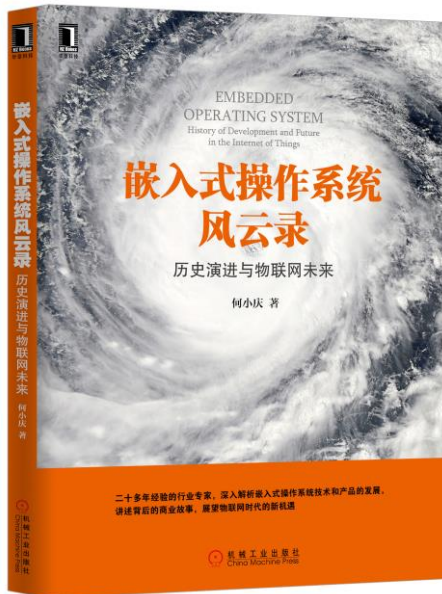


Global Development Trends of Embedded and Internet of Things Technology

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Nov 2017
Shenyang



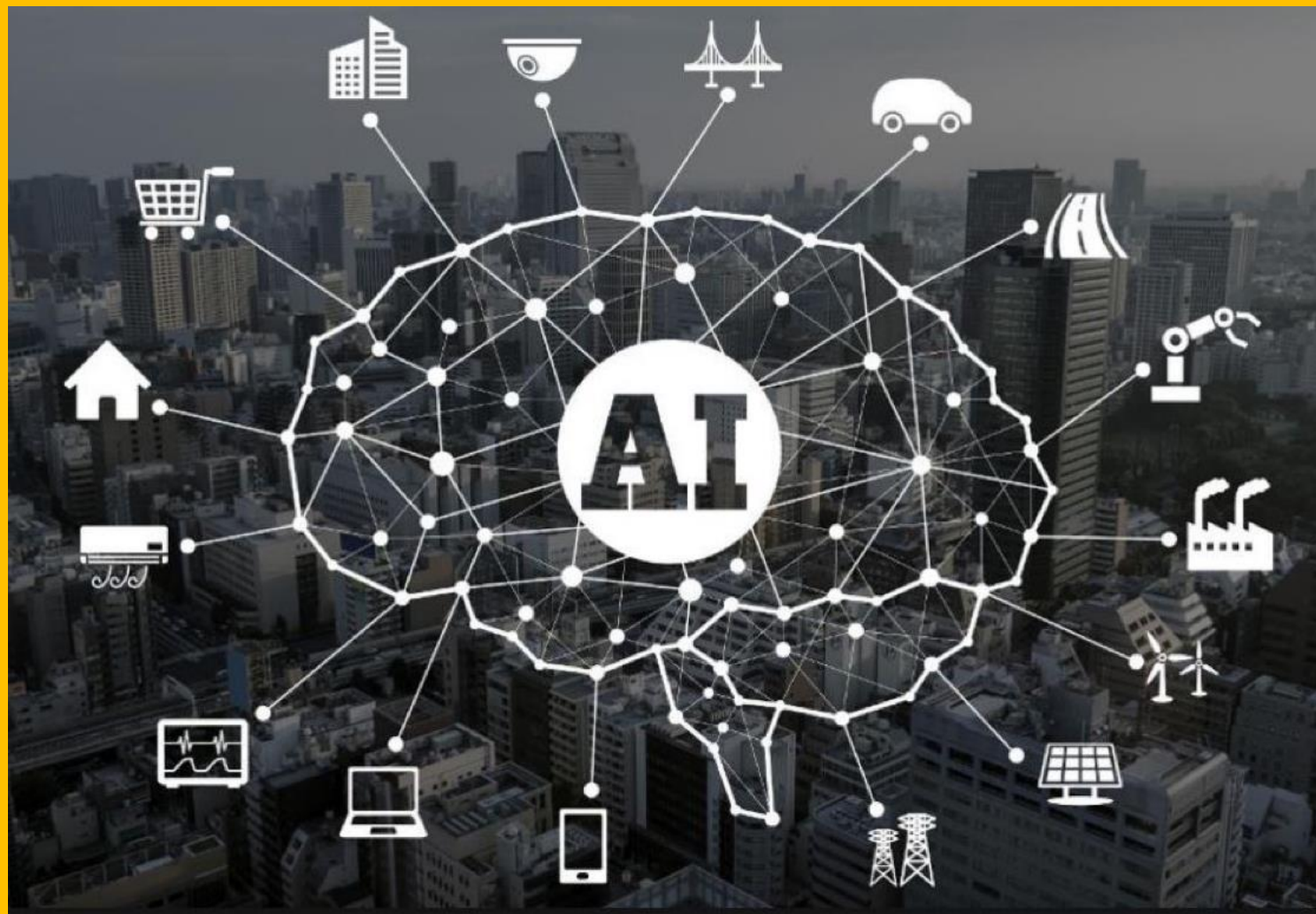
Personal Profile



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 domestic conferences. Allan also authored the book “Embedded Operating System: History of Development and the Future of the Internet of Things”.



Everything will be an AI ?



Acquisitions will Continue to Influence Embedded Processor Development(1)

- The main reason being the incentive to cut cost and raise profit
 - Including with Qualcomm and NXP,(Freescale) Microchip and Atmel, Renesas and Intersil (spend time buying)
- Such deals will normally take 1 to 2 years to close
 - While acquisitions probably will impact the industry in a negative way at first, they will help popularizing IoT technology and system in the long term
- IoT driver chip design move to high efficiency, security, usability and low cost.
 - All of which demand investment to create embedded processor (MCU) designs that are highly integrated with rich software support.
 - By 2018, I believe we will see more innovative chip solutions for IoT.

Acquisitions will Continue to Influence Embedded Processor Development(2)

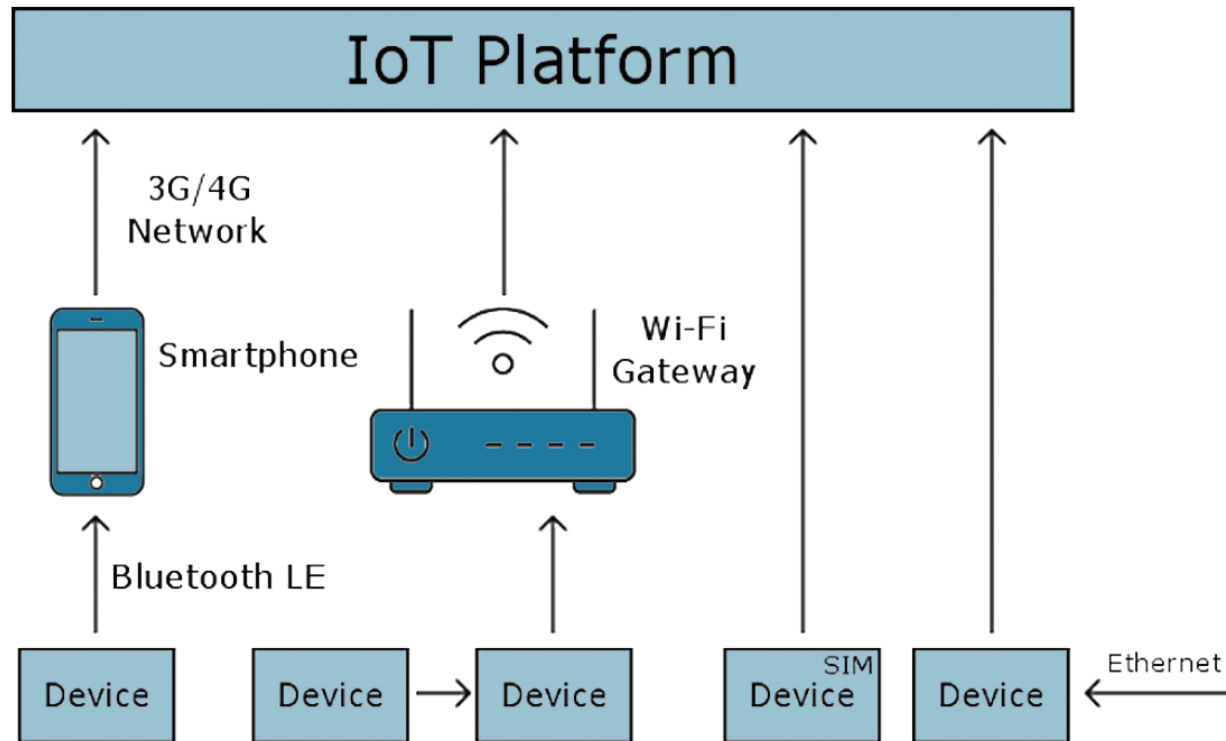
- **Mergers will lead embedded processor into the vertical market of IoT**
 - **Industry leaders will seek to seize market opportunities that have high growth rate, e.g. Advanced Driver Assistance Systems (ADAS), Autonomous Driving, Computer Vision, Artificial Intelligence (AI) and 5G Network**
 - **examples like Samsung/Harman International in automobile market and Intel/Movidius in computer graphics field**
 - **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.**

Acquisitions will Continue to Influence Embedded Processor Development(3)

- Although ARM-based processor and MCU are currently leading the market of embedded/IoT, IoT is feeding to the development of low-energy edge computing and wireless networking, where new processor technology and business model will arise.
 - RISC-V,ARC and Tensilica (inside of famous ESP8266 WiFi chip)
- Embedded edge computing will play an important role in improving computing capacity and real-time 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.

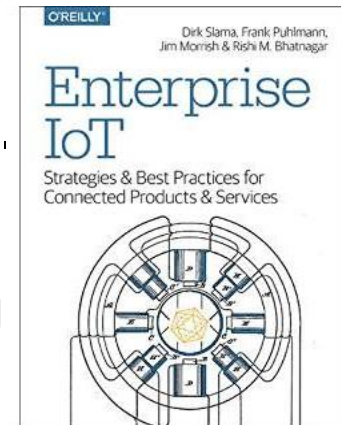
The IoT platform is reaching maturity

- 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



Well-known IoT Cloud platforms

- 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 Kaa and Eclipse Kura are prime examples
- Oracle, SAP and RedHat are also developing IoT platform solutions, reaching into the field of IoT sensors.
- IoT targeting enterprise application (Enterprise IoT) will be enjoying high growth in the next 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**
- **Traditional embedded OS has been moving slowly with few good profitable business models.**
 - **a few exceptions like automobile electronics, aerospace and military/defense.**
 - **Service was becoming a major revenue of Embedded OS vendor**
- **IoT Cloud platform is evolving, operating system on devices are integrating with Cloud platforms and become IoT OS**
 - **ARM mbed OS , Google Android Things, Microsoft IoT core**
 - **MxChip MiCO OS, Huawei LiteOS and Ali OS**

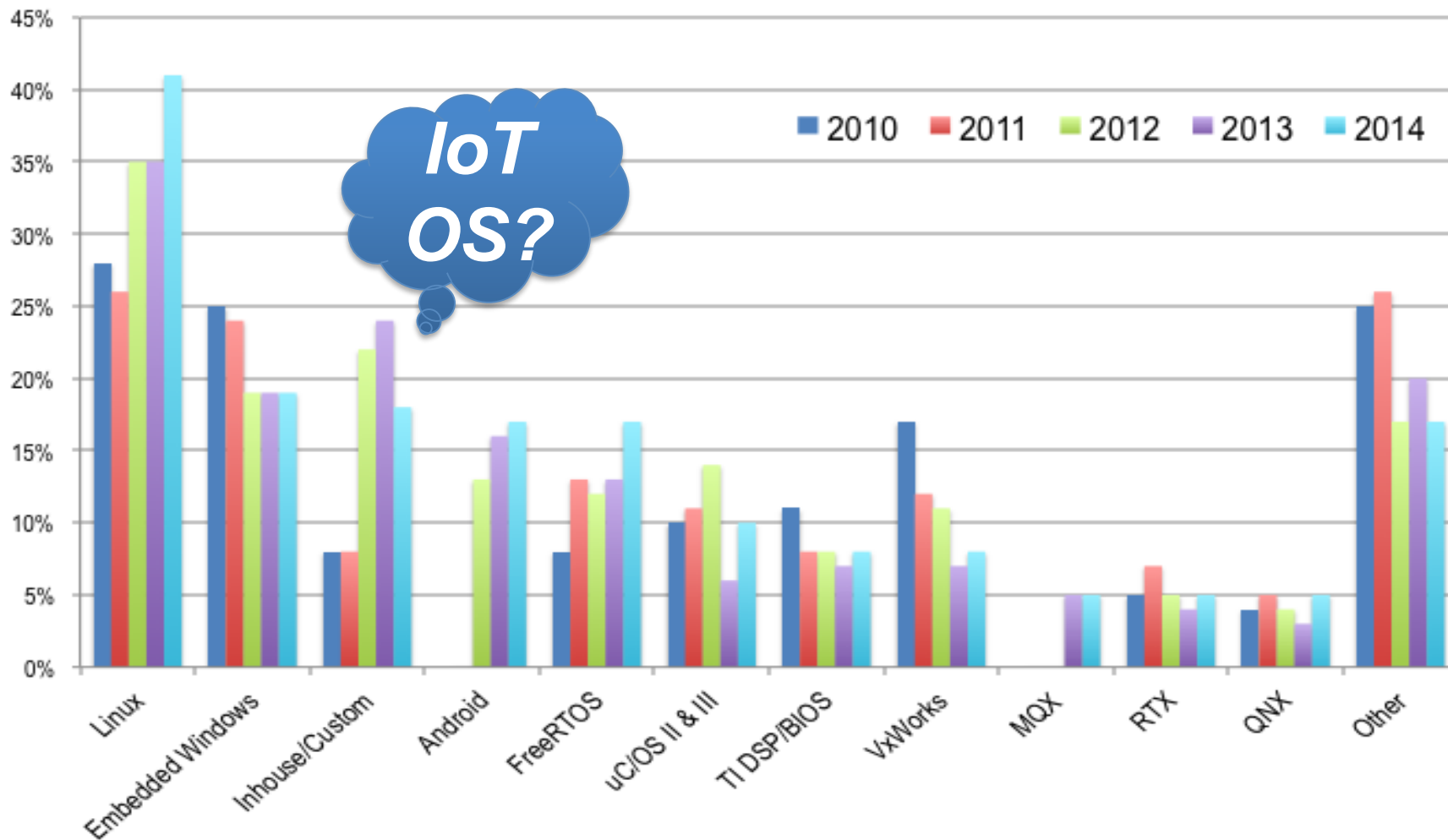
The origin and development of IoT OS

- Start from two Open source Sensing Network OS
 - TinyOS—UC Berkeley (All most stop)
 - Contiki— Ph D Adam Dunkels former Institute of Computer Science, Swedish Institute of Technology, Thingsquare founder, wrote uIP / LWIP ,activity project
- 2010 Europe announced IoT OS-RIOT
- Jan 2014 Microsoft announced Windows 10 IoT Core
- Oct 2014 ARM announced mbed OS
- Oct 2014 Micrium announced Spectrum project (base on uc/OS-III)
- 2014 Mixchip announced MiCO OS
- 2015 Huawei announced Lite OS
- 2015 Google announced Brilo OS (new rename as Android Things)
- 2016 Linux foundation released Zephyr project
- Jan 2017 Haier demo Uhome OS on CES
- Oct 2017 Ali announced AliOS for IoT

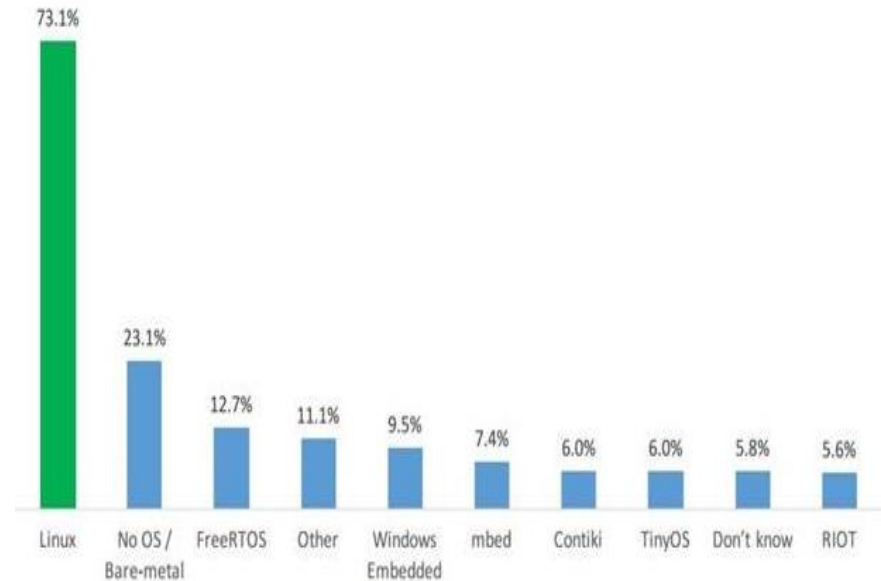
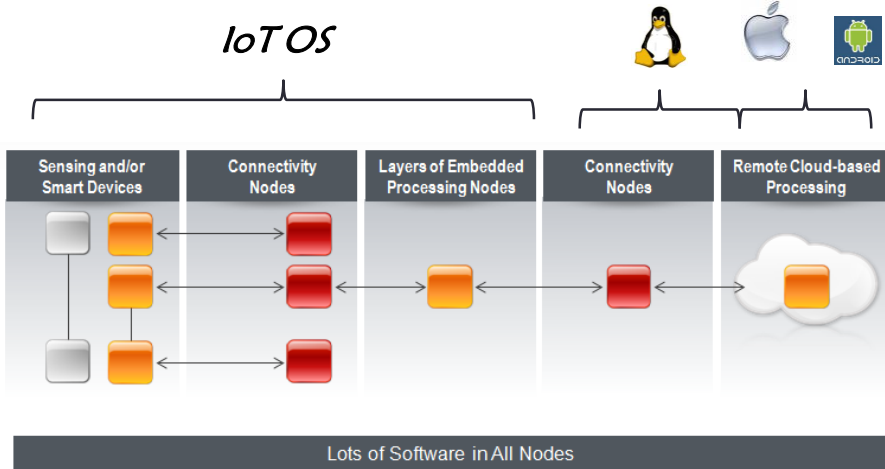


2014 world media coverage of the IOT OS

Where are the IoT OSEs?



Multiple OS in the IoT world



*IoT device OS survey
(from: IoT Developer Survey 2016)*

Internet of Things Building Blocks

- Media coverage for Linux and Android is high, creating a certain perception in the industry
- RTOS opportunity (in unit volume) is 3x as large as the general purpose OS
- Linux and Android can only run on Application Processors
- MCU's targeted for IoT do not have enough resources for Linux or Android

The definition of IoT OS

One name is IoT Operating Systems (OS)

Or Operating System for Internet of Things

No matter academia or industry for the IoT OS

A clear definition, accurate connotation and extension of the elaboration

*ELSEVIER Future generation computer system
IoT OS issue content*

- IoT Operating Systems (OSs)

- Energy and memory efficient approaches
- Sensors, IoT platform support and limitations in IoT OSs
- Interoperability of IoT OSs protocols and devices
- Simulation, emulation and testbed support, limitations and Solutions
- Resource management for IoT OSs
- Memory management for resource constrained IoT devices
- Security issues and solutions for privacy in IoT OSs
- Co-existence of technologies, limitation and solutions
- Standard API specifications for IoT OSs

Windows 10 IoT Core

The operating system built for your Internet of Things

Android Things

Build connected devices for a wide variety of consumer, retail, and industrial applications

Arm Mbed OS is an open source embedded operating system designed specifically for the "things" in the Internet of Things.

It includes all the features you need to develop a connected product based on an Arm Cortex-M microcontroller, including security, connectivity, an RTOS, and drivers for sensors and I/O devices.

Huawei LiteOS 简介

Huawei LiteOS 是华为面向IoT领域，构建的轻量级物联网操作系统，以轻量级低功耗、快速启动、互联互通、安全等关键能力，为开发者提供“一站式”完整软件平台，有效降低开发门槛、缩短开发周期。

ELSEVIER Special Issue on Internet of Things (IoT)

- The key features of IoT Operating Systems (OSs) are modularity, energy-efficient scheduler, hardware support, architecture, network stacks, reliability, interoperability, unified APIs, generic interfaces, and real-time capabilities.

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Special Issue on Internet of Things (IoT): Operating System, Applications and Protocols Design, and Validation Techniques



- 书中的阐述：具备低功耗、实时性和安全的传感、连接、云端管理服务软件平台

IoT Security has a Long Way to Go

- **Previously, smart device manufacturers only need to be concerned about the device and the data generated. Even this requirement is often not met on consumer electronic products.**
- **Now they are asked to protect the device and the network, which is not strictly about their customers. What's more, the security design of IoT is still being researched. There is no true mature design or implementation.**
- **Another aspect is IoT device functional safety, which is closely tied to industrial IoT(IIoT) fields like automobile electronics, factory automation, industrial control, railway signal, smart power grid etc. Design and implementation in IIoT are more formalized, with mature software, tools and consulting services.**

- **2017 is going to be another year of development of embedded and IoT technology. After integrations within chip manufacturers, many IoT applications will scale up and prosper.**
- **Low-Power Wide-Area (LPWA) will also likely to advance rapidly, with different platforms and network standards (e.g. LoRa, Sigfox and NB-IoT/eMTC) competing with each other. Huawei's report said there 42 billion USD market of NB-IoT in the world**
- **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.**

Conclusion

- In 2018, we can foresee a year of breakthrough.
- In 2018-2020 OS and wireless and wire network technology in IoT will mature; processor technology, under influence of AI will explode; IoT will embrace a major growth period with next generation network
- The infrastructure of IOT security is gradually maturing, the actual results have yet to be recognized by the market and users



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.

5G will be a major boost to IoT. 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.

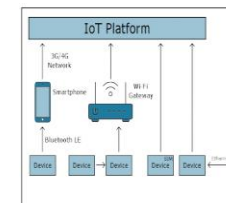



Figure 2: ARM mbed OS.

IoT Security and safety – a long way to go
 On Oct. 21st 2016, DNS service provider Dyn 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 Mirai malware might be the culprits, heating up the debate on IoT security. Shenqin'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.

The Author
 Alan 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 Alan 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. Alan also authored the book "Embedded Operating System: History of Development and the Future of the Internet of Things".



请参考“全球嵌入式技术和物联网发展趋势 Elektor Business Magazine 5/2017 (Global Development Trends of Embedded and Internet of Things Technology)”

Thank you !

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