DOI: 10.21917/ijct.2022.0418

ENHANCEMENT OF BANDWIDTH AND BEAM FORMING ANTENNA ARRAYS IN 5G CELLULAR COMMUNICATION NETWORKS

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Abstract

In general, an antenna is an interface that transmits signal data and receives incoming signal data. The radio waves received through this interface help to do the necessary things for the transmitter and receiver circuit systems used there. Also a radio transmitter antenna transmits different waves generated from the current generated at its tip to different areas. In this paper, the functions of increasing its bandwidth by making changes in some dimensions of the antenna are proposed. The oscillating current used in its transmitter area increases its vibration waves. This increases the amount of airwaves generated there and the number of data transmitted through it. So its bandwidth is more likely to be high. Furthermore these functions generate varying magnetic fields so that the time taken by the cross-sectional magnetic fields of the antenna varies.

Keywords:

Antenna, Radio Waves, Electric Current, Radio Transmitter, Bandwidth, Broadcasting, Two-Way Radio

1. INTRODUCTION

In this modern antennas are used to transmit and receive data through a communication wire channel or wireless channel. Or in other words, it can be defined as transmitting and receiving radio waves in all horizontal or specific directions [1]. These antennas act as an interface between electrical signals and radio signals [2]. Here, electrical signals are transmitted through metal conductors and radio signals are transmitted through free space. The main part of the antenna is made up of a conductor and the wider the antenna, the better the antenna performance [3-4]. At that time, wavelength comparison was based on the wavelength of the electromagnetic waves used [5]. Generally, an antenna with a long wavelength band is usually made of a transmitting wire, and an antenna with a very short wavelength band is mainly made of a plate conductor [6]. A conductor rod is used in the intermediate wavelength band. In these antenna conductors, current with a frequency similar to the wavelengths used, and the electrical charges are distributed with it [7]. For example, a strong electric field is generated near the conductor end of a high power transfer antenna due to high density electric charges, and a large current flows near the feed point [8]. When a fluorescent lamp is brought near such an antenna for that purpose, it burns due to a strong electric field [9]. Note that the current in the antenna is different from the current in the battery or the current in the household, and it is either high frequency current or very high frequency current, the direction of which repeats the vibrations at very high speeds and is continuous [10]. Even on a single wire, the current will vary in magnitude and direction depending on the location. However, if an incandescent light bulb is connected to the transmitter output terminal instead of the transmitting antenna, the current will flow and it will glow [11].

When an antenna individually, at a certain power, in a certain direction, produces the best transmission, how can it produce efficient output if a few more components are added? It was this idea that led to the invention of antenna arrays. The antenna sequence can be better understood by observing the following pictures [12]. Notice how the antenna rows are connected. An antenna array is a radiation system that consists of individual radiators and components [13]. Each of these radiators has its own induction field when operating. The elements are placed very close together, each in the induction field of a neighbor. Therefore, the radiation pattern they produce is the vector sum of the individuals. The Fig.1 shows another example of an antenna array. When designing these antennas the spacing between the elements and the wavelength corresponding to the wavelength must be kept in mind. The antennas radiate individually and when in line, the radiation of all the elements together brings together the radiation beam, which has a higher gain, greater mobility, and better performance.

When a high frequency current is transmitted through the antenna, a magnetic field is generated and an electric field is generated due to the charge distribution associated with the current. The generated electric and magnetic fields also oscillate as the current and electric charge change with oscillation depending on the operating frequency. However, since the fluctuations in the electric field excite one magnetic field and the fluctuations of the magnetic field induce an electric field, the vibrating electric and magnetic fields generated near the antenna propagate like waves in water to the surroundings while the other stimulates the surface [14]. It is an electromagnetic wave, and the radiation coming from the transmitting antenna is made according to such a principle. Note that the magnetic field and magnetic field strength of the electromagnetic waves are proportional to each other, so the strength of the electromagnetic waves is usually denoted by the electric field strength. The electromagnetic wave frequency of 3×10^{12} Hz or less used for wireless communications is called the radio wave. On the other hand, in order to cancel the electric field components of the incoming electromagnetic field, the receiving antenna acts to transfer current to the receiving terminal by flowing current through the antenna conductor [15]. This is the principle of the receiving antenna.

2. RELATED WORKS

Chuang, S.F et al. [1] discussed the oscillating electric and magnetic fields of the incoming radio waves exert power on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Chen, X.M et al. [2] explained radio filters; a transmission transmits not only sound signals but also images of the object over long distances. Radar plays a major role in modern naval, aviation and cosmonautics. Radar base is the reflective property of waves from transmitting bodies.

Darzi, S et al. [3] discussed the occurrence of variations of electromagnetic waves is seen in the direction of their reproduction from direct, when passing through the region of the barrier or through the hole. Electromagnetic waves are intermittent. In some places the waves increase with each other

Ahmadi, H et al. [7] expressed electric and magnetic fields are not only in matter, but also in vacuo. Therefore, the propagation of electromagnetic waves in a vacuum should be possible. The stage for the occurrence of electromagnetic waves is the rapid movement of electric charges. Therefore, the change in the magnetic field occurs

Ashikhmin, A et al. [10] discussed the antennas can be designed to transmit and receive radio waves equally in all horizontal directions (unidirectional antennas), or preferably in a specific direction (direction or higher gain antennas). An antenna may contain parasitic components, parabolic reflectors, or horns that transmit radio waves in the form of a beam or other desired radiation.

Bae, J.S et al. [11] discussed an antenna with a phase antenna array (PAR) have not yet found widespread use in the mass market of telecommunications devices (such as WiMAX, LTE, 3G, WiFi) and wireless communication systems. Isolated attempts have been made to develop such commercial antenna systems, but the results are not suitable for mass use.

Barua, S. et al. [13] discussed the significant cost of such devices associated with the high cost of microwave components (phase modifications, waveguides, etc.), in which most modern antenna systems are built with controlled radiation patterns, and most importantly, software, which is a very trivial task within the framework of this technology.

3. PROPOSED METHOD

An energy converter between electromagnetic waves and electrical circuits. The transmitting antenna converts the electrical circuit energy into electromagnetic wave energy and radiates it into space, while the receiving antenna absorbs the electromagnetic wave energy and converts it into electrical circuit energy. The antenna first refers to the insect antenna-like, and has nothing to do with shape, installation location, etc. However, since most of the early antennas were wires stretched in the air, in English it was called aerial, in Japan it was called an aerial. Recently, however, for many, the term flight has become irrelevant, not linear. Therefore, there is a strong tendency to merge with the word antenna.

Antennas developed using this technology have the following advantages:

- Low cost model for bandwidth utilization;
- Distributed automated generation wireless networks with multiple nodes;
- Reducing the influence of sources that interfere with the quality of communication;
- Minimizing the negative impact on the communication quality of signal reflections from surrounding objects;
- Determining the direction for the moving signal source;
- Low power consumption;
- High speed for changing final states;
- Quick communication interface with the computing device;
- High accuracy of output signal (voltage);
- Reconstruction capacity.

3.1 ANTENNA DESIGN

The use of electric vibrators mounted in the center of a capacitor resistor, whose value may vary, is considered to be controlled diffusers. The variation of the load resistance allows you to adjust the phase of the scattered waves by vibration. With this, the amplitude of the scattered field also changes. The proposed design (in which the scattering is placed in space, not in an airplane) allows you to arbitrarily change the relative position of the scattering, which expands the possibilities for improving its structure to obtain certain properties.

Directivity D = (Highest emission concentration of assessment antenna)/(isotropic antenna emission concentration) (1)

The ratio of the highest emission concentration of a test antenna is compared to the emission concentration of an isotropic antenna or reference antenna, which radiates the same power as a whole. The displays of the antenna show how energy can be radiated in one or more specific directions. The radiation pattern of the antenna determines its movement value. Alternatively, the ratio of the highest emission concentration of the test antenna to the ratio of the average emission concentration of the test antenna to the antenna direction can be defined.

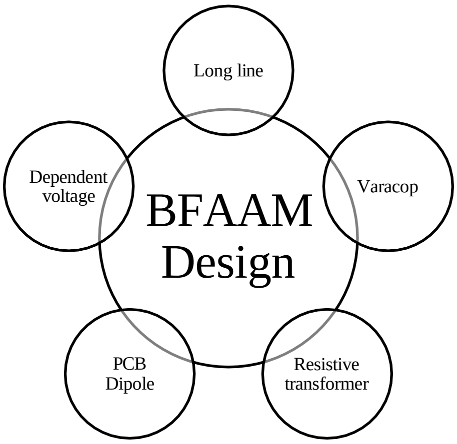

Fig.1. BFAAM Design

3.2 PRINCIPLE OF OPERATION

The operating principle of the product is as follows - For effective reception of radiation, the values of the loads of the scattering must be such that the phases of the waves generated by the scattering must be selected to ensure the optimal inclusion of these waves at the location of the transceiver element (feed).

Antenna Motion = (Highest emission concentration of an assessment antenna)/(Average emission concentration of the test antenna) (2)

To implement the described concept, the design of the diffuser - an electric dipole, as well as the structure of the entire glass formed from the diffusers - were calculated.

In addition, the design of the glass feed and its location relative to the diffusers are determined. Diffuser design shown in Fig.(1):

- Diffuser one side printed circuit board and a dipole
- A resistive transformer - a long line
- A veracop connected to a long line, shunt socks from the control lines and to the HF part of the diffuser separates.
- A dependent voltage is applied to the varicose vein.
- A long line (impedance transformer) was introduced in the design to expand the range of load resistance at the bipolar input.

The most basic constant gain for displaying the characteristics of such an antenna.

Step 1: First, the transmission antenna will be described.

Step 2: The value that indicates how many times the radiant power is greater in a exacting path is called the antenna power gain-factor or simply a gain-factor than the reference antenna that provides the same power.

Step 3: The radiant power reaching a given point is proportional to the quadrangle of the concentration of the electric field radiating to that point, it can be said that a high gain antenna is capable of radiating a strong electric field.

Step 4: The value of the gain will vary depending on what is used for the reference antenna. Next, the gain of the antenna will be explained to the receiving antenna.

Step 5: The antenna is placed in the incoming electromagnetic field, the maximum circuit that can be extracted from the antenna terminal by adjusting the electrical circuits connected to the terminal to match the antenna.

Step 6: The value of how many times the power is compared to the antenna is a power gain. Note that the gain when a particular antenna is used for transmission and the gain when used for reception are the same when the same antenna is used for a particular one.

Another important constant indicating the characteristics of the antenna is the radiation motion. It refers to how radiation changes with direction, and is also known as radiation motion or simply directing, and the form of the radiation is called the radiation pattern. When the radiation pattern is divided into several petals, the strongest radiation in them is called the main lobe and the others the side flaps. The direction of the antenna will vary greatly depending on the type, but the motion will be the same as when used for reception when the same antenna is used for transmission.

4. RESULTS AND DISCUSSION

The proposed beam forming antenna array model (BFAAM) was compared with the existing High-resolution AoA estimation (AOAE), exploiting multi-antenna techniques (EMAT), particle swarm optimization (PSO) and the memory based gravitational search algorithm (MBGSA)

Test sample measurements showed that the antenna had the following characteristics:

- Operating frequency range 2.4 GHz;
- Bandwidth working up to 200 MHz;
- Antenna range 60cm x 100cm with more than 21dBi;
- Reconstruction of the major lobe of the emission prototype in the azimuth plane from -60 to +60 and at an altitude of -15 to +15;
- Ensure transmission / stability when changing environment, and support multiple user operating modes when meeting high-speed end-stage switching and interface speed requirements.
- Average data transfer rate for Wi-Fi devices (IEEE 802.11b) - 6.85 Mbps over a distance of 6.5 km Number of simultaneous connections - 135

4.1 LONG WAVE PROPAGATION

This is usually larger because the wavelength used is longer. For this reason, it is built with an extended wire for propagation, but the radiation capacity is still generally low. There are umbrella antennas, T-shaped / reverse L-shaped antennas, vertical antennas, etc., named after their shapes.

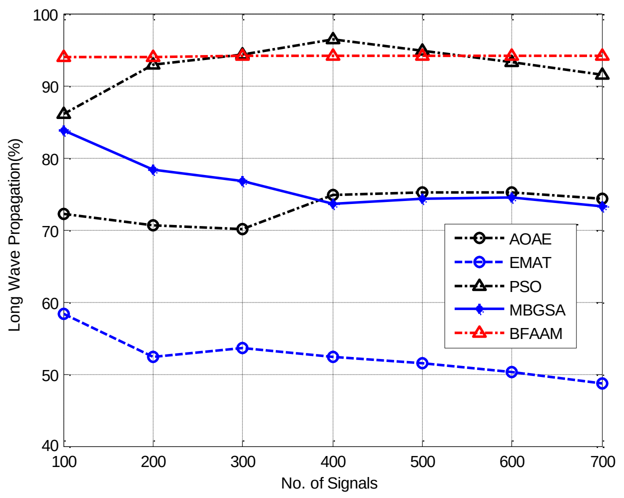

Fig.2. Comparison of Long Wave Propagation

Both are ground type, and a power supply terminal is provided between the ground terminal and the ground terminal of the conductor. In addition, there is a wave antenna with a running wire that extends straight to the ground for several kilometers.

4.2 MEDIUM WAVE PROPAGATION

The circular column antenna is a medium wave radio transmission antenna. It is a type of vertical antenna that uses the circular column as an antenna conductor. The lower end is insulated and acts as a feed end. To receive, there is a whip antenna and a loop antenna. The former is a small vertical antenna that receives vertically polarized waves (electric waves with a vertical electric field) and is used in other wavelength bands.

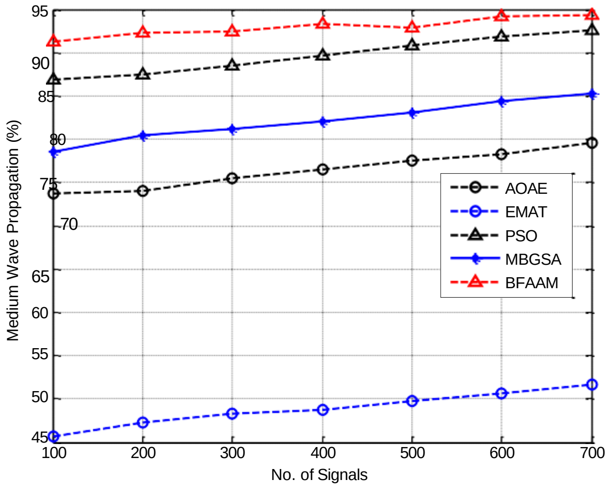

Fig.3. Comparison of Medium Wave Propagation

The latter is used to receive the magnetic field components of broadcasting effect, and a disk antenna with a magnetic center is used to reduce the magnitude using a magnetic field. The ferrite bar antenna is one of them. T-shaped and reverse L-shaped antennas used for long waves are used in the middle wave band.

4.3 SHORT WAVE PROPAGATION

The half-wavelength lead wire supplied from the center is called the half-wave bipolar antenna. This antenna is practically used in the bandwidth from a short wavelength to a very high frequency, while the antenna gain is a reference for comparison.

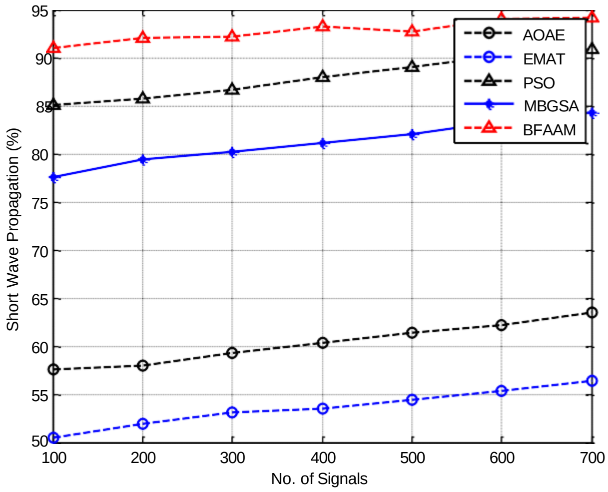

Fig.4. Comparison of Short-Wave Propagation

A sinusoidal standing wave current flow through the transmitting wire, and its radioactive motion is in the form of 8 in the hydroplane, including the antenna as shown in the Fig., and the circle in the hydroplane is at right angles to the wire conducting the antenna. A single-wavelength bipolar antenna with the effect of regulating two half-wavelength dipoles is also used. To further increase the gain, several of these are arranged to create a beam antenna. Beam antennas are used for shortwave international broadcasting and more.

4.4 ULTRA HIGH FREQUENCY PROPAGATION

Even in this wavelength group, the basic element is the half-wave bipolar antenna, but a folded antenna with the same radiation characteristics and better characteristics as the electric circuit is widely used. In both, there is a horizontal polarity type in which the conductor components are installed horizontally and a vertical polarity type in which the conductor components are installed vertically. In order to maximize profit, the diversity of such components is organized and used. There is a common high gain antenna in this band.

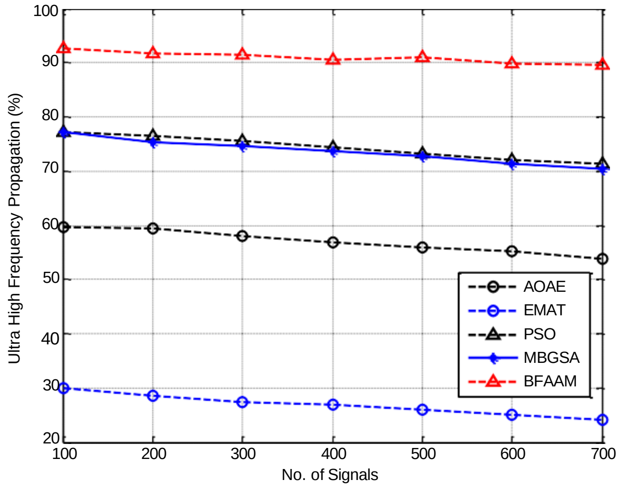

Fig.5. Comparison of Ultra High Frequency Propagation

The most frequently used antenna for television broadcasting is a super turnstile antenna. It is a combination of two components made of conductive wires in a military structure that are stacked in multiple layers for practical use. In addition, there are numerous dissimilar categories of antennas in practical use in this wavelength band, and there are many more types. For example, a circular loop antenna, two or more rows of them, a helical antenna, a slot antenna that exits a slit on the conductor surface, and various modified antennas of amateur radio. Their properties are also different.

4.5 MICROWAVE PROPAGATION

This is a common parabolic parabolic antenna. Some radar rotate the antenna using a complex curved surface close to a parabolic surface to create a reflector. One of these primary antennas is the horn antenna. It is a shape in which the cutting edge of the waveguide for microwave transmission is open and the shape and size vary depending on the purpose of the application.

A square pyramidal horn antenna is used specifically for the gain measurement of microwave antennas. Apart from these, various types of antennas such as a horn and a parabolic connecting horn reflector antenna and the slot antenna described above are placed for practical use. In addition, a series antenna with a multiplicity of these antennas is called a series antenna, which provides properties that cannot be obtained with an antenna.

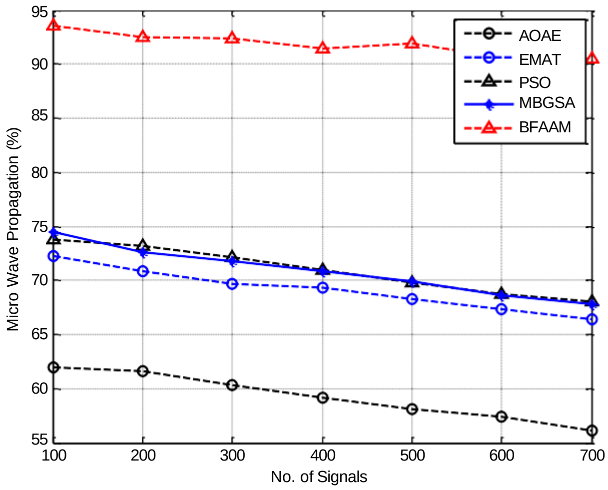

Fig.6. Comparison of Micro Wave Propagation

4.6 ANTENNA EFFICIENCY

The efficiency of an antenna is defined as the ratio of the total input power supplied to its terminals to the radiant power in all directions. Due to the loss of resistance in the antenna, the total utility input is not radiated in its target direction. The performance of the antenna is ‘The’. Antenna performance can be found in percentages when multiplied by 100. Usually, the antenna performance factor is between 0 and 1.

Antenna Efficiency=(Antenna Radiation power)/(Total Input Radiation)

$$AE = E_r/(E_r + E_i) \tag{3}$$

where,

E_r = radiation power

E_i = ohmic losses in the antenna

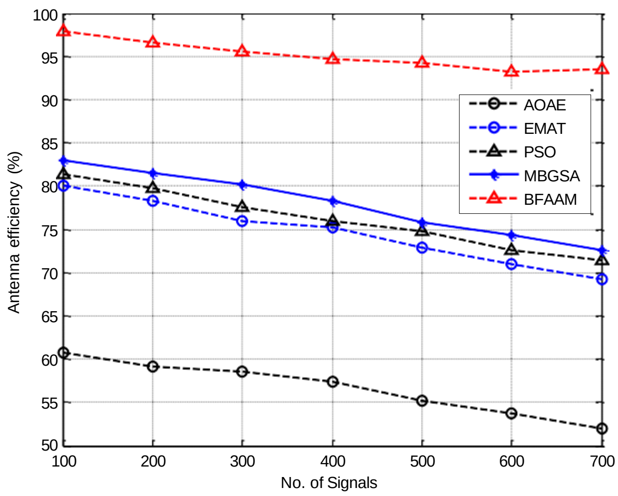

Fig.7. Comparison of Antenna efficiency

4.7 UTILIZATION OF BANDWIDTH

At a particular time, the highest amount of data transmission over the spectrum transferred is called the bandwidth utilization of a network.

BU (in %) = ((Total messages transmitted and received))/(speed of transmission)×100 (4)

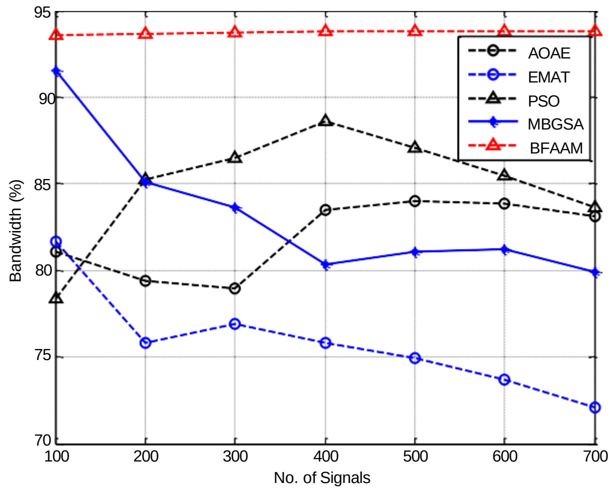

Fig.8. Comparison of Bandwidth

5. CONCLUSION

In general, the antennas have a limited bandwidth depending on their length, but some antennas can be used over a wide range of wavelengths. An example of this is a rhombus antenna built by extending long conductors in the form of a rhombus. The proposed beam forming antenna array model (BFAAM) was compared with the existing High-resolution AoA estimation (AOAE), exploiting multi-antenna techniques (EMAT), particle swarm optimization (PSO) and the memory based gravitational search algorithm (MBGSA). To make more profit, a lot of them are used. Also, as a ultra-white band antenna, the antenna has a recording interval in which bipolar antennas of different lengths are alternately fed in opposite directions. A loop antenna is used for direction detection. Hence the direction efficiency and bandwidth was increased.

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