

# Opportunities and Challenges of Mobile Communication Antenna Industry in 5G

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**Keywords:** 5G, mobile communications technology, antenna, study design.

**Abstract:** In the 21st century, the science and technology are changing with each passing day and the technologies are upgrading at an unbelievable speed. The development of China's mobile communication antenna industry is so fast that it didn't took a long time for 4G to be upgraded into 5G. In this paper, the development process of China's mobile communication antenna industry and the opportunities and challenges brought to the mobile communication antenna industry with the arrival of 5G era are described.

## 1. Introduction

Although the fifth generation of mobile communication technology (5G) is still relatively strange to many people, it will be applied to people's daily life soon. Compared with other networks, 5G network has faster speed and wider capacity, and greatly shortens the time delay in transmission, which makes network connection more extensive and rapid. In addition, the speed and quantity of data processing will also increase greatly so as to finally realize the interconnection of various platforms. 5G is a new generation mobile communication system after 2020. According to the development law of mobile communication, 5G will have ultra-high spectrum efficiency and energy efficiency [1]. The fifth-generation mobile communication system will further improve the network system and wireless transmission technology of wireless mobile communication based on the fourth-generation (4G) mobile communication system. The basic way to explore infinite spatial dimension resources, improve the effectiveness of power efficiency and spectrum efficiency is multiple-input and multiple-output (MIMO) technology [2].

As a very important part of the mobile communication antenna industry, the base station antenna is like the eyes and ears of people. The significance of eyes and ears lies in that they act as an important medium to absorb information from the outside world, and the role of base station antenna in the mobile communication network is an important medium to absorb information from the outside world. The intercommunication of mobile communication networks depends on the information output and input, and the base station antenna plays an important role in the output and input. When the output and input are blocked, the whole communication network will be blocked, making the quality of the communication network reduced, which will prevent the communication network from smoothly transmitting between devices.

With the long-term evolution from 1G simulation technology to 4G technology, the mobile communication system is now used by more than two-thirds of the world's population, and has become an important part in people's daily life. At present, it is the 4G technology that are widely promoted in a large scale, therefore, comparatively speaking, 5G technology is still very strange to the public. 5G network is not far away, on the contrary, it will be in use soon. It is an important issue how the antenna industry should cooperate with 5G network, and ultimately promote the coverage of 5G network more widely. Next, this paper will discuss the opportunities and challenges faced by the mobile communication antenna industry in the 5G era from the perspectives of the development course of China's mobile communication antenna industry, engineering design and technical demand development.

## **2. The Development Course Of China's Mobile Communication Antenna Industry**

The development of base station antennas in China dated back to 2001. Before 2001, China's base antenna did not have its own independent industry, instead, it relied almost exclusively on foreign companies. Almost all the Chinese antenna companies were leeching on to multinational companies, and did not earn much money. The mobile communication antenna industry has been monopolized by multinational companies. After 2001, with the efforts as well as independent innovation of China's antenna companies, the communications industry gained continuous development, as a result, the antenna companies have continued to grow and the number of base antennas has also increased. It was in 2002 that the independent antenna industry began to develop in China. For the two years after 2002, the domestic antenna industry has made some improvement in the market, however, China's antenna industry has a smaller market share compared with the market share of multinational companies. After 2004, China's antenna industry is occupied by three major telecommunication industries of China Mobile, China Telecom and China Unicom. Not only the market share of domestic antenna industry is also expanding, but also the antenna industry is developing rapidly. In less than five years, the market share of domestic antenna industry has exceeded 80%. However, there was still a serious problem at that time that the antenna companies of the United States and Germany were still in a dominant position in the global market, which greatly hindered our antenna industry from going abroad and going to the world market. Through the continuous efforts, independent innovation and independent development, China's mobile communication antenna industry broke the monopoly of multinational corporations, the antenna industry began to go abroad, and occupied larger and larger share in the global market. In recent years, Chinese antenna companies has got a very good ranking in the global antenna market, and it can be said to be a leader in the global antenna company.

## **3. 5g Network Characteristics and Demand Evolution of Antenna**

Although 5G commercial is on the way, it has no cost-effectiveness advantage in network coverage and high - capacity scenarios because the goal of 5G network technology is to solve the problems of ultra-high capacity, low delay and large connection. Moreover, the high-level 5G Massive MIMO base station system still has the problems of large volume, high energy consumption, difficult location of new stations, high cost of network construction, etc., which are difficult to solve in a short period of time. Therefore, in the next 5 to 8 years, 4G network will still be the foundation and 5G network will be the superposition of 4G networks.

During this period, the best cost-effective solutions for 5G network construction are this. In ultra-high capacity and flow layers, the outdoor Sub 6GHz will use 64TR Massive MIMO antenna, and the indoor millimeter wave will also use the Massive MIMO antenna. In medium-high capacity and coverage layer, outdoor Sub 6GHz uses 16TR Massive MIMO antennas, 8TR Massive MIMO antennas, and 4G multi-system shared active/passive antennas, and indoor Sub 6GHz uses active/passive systems.

The coexistence of 2G/3G/4G/5G networks will also leads to a series of engineering difficulties. The base station site is a scarce resource like frequency spectrum, and the site selection is difficult; the load of the tower infrastructure is not enough to support the number, size and weight of the base station antenna, and the layout is difficult. According to the current situation of multi-network coexistence and multi-system integration, integrated, comprehensive and miniaturized active and passive antennas are urgently needed to solve these problems. It is predicted that in the future under the mainstream scenario, all non-5G demands will be highly integrated into one pair of antennas, and all 5G demands will be highly integrated into one pair of antennas, thus forming a binary layout in the 5G era. In the special scenario, all the requirements are highly integrated into a pair of antennas, thus forming the ALL-IN-ONE layout in the 5G era. In this sense, antenna is an expert of network coverage, and scientific planning of antenna resources is an important part of network construction planning.

Driven by the two factors of increasing capacity and operating frequency band, the coverage radius of the cellular will be significantly reduced, and the number of base stations needed will be multiplied, as a result, the demand for base station antennas will be multiplied, and the usage of active antennas will increase. In the 5G era, the purchase amount of antennas by operators will be doubled. It is estimated that at the peak of 5G construction, the global annual purchase amount of antennas will exceed 20 billion US dollars, which is four or five times what it is now. It will bring huge development opportunities to the mobile communication antenna industry.

## **4. 5g Challenges and Opportunities Faced by Antenna**

### **4.1 Challenges for 5G Antenna Engineering**

First, power amplifier efficiency and heat dissipation challenges. 4G antenna is connected to RRU after RF beam forming network, i.e. centralized high power amplifier. Massive MIMO antenna is connected to a small power amplifier after each subarray, that is, 64TR antenna needs 64 sets of small power amplifier. The efficiency of a small power amplifier is much lower than that of a large power amplifier, and invalid power will be converted into heat energy. Since the base station antenna is placed outdoors in the open air, where water cooling and air cooling can't be easily used, so only thermal grease and cooling fins with poor heat dissipation effect can be used. Seen from the miniaturization layout of the antenna, the power amplifier is just sandwiched between the antenna array surface and the digital circuit board, which is not conducive to heat dissipation. Therefore, improving power amplifier efficiency is not only a major challenge for RF technology and even chip development, but also the key to realize energy saving, environmental protection and low-cost operation of 5G network.

Second, the challenges of mass production and rapid testing capability. It is estimated that China's three major operators need about 5 million 5G macro sites, which means needing more than 15 million sub base station antennas. Assuming that 30% of the base stations to be built in five years use 64TR Massive MIMO antenna, one million 64TR Massive MIMO antennas will be needed every year, and 3000 antennas need to be produced every day. Therefore, large-scale production capacity and fast test capability are also the key to the successful landing of mass MIMO antenna. Chinese antenna manufacturers are required to highly integrate production automation, business digitalization and information intelligence to improve production and testing capabilities.

Third, cost challenges. The antenna adopts Massive MIMO technology, especially the 64TR in ultra-high capacity, so it needs to be equipped with multiple groups of RF units. From the perspective of cost, the cost of a 5G base station with a 64TR Massive MIMO antenna is much higher than that of a 4G base station, in addition, 5G base station consumes two or three times as much power as a 4G base station. Lowering the cost of 5G Massive MIMO antenna system is not only the primary condition for 5G low-cost network construction, but also the inevitable requirement for operators to "reduce cost and increase efficiency" in the construction and operation of 5G network.

Fourth, the challenge of resource allocation for antenna systems. In order to further improve the efficiency of wireless resources in the network, it is also necessary to further optimize time and space resources and power resources, which is a new challenge in wireless resource management. Therefore, the high-performance and low-complexity resource allocation for the implementation of antenna system plays an important role in the realization of antenna system.

Only after overcoming the above four challenges, can the 5G Massive MIMO antenna truly achieve large-scale applications.

### **4.2 The Opportunities Brought by the Internet of Everything Stimulate Huge Market Demand**

From 3G to 5G, different network technologies have brought new challenges to the antenna industry, and the antenna industry has continuously improved its technology with the development of different networks, which has laid a solid foundation for the development of the next network, and made the industry more and more mature. The 3G era can be said to lay a solid foundation for the 4G

era, and the foundation of communication antenna is in the 4G era, during which China's mobile communication antenna industry is becoming more and more mature. With the continuous development of domestic mobile communication antenna industry, China's base antenna industry has also made very great achievements. Taking the number application for base antenna as an example, the number of antenna patent applications in China ranks the first in the world. Moreover, the number of patent applications in China is showing an increasing trend, which becomes more obvious after breaking down the patent monopoly barriers of multinational companies. In the field of base station antenna, it can be said that many important technologies come from our country despite the fact that Europe and the United States are veritable antenna giants with development earlier than China and more mature industry than our country. In the 2G and 3G era, the development of China's antenna industry is slow, following European and American countries without competitive advantage and core technology. However, in the 4G era, China's antenna industry has gained great achievements, surpassing many antenna giants. Under this condition, China's 5G network advantage is more obvious, and the antenna industry ushered in new development opportunities. With the continuous development of society and people's deepened dependence on network demand, the core of antenna industry will change from technology orientation to user experience orientation.

The peak of the 4G network construction has passed. Since 2017, the global mobile communication antenna market has entered a turning point and quantity demand has begun to decline. However, with the advent of the commercial process of 5G network, the antenna market will usher in new demands.

From the perspective of output structure, in the early stage of 5G commercial operation, operators will carry out large-scale network construction, and the investment in communication equipment will increase significantly, which will last until the mid-term of 5G commercial operation. In the middle and late period of 5G commercial, information services related to 5G of Internet enterprises will become the main source.

From the perspective of equipment expenditure, in the early stage of 5G commercial, operators will carry out large-scale construction of 5G network. With the continuous improvement of network deployment, the vertical industries in the middle and later stages of 5G commercial will become the main force of network equipment expenditure.

According to HIS, it is predicted that by 2035, the global 5G value chain itself will have generated up to \$3.5 trillion in output, and indirectly generate an economic value of \$12.3 trillion.

After the 5G network is put into operation, it will be extended to the Internet of Things, vehicle navigation entertainment, HD video, smart city, smart port, smart home, smart grid, smart manufacturing, unmanned aerial vehicle and 5G-V2X and other all-round fields, thus bringing huge vertical industry market demand.

## 5. Conclusions

It can be foreseen that with the advent and applications of 5G network, China's Internet of Things and other intelligent industries will usher in qualitative changes and improvements. Although great achievements have been made, it is necessary to clearly understand that there are still many engineering and scientific problems for us to explore and solve in the research of 5G technology. China's mobile communication antenna industry should also seize development opportunities and achieve even more remarkable achievements.

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