Global Development Trends in Embedded and Internet of Things Technology

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2016 was a year of swift development in embedded technology and Internet of Things (IoT). Based on traditional application, embedded technology is now deep in the process of exploring rising market, where IoT is one of the most promising aspects. In the current evolution of new technology, IoT is the game disrupter; it bridges the physical and digital worlds and is changing how companies approach customers and provide new services. Mid 2017 has arrived and I analysed the current trends of embedded and IoT technology.

Acquisitions will continue

Acquisitions have been frequent within the chip manufacturing this past year, and are likely to continue this year — the main reason being the incentive to cut cost and raise profit. As R&D cost rises, manufacturers have to find ways to squeeze out more profits. Recent high profile mergers include Qualcomm/NXP, Microchip/Atmel and Renesas/Intersil; such deals will normally take 1 to 2 years to come to a close. While acquisitions are likely to impact the industry in a negative way at first, they will help to popularize IoT technology and systems in the long term. IoT applications are end-user-facing; chip design require high efficiency, security, usability (for dev tools), and low cost. All of which demand investment to create embedded process (including MCU) designs that are highly integrated with rich software support. By 2018, I believe we will see more innovative chip solutions for IoT.

Mergers will lead embedded processor into the vertical market of IoT. Industry leaders will seek to seize market opportunities that have high growth rate, e.g. Advanced Driver Assistance Systems (ADAS), Autonomous Driving, Computer Vision, Artificial Intelligence (AI) and 5G Network. Leading chip manufacturers are already using acquisitions to leap into the vertical markets, noticeable examples like Samsung/Harman International in automobile market and Intel/Movidius in computer graphics field (graphic chips are now installed on devices like DJI UAV and Tango AR smartphones). While these vertical markets are still small in scale, chip companies are counting on the future of them; the trend of acquisitions will likely continue.

IoT lays particular emphasis on low cost, energy consumption and high efficiency. Current embedded processor and microcontroller (MCU) products are suitable for most IoT applications since they do not require particularly high performance. Prominent embedded processor vendors will continue to target specific application and provide new products of suitable sizes with best efficiency.

After years of development the MCU, which became prominent with its 8-bit variant, is now at the frontier of IoT. Specifically, 32-bit MCU is enjoying a good share of IoT due to its low power and high uptime. As MCUs become more integrated and software solutions become richer, processors/sensors are going to be closely tied with the Cloud.

Although ARM-based processors and MCUs are currently leading the market of embedded/IoT, GPUs are gradually becoming influential as computer graphics processing, artificial reality (AR) and AI (artificial intelligence) are growing. IoT is boosting the development of low-energy computing and wireless networking, where new processor technology and business models will arise. AI also has a long way to ripeness. Embedded edge computing will play an important role in improving capacity and real-time aspects of computing, with Amazon

Alexa being one instance. IoT and AI will push the envelope of R&D in processor architecture and application; open source hardware will also be a continuous trend.

The IoT platform is reaching maturity

Cloud computing can be categorized into Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The IoT cloud platform is in line with the definition of PaaS, Figure 1 shows its typical architecture. IoT

devices are connected to device gateways or smartphones via Bluetooth or Zigbee, then to an IoT Cloud platform using WiFi or 4G/LTE. Cloud platforms are usually built on top of public cloud (IaaS), and provide lifecycle support to connected devices.

Well-known IoT Cloud platforms include Amazon AWS IoT, Microsoft Azure IoT, General Electric Predix IoT IBM Watson IoT and PTC IoT (ThingsWork). In China there are China Mobile OneNet, Guangzhou GizWits and Alibaba Smart Cloud. Open source framework wise, Kaa and Eclipse Kura are prime examples.

Traditional enterprise software vendors like Oracle, SAP and RedHat are also developing IoT platform solutions, reaching into the field of IoT sensors. IoT targeting enterprise applica-

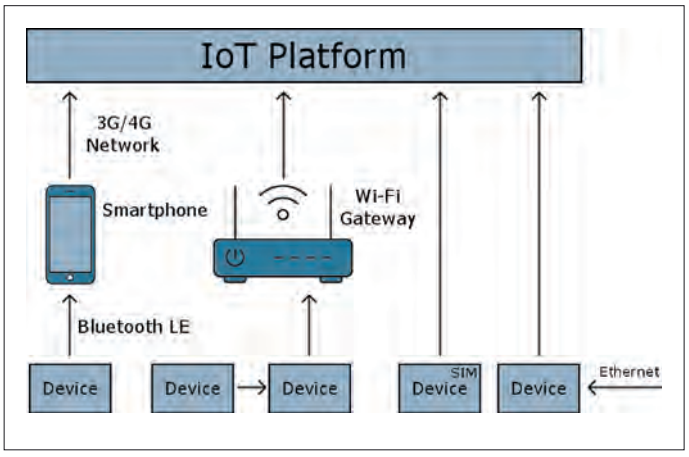

Figure 1: IoT Cloud Platform.

Level:	**Beginner**	**Company Status:**	**Trading**	**Approach:**	**Theoretical**
	Intermediate		Start-Up		Practical
	Professional		Potential		Mixed
Subject:	Product	**Advice:**	Production	**Website:**	
	Service		**Technology**	www.bmrtech.com	
	Advice		Regulatory		

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tions (Enterprise IoT) will be enjoying high growth in the next 1-2 years, serving, for example, connected automobiles, the smart city and the intelligent industry.

IoT OS emerging as a new force

Embedded systems have been using open source software（OSS）widely, one of the best examples being Linux. The traditional embedded OS has been moving slowly with few good profitable business models. This is true with only a few exceptions like automobile electronics, aerospace and military/defense. As the IoT Cloud platform is evolving, operating system on devices are integrating with Cloud platforms and become IoT OS (aka Operating System for Internet of Things), for instance, ARM mbed OS (Figure 2), Google Android Things, Microsoft Windows 10 IoT Core, Huawei LiteOS and MxChip Mico OS.

While high-tech giants are pushing IoT OS, open-source software will continue to be active, e.g. FreeRTOS (users include smart watch pioneer Pebble and many other IoT devices) and TinyOS. As the requirement and business model for IoT systems are not yet clear, and IoT OS technology still has a long way to go, many engineers opt to use OSS to customize IoT OS solutions.

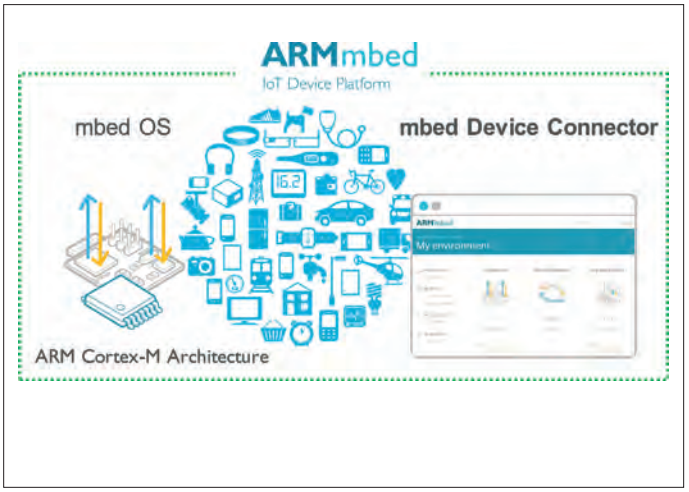

Figure 2: ARM mbed OS.

IoT Security and safety — a long way to go

On Oct. 21st 2016, DNS service provider Dys suffered severe a DDos attack, causing widespread downtime of US websites like Amazon and Twitter. Analysis indicates that 100 thousands of IoT devices infected with Miral malware might be the culprits, heating up the debate on IoT security. Shellphish's live hack on fingerprint unlock of Huawei P9 Lite (Oct 26th 2016), a massive video surveillance leak in Hangzhou (2015) — there are many incidents that raise public awareness of IoT security issue.

Previously, smart device manufacturers had to be concerned about the device and the data generated only. Even this requirement is often not met in consumer electronic products. Now they are asked to protect both the device and the network, the being outside their customers' direct powers. What's more, the security design of IoT is still being researched. There is no true mature design or implementation yet.

Another aspect is IoT functional safety, which is closely tied to industrial IoT (IIoT) fields like automotive electronics, factory automation, industrial control, railway signalling, smart power grids etc. Compared to the IoT, the design and implementation within IIoT are more formalized, with mature software, tools and consulting services.

2017 is likely to close as another year of development of embedded and IoT technology. After "integrations" within the chip manufacturer arena, many IoT applications will scale up and prosper. Low-Power Wide-Area Network (LPWAN) is also likely to advance rapidly, with different platforms and network standards (e.g. LoRa, Sigfox and NB-IoT) competing with each other. The world's largest 5G experiment field was just announced in China, located in Huairou, Beijing, proving end-to-end test environment to help forming 5G standard and pushing the industry forward. Low-power connection, low latency and high availability aspects of 5G will be major boosts to IoT.

2018 is likely to be a year of breakthroughs. OS and network security technology in IoT will mature; processor technology, under influence of AI and AR, will explode; IoT will enjoy a major growth period using the next generation of networks. ⏮

The Author

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