



# Current Situation and Future Development of Smart Home Chips

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**Abstract.** The initial definition of smart home is to connect various information-related communication devices, household appliances and home security devices inside the home to a home intelligence system through home bus technology (HBS) for centralized or off-site monitoring, control and home transactional management. With the continuous progress of science and technology and the development of society, the concept of smart home is constantly updated and gradually evolved into the current definition: "platforming on residential, with the use of integrated wiring technology, network communication technology, security technology, automatic control technology, audio and video technology, integrating home life related facilities and building an efficient management system of residential facilities and family schedule, thus enhancing home security, convenience, comfort and art, and realizing an environmentally friendly and energy-saving living environment." This article introduces the current status of the smart home chip industry and predicts the future development direction and prospects. The article first makes a description of the concept and content of smart home, which illustrates the role of chips in smart home. The second part expounds the classification of chips. The third part analyzes the current situation of smart home chip industry and the requirements of smart home for chips from various aspects such as core technologies, chip material, main application scenarios, etc., by making comparison with 5G technology. Finally, the article summarizes the smart home chip industry and looks forward to the development prospect of smart home chips.

**Keywords:** Smart home, IoT, chip, industry, material, data transmission, latency, Bluetooth, semiconductor process, industry standards

## 1 Introduction

Smart home refers to using advanced computer technology, network communication technology and integrated wiring technology to organically combine various subsystems related to home life, and making domestic life more comfortable, safer and more effective through integrated management. In recent years, smart home has been developed rapidly, ranging from intelligent machines such as robot vacuum cleaner, intelligent dishwasher and intelligent refrigerator, to intelligent lighting, intelligent

perception, network communication, home audio equipment and other intelligent systems. Smart home has gradually come into people's lives. Home life is increasingly intelligent, in which the chips play a vital role. Chip is one of the key components of every Internet of Things (IoT) device in the future, which is essential to data processing and transmission of IoT. Chip is the control core of smart home, through which we realize fingerprint recognition, voice recognition, videographic display, button touch, frequency control, connection of each module, data interaction between modules, etc. The chip can be called the bridge and link of the whole product. In addition, the chip can also form a home gateway, control illumination, so that the relationship between people and things becomes easier and more convenient. The chip is indispensable for smart home to be growth industries and to enter people's lives smoothly. This paper analyzes the types of chips used in smart homes and the current status of their use, compares them with 5G cell phone chips in different aspects, and makes predictions and outlooks on the future of smart homes. It helps to enlarge people's knowledge of smart home chips and their understanding of the future direction of the smart home industry.

## **2 Types of smart home chips**

As for smart home, in general, the following types of chips are mainly used.

### **2.1 Security Chips**

The security chip is equivalent to a "safe" in which the most important information and password data are stored. Encryption and decryption operations are all done inside the security chip, and the password data can only be exported from the security chip to the upper layer, thus avoiding the possibility of the password being cracked. The key length that the security chips support is up to 2048 bits, making personal information less likely to be leaked.

### **2.2 RF Chips**

RF chip refers to an electronic component that converts radio signal communication into a certain radio signal waveform and sends it out through antenna resonance.

### **2.3 Identification Chips**

Identity recognition relies on the physical characteristics of the human body for identity verification. Physical characteristics include human identity characteristics such as fingerprints, voice, face, skeleton, retina, *iris* and DNA, as well as personal behavioral characteristics such as the action of signing, walking gait, and the strength of hitting the keyboard. Identification chip has the advantage of being fast and secure. Take fingerprints as an example, it does not require people to memorize. It can be used at any time

during the process of carrying out identification, and there is no possibility of being forgotten or lost.

These three kinds of chips are widely used in intelligent sensors, network communication, human-computer interaction and other technologies. Specifically, the chips involved in smart home are extremely rich, including MCU main control chips, card reader chips, voice chips, microcontroller chips, switching mode power supply chips, storage chips, motor driver chips, Hall monitoring chips, fingerprint algorithm chips, protocol connection chips and codec chip, etc. [1].

### **3 Current situation of China's smart home chips**

As a part of the IoT, the development of smart home is quite different from other high-tech fields, and the requirements of its chips are also different. Taking 5G cell phone for comparison, we can analyze the current situation of smart home chip development in China from the following aspects.

#### **3.1 Core Technologies and Their Research & Development Status**

To make smart home have better performance, it is necessary to make a breakthrough in its control technology. From the past analysis of control effects, power carrier (PL), twisted pair (RS485, etc.), Bluetooth technology, wireless communication Ethernet (IEEE802.11), X11 and infrared technology are suitable for smart home control [2]. These existing technologies need to be adapted, adjusted, or upgraded on their current basis to make them better suited for smart homes. After the establishment of intelligent bus standards and appropriate protocols, the key to the control of home appliances lies in the interface, while the key to the interface technology lies in the integrated circuit. China's research level in the production of semiconductor integrated circuits is low and lags behind foreign levels, making it difficult to meet the requirements of the chip industry for the development of IoT.

Compared with the smart home chip industry, the China's 5G chip industry faces greater difficulties and challenges: China's 5G chip industry foundation is weak. The whole industry is lack of key core technologies, facing the risk of being choked by foreign enterprises. With 5G chip product development facing foreign patent blockade, China's patent reserves are very weak, and the independent research and development is facing many barriers.

#### **3.2 Chip Materials**

For chip makers, the rising prices of upstream raw materials in recent years have led to escalating costs of manufacturing chips, which has dealt a heavy blow to the entire chip industry. Consequently, the capacity of smart home chips has inevitably been in crisis. Take MCU chip as an example. MCU chip is the main control chip in smart home, and the development of smart home has put forward more requirements on its quantity, quality and performance. Since the second half of 2020, the prices of semiconductor

raw materials and components have risen sharply and the problem has continued to fester. MCU chips, as important ones among them, have seen a period of price surge, with some MCU chip prices rising even more than 10 times. In addition, factors such as insufficient production capacity led by the COVID-19 epidemic, policy-induced shortages, and the 5G industry accelerating the expansion of chip market demand have jointly led to global production difficulties.

As an emerging industry, 5G is facing the problems of rising prices of raw materials and insufficient production capacity in addition to its manufacturing process technology, while continuous breakthroughs are also required to enable users to have a better experience. Among all the chips, the material process technology of RF chips and devices will undergo significant changes. For wave filters which is an essential part of RF chips, 5G terminals and small base stations will use body acoustic wave (BAW) filter based on aluminum nitride, zinc oxide and other piezoelectric thin film material more often in response to the demand for high-frequency applications. In terms of packaging, due to the increased loss in the high frequency band, the PCB board for RF device packaging needs to be replaced by high-end ceramic substrates. However, the compound semiconductor OEM market is mainly monopolized by Taiwan's large manufacturers, while large foreign manufacturers are technically advanced in germanium silicon and insulating silicon material processes [3].

### **3.3 Main Application Scenarios**

The main application scenarios of smart home are homes and companies. These scenarios do not require continuous wide area coverage or extremely low latency, and the requirements for chip technology are relatively low. The main application scenarios of 5G are designed for continuous wide area coverage, wi-fi hotspot high capacity, low power consumption, large connection, low latency and high reliability [4]. The difference in scenario scale determines the differences between smart home and 5G chips in terms of IC scale, microcontroller scale, etc.

### **3.4 Data Transfer Technology and Data Throughput**

From the demand of smart home applications, Bluetooth technology which has low power consumption and is equipped on every cellphone has great advantages. However, Bluetooth technology still has certain problems. Each Bluetooth device can only stay connected to a maximum of 7 devices at the same time, and the Bluetooth communication controller needs to interact with a number of devices. In the complex process of device coordination, the data processing efficiency may be significantly affected, and it may even lead to communication failure. If the microprocessor uses queuing processing for messages, the time delay will increase apparently. In addition, information transfer between different devices may cause crosstalk, and the greater the number of communication paths, the greater the crosstalk, and the transmission rate will be subsequently reduced [5]. Compared with cellphones, there are few application scenarios for large data throughput. Scenarios with large data transmission are mainly video transmission scenarios such as TVs, and the rest of smart appliances do not require large

data throughput. Large-capacity high-speed access can shorten the time delay of the main chip, which puts higher demands on data throughput bandwidth. Although the waiting time requirements for smart home products are not as stringent as those for cellphones, it is undeniable that shorter waiting time can effectively improve user experience. As the number of interconnections between smart homes gradually increases, the requirements of data throughput are bound to increase.

5G's extremely high transmission rate leads to stringent requirements for signal bandwidth and baseband signal processing speed. We can ensure its data transmission rate and accuracy to be achieved by adjusting the frequency band used and adopting different protocols such as MAC protocol, RLC protocol and RRC protocol. 5G requires high data throughput, which enables users to play games smoothly, download movies quickly, use virtual reality and enhance user experience.

### **3.5 Semiconductor Processes**

Process refers to the etch size of the processor, in other words, the fineness of integrated circuits. Different chip process will lead to changes in chip performance. The smaller the etch size, the more computing units can be positioned on the same size processor. Chip performance will improve, and its power consumption will be reduced, and the stronger the performance will be [6].

IoT devices generally do not have high requirements for chip processes. For smart home, most of the products do not need high process chips, and the requirements for size and power consumption are relatively low, and the space for wiring and installation of devices is relatively large. Therefore, I speculate that in terms of chip process, 28nm process or even 40nm process can meet the needs of smart home.

With the rise of 5G and its widespread use, the fierce competition for mobile chip makers is the advanced process. The size and the available space of a cell phone is quite limited. When 5G just emerged, 7nm process became a hot competition. Nowadays 4nm process gradually becomes the leader, and Samsung has announced its success in conquering the key technology of 3nm process. For cellphone chips, this is an urgent need in technology.

### **3.6 Internal Industry Standards**

From an international perspective, there are multiple standards within the smart home industry that cannot be unified. Japan is one of the earlier countries to promote the development of smart home. It proposed the Home Bus System (HBS) and developed the Japanese HBS standard. Other more mature bus standard protocols are mainly proposed by American companies. X-10 protocol has been used for a long time and is the easiest to operate. It is still the dominant system for home automation in the U.S.. Lon-Works has better performance in the formation of distributed monitoring networks, and more than 500,000 nodes have been established worldwide. CEBuS, as an electronic industry promotion protocol, is also the industry recommendation standard of home automation electronic products in Europe and America. European Installation Bus (EIB) is the European installation bus standard [7]. China has not proposed a unified

home bus system for home intelligence, and the home appliance industry is so far lagged behind the advanced countries. Network access is the basis of smart home, so access technology is one of the most competitive areas of smart home chips. However, it has not yet seen the possibility of unified access standard. This leads to the fact that various smart home products cannot be interconnected, and therefore cannot be industrialized and scaled up. The non-uniformity of industry standards brings trouble to users and installation companies of comprehensive wiring, product selection and installation issues in the early stage, and creates restrictions for repairing and replacing new equipment at a later stage. To a certain extent, this also restricts the development of smart home [8].

China's information and communications industry standard system is continuously improved. Domestic enterprises and institutions actively contribute Chinese wisdom and Chinese solutions to the international community, jointly develop a globally unified 5G standard. In the aspect of further improving the standard system, China will accelerate the implementation of the national standardization strategy and accelerate the construction of a new standard system to meet the high-quality development of the information and communication industry. China Communications Standards Association (CCSA) actively carry out research work on communication standards, and counterpart with international standardization organizations such as ITU-R, 3GPP and OMA, and jointly establish international communication standards.

### **3.7 Industrial Ecology**

Smart home industry is still in the development stage, and the scale of China's smart home market will continue to grow steadily. This also intensifies the competition in this field, with startups actively participating in it and many big transboundary manufacturers joining the smart home industry. These companies are actively developing their own sets of products and gradually forming a complete system of smart home [9].

As for China's 5G industry chain, including chip design, manufacturing, packaging and testing, as well as equipment and materials supporting lacks synergy among upstream and downstream industries. The inertia of cooperation between communications equipment manufacturers and foreign chip manufacturers is difficult to break. Chip industry lacks close interaction between software, complete equipment, system applications, test of instruments and other industrial ecological links. Industrial ecology needs to be created immediately [10].

## **4 Conclusion**

In the age of technology, the development of smart home industry is unstoppable. In the future, smart home will go in the direction of standardization, diversification, intelligence, customization and personalization in order to create a better and more convenient life for people. After the unification of industry standards, manufacturers need to strive to reduce selling prices and production costs to expand the range of users. After building a certain scale and reaching a certain height of technology, smart home needs

to provide customized and personalized services for each customer, and further simplify the operation on the basis of ensuring users' personal privacy and home security. All the above-mentioned ideas can be realized through the modification and upgrade of the chip. In conclusion, we can look forward to a wonderful prospect for the smart home industry: in the next ten years, smart home may be popular among the masses; in thirty years, perhaps everyone can enjoy the convenience brought by smart home.

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