However, there are a number of significant flaws in the electrical performance of the fundamental MPAs or array, including limited bandwidth, high feed network losses, subpar cross polarization, and low power handling capability. As a result, many antenna designers have been working diligently in recent years to improve numerous MPA properties as well as those of more specialized applications like nanometer, WiMAX, wireless local area network (WLAN), and UWB.

Broadband communication devices are equipped with numerous single-band or multi-band antennas in order to access multiple wireless networks since they must comply with multi-radio systems [21]. Currently, many fixed performance antennas are merged into a single device in order to accommodate a variety of communication protocols [21]. In certain cases, a separate radio and antenna are allotted for each protocol, taking up a significant amount of the portable unit's small interior area. Wavelength reconfigurable antennas and others like them are ideal in this situation since one antenna may replace numerous single-function transmitters and meet a variety of needs.

## III. Phased Array Antenna in Wireless Communications

Partial Array Antennas are arrays of antennas with the extraordinary capacity to alter the direction and form of the radiation pattern without actually moving the antenna. An antenna array's components are arranged so that the signals sent by each individual antenna combine and offer superior gain, directivity, and performance in a certain direction. This is accomplished by emitting signals at the same frequency from each individual antenna element in the array, but with a slight phase shift between them. While destructive interference might happen in other directions, the phase shift is calibrated to generate diffraction pattern in the desired direction. A phased array is a multiple-antenna technology that electronically adjusts or directs an electromagnetic (EM) beam during transmission or reception. These systems can be put into practice by adding a natural variability or phase delay to each antenna's signal path in order to account for path changes in free space.

The fifth-generation (5G) wireless communication systems, also known as millimeter-wave (mm-wave) communications systems, have gained a lot of attention as a next-generation solution and are anticipated to be deployed in the early 2020s. Regarding antenna topologies, For mm-wave 5G cellular devices, antenna technologies is still not widely used. For 5G mobile services, mm-wave antennas are recognized as the paradigm-shifting technology, given the importance and function of mobile phones in the mobile network sector. Considerable difficulties arise when using a mm-wave transponder inside of a mobile phone [22]. As a result, S. Ogurtsov in[23] presents conflicting design limitations and criteria to 5G antenna array designers. Additionally, these designers must manage a significant number of antenna array model designable parameters, which can be computationally expensive, particularly for repeating and adaptive simulations needed for design optimization and tuning. The difficult but essential process of determining the locations, orientations, and excitations of the array radiators is known as antenna array synthesis. This procedure makes sure that the antenna array's performance requirements are met. To make the process of creating 5G antenna array solutions easier, from the initial prototyping stage to the manufacturing tolerance analysis, the author argues that there is a need for reliable yet quick technological and mechanical design (CAD) and synthesize tools.

In [24], The BM-based BFNs are thoroughly analyzed by Vallappil, who also discusses whether BM type will be suitable for the staggered array antenna (PAA) system is a system in the next 5G and B5G wireless systems. Additionally, the author lists the various BM design types according to the quantity of layers. The three-layer, four-layer, and bi-layer architectures of BMs are distinguished. It comprises many methods that have been employed to address the issues of crossover, low bandwidth, and BM size reduction. According to earlier study, bi-layer BM systems were used for the majority of previous research projects, but tri- and four-layer BM, which had challenging shapes and difficult fabrication processes, were avoided. The bi-layer BM in this article, which is based on metamaterial (MTM), is also discovered to achieve low insertion-loss and phase-error, large bandwidth, a small size, and good S-parameter efficacy, making them a desirable BFN candidate for the next 5G and next-generation B5G systems.

In article [25], S. Ali sought to present a thorough overview of SIW MIMO and phased array antennas operating in the 5G sub-6 GHz and mmWave bands. It discusses the difficulties in developing various antenna structures as well as the particular problems associated to the band of operations. A similar analysis of manufacturing and antenna integration technologies for silicon-based micrometer phased arrays in developing communication applications is provided in article [26], as well as future research and development prospects.We focus on array topologies for scalability, antenna interface options, substrate materials and processes, antenna design, and IC-package codesign as we examine deployments of state-of-the-art silicon-based phased arrays below 100 GHz.

Downey will present a brand-new, Null-steering and/or beam shaping are used by the lightweight conformal phased array antenna in [26] to lessen ground contamination. and boost satellite microwave connectivity for telecommunication. Due to this design's lighter weight and capability to be fitted into the fuselage of smaller UAS aircraft, a viable technique to enable BLOS operation via spectrum sensing for a larger user base will also be investigated. Each and every frequency interval that is envisioned will have unique needs for the RF system, with repercussions for silicon-based differentiating technologies that will allow the development of related highly integrated ICs and Mechanisms on Chip (SoC). This is particularly true for SiGe BiCMOS technology, which supports a large number of ICs used in cellular systems, and on which Pallotta focuses in [27].

## IV. Limitations and Challenges

Significant research has been done in this area as a result of the exponential growth in data rates for mobile communication systems over the past few decades. have been widely used in the past for their record-breaking data speeds, particularly in the current fifth generation (5G) wireless communication technologies [28]. Higher data rates are also necessary to accommodate the anticipated sharp rise in cellular data traffic. Mobile communication devices can transport more signals at the THz band, which offers a potential solution to ensure the trans-mission rate and channel capacity, to address this problem. Technology in the Low-THz band is especially important for the planned beyond-5G or 6G communication infrastructure.According to article [29], it is a technique used to make up for fading channel deficiencies. Utilizing two or more receiving antennas is how it is put into practice. While Diversity is frequently used to lessen the depth and duration of the fades perceived by a receiver in a flat fading channel, Equalization is typically used to combat the effects of ISI. Both base stations and mobile receivers can use these strategies [30]. The most popular diversification strategy is spatial diversity. In this method, several antennas are placed at specific intervals and linked to a single receiving station.The receiver can choose the transmitter with the best signal at any time even if one antenna detects a signal null while another antenna detects a signal peak [31–35].

The use of feedback has been the major breakthrough that has surmounted the difficulty of making immediate channel adaptation practical[36]. Using a low rate data stream on the back of the shirt of the link, a feedback system feeds content to the transmitter of the forward side of the link. The transmitter incorporates this data to modify forward link transmission [37–39]. This data provides some insight into the issue with the forward link (e.g., channel state, receiver sensitivity, interfering level, etc.). The microenvironment, which significantly affects signal reception, is the most crucial factor for the assessment of channel path loss. However, it is unclear what factors, such as the depth and height of buildings, structures along roads, and rain absorbency, are taken into account when making observations [40–42]. Additionally, the authors of these studies looked into the path loss customizing to their own countries, hence there is no uniform international standard in these studies [43]. The understanding of smart antennas plays a dynamic leading role in the communication system. Smart antennas exhibit a wide range of benefits in the areas of coverage expansion, statistics rate enhancement, spectrum effectiveness improvement, and interference reduction, which controls the various features in better wireless communication [44].

An antenna must have a sufficient number of active elements if it is to be capable of switching between numerous states. A large number of premium active components, however, raises the cost and calls for intricate biasing networks and control circuits [45]. Cross-layer optimization, multi-user diversity approaches, and design flexibility to changing channel propagation and network conditions have all been addressed as major topics in the field of smart antennas. Challenges have been addressed, such as the design of a suitable simulation technique and the accurate modeling of signal transmission, involvement, and application losses, in addition to market changes, future predictions, and the anticipated financial impact of the deployment of smart antenna systems [46].

## V. CONCLUSION

Wireless communication is the most exciting and quickly developing technological field in the communications sector. The demand for faster connectivity and higher data rates has led to the creation of sixth-generation (6 G) wireless networking systems. The 6G mobile communication system is scheduled to go live around 2030. All means of communication, including radio and LAN, require an antenna. Sending and receiving crystal-clear signals between various wireless settings is the antenna's primary function. It is reasonable to assert that antennas are necessary for an efficient and effective wireless network to operate. Therefore, picking the right antenna is essential to enhancing wireless systems' network throughput. This essay has reviewed numerous modern communications antenna types.

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