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The Antennas of Next Generations

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ABSTRACT

The increasing complexity of optical networks to support a multitude of services leads to massive amounts of data. Moreover, any interruption, even momentary, can cause huge data losses, leading to a poor customer experience. The use of machine learning in various domains has been proposed and tested over the past decades. In this study we will propose a tool for estimating the transmission quality of optical connections before their establishment in the network, based on machine learning algorithms. A high level of service is guaranteed at any geographical location on both fixed and mobile equipment. The Internet of Things will connect billions of devices and sensors. The latency of data in 5G networks will be only one millisecond, compared to 50 ms for current systems. This is important because minimised latency will make near real-time communications possible, such as between two unmanned vehicles travelling in tandem at relatively high speeds or for applied virtual reality The main role of our paper is to study the analysis of the papers that have been published before on next generation antennas, in this area and see how to study and model the different algorithms of IOT and also of 6th generation antennas.

1. INTRODUCTION

In all these applications, the antenna is the component that is essential for radiating and receiving waves. The word is of Latin origin (antenna) and was used to designate the yardarm of the rigging of Roman ships. This name was therefore particularly appropriate for the radiating wire structures deployed by the pioneers of radiotelegraphy at the end of the 19th century. Subsequently, the structures evolved and diversified considerably to take account of both the discovery of new terrestrial propagation modes and the constant technological progress towards higher frequencies [1]. The aim of this paper is to investigate new generation antennas by highlighting the different antenna designs that have been studied, their modelling methods, structure, size, operating frequencies and the different application areas for future use. The objectives of this article are to research in a global way what has already been done in relation to new generation antennas in a general way, to bring out the references and to define the limits of these articles and results obtained to better approach the research subject and to project the different tools to be used. The domains of this article are numerous, namely: telephony, the Internet of Things (IOT), industries, artificial intelligence, telemedicine, remote sensing, radar systems, etc. This review is frequent when the scientific relevance of a research question is not clearly established. A relevance analysis will then be useful in identifying a research question of scientific interest.

2. LITERATURE REVIEW

For 5G, as for all other generations of mobile networks, antennas are an indispensable support. They are the ones that relay and transmit the signal. Without an antenna, there are no waves, and therefore no 5G. In order for the new 5G mobile network to work, operators must deploy tens of thousands of new antennas. This is because 5G antennas are completely different from 4G antennas. And they contain some of the major technological innovations of 5G that make the new mobile network so special. They are called Massive MIMO, beamforming, small cells. It's a bit of a mouthful, but we thought it would be helpful to decipher it for you to familiarise yourself with the new 5G antennas [2]. In the article published in the *International Journal of Communication Systems of* Md. Zulfiker titled « A dielectric resonator-based line stripe miniaturized ultra-wideband antenna for fifth-generation applications » Where their papers present a miniature dielectric resonator-based line band ultra-wideband (UWB) antenna original for 5G applications where this technique ensures the lower operating band and has significantly improved the efficiency without compromising the antenna size. The proposed design achieved the frequency bandwidth range of 3.55 to 4.2 GHz in the -10 dB scale, which covers the lower fifth generation (5G) communication band offered by the Federal Communications Commission (FCC) [3] and in the same scientific research momentum, Nawal Kishor published a paper in June 2022 entitled "5G smart antenna for IoT application" in International Journal of Communication Systems which discusses the fifth generation of mobile technology is called "5G" and relates that 5G refers to the next important phase of mobile communication standards after the upcoming 4G standards. With 5G technology, most broadband consumers would be able to use their phones in new ways. The better the propagation conditions for electromagnetic waves, the higher the frequency. To some extent, multi-antenna networks and beamforming can help mitigate this problem. Radio signals can be transmitted and received in a spatially targeted manner due to beamforming [4]. Thus, to evolve in the research with the evolution of antennas Ajit Kumar Singh published an intriguing paper "Reconfigurable circular patch MIMO antenna for 5G (sub-6 GHz) and WLAN applications", published in International Journal of Communication Systems in July 2022 which summarizes by saying: "A circular patch microstrip monopole feeder radiator with a dimension of 15 × 20 × 1.6 mm3 is proposed. An inverted L-shaped stub is used in the partial ground plane to achieve optimal bandwidth, radiation pattern and radiation efficiency. To further cover the spectrum below 6 GHz (3.4-3.8 GHz) for future 5G communications, a two-element MIMO antenna configuration is designed using the single element antenna. The edge-to-edge distance between the two elements is 0.15λ0 (15 mm). The proposed antenna achieved dual operating bands of 3.35 to 4.60 and 4.93 to 5.19 GHz in the diode (D) = ON state. The minimum isolation between 3.35-3.94 and 4.99-5.16 GHz frequency range is -14.5 and -12.5 dB, respectively, by incorporating a rectangular stub between two inverted L-shaped stubs. The average total efficiency at port 1 between 3.35-3.94 and 4.93-5.19 GHz is 65%, while at port-2 it is 75%..." [5] and finally Zikrul published a paper entitled "A low-profile rectangular slot antenna for sub-6 GHz 5G wireless applications", in International Journal of Communication Systems, 19 August 2022 which is summarised as follows: "This paper proposes a novel flat rectangular slot antenna designed and fabricated for sub-6 GHz 5G wireless application. The proposed design can operate in the 5G, WiMAX and LTE 42 bands below 6 GHz. The antenna has an inverted rod and a rectangular and E-shaped radiating slot with a circular parasitic element on its top side simultaneously activated by a microstrip feed line with a two-ply T-shaped design. The proposed antenna covers the 5G N77 band at 3.5 GHz. It has a size of 32.4 × 27.9 × 1.6 mm^3 with good reflection coefficient characteristics and excellent impedance matching. The reflection coefficient (S11) is at -26.5 dB, and the resonant frequency is 3.5 GHz, with a peak gain of nearly 4.2 dB. The proposed antenna has an efficiency of ≈82% for the whole frequency band and provides 19 MHz of total bandwidth. Finally, the proposed antenna is an attractive solution for 5G wireless applications below 6 GHz."[6]. The aim of this literature review was to bring out some of the antennas that have already been discussed on the subject of new generation antennas. The observation is that these antennas are generally of the 5th and 6th generation whose architecture is currently being studied and whose different domains are mobile networks, IoT, wireless networks.

3. PROBLEMS IDENTIFICATION

The Digital Divide creates major problems that contribute to desertification. On the one hand, 5G does not immediately solve the issue, because because of its frequencies, excellent coverage is more difficult to achieve. On the other hand, it is possible to imagine a small local loop for a hamlet with a central point (served by radio or fibre) and scattered points a few kilometres apart [6-8]. With 5G, it is possible to have "aggregate throughput", and radio resources could be distributed more flexibly among network users. However, public authorities have to play their part and with the increase in the number of users, frequency allocation becomes insufficient due to the limited number of channels. The allocation of frequencies becomes insufficient due to the limited bandwidth. On a single frequency, the number of users cannot exceed a certain limit. Therefore, there is a need for more bandwidth and faster data rate for fast transmission and reception of high quality multimedia data wirelessly from one terminal to another. To address this issue, 5G and 6G frequencies are being researched because of their higher bandwidth.

4. ADVANTAGES OF NEXT GENERATION ANTENNAS

The new generation of antennas has many advantages which can be summarised as follows:

- **Intelligent antennas thanks to beamforming**

Today, relay antennas, generally high points (pylons in rural areas and building roofs in urban areas), work like a street lamp. This means that they emit in all directions [9].

Thanks to beamforming technology, the signal processing by 5G antennas is different. Beamforming allows the waves emitted by an antenna to converge on a particular smartphone. Instead of indiscriminately spraying the entire environment. The macro antennas of 5G are therefore directional antennas that act like a directional beacon. The signal is directed in a specific direction rather than being directed in all directions, as is the case today with 4G antennas. Even better, 5G antennas work in this way even when users are on the move.

- **A signal adapted to users' needs with 5G antennas**

As we have just seen, with 5G antennas, the delivered signal is directed in a specific direction. And since the waves emitted converge on a particular device, this allows the antennas to emit a personalised signal, adapted to the needs of the users. This is called data slicing. But how does it work in practice? Today, when 10 smartphones connect in 4G to the same antenna, each receives roughly 1/10th of the bandwidth. In dense areas, in a stadium or at a concert, this can lead to a loss of network, even if you only wanted to send a simple message. With data slicing, the problems are over. Because the signal delivered by 5G antennas is targeted and adapted to the needs of each user. For example, someone who plays games on their smartphone will receive more bandwidth than someone who sends a message with a photo. In simple terms, data slicing is network virtualisation. This means that the 5G network is divided into slices. Each slice can be configured according to the use it supports. This allows for real-time, à la carte network management [10]. It will also allow prioritisation of uses. This means that a telemedicine operation will come before a streaming series.

- **A network with more capacity thanks to 5G antennas**

With 4G+, we discovered MIMO (Multiple Input Multiple Output) antennas, which means higher speeds and greater range than with 4G. With the 5G network, we discover massive MIMO antennas, which means the same effects, but multiplied.

The difference between the two? The number of connectors (miniature antennas). There are 128 connectors on 5G Massive MIMO antennas compared to only a dozen on 4G+ MIMO antennas. Eventually, Massive MIMO antennas will have up to 256 connectors. the illustrative Figure 1. of the 4G and 5G antenna

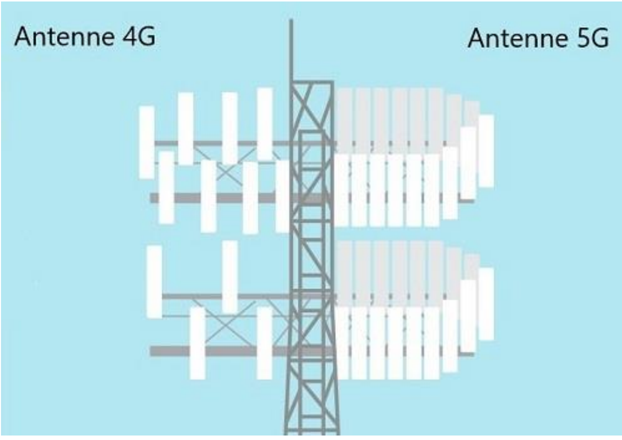


Figure 1. Comparative 4G et 5G [1]

- **Small cells for millimetre waves**

In the long term, the 5G network will use high frequencies, in the 26 GHz band (24.25 - 27.5 GHz). This is the so-called millimetre-wave band. It will make it possible to find bandwidth, which is essential for responding to the exponential growth in the number of connected objects, and to achieve speeds comparable to optical fibre. But, as their name suggests, millimetre waves have a notable drawback: a range of only a few hundred metres and difficulty in overcoming obstacles. The illustrative Figure 2.

Figure 2. Small CELLS [2]

Millimetre waves are perfectly suited to very dense areas (in cities), but they will require the installation of miniature relay antennas, in addition to macro antennas. These are called Small Cells and will need to be installed every 300 metres or so. They are small in size and can be perfectly integrated into street furniture, such as street lamps, bus shelters or advertising panels.

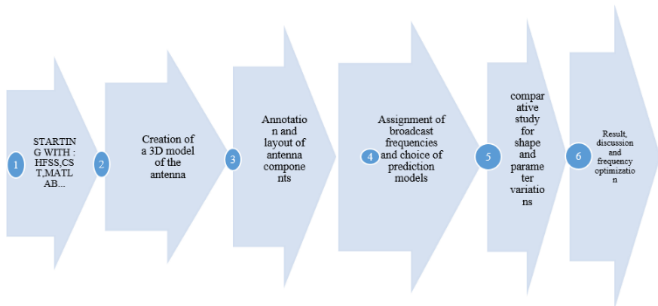
5. DETAILS OF PARAMETERS AND STATISTICAL OVERVIEW OF THE EVOLUTION OF NEW GENERATION ANTENNAS

5.1 Parameter details

The methods used to set up the simulation are described as the following steps are followed [11]:

- Configuration of the layers;
- Configuration of the model;
- Configuration of the excitation;
- Configuration of the analysis;
- Analysis setup;
- Plotting the results.

With these different steps we can draw the design and modelling diagram of the new generation antennas as follows:



5.2 Statistical review of NGN antennas

After several researches we can note that the new generation antennas are generally 5G antennas at the moment and generally the different types used are: Patch antennas, MIMO, miniature, multi-band and circular polarized antennas based on polarized ferrite materials, satellite technologies, miniature rectangular antennas all based on patch antennas and we have noticed that the frequency bands allocated are generally in the range of 2 to 6 GHZ with reduced dimensions in order to facilitate noise reduction [12].

6. SOFTWARE REQUIRED

After analysis of the different articles published so far, the most used software is the following:

- **ANSYS HFSS** (for all modelling, analysis and simulation). Ansys HFSS is a commercial finite element solver. method solver for electromagnetic structures from Ansys. The acronym stands for "high frequency structure simulator". Structure simulator. HFSS is one of several commercial tools used for antenna design and the design of complex radio frequency electronic circuit elements, including frequency range elements. Complex RF electronic circuit elements, including filters, transmission lines and packages [13, 14];
- **CST STUDIO** which is a dedicated set of solutions for performing simulations across the electromagnetic spectrum to design, analyse and optimise electromagnetic (EM) systems;
- **MATLAB** which uses predefined prediction models and applications in antenna optimisation;

- **PYTHON** which is a next generation language used for model predictions in artificial intelligence and genetic algorithm.

7. CONCLUSION

The comprehensive study of new generation antennas offers a lot of information about different types of antennas depending on the desired wireless communication system, we will choose the most efficient antenna, meet the need with the help of this analysis paper, we will choose the most efficient antenna to meet the need. In this paper, the applications and functioning of the antennas are studied along with their teams. After careful analysis we will say that the new generation antennas are based on the principles of machine learning and having well defined prediction models depending on the types of antennas (MIMO, Circular or Rectangular PATCH) and or Satellites; we also notice the applications of these antennas in mobile networks and IoT [15, 16].

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