Global Development Trends of Embedded Technology and Internet of Things
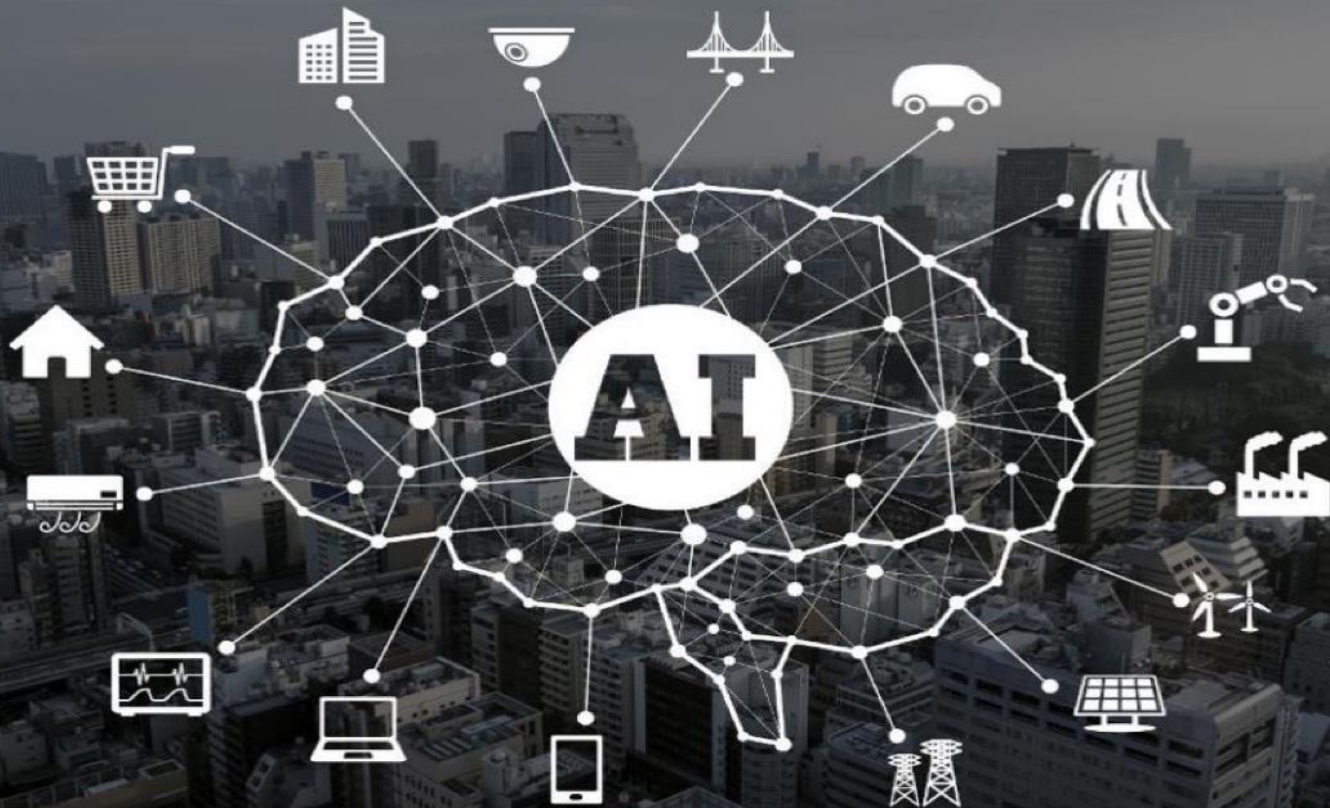# 全球嵌入式技术和物联网发展新趋势

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嵌入式系统联谊会
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Everything will be connected

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Everything will be an AI ?

构建未来智能社会的嵌入式技术三大基石

1   **Connectivity** 互联互通是构建智能社会的基础，致力发展高效，可靠和低功耗的联网技术

2   **Ecology** 面对大数据未来，发展绿色环保的高能效的嵌入式计算技术

3   **Safety & Security** 连入开放网络的嵌入式，自身的功能安全和系统的信息安全都将非常重要

- **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.

- **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

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- 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（Tensilica)

- Embedded edge computing（边缘计算） will play an important role in improving computing capacity and real-time with AI device 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.

什么是边缘计算?

- Edge computing refers to the enabling technologies allowing computation to be performed at the edge of the network, on downstream data on behalf of cloud services and upstream data on behalf of IoT services.[1]

- In the context of IIoT, 'edge' refers to the computing infrastructure that exists close to the sources of data, for example, industrial machine,controllers and time series databases aggregating data from a variety of equipment and sensors. These devices typically reside away from the centralize computing available in the cloud.[2]
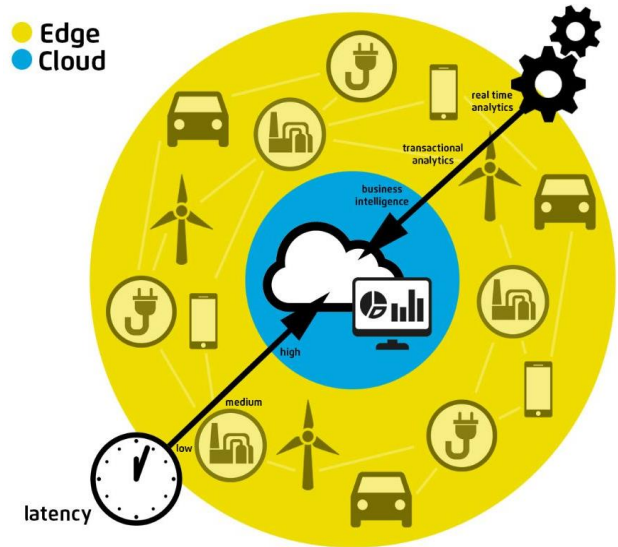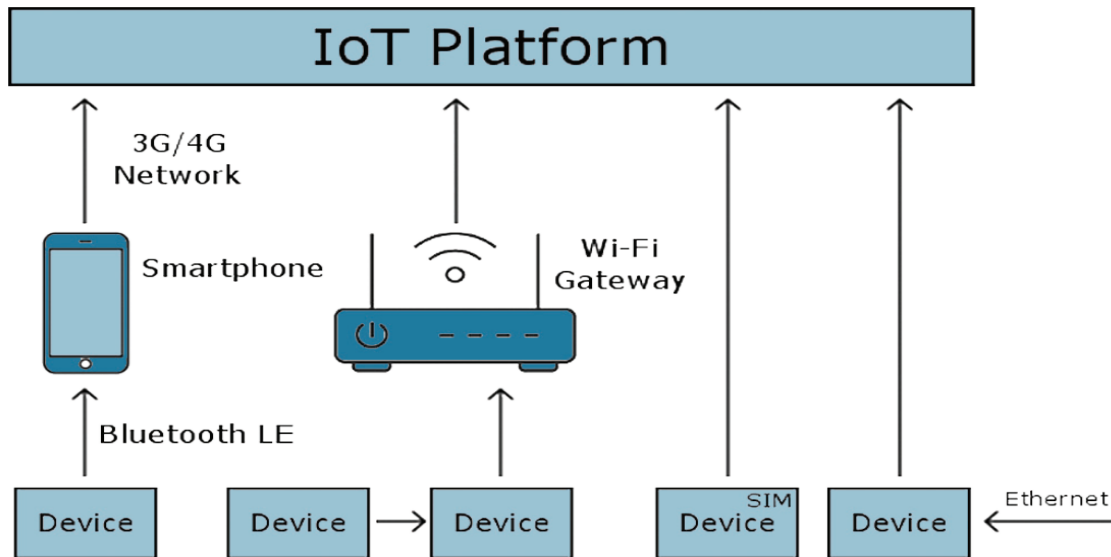

1 Edge Computing: Vision and Challenges Prof WeiSong Shi
IEEE INTERNET OF THINGS JOURNAL OCT 2016
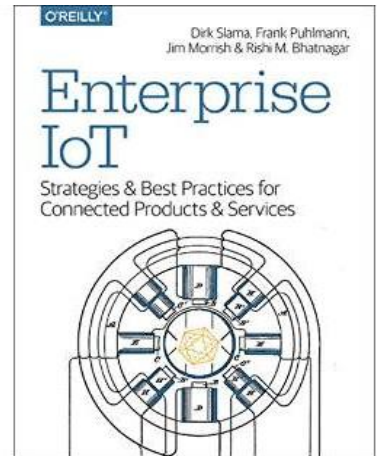2 https://www.ge.com/digital/blog/what-edge-computing

IoT 云平台将趋于成熟

- 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

著名 IoT 云平台

- Amazon AWS IoT, Microsoft Azure IoT, General Electric Predix, IoT IBM Watson IoT and PTC IoT (ThingsWork)

- China Mobile OneNet, Guangzhou GizWits and Alibaba Smart Cloud.

- Open source framework Kaa and Eclipse Kura are prime examples

- Oracle, SAP、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 比如 智能汽车、智慧城市和智能制造

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Dirk Slama, Frank Puhlmann,
Jim Morrish & Rishi M. Bhatnagar

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物联网操作系统异军突起

• Embedded systems have been using OSS widely

- one of the best examples being Linux

• Traditional embedded OS has been moving slowly with few good profitable business model

- A few exceptions like automobile electronics, aerospace and military/defense.

- Service was becoming a major revenue of Embedded OS

• 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

- Open Source RTOS Evolution to IoT OS , Amazon FreeRTOS and Zephery for example
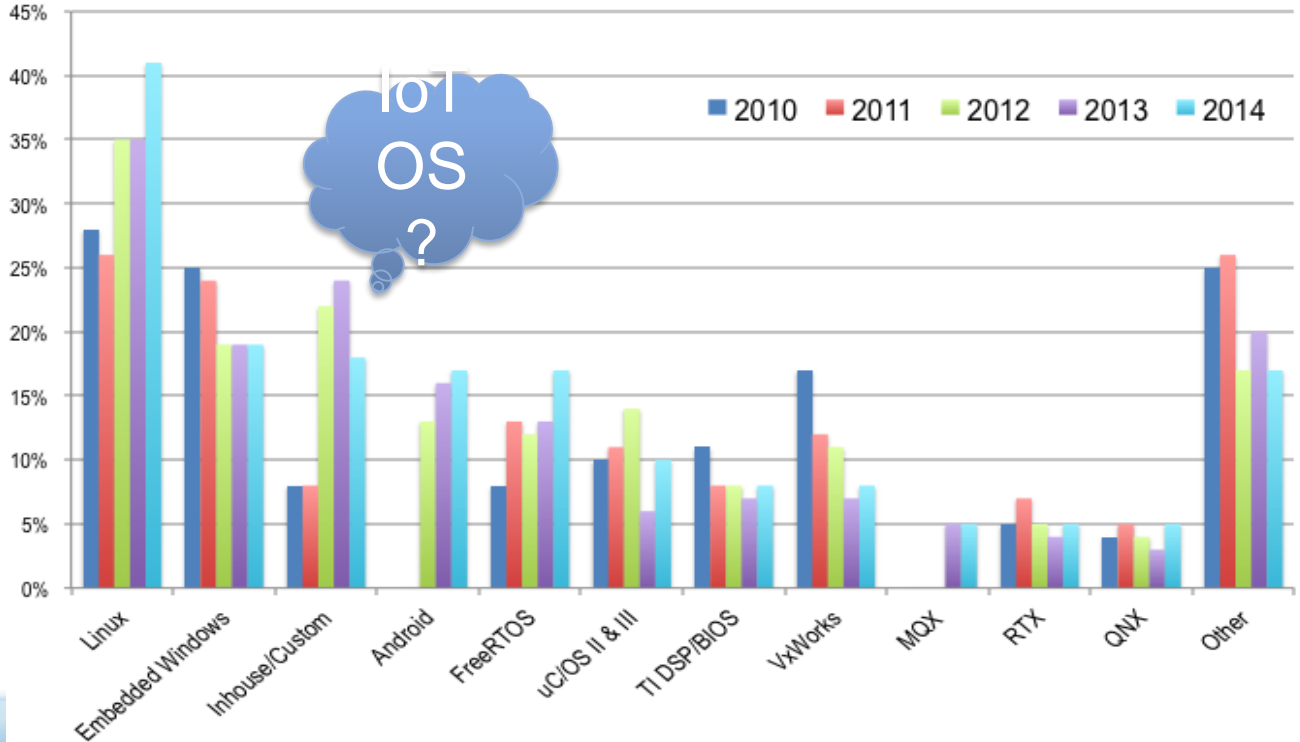
物联网操作系统发展历史

- 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, Thingsqure 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 Zephry project
- Jan 2017 Haier demo Ulhome OS on CES
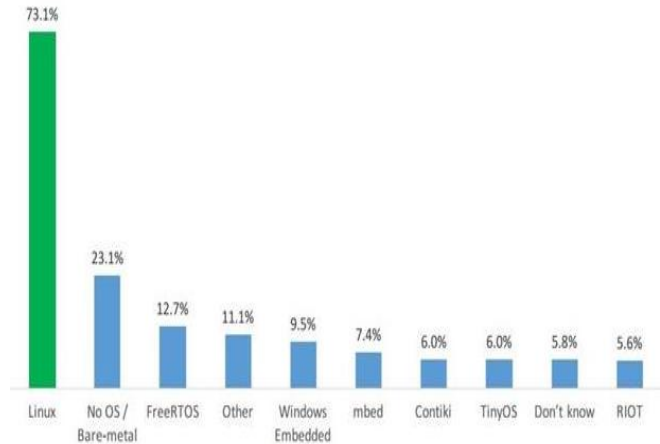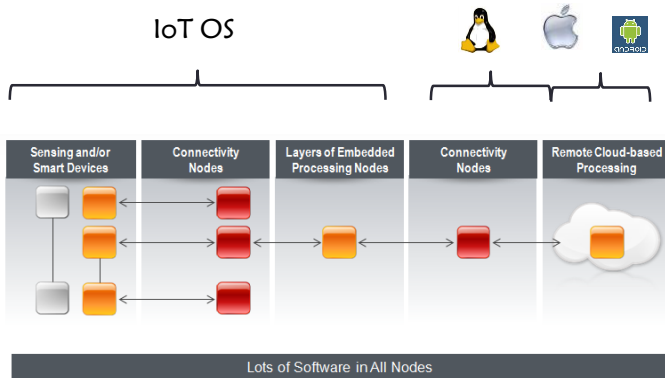- Oct 2017 Ali announced AliOS for IoT

The Internet of Things Gets a New OS

By Neel V. Patel
Posted 7 Oct 2014 | 0:00 GMT

WIRED

OPERATING SYSTEMS FOR THE INTERNET-OF-THINGS

2014 world media coverage of the IOT OS

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IoT OS 的市场在哪里?

IoT世界多种OS 并存

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

- 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

IoT OS 的 定义

One name is IoT Operating Systems (OS)

Or Operating System for Internet of Things

No matter academia or industry for the IoT C

A clear definition, accurate connotation and

extension of the elaboration

- 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

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。

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.

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IoT OS 应用：Amazon FreeRTOS

- IoT operating system for Microcontrollers(MCU)
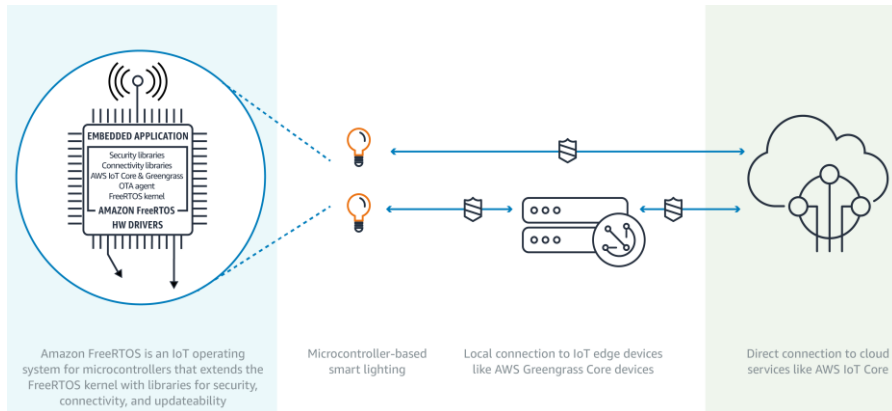
  适用微控制器的 IoT 操作系统

- Amazon FreeRTOS

  - Amazon FreeRTOS 是一款适用于微控制器的操作系统，可让您轻松地对低功耗的小型边缘设备进行编程、部署、安全保护、连接和管理。Amazon FreeRTOS 以 FreeRTOS 内核 为基础，并通过软件库对其进行扩展，从而让您可以轻松地将小型低功耗设备安全连接到 AWS 云服务或运行 AWS Greengrass 的功能更强大的边缘设备：

- Amazon FreeRTOS 与传统嵌入式开发区别；

  - 致力于提供MCU连接到云端的便捷和安全方案

  - 克服传统的MCU 云连接开发的困难：多平台和缺少安全机制

- Amazon FreeRTOS 是一个开源系统，可以免费使用

Amazon FreeRTOS 工业应用案例

▪ 工业传感器、致动器、泵和自动化组件均使用微控制器，因为它们成本低、功耗低，并且可以执行实时操作。工业客户的设备会生成大量工作负载数据，石油钻塔上的单个泵由微控制器控制，如果出现故障，则可能会完全停止生产。借助 Amazon FreeRTOS，这些客户可以直接连接到云来收集系统性能和压力方面的数据，并通过 AWS Greengrass 在本地实时采取行动来防止出现破坏性中断事故

Honeywell

THE POWER OF **CONNECTED**

Amazon FreeRTOS is an IoT operating system for microcontrollers that extends the FreeRTOS kernel with libraries for security, connectivity, and updateability

Microcontroller-based smart lighting

Local connection to IoT edge devices like AWS Greengrass Core devices

Direct connection to cloud services like AWS IoT Core

IoT 安全任重而道远

- 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.

- **IoT 安全需要产业链的通力合作**
  - Chip-Device-Communication-Cloud-User

LPWA 和 5G

- 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 of 2023

- 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.

结论

- In 2018-2019, 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, chip and cloud will make the progress. 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.

environments 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. ◄
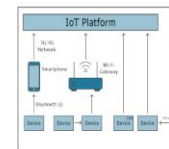
The Author

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".

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 Mirai 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.

Thank you !

Any question please feel free to contact:

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