Global MCU Market and Technology Development Trend

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Microcomputer and Microcontroller became popular in world since the 70s. It has been 36 years since 8051 microcontroller appeared in 1981. Quantity speaking, 8-bit MCU is still leading the market, 8051-based chips are still being designed and manufactured. In early 90s, 32-bit MCU is only needed in some high performance computing due to its cost. After 2008, new technologies like Internet of things (IoT) has given rise to inexpensive and capable MCU with wireless communication capability among developers. As ARM-Cortex M-based MCU become the leader in the market, wide-spread application and advanced manufacturing have helped closed the price gap between 32-bit and 8-bit MCU. These plus the ecosystem of ARM, have made 32-bit MCU become the core of today's consumer and industrial electronics. We will be reviewing the process of global MCU development from 3 aspects, and discuss future trends.

MCU Market

Since 2015, there has been many high-profile mergers within MCU manufacturers, in order to compete for market share and invest in IoT applications. According to market research institute IC Insights, NXP, Microchip and Cypress have seen major growth in sales in 2016 (see figure 1), compared to those did not participate in the mergers like ST, TI or Samsung (whose sale number declined noticeably).

Leading MCU Suppliers ($M)

2016 Rank	Company	2015	2016	% Change	% Marketshare
1	NXP*	1,350	2,914	116%	19%
2	Renesas	2,560	2,458	-4%	16%
3	Microchip**	1,355	2,027	50%	14%
4	Samsung	2,170	1,866	-14%	12%
5	ST	1,514	1,573	4%	10%
6	Infineon	1,060	1,106	4%	7%
7	Texas Instruments	820	835	2%	6%
8	Cypress***	540	622	15%	4%

*Acquired Freescale in December 2015.

**Purchased Atmel in April 2016.

***Includes full year of sales from Spansion acquisition in March 2015.

Source: IC Insights, company reports

Figure 1 – Leading MCU Suppliers

From figure 1 we also learn that the top 8 manufacturers have a combined 88% market, smaller MCU companies have very small share. IC Insights 2016/05 report showed that MCU market will peak in 2020, reaching 20.9 billion USD and 26.7 billion of chips (Figure 2). In STM32 2017 summit, ST set 4 billion USD sales and 20% market share (from 10%) targets for 2020.

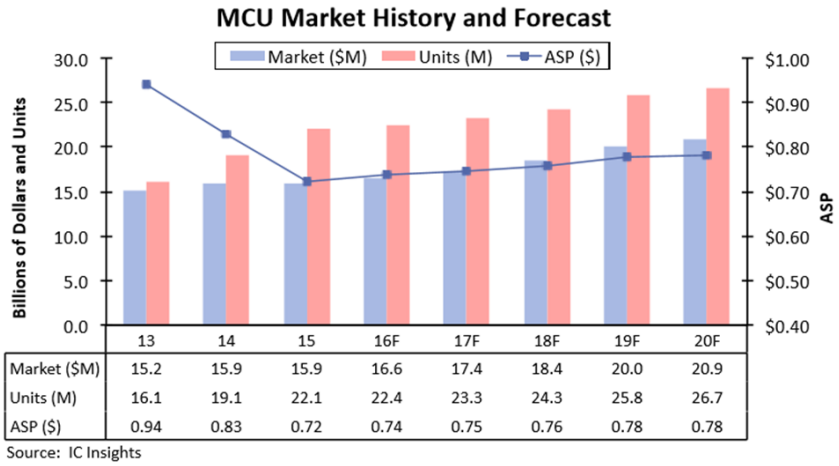

Figure 2 – MCU Market History and Forecast

MCU Technology Evolution

Developer Tools

8-bit MCU is functionally simple and has small memory (FLASH and RAM) space. Developer tools were very simple; usually only download and compile tools are needed. Many application code can be written entirely in assembly. As more functionalities are added to MCU and memory increased in side, C language, IDE and JTAG debugging became the main stream development signatures. This has been dominated the market for the past 20 years.

With the rise of IoT, many electronics need to be made "smart", where connectivity (especially wireless) is the basic requirement. RTOS has also became a necessity rather than a "luxury" in MCU. Benefit from open source community, open source RTOS like FreeRTOS, Contiki and Zephyr are now the top choice of developers. OSes targeting IoT have also became prevalent, e.g. ARM mbed OS, MXChip Mico OS and Huawei Lite OS. In reality they are all based on RTOS.

IDEs are usually very expensive for entrepreneurs. Lending help from open source software, MCU manufacturers all rush to launch their own IDE, for instance Renesas e2studio, Silabs Simplicity Studio and NXP LPCXpresso. These IDEs are based on Eclipse and GCC ARM. IDEs from chip manufactures cannot compete with Keil and IAR in terms of performance and optimization, but they are already very useful. ARM rolled out web-based mbed tool, developers can program any mbed-compatible mcu board without purchasing or installing any IDE. Say you have an Arduino board, you can accomplish a lot, as Arduino IDE integrate a rich open source hardware knowledge base.

Today, with a powerful open source ecosystem, MCU developer need not to worry about their project being impacted by lack of technical support or developer tools.

Manufacturing Technology

Moore Law, and manufacturing technology behind it, has been the main accelerator of IC industry. Traditionally, MCU like 8-bit OTP mcu rely on 0.5um technology. With latest developments, 190nm or 90nm are the current mainstream. We can anticipate 40mm or even 28nm to be used for MCU manufacturing.

Advanced manufacturing technology means more transistors inside MCU to realize more functionality and higher performance. As a result, the size of MCU core will become a minor factor; more 32-bit MCU cores will replace 8-bit, lowering power consumption without changing the geometry significantly. Besides, flash capacity on the chip will increase, MCU with 1MB or even 4MB flash will be commonplace.

It is a given that manufacturing technology will challenge MCU ecosystem, in terms of initial cost rise and complexity in chip design. With 32-bit cores, software development also become harder. MCU, RF and sensor integration in IoT application also impact power management and PCB design.

Application Solutions

Application of MCU range from the smallest consumer electronic devices to major industrial machines, covering almost all aspects of embedded system. MCU manufacturers used to only provide application guide and reference code, and let the customers or their solution provider supply solution design before manufacture process begin. This method is still widespread as for today.

With the rise of IoT and the demand of intelligent electronics, traditional industry badly need an upgrade. Electronic industry is demanding more and better innovative solution from MCU manufacturers. With online shopping and flat supply channel, chip vendors become unable to invest in solution design that will only grow in complexity. Traditional solution providers are now transforming to product provider in the vertical market, leaving MCU manufactures in charge of solution design.

Many of the leading MCU vendors, for instance ST, NXP, TI and Renesas provide a list of cutting-edge MCU solutions. During STM32 summit, we see smart lock solution that prevent hacking, ultra-low-power MCU smart watch that can display cool game screen, and LoRa network gateway based on low-cost STM32F7 MCU.

Maker movement of the recent years also contribute a lot to MCU solutions. Makers often adopt Arduino open source hardware with MCU from Atmel AVR series. Pibot robot project use Arduino as the core control chip. Even without much development experience, developers can complete product development with open source hardware. A low entry bar means more people can realize their innovative ideas, which also lead to more products and elevated demand of MCU.

Opportunity of MCU in China

MCU 30 Year

Early 80s, Beijing Industry University Factory started the rush of TP801 development system. Around the same time, MCS-51 development System was developed in Shanghai, Jiangsu and other places. These

incidents triggered the era of electronic evolution across the country. In October 1986, the first academic conference of microcontroller was held in Shanghai Fudan University, marking the start if MCU industry in China. Nov 2016, Embedded System Beijing Forum organized the 30-year anniversary; generations of practitioner over the years paid tribute to the history and discuss the future of MCU in China.

MCU market in China has been expanding for many years. According to the 2015 report IHS isuppli Research (Figure 3), sales was 3 billion USD across China in 2011, later it was 4 billion in 2016, a 10% of compounded growth rate during the years. Mainland and Taiwan MCU manufacturers each hold 10% share of the market, while none of them is among the top 8 we saw earlier. From 2017 STM32 summit, we learned that China market accounted for 36% of ST's global general MCU market, where an average 27 percent growth has been recorded since 2007. IoT, wearable, smart phone, smart building, electric car and drone are the main driving forces of MCU market.

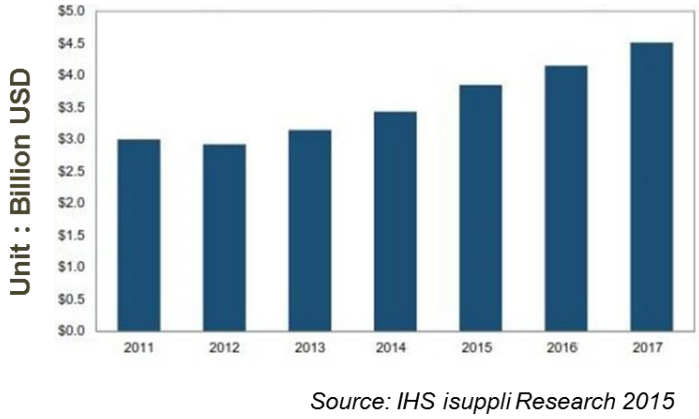

Figure 3 – MCU Market in China

Most MCU manufacturers in China compete in 8/16-bit lower end market. In the largest electronic manufacturing market, they can survive. However, without strategic plan, capital support and design capacity, these companies will remain small players.

Growth of 32-bit MCU

We have seen rapid growth of MCU manufacturers in China. In 32-bit market, we see popular Cortex M chips from GigaDevice. Tangram, MindMotion etc.. Advantages like lower price, better performance, local service and pin-to-pin compatibility of foreign products all benefit these companies.

In 2016, GigaDevice reported sales of 1.49 billion, profit 176 million (25% and 12% increase respectively); 45.78 million of MCU sold for a total profit of 197 million (55.2% year-to-year increase). Recently, GigaDevice acquired ISSI for 6.5 billion , whose main focus is volatile storage chip like SRAM, mid/low density DRAM, EEPROM and other IC products for areas like automobile, industrial, medical, network/communication and consumer electronics. These complement GigaDevice's current strength of non-volatile chips, for instance NOR/NAND flash, and MCU R&D, support and sales. The acquisition will contribute to the new GD32 series MCU and the plan to expand in automobile market.

Challenge of China's MCU

Compared to high-end CPU, the road of 32-bit MCU has been a smooth one. Opposed to what we see with smartphone chip, a relatively simple ecosystem helped a lot. Smartphone chip requires huge investment to manufacturing technology. For example, Samsung use astonishing 10nm technology to manufacture the Snapdragon 830 chip in Galaxy S8. Operating system wise, if you are not part of Open Handset Alliance, which composed of 84 members, you may not be able to access the latest Android OS; even if you are member, you may not have the developers to compete with the big names like Qualcomm, Samsung or Huawei.

Earlier, we mentioned the technical roadmap of MCU, which is very different from smartphone. MCU is a diverse application space, the products, although many of them are very popular (drone, wearable bracelet, thermometer etc.), are based on totally divergent software/hardware architectures. Chinese manufacturers and their 90nm technology/application and end-to-end full server may be able to give a surprise blow.

But can we say China's MCU is heading for a smooth ride? Not necessarily. Mainland and Taiwan manufacturers still have a long way to go compared to the leaders. More than 750 models of STM32 mostly use 90nm technology; ST's new ultra-performance STM32H7 will adopt 40nm manufacturing; MindMotion's mature product F103 is still on traditional 0.18um.

Developer tool wise, usually there is no IDE released with MCU. ARM Keil or IAR are typically recommended with custom plugin, and many customers will use unauthorized copies.

MCU in China is also far behind in terms of application design and ecosystem. Following the STM32 summit, dozens of partner companies showcased their solutions like LoRa, Bluetooth/WiFi modules, OTA firmware update, NB-IoT test devices, automobile BUS communication platform and security certified RTOS. STM32 products from China, including DJI and Xiaomi drone, Huawei Sport Watch, MOOV earbud and Alpha Smart Robot also attract the attention of the developers (Figure 4).

Figure 4 – STM32 Solution Showcasing

While chip design and manufacturing are surely important areas of 32-bit MCU development, product ecosystem, developer tools, RTOS support, innovative solution, mature supply chain and technical support are also integral parts. Becoming one of the top international vendors is a long shot for Chinese MCU manufacturers, the IoT market that will worth tens of billion is an unprecedented chance.

Allan He is the founder of BMR, an embedded software company in China since 1995. Allan is an early practitioner in the field of embedded operating systems with more than 30 years of embedded system development and marketing experience in Asia. He was the deputy chief editor of "MCU and Embedded System Applications" journal, and has published more than 60 paper or articles in various international and domestic conferences or domestic journals. He was also the author of book "Embedded Operating System: History of Development and the Future of the Internet of Things".