Detailed explanation of server BIOS and BMC

A public account dedicated to technology

Introduction: The firmware industry with BIOS as its core is an important part of the ICT industry chain and can be called the "Shanhai Pass" of the ICT industry. In the computer system, BIOS plays a more basic and fundamental role than the operating system. It is the first system program to be activated after the machine is turned on. It is mainly responsible for detecting, accessing and debugging the underlying hardware resources and allocating them to the operating system to ensure the smooth and safe operation of the entire machine.

At present, there are 4 X86 authorized BIOS manufacturers in the world, namely AMI, Phoenix, Insyde and Baiao, and Baiao (under Zhuoyi Information) is the only BIOS manufacturer in China. This article will focus on the BIOS industry ecosystem, centering on 10 core issues, and conduct in-depth analysis from multiple dimensions such as technology and product definition, industry market size, competition landscape, and investment opportunities, in order to assist investment decisions.

1. Computer core components: BIOS, BMC

1. What is BIOS?

BIOS (Basic Input Output System) is a startup program that cannot be tampered with and is engraved on the motherboard ROM chip. BIOS is responsible for calculating the system self-test program (POST, Power On Self Test) and the system self-starting program, so it is the first program after the computer system starts. Due to its non-tamperability, the program is stored in the ROM chip, and the original settings can still be maintained after power failure.

The main function of BIOS is to control the basic programs after the computer starts, including hard disk drive (such as DVD or USB boot disk is preferred during installation), keyboard settings, floppy disk drive, memory and related devices.

Table 1. BIOS main programs and their functions

程序	具体实现
POST 自检程序	通过读取CMOS存储中的硬件信息，识别硬件配置，并对硬件自检和初始化
OS 启动程序	硬件自检成功后，跳转到操作系统引导设备的引导分区，将引导程序读入内存，若成功读入，则进入相应设备上OS启动过程
CMOS 设置程序	在开机自检中，按下进入CMOS设置快捷键，则进入CMOS设置。结束后，若进行保存操作，则更新后的硬件信息会存入CMOS中并重新进行自检，否则继续完成本次自检后续的过程
I/O 和中断服务	软件在一些对硬件底层的操作中，需要中断服务或硬件I/O操作，这时就需要BIOS充当软件和硬件之间“临时搭桥”的作用

Source: IT Home, compiled by Industrial Securities Economic and Financial Research Institute

2. What are BMC and IPMI?

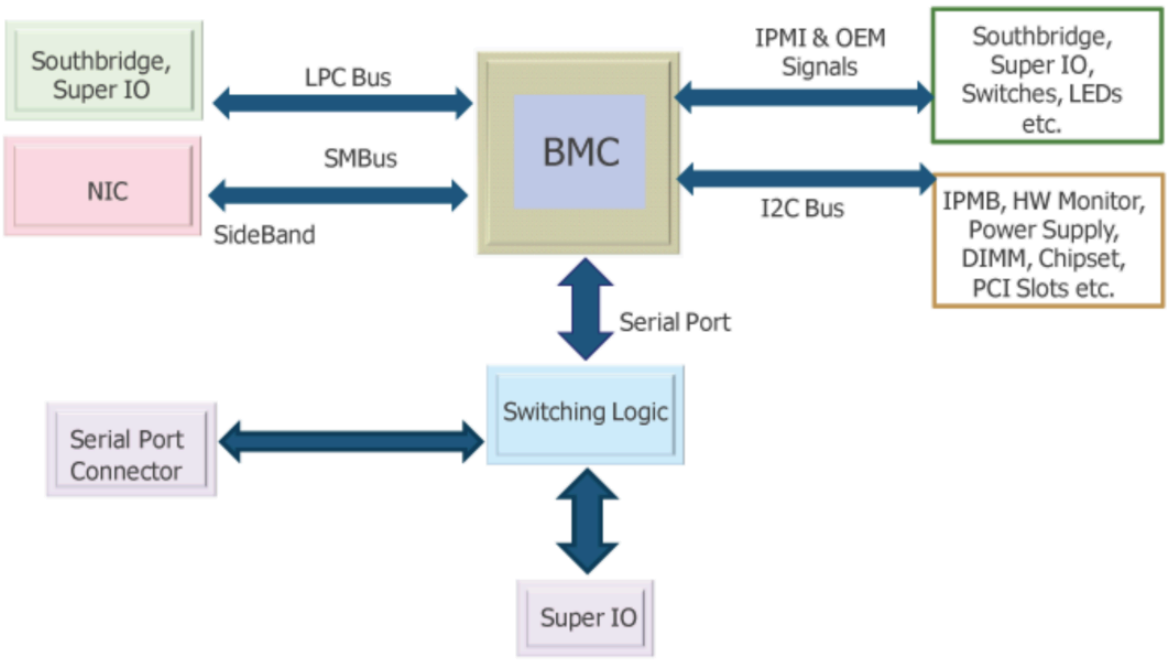
BMC (Baseboard Management Controller) and IPMI (Intelligent Platform Management Interface) , namely baseboard management controller and intelligent platform management interface, are the basic core functional subsystems of the server, responsible for the server's hardware status management, operating system management, health status management, power consumption management and other core functions.

BMC is a small operating system independent of the server system . It is a chip integrated on the motherboard. Some products are plugged into the motherboard through PCIE and other forms. The external form is just a standard RJ45 network port with an independent IP firmware system. Server clusters generally use BMC instructions for large-scale unattended operations, including remote management, monitoring, installation, and restart of servers.

IPMI is a set of interactive standard management specifications , jointly proposed by Intel, HP, Dell and NEC on September 16, 1998. It is mainly used for server system cluster autonomy and monitoring the physical health characteristics of the server, such as temperature, voltage, fan working status, power supply status, etc. At the same time, IPMI is also responsible for recording various hardware information and log records to prompt users and locate subsequent problems. At present, IPMI has been supported by more than 200 computer vendors.

IPMI is an onboard component that can run independently of the host system CPU, BIOS/UEFI and OS, and its core component is BMC. In other words, the interaction between BMC and other components such as BIOS/UEFI and CPU is completed through IPMI. With the help of IPMI, users can remotely start, reinstall, and mount ISO images on a shut down server.

Figure 1. IPMI logic diagram



Source: Wiki, compiled by Industrial Securities Economic and Financial Research Institute

3. What are EFI and UEFI?

EFI (Extensible Firmware Interface) is an extensible firmware interface . Since the traditional BIOS is an assembly program developed based on 16-bit processors, its inefficiency is exposed when facing 32/64 processors. Therefore, Intel has launched a new alternative upgrade solution for BIOS in computing systems.

UEFI (Unified Extensible Firmware Interface) is a standardized version of EFI and an evolution of BIOS. To distinguish UEFI BIOS from traditional BIOS, traditional BIOS is also called Legacy BIOS. In 2005, Intel handed over EFI to UEFI Forum for promotion and development, and EFI was renamed UEFI. UEFI is responsible for power-on self-test (POST), contacting the operating system, and providing an interface between the operating system and hardware.

Existing mainstream BIOS firmware companies have basically adopted UEFI.

Unified Extensible Firmware Interface Forum

In terms of main functions, both UEFI BIOS and Legacy BIOS are used to initialize the hardware platform and boot the operating system. The main difference between the two is that Legacy BIOS has no unified standard, while UEFI BIOS uniformly defines the interface standard between firmware and operating system. The advantages and disadvantages of the two are as follows:

> 1. UEFI BIOS is mainly written in C language, which is easy to implement cross-architecture and cross-platform support and share code modules, while Legacy BIOS is written in assembly language.
> 2. UEFI BIOS fully supports the new firmware security features to minimize the risk of firmware attacks
> 3. Legacy BIOS has poor portability and serious duplication of development. Overall, UEFI BIOS has obvious advantages over Legacy BIOS.

2. BIOS/BMC industry chain, from CPU to complete machine

4. At which link of the industrial chain does BIOS belong?

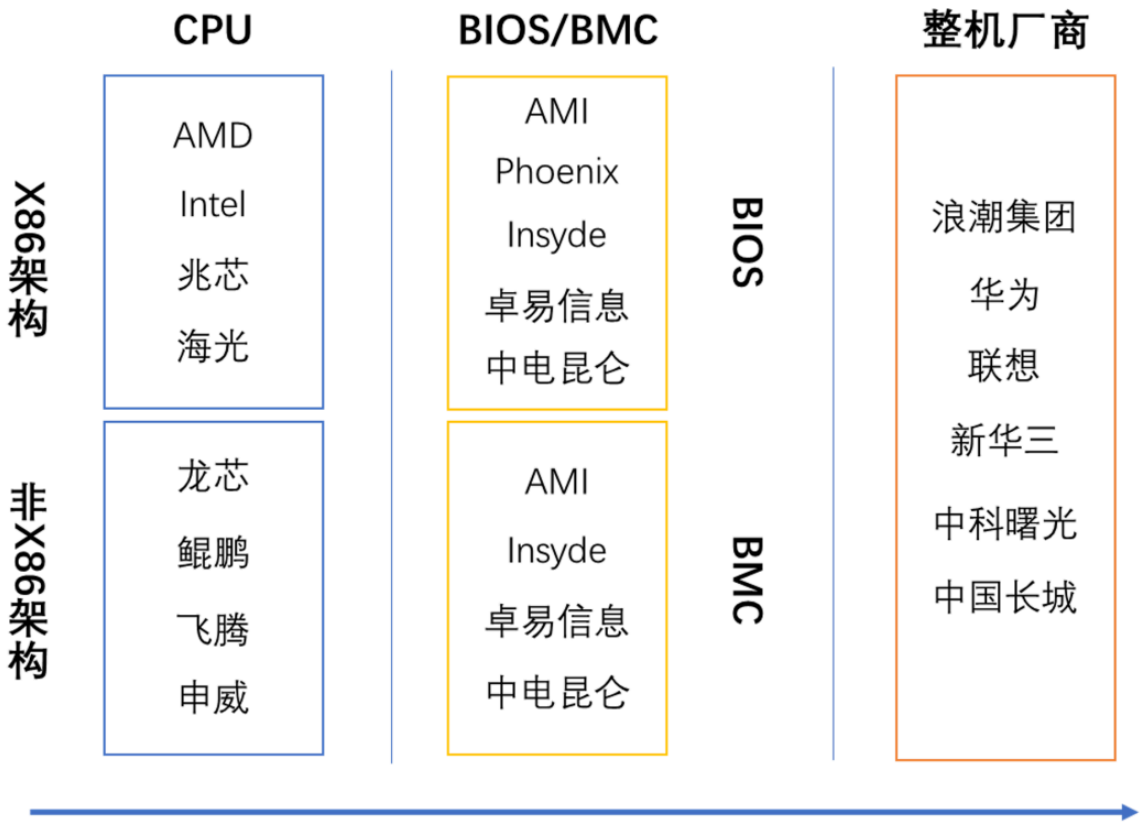
In the entire computer system, the CPU is the core and key link. According to the different instruction sets, it can be divided into X86 (CISC, complex instruction set) and non-X86 architecture (RISC, reduced instruction set). The former is mainly produced by Intel/AMD/Haiguang/Zhaoxin; the latter includes Kunpeng (ARM), Feiteng (ARM), Loongson (MIPS) and Shenwei (Alpha).

In the BIOS/BMC industry chain, the CPU is at the upstream of the industry, and the system core code authorization of the upstream CPU manufacturers is closely related to the BIOS/BMC operation. Only after obtaining the CPU-related core parameters, the firmware manufacturers are qualified to develop BIOS/BMC programs based on their versions.

Currently, among the global X86 computing devices, the chips used in PCs, servers, etc. are mainly Intel's X86 architecture chips. Therefore, Intel's authorized code is a prerequisite for the development of BIOS/BMC work. Currently, only four companies in the world have signed cooperation agreements with Intel to independently develop X86 architecture BIOS for commercial purposes. They are AMI and Phoenix in the United States, Insyde in Taiwan, China, and Nanjing Baiao, a wholly-owned subsidiary of Zhuoyi Information.

The downstream of the firmware business is mainly computing equipment manufacturers. The shipment volume of downstream whole machine manufacturers directly determines the demand of firmware BIOS/BMC manufacturers. The current mainstream whole machine manufacturers in the domestic market include Inspur, Huawei, Lenovo, H3C, Sugon, China Great Wall, etc.

Figure 2: Overview of the BIOS/BMC Industry Chain

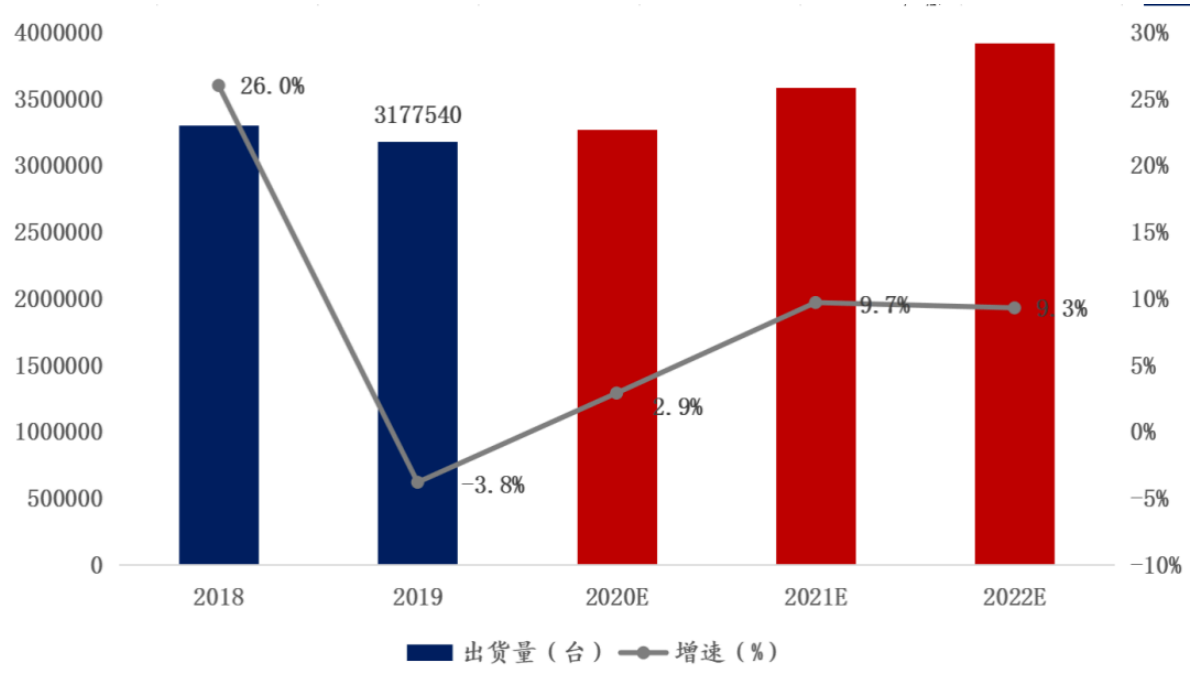


Source: Public information, compiled by Industrial Securities Economic and Financial Research Institute

5. BIOS market space?

In recent years, the shipments of devices represented by PCs, servers and IoT devices have continued to grow, laying a good foundation for the expansion of the BIOS and BMC firmware market. According to Gartner data, in 2019, the global shipments of X86-based servers and PCs were 12.497 million and 261 million units, respectively.

Figure 3. Domestic X86 server shipments

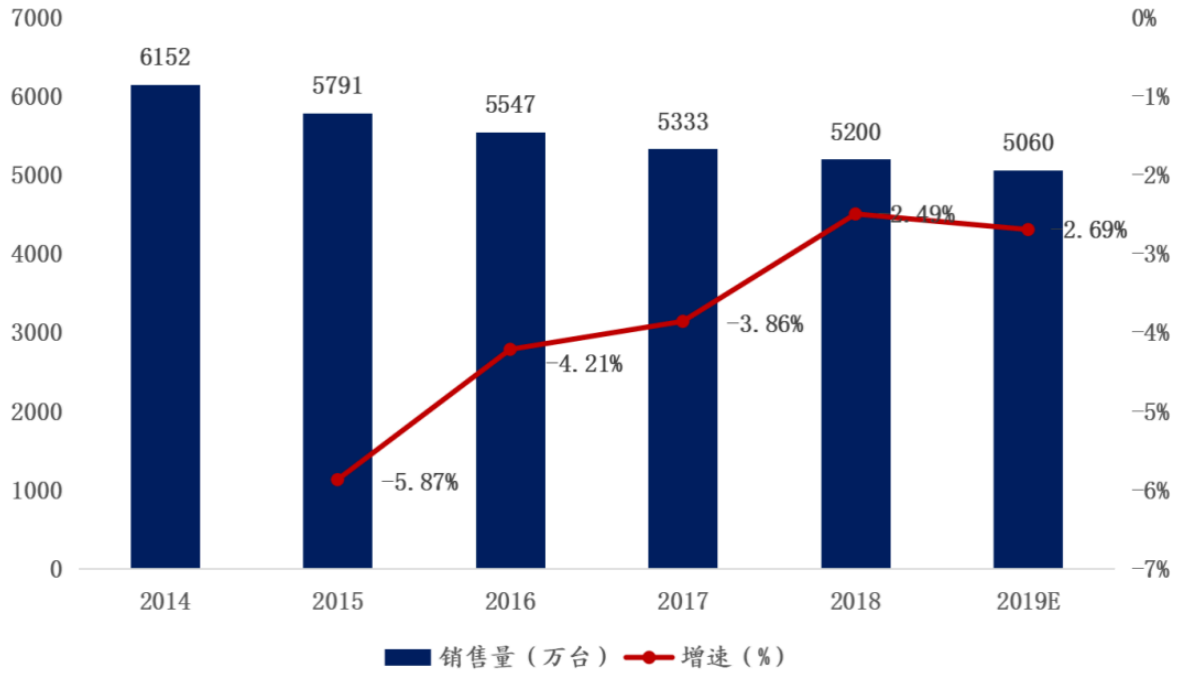


Source: IDC, compiled by Industrial Securities Economic and Financial Research Institute

Based on the unit price of 300 yuan for each X86 architecture server BIOS/BMC firmware, the server firmware market size can reach 3.7 billion yuan; based on the unit price of 15 yuan for each X86 architecture PC BIOS firmware, the PC firmware market size can reach 3.9 billion yuan. The combined market size of BIOS and BMC firmware is about 7.6 billion yuan.

In addition, with the rapid growth of IOT devices, the number of global IOT devices is expected to reach 20.4 billion in 2020. Due to the wide variety of IOT devices and different technical development difficulties, their BIOS prices are different, but generally lower than PC firmware prices. Considering their tens of billions of shipments, the global firmware market size is expected to exceed tens of billions of yuan.

Figure 4: Domestic PC shipments from 2014 to 2019E



Source: IDC, compiled by Industrial Securities Economic and Financial Research Institute

3. List of major BIOS companies

At present, the world's mainstream X86 architecture BIOS firmware products and technologies have long been monopolized by three companies: AMI, Phoenix in the United States, and Insyde in Taiwan, China. Among them, Phoenix started the earliest, AMI is currently the largest, and Insyde is a rising star.

Among the independent X86 architecture manufacturers in mainland China, only Baiao, a wholly-owned subsidiary of Zhuoyi Information, has the ability to develop BIOS and BMC firmware products. However, its overall market size and technical strength still lag behind those of the above-mentioned manufacturers.

6. AMI Business Profile

AMI (American Megatrends Inc.), a BIOS leader . AMI was founded in Atlanta, USA in 1985 by Pat Sarma and Subramonian Shankar. AMI initially produced complete motherboards and served high-end customers. Its first customer was PCs Ltd, now Dell, which was the first company in the world to launch a motherboard for Intel 386 processors.

As the motherboard manufacturing industry gradually shifted to Taiwan, AMI focused its business on OEM and ODM (mainly BIOS firmware) technologies. Currently, AMI has nearly 1,500 employees worldwide, 85% of whom are engineering development-related personnel.

AMI's main product lines include UEFI BIOS firmware and controller (EC), MegaRAC remote firmware management solutions, AMI backplane controller product series, diagnostic utilities and engineering services. Among them, Aptio V is AMI's latest generation of UEFI BIOS firmware, which can meet the needs of all platforms (X86 and non-X86). Aptio 4 evolved from traditional BIOS and also complies with UEFI specifications. In terms of support services for UEFI, AMIDiag is currently the only hardware diagnostic solution available on the market.

Figure 5. AMI BIOS/UEFI firmware products

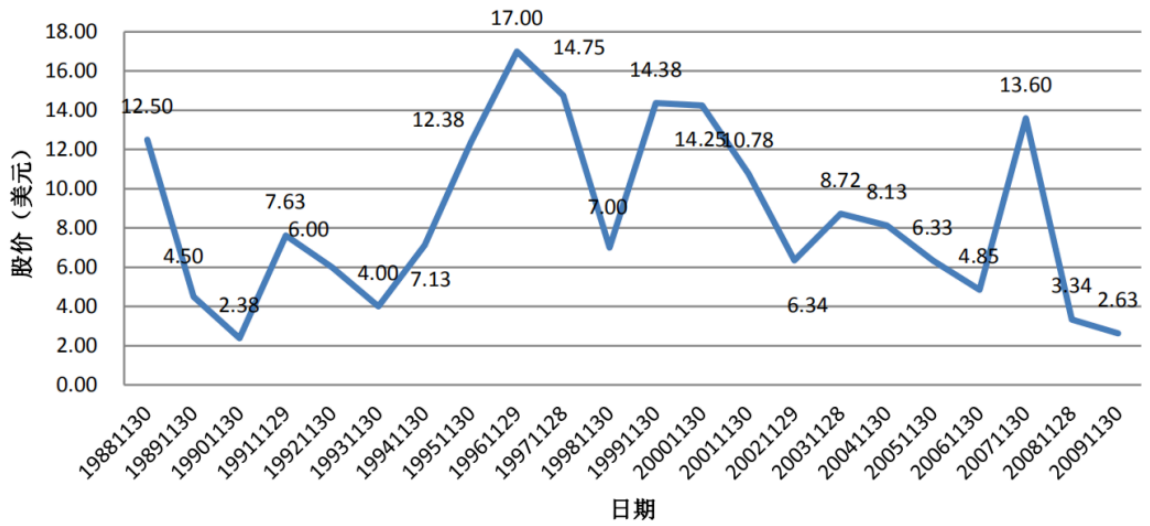
Source: Company official website, compiled by Industrial Securities Economic and Financial Research Institute

7. Phoenix Business Profile

Phoenix (Phoenix technologies Ltd.), a BIOS pioneer. Phoenix was founded in Boston, Massachusetts, USA in September 1979 and is headquartered in Pasadena, California. Phoenix pioneered clean room design (also known as firewall technology) and cloned its own BIOS through reverse engineering. Phoenix entered a golden period of development relying on its own intellectual property rights.

In 1988, Phoenix successfully went public through an IPO (PTEC), and in the 1990s, it acquired two powerful BIOS manufacturers, Quadtel and Award, and gradually became the leader of the BIOS industry at the time, with products covering various markets from low-end to high-end.

Figure 6: Phoenix 1988-2009 stock price performance



Source: CRSP, compiled by Industrial Securities Economic and Financial Research Institute

In the early 21st century, affected by the decline of the PC market, the price of BIOS firmware fell, and the company adopted a one-time licensing method to increase the company's short-term revenue. In addition, immature mergers and acquisitions and market exploration also led to the deterioration of Phoenix's operating conditions, and the company suffered a huge loss in 2006. In August 2010, the US investment company Marlin Equity Partners acquired Phoenix's outstanding shares for US$139 million. Phoenix announced its delisting and gradually divested its non-BIOS business group. As of 2009, the company had about 300 employees.

In the Chinese market, Phoenix established its Chinese branch, Phoenix Software (China), in Nanjing in 2000. In 2009, it withdrew from the Chinese market due to operational problems.

Figure 7: Phoenix partners

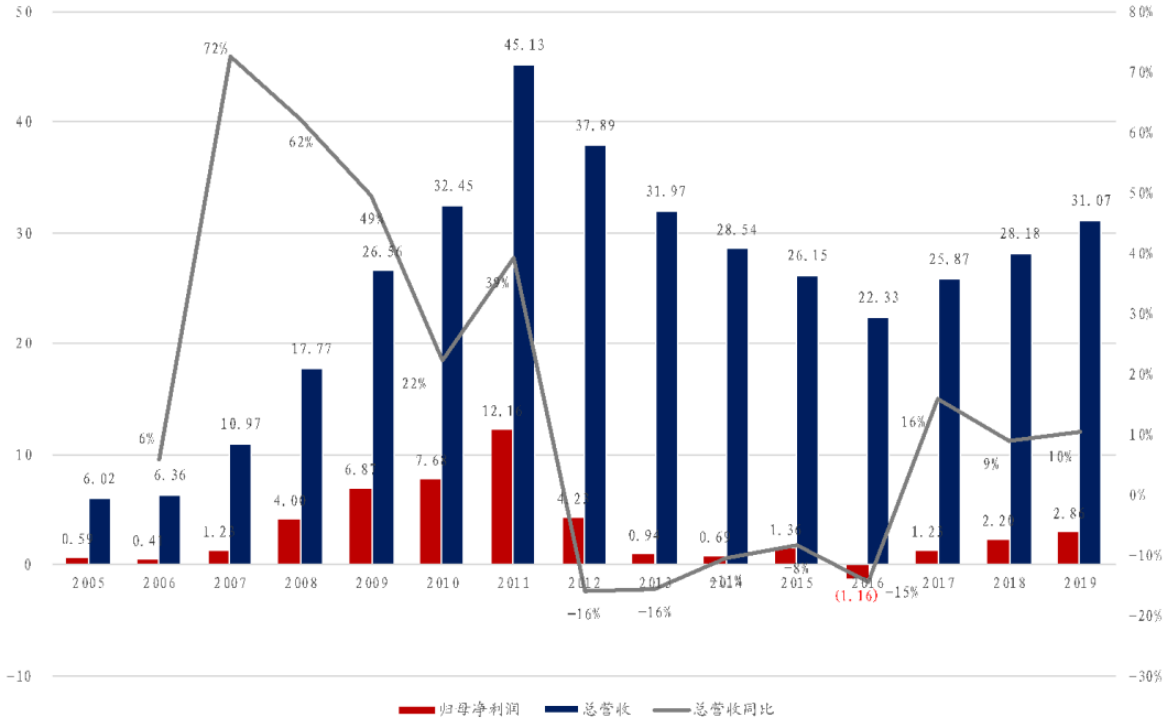
Source: Company official website, compiled by Industrial Securities Economic and Financial Research Institute

8. Insyde Business Profile

Insyde is a rising star in the BIOS market. In 1998, Insyde was established by acquiring SystemSoft of the United States, and was listed in Taiwan in 2003 (6231.TWO). Unlike AMI and Phoenix, Insyde focused on UEFI when it entered the BIOS field. Its business is highly concentrated on BIOS/BMC technology, covering major manufacturers such as Intel, AMD, and Microsoft. Benefiting from the development of the PC market in Taiwan and Intel's mandatory promotion of UEFI BIOS, Insyde quickly jumped to the second place in the BIOS market.

In 2018, Insyde's flagship product Insyde H2O BIOS achieved revenue of NT$781 million, accounting for 92% of total revenue; BMC product Supervyse achieved revenue of NT$58 million, accounting for 7%; other businesses achieved revenue of NT$10 million, accounting for 1%. As of December 31, 2018, Insyde had a total of 439 employees, of which 384 were R&D technicians, accounting for 87.5%.

Figure 8. Insyde revenue and net profit Unit: million US dollars, %



Source: Thomson Reuters, compiled by Industrial Securities Economic and Financial Research Institute

9. Easytec Business Profile

Zhuoyi Information (688258.SH), the only BIOS X86 manufacturer in mainland China. The company was founded in 2008. Its wholly-owned subsidiary, Bioo, is the fourth BIOS/BMC manufacturer in the world to obtain Intel X86 architecture authorization. It is also the only manufacturer in mainland China that masters X86 architecture and one of the few that masters BIOS/BMC firmware development technology for ARM and MIPS architectures.

Based on this technical capability, the company can develop and meet various PC and server chip needs at home and abroad. Its business model is to complete technical development for CPU manufacturers, including solving individual firmware problems or developing complete functions, and then realize batch sales of computer equipment.

Table 2: Application cases of company BIOS and BMC

产品类型	典型项目	代表客户
服务器 BIOS 固件	华为 Intel X85 服务器 BIOS 项目 长城 Intel X86 服务器 BIOS 项目 烽火 Intel X86 服务器 BIOS 项目 中兴通讯 Intel X86 服务器 BIOS 项目 ARM64 BIOS 工具技术合作项目 UEFI BIOS 安全设计技术合作项目 联想 LEPT2 项目 联想/长城津逮项目等	华为 联想 长城 曙光 烽火 中兴通讯等
PC 端 BIOS 固件	小米平板 BIOS Android 平板 BIOS 支持国产计算机的固件软件开发项目（国家核高基项目） 固件适配项目 科研用笔记本开发项目等	联想 曙光 清华大学 小米 诚迈科技等
IoT BIOS 固件	视频监控 BIOS 开发项目 瘦客户机 BIOS 开发项目 车载设备 BIOS 开发项目等	海康威视 中兴通讯 天地伟业 万利达等
国产服务器平台 BMC 固件	支持国产计算机的 BMC 固件开发项目（包括国家核高基项目） 以及国产自主可控特性服务器 BMC 固件开发项目等	联想 浪潮 曙光 长城 清华大学等
通用服务器平台 BMC 固件	长城 Intel X86 Purley 服务器项目 星网锐捷服务器项目等	长城 星网锐捷等

Source: Company announcement, compiled by Industrial Securities Economic and Financial Research Institute

10. Related companies and risk warnings

The BIOS/BMC firmware industry is a very important sub-industry direction in the computer industry chain. After more than 40 years of development, the world has now presented an oligopolistic competition pattern. There are four major mainstream X86 architecture BIOS authorized manufacturers, namely AMI, Phoenix, Insyde and Zhuoyi Information.

Zhuoyi Information is currently the only manufacturer in mainland China that has been officially authorized by Intel, and has a rare advantage in the track. At the same time, the information and innovation industry (including the Kunpeng ecosystem) will also usher in a comprehensive development stage in 2020. Zhuoyi Information also has excellent R&D capabilities in non-X86 architectures, such as MIPS/ARM/Alpha chip architectures, and is expected to fully enjoy the industry dividends and usher in rapid development.

Source: Architect Technology Alliance

Conclusion

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