

Trends of Embedded Technology and Internet of Things: IoT OS and EC

嵌入式技术和物联网发展新趋势 -IoT OS和边缘计算

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嵌入式系统联谊会介绍

- 由国内知名学者和产业人士共同发起，于2008年底在北京正式成立。嵌入式系统联谊会为中国嵌入式系统不同学科领域的专家学者、工程技术人员、市场人士和科技媒体人士提供学术和产业信息交流的环境，是增进个人友谊的科技沙龙机构
- 主题讨论会自2009年开始，已经召开22次会议，会议反响热烈，参加总人数已经累超过千人次，见诸媒体的报道百余篇。联谊会作为嵌入式系统学术界、产业界、科技媒体的交流和联系平台的作用和定位得到广泛认可
- 联谊会是公益性组织，不向发言人收费，不向参会者收费，活动费用来自协办和支持机构的赞助！
- 联谊会有7家合作媒体，3家支持会展机构
- 联谊会微信群和工作组工作组
- 联谊会官方网站 www.esbf.org



2009年-2017年嵌入式系统联谊会举办的活动

- **2009年-2017年嵌入式系统联谊会会议题**
- **2009年03月** 嵌入式系统的集成电路产业。
- **2009年06月** 嵌入式软件产业与软件集成。
- **2009年12月** 嵌入式系统的学科建设。
- **2010年03月** 嵌入式系统的发展趋势。
- **2010年07月** 嵌入式系统新技术论坛。
- **2010年12月** 物联网、云计算与高校教育。
- **2011年05月** MCU中国设计与中国应用。
- **2011年12月** 嵌入式操作系统现状与趋势。
- **2012年4月** 嵌入式系统的无线互联技术。
- **2012年11月** **FPGA**在嵌入式系统中的应用。
- **2013年5月** 展往未来、探索教育。
- **2013年11月** 使用**ARM Cortex-M MCU** 拓展单片机教学
- **2014年3月** 智能硬件设计与应用研讨会
- **2014年11月** 展望**工业4.0**、聚焦机器人
- **2015年5月** 物联网教育与产业发展研讨会
- **2015年12月** 全球集成电路产业整合与嵌入式系统发展
- **2016年3月** 嵌入式系统创新与创业
- **2016年7月** 西南地区嵌入式系统技术和产业研讨会（成都）
- **2016年11月** 中国单片机三十年回顾与展望
- **2017年4月** 华南地区嵌入式技术和物联网产业发展（深圳）
- **2017年11月** 物联网操作系统现状和发展前景

感谢参与和支持联谊会！



科技创新的浪潮

▪ Cloud

- Globally available, unlimited compute resources

▪ IoT

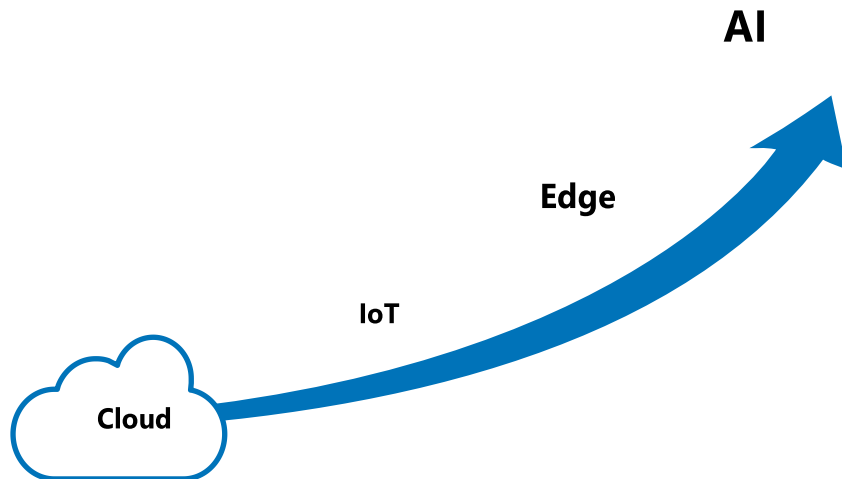
- Harnessing signals from sensors and devices, managed centrally by the cloud

▪ Edge

- Intelligence offloaded from the cloud to IoT devices

▪ AI

- Breakthrough intelligence capabilities, in the cloud and on the edge



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



半导体行业的并购将影响嵌入式系统发展

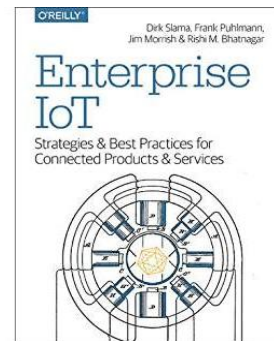
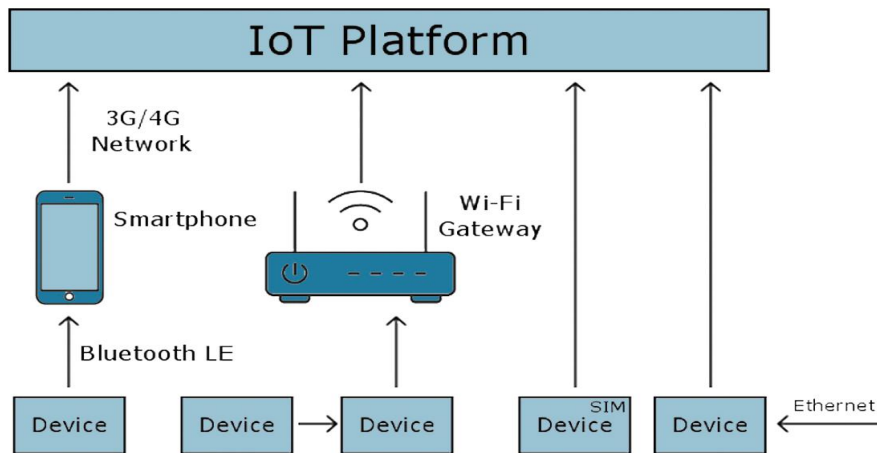
- The main reason being the incentive to cut cost and raise profit
- Mergers will lead embedded processor into the vertical market of IoT and AI
- New processor technology and business model will arise in the IoT low-energy EC and Sensor Node
- Embedded edge computing（EC:边缘计算） will play an important role in improving computing capacity and real-time with embedded AI device being one instance.

LPWA 和 5G

- 2018 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.

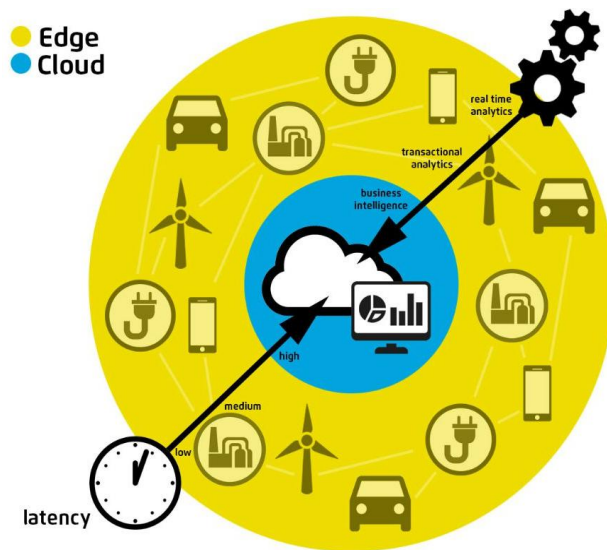
IoT 云平台趋于成熟

- 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
- AWS IoT, Azure IoT, GE Predix, Watson IoT and Huawei Ocean connect IoT..
- Enterprise IoT will be enjoying high growth in the next two year, for example Smart City 、 Smart Car and Industry Manufacture area



什么是边缘计算？

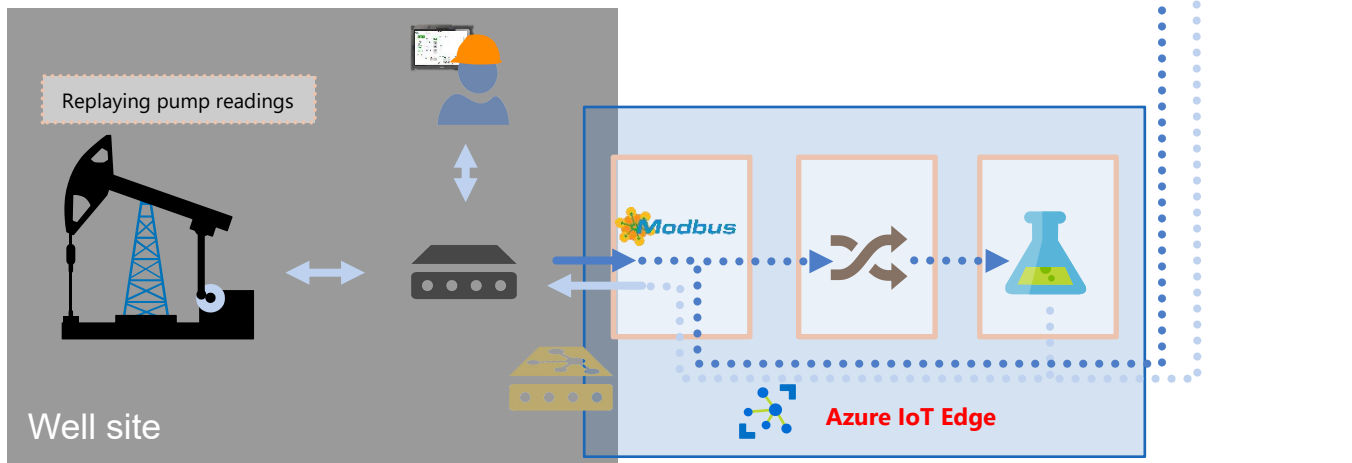
- Edge computing refers to the enabling technologies allowing computation to be performed at the edge of the network, on downstream data on behalf of cloud services and upstream data on behalf of IoT services.¹
- In the context of IIoT, 'edge' refers to the computing infrastructure that exists close 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 centralized 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 边缘计算和机器学习- 微软案例

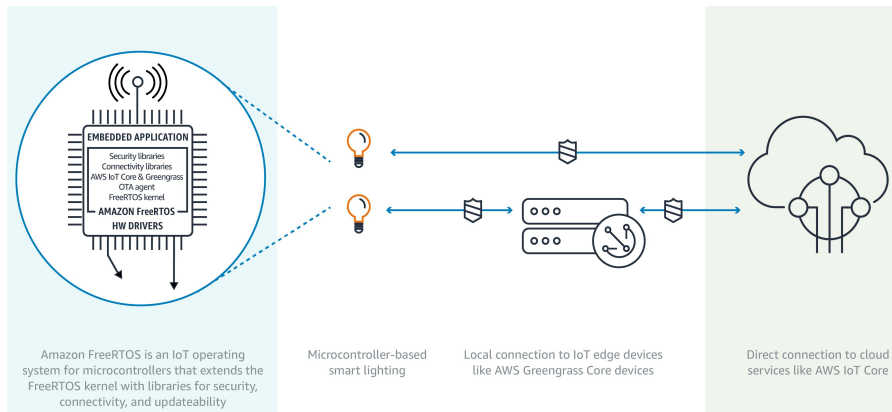


Amazon FreeRTOS IoT OS 和边缘计算案例

- 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**



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边缘计算目前的进展

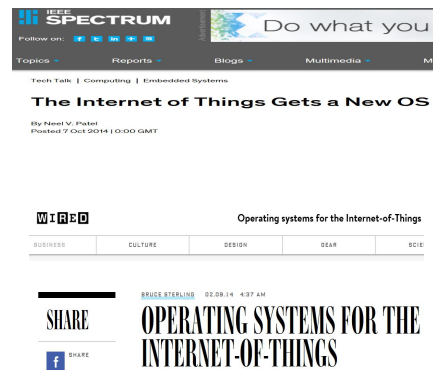
- Telecom Industry-Related Initiatives
 - 5G Convergent Virtualized
 - Radio Access Network,
 - 5G-CORAL (research, combines telecom edge computing and fog)
- Intelligent IoT Gateway Model
 - Bosch (Prosyst gateway software),
 - Siemens (IoT 2000 serie gateways),
 - Microsoft (Azure IoT Edge),
 - Amazon (Greengrass and Snowball Edge)
 - EdgeX Foundry (IoT gateway open source)
 - ParaDrop (University of Wisconsin-Madison)¹

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 Zephyr for example

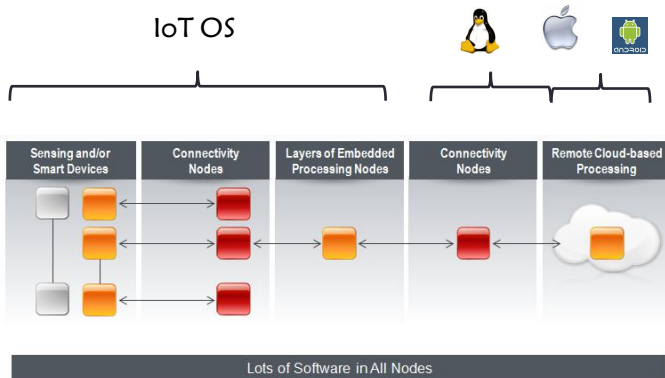
物联网操作系统发展历史

- 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, 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 Brillo 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

IoT OS 实际应用的现状

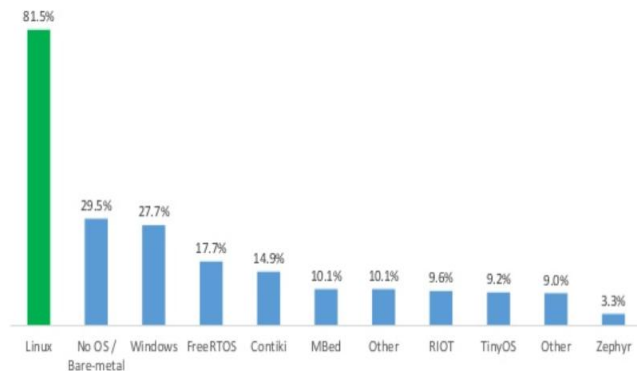


Internet of Things Building Blocks

- 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

IoT OPERATING SYSTEMS

Which operating system(s) do you use for your IoT devices? (Summary)



IoT device OS survey
(from: IoT Developer Survey 2017)

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

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。

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

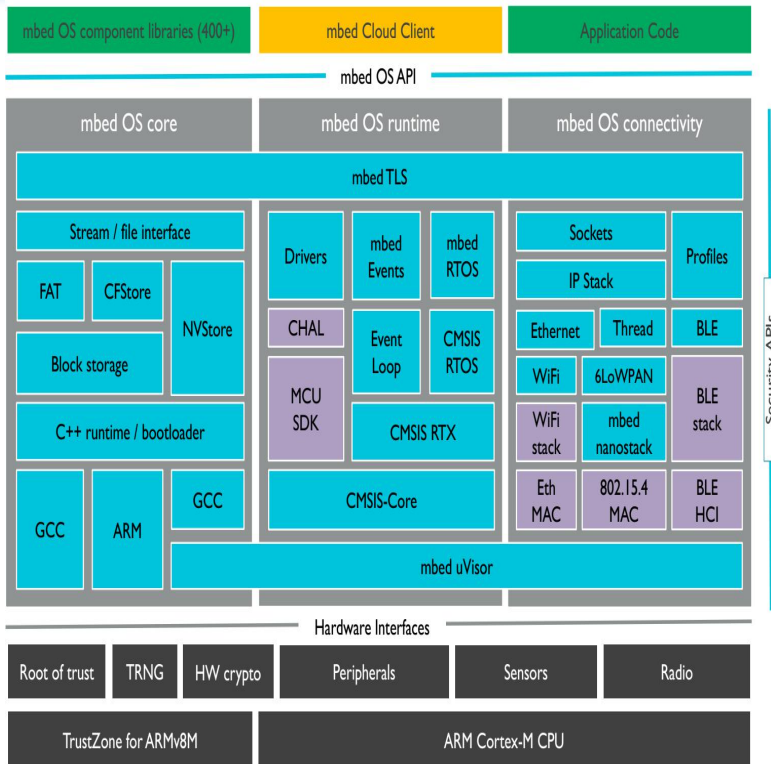
Arm Mbed OS is an open source embedded operating system designed specifically for the "things" in the Internet of Things.

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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ARM mbed OS

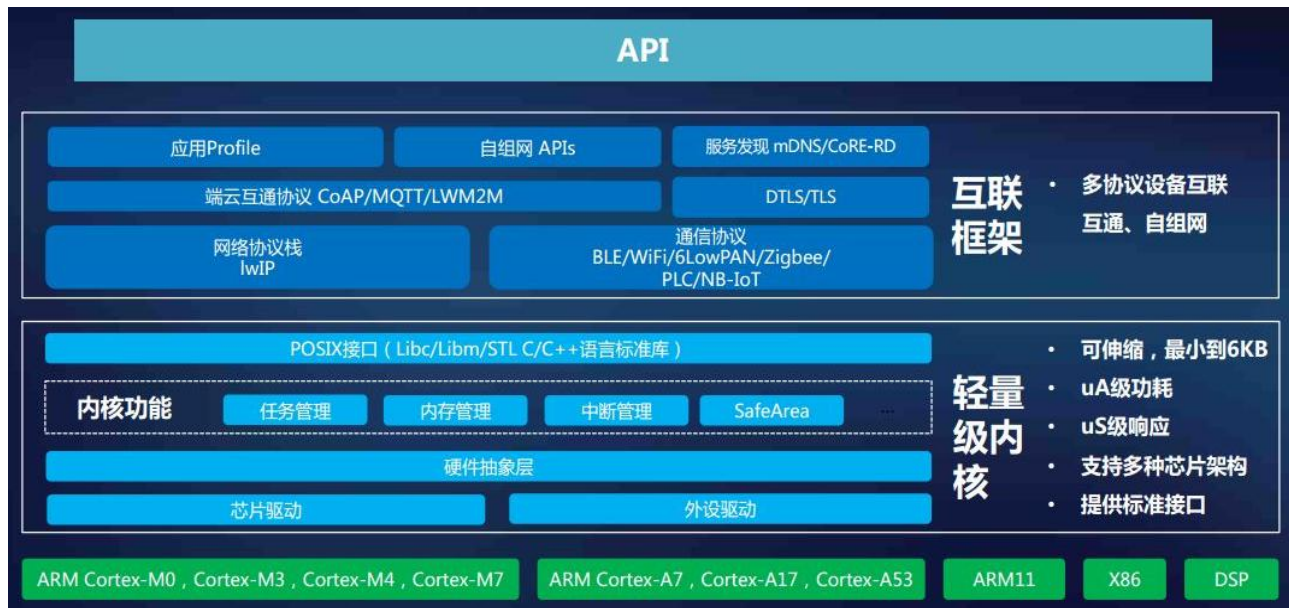


- Mbed OS 内核
 - 支持MCU 架构、C/C++ API
 - CMSIS-RTOS RTX
- mbed OS 中间件- 见左图
- mbed OS支持各种通信连接
 - WiFi、BLE、LoRa、6Lowpan, 蜂窝网络、Ethernet/CAN 有线 (NB-IOT除外)
- mbedOS 安全
 - 三层保护机制: mbed uVison、mbed TLS 和mbed Client
- 丰富的工具-mbedCLI、GIT、IAR/GCC
- mbed cloud connection
 - 支持公有云 (Watson IOT、AWS)
 - 工业IoT云 (ADVANTECH...)
 - 计划支持边缘计算-Mbed Cloud Edge

<https://developer.mbed.org/>
<https://github.com/ARMmbed>

Huawei LiteOS

Huawei LiteOS 的内核分为两个层次，第一层是基础内核，第二层是扩展内核，基础内核的源码是开源的, https://github.com/LITEOS/LiteOS_Kernel

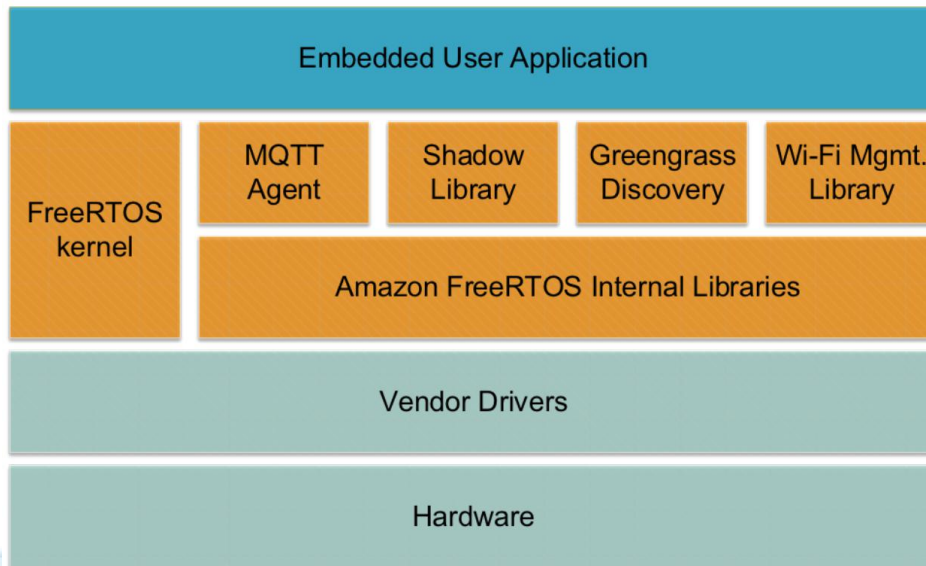


<https://github.com/LITEOS>

物联网操作系统，终端设备智能化使能平台

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（边缘计算）**的功能更强大的边缘设备，开源系统，可以免费使用



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 security needs cooperation in the industry chain**
 - Chip-Device-Communication-Cloud-User

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. Linux includes smart-watch-powered tablets 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 OSes to customize IoT OS solutions.

processors, or wire networking are becoming more pressing and industry leaders. Low-power operation, low latency and high availability aspects of SE will be major issues to IoT.

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

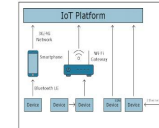


Figure 2: IOT-based OS.

IoT Security and safety – a long way to go
On Oct. 22nd, 2016, DNS service provider Dyn suffered severe a DDoS attack, causing widespread downtime of all websites like Amazon and Twitter. Analysis indicates that 100 thousands of IoT devices infected with their malware might be the culprits, leading up the debate on IoT security. Shodan's live hack on fingerprint clock of Huawei P8 (see 20th, 2016), a massive video surveillance leak in Hongzhou (2015) – there are many incidents that raise public awareness of IoT security issue.

The Author
Alan He is the Founder of SPM, 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 "HCS and Embedded System Applications" journal, and has published more than 50 papers and articles in various international and domestic journals, and he generates 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 !

Any question please feel free to contact:

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