Introduction to mbed OS

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Mihail Stoyanov
Partner Enablement Team Lead, ARM mbed

ARM mbed Connect / China
December / 05 / 2016

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mbed OS Introduction

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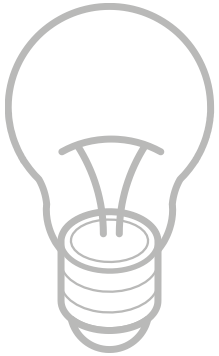
OS platforms for IoT and embedded

- IoT is a disruptive jump in complexity for embedded software
  - Requirements for Connectivity → Security → Management
- Adoption of OS platforms is necessary for industry success
  - The cost and risk of projects building from scratch is too high
  - A platform OS lowers the barrier to entry for new entrants
- IoT products require device management services
  - Will become essential components within a platform OS



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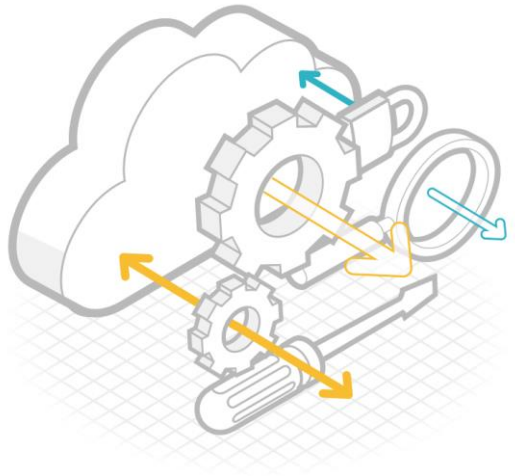
Platform OS requirements

- Accelerate the development of IoT devices
  - Pre-integrate all the necessary connectivity and software components
  - Provide across many hardware solutions
- Accelerate the deployment of IoT devices
  - Solve the device management problems
- Utilize ecosystem scale
  - In collaboration to provide maximum gearing and pace



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mbed OS core

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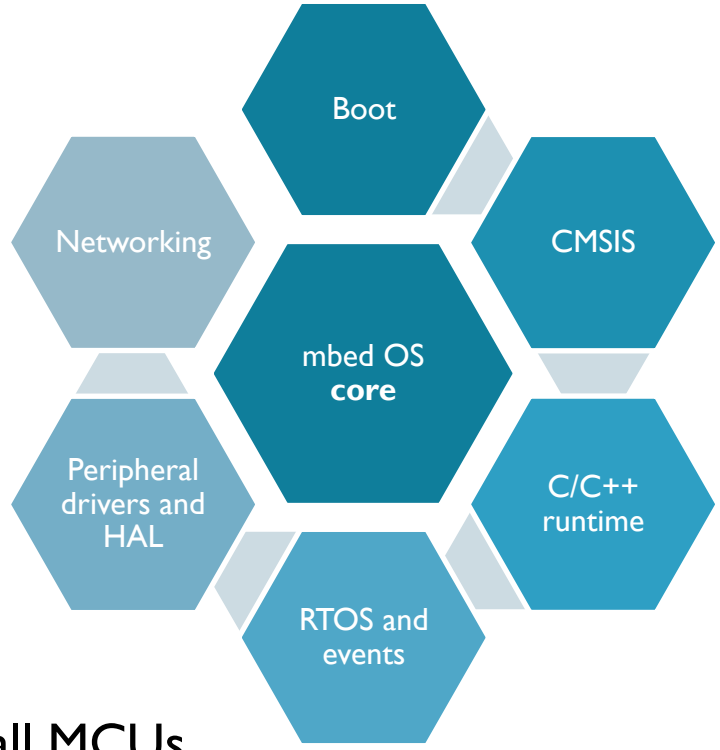
mbed OS core

- Enables application and component libraries to work unchanged across MCUs
  - Provides portability for developers
- Consistent boot and C/C++ runtime across MCUs
  - Including support across different toolchains, std library integrations
- RTOS kernel
  - Built on the established, widely used, open source CMSIS-RTOS RTX
  - Very small kernel optimised for constrained memory devices
- Peripheral driver APIs
  - Common Driver APIs for all common peripherals, supported across all MCUs



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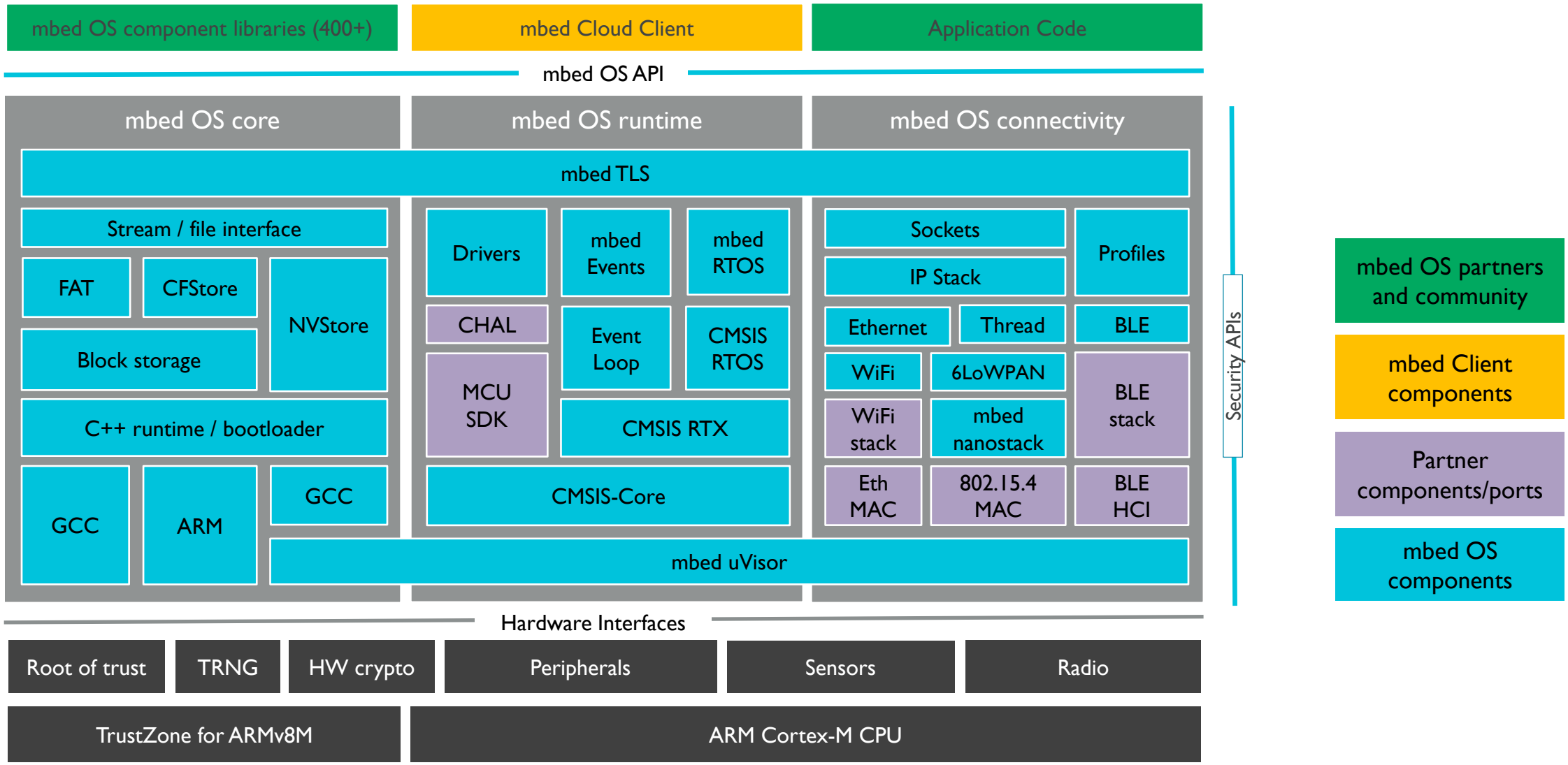
mbed OS stack



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mbed OS connectivity

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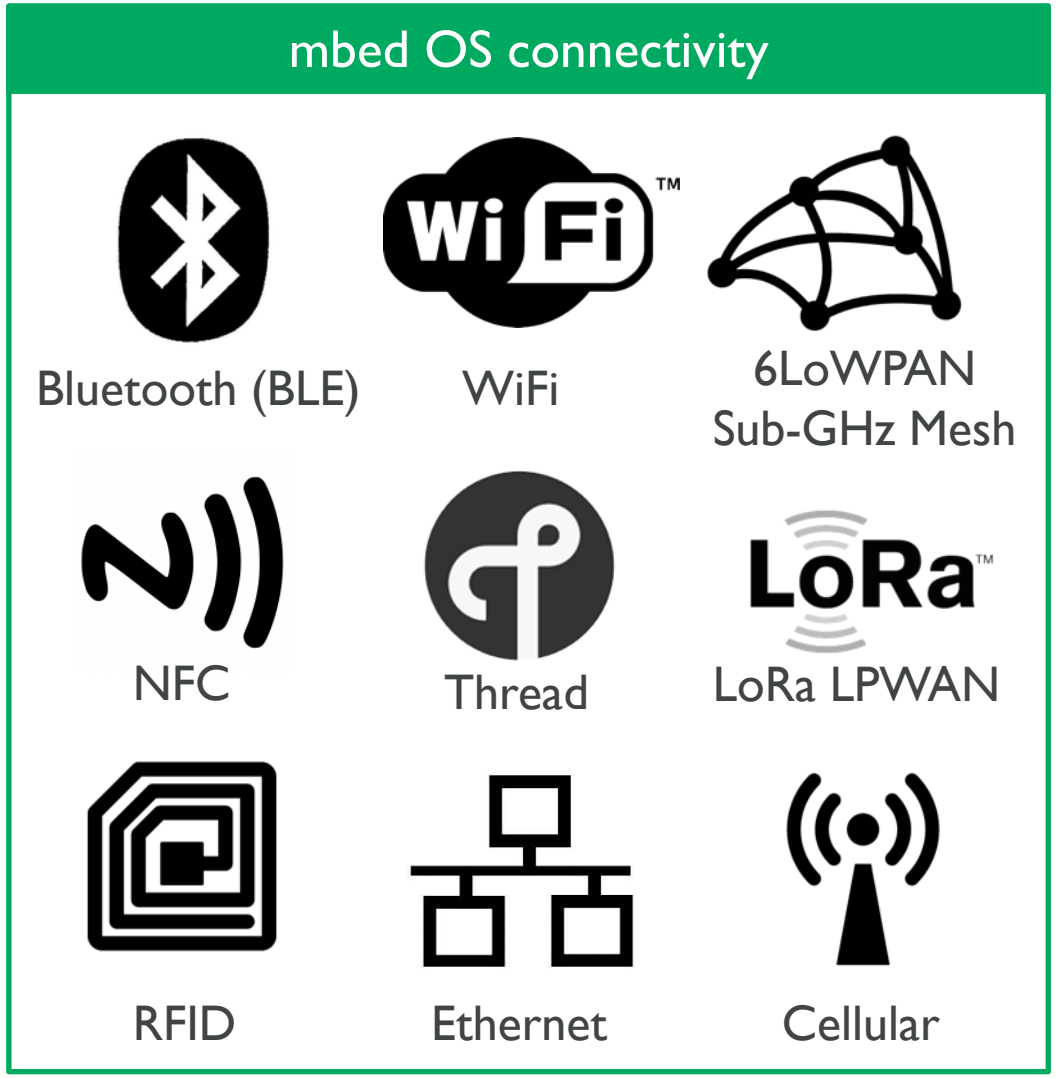
mbed OS connectivity

- Broad IoT connectivity
  - Unified support of customer product portfolio
- mbed partner and community contributions
  - Development hardware
  - Software libraries
  - Tutorials and examples
  - Commercial products and support
- Future standards:
  - Next-gen Industrial 802.15.4 Mesh
  - NB-IoT



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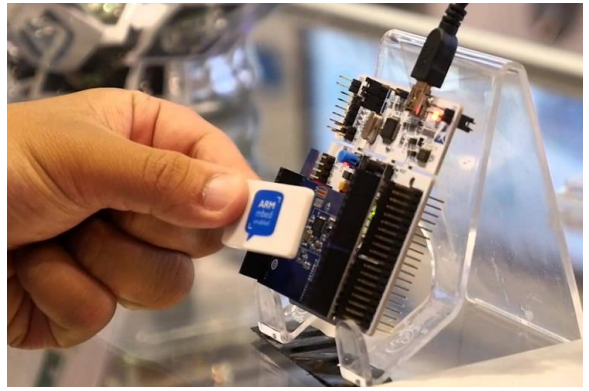
Bluetooth Low Energy

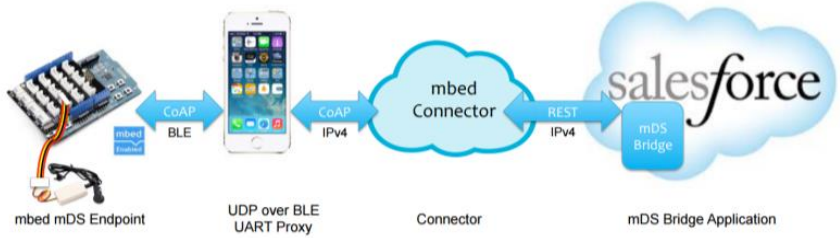
- mbed OS BLE APIs already widely and successfully used
  - Portable across different vendors
  - Used in e.g. Google Eddystone beacons
- BLE has huge potential beyond its current application areas
  - Trusted robust radio, low cost chips, built into every mobile and laptop
  - Roadmap to longer range and IP
- Currently expanding support for BLE across more platforms
  - Already supporting Cordio Radio IP, Nordic SoC, Maxim, ST



NORDIC SEMICONDUCTOR
Smarter Things

Bluetooth SMART

ARMCORDIO
Radio core IP



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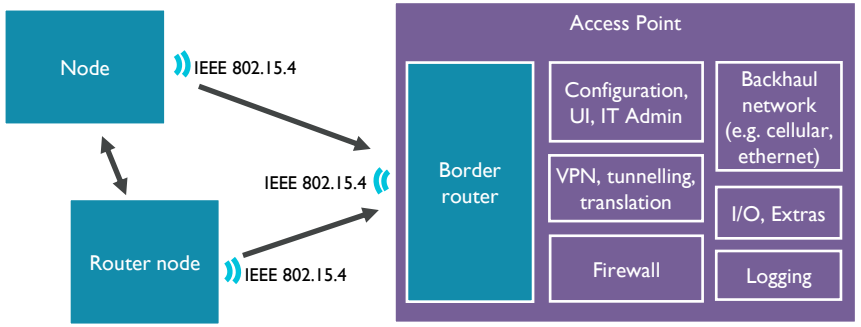
mbed OS 6LoWPAN 802.15.4 and Thread

- Continue to be a leader in Thread implementation and standardisation
  - Also supporting generic 6LoWPAN 2.4GHz and Sub-GHz
- mbed OS implements MAC abstractions for simple transceiver support
  - Enables any 802.15.4 SoC or transceiver access to Thread/6LoWPAN
  - Multiple transceivers now working, can be used with any suitable mbed Enabled MCU
- Border router and access point references available
- Focus on commercial, industrial and smart city



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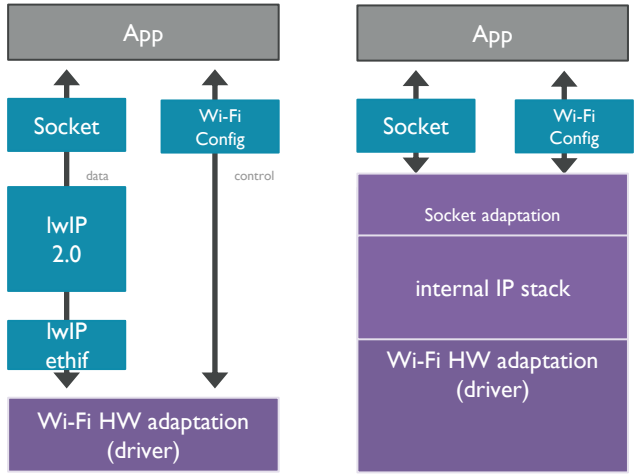
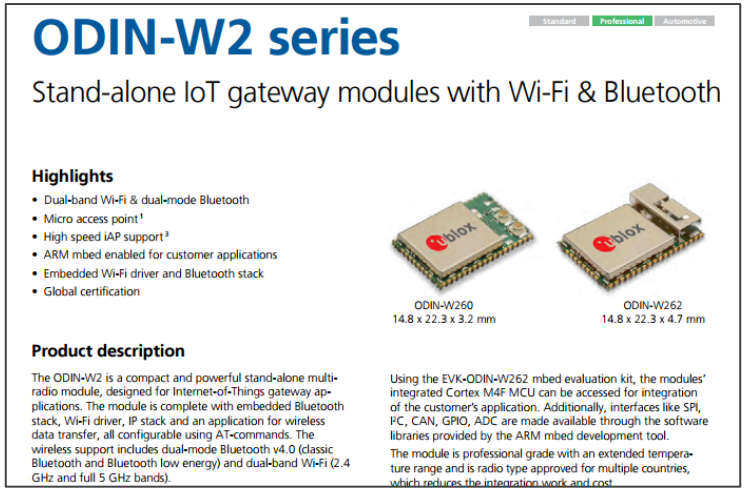
Enabling single module WiFi solutions

- mbed OS unlocks WiFi modules as a platform
  - Application and OS runs on the integrated wireless modules
  - Enables BOM reduction and reduced design complexity
- Supports integration of different WiFi architectures
  - WiFi MAC (mbed OS IP stack)
  - WiFi Network Processor (internal IP stack)
- u-blox ODIN-W2 module support in mbed OS 5.2
  - Look out for other partners landing their support





ODIN-W2 series

Stand-alone IoT gateway modules with Wi-Fi & Bluetooth

Highlights

- Dual-band Wi-Fi & dual-mode Bluetooth
- Micro access point[1]
- High speed iAP support[3]
- ARM mbed enabled for customer applications
- Embedded Wi-Fi driver and Bluetooth stack
- Global certification

ODIN-W260
14.8 x 22.3 x 3.2 mm

ODIN-W262
14.8 x 22.3 x 4.7 mm

Product description

The ODIN-W2 is a compact and powerful stand-alone multi-radio module, designed for Internet-of-Things gateway applications. The module is complete with embedded Bluetooth stack, Wi-Fi driver, IP stack and an application for wireless data transfer, all configurable using AT-commands. The wireless support includes dual-mode Bluetooth v4.0 (classic Bluetooth and Bluetooth low energy) and dual-band Wi-Fi (2.4 GHz and full 5 GHz bands).

Using the EVK-ODIN-W262 mbed evaluation kit, the modules' integrated Cortex M4F MCU can be accessed for integration of the customer's application. Additionally, interfaces like SPI, I²C, CAN, GPIO, ADC are made available through the software libraries provided by the ARM mbed development tool.

The module is professional grade with an extended temperature range and is radio type approved for multiple countries, which reduces the integration work and cost.

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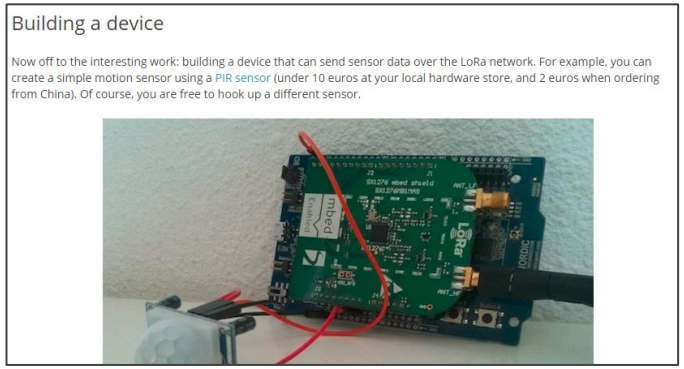
Native support for LoRaWAN

- mbed OS is already used for LoRa development
  - We invested early in LoRa, and are planning to increase investment
  - 7 LoRa hardware devices already in platform/component database
  - mbed LoRa examples imported 1000's times
- Extending to provide integrated LoRaWAN support



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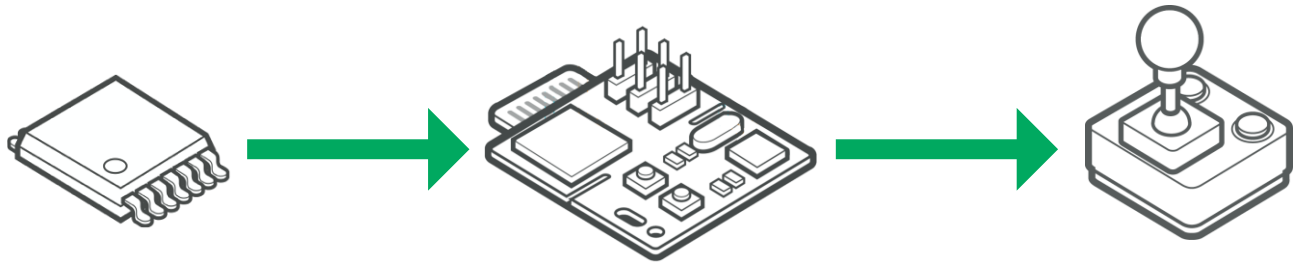
mbed OS modules

- Smart Modules will become a key building block for IoT products
  - Wraps up complexity to simplify product design – radio, application, services
  - Common design-in for IoT applications with initial runs of 10-100k units



- Partnering with manufacturers on mbed Enabled wireless modules
  - WiFi, BLE, 802.15.4, LoRa

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mbed OS security

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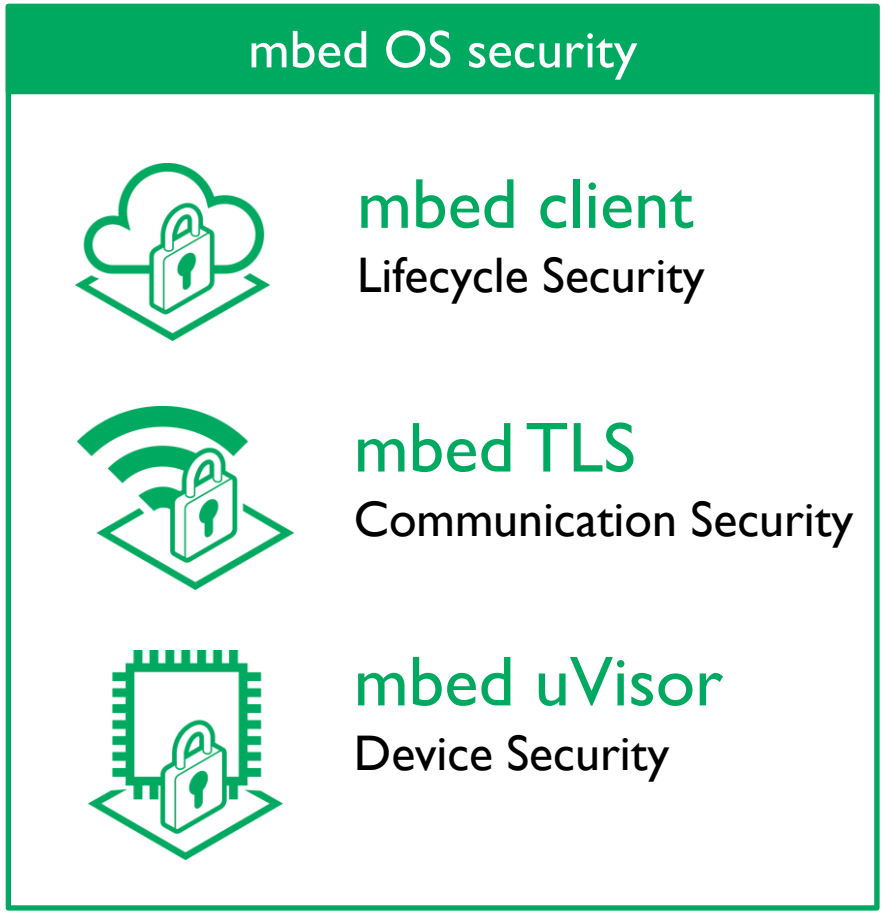
mbed OS security

- Covers three main types of threat
- Security of system, including ability to provision, manage and update devices (e.g. security fix)
- Security of communications between device and cloud services
- Security and integrity of device itself from untrusted or malicious code



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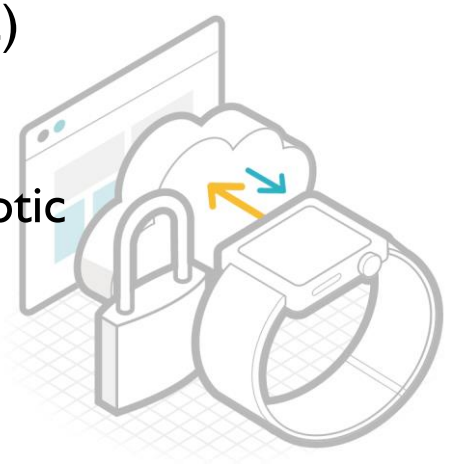
mbed TLS

- mbed TLS enables mbed OS cryptographic and SSL/TLS capabilities

Features:

- SSL / TLS (SSL 3.0 up to TLS 1.2)
- Extensive TLS Extension support
- X.509 certificate handling
- Abstraction layers
- DTLS

- Symmetric encryption (AES, etc)
- Hash algorithms (SHA-2, etc)
- Public Key algorithms (RSA, Elliptic Curves, etc)
- Random number generation (CTR_DRBG, etc)



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mbed OS tools

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mbed OS tools

- Free core tools provide build, debug, test and collaboration workflows
- Third party partner industry tools support

mbed OS DVCS support

git

mercurial

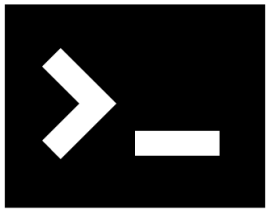
GitHub

Atlassian Bitbucket

GitLab

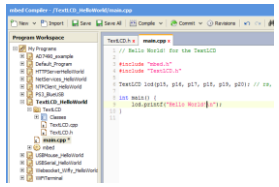
mbed.org/code

mbed OS core tools



mbed CLI

Command Line Interface

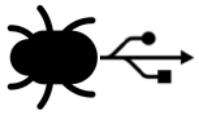


mbed Compiler

Free Online IDE

mbed Greentea

Porting Testsuite and CI



mbed pyOCD

CMSIS-DAP Debug Library

mbed DAPLink

CMSIS-DAP Debug Firmware

mbed OS IDEs and toolchains

ARMKEIL

Microcontroller tools

ARM Compiler 5

IAR SYSTEMS

GCC

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mbed CLI

- Single tool for fetching, configuring, building and updating all source code that an mbed OS program depends on
  - Offline development - simple to install for Windows, Mac OS X, Linux
  - Backwards compatible with existing mbed OS 2 programs and libraries
- Supports mixing multiple version control backends: mercurial (hg) and git
- Supports building for multiple toolchains: ARMCC, GCC, IAR and exporting to IDEs

```
new         Create new mbed program or library
import      Import program from URL
add         Add library from URL
remove      Remove library
deploy      Find and add missing libraries
publish     Publish program or library
update      Update to branch, tag, revision or latest
sync        Synchronize library references
ls          View dependency tree
status      Show version control status

compile     Compile code using the mbed build tools
test        Find, build and run tests
export      Generate an IDE project
detect      Detect connected mbed targets/boards

config      Tool configuration
target      Set or get default target
toolchain   Set or get default toolchain

help        This help screen
```


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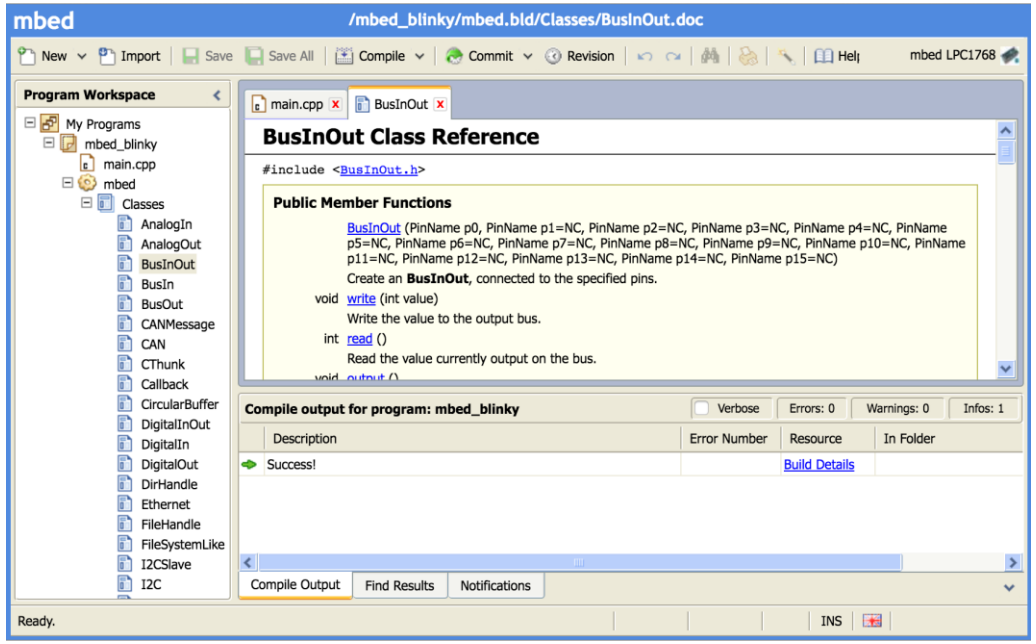
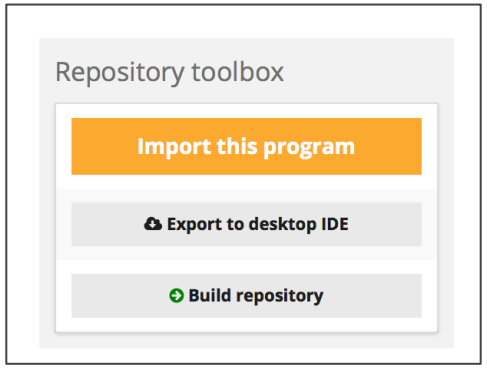
mbed Online Compiler and third party IDEs

- mbed Online Compiler
  - Instant access to working build environment
  - Supports compilation, version control, publishing projects, library documentation
  - Compilation using ARM Compiler 5
  - Free to use

- Third party IDEs
  - Develop and debug with your favourite IDE
  - Export from mbed CLI or website to 3rd party IDEs
  - Keil uVision, IAR Workbench, GCC/Makefile, etc




```
> mbed export -i uvision -m K64F
```



ARMKEIL
Microcontroller tools
ARM Compiler 5

IAR SYSTEMS

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mbed OS ecosytem

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mbed OS partner ecosystem

- mbed OS runs on platforms from a wide range of MCU partners
  - Cortex-M0 to Cortex-M7
  - Simple MCUs to full-featured IoT SoCs including radios
- Incremental effort for each partner, network effects for all

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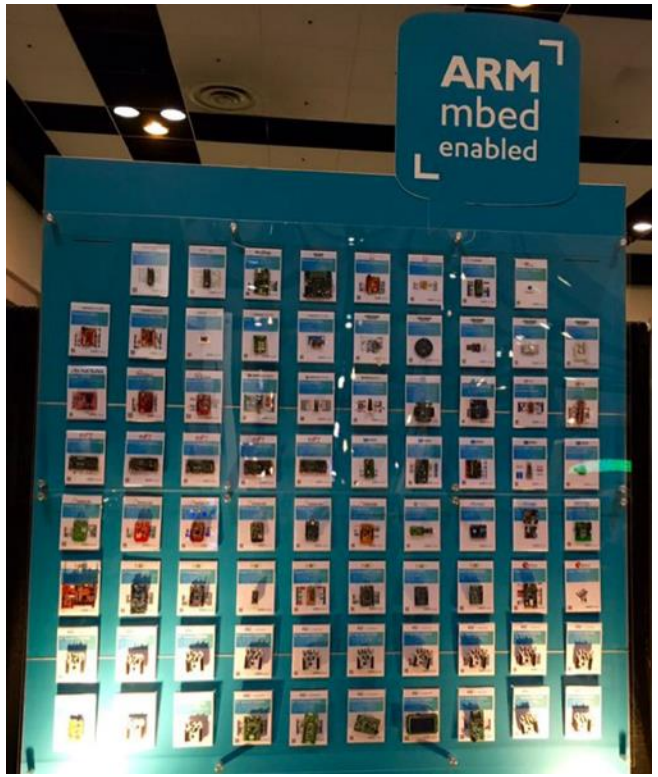
mbed Enabled

- mbed developers are looking for trusted building blocks they know work with mbed OS
- mbed Enabled offers partners a unique opportunity to demonstrate IoT compatibility, gaining customer mindshare and reach new customers



mbed Enabled is a mark of confidence for developers

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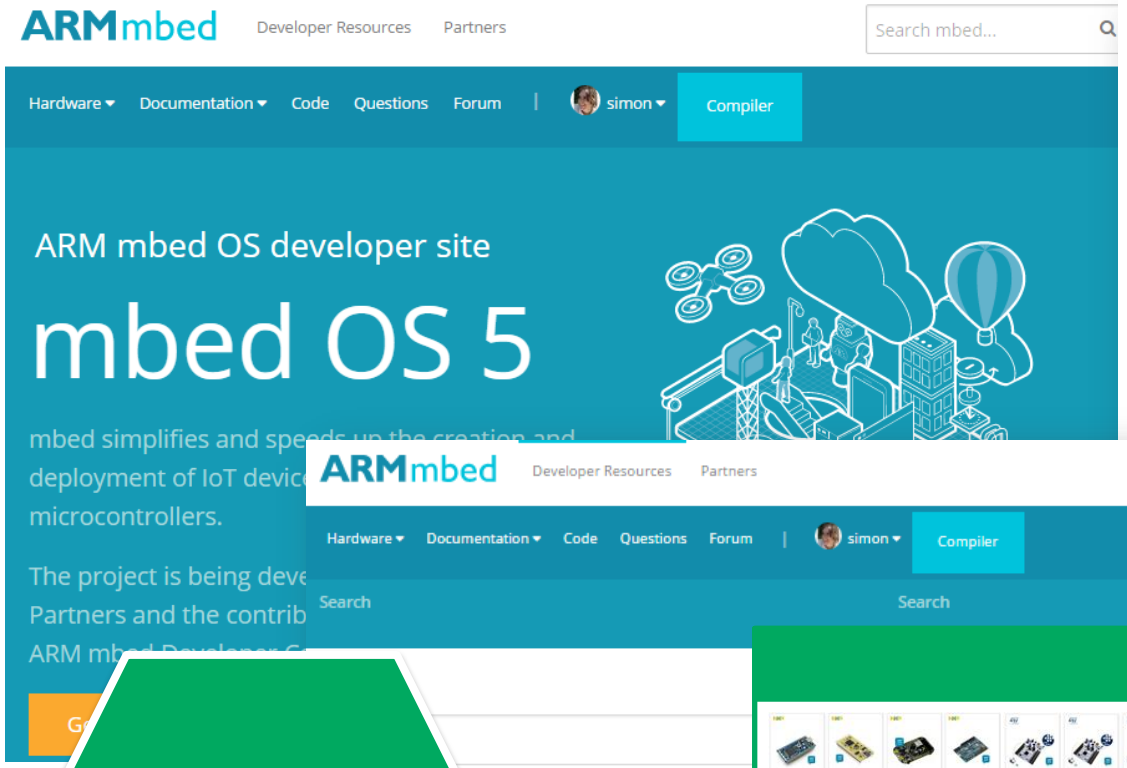
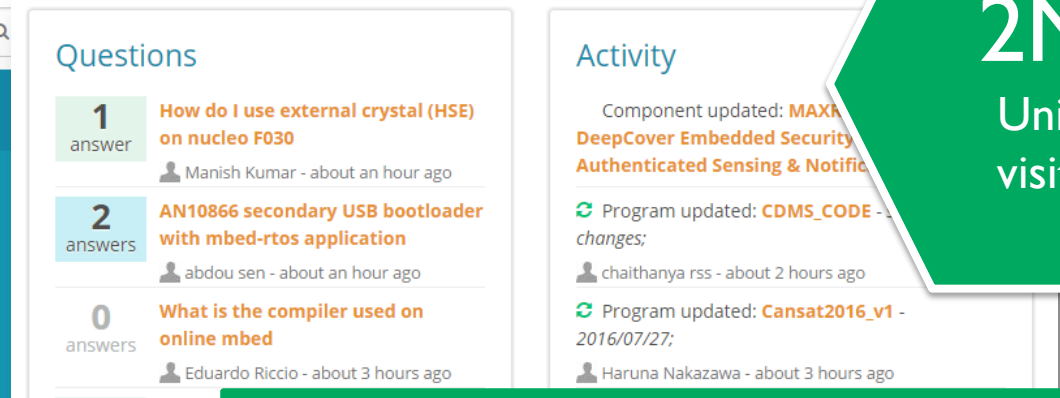
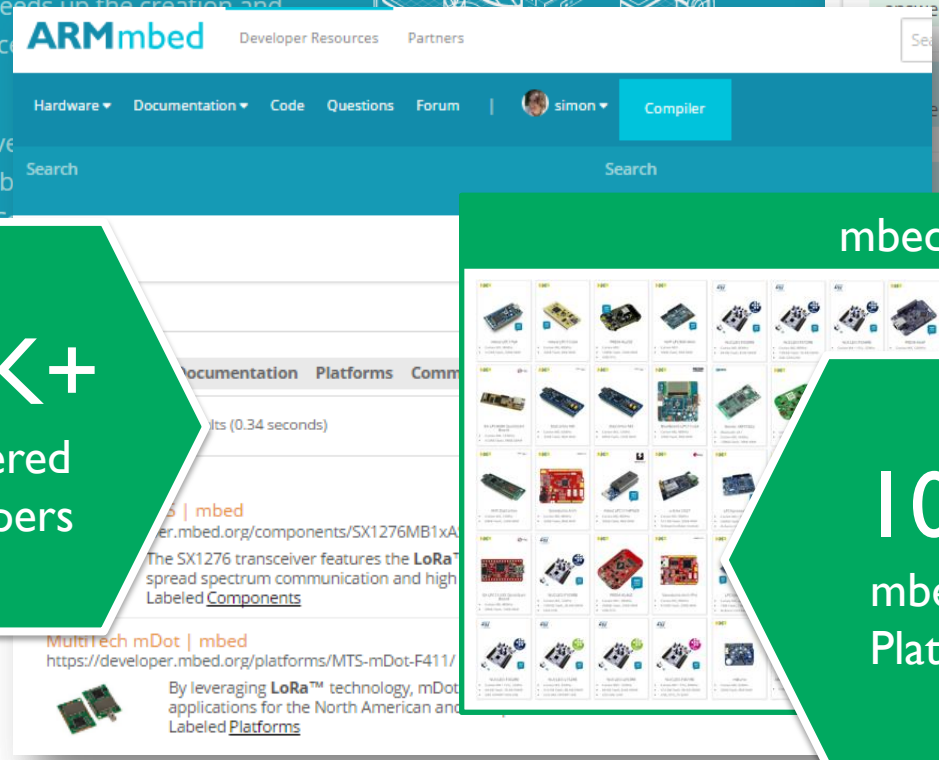
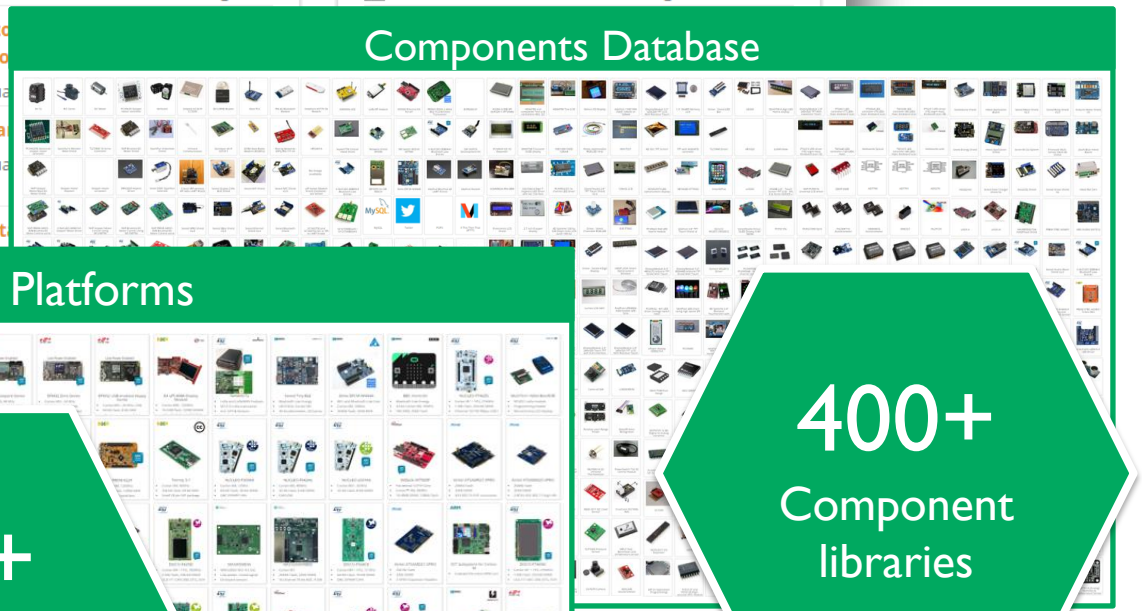
mbed OS developer community









2M+ Unique visitors

200K+ Registered developers

100+ mbed OS Platforms

400+ Component libraries

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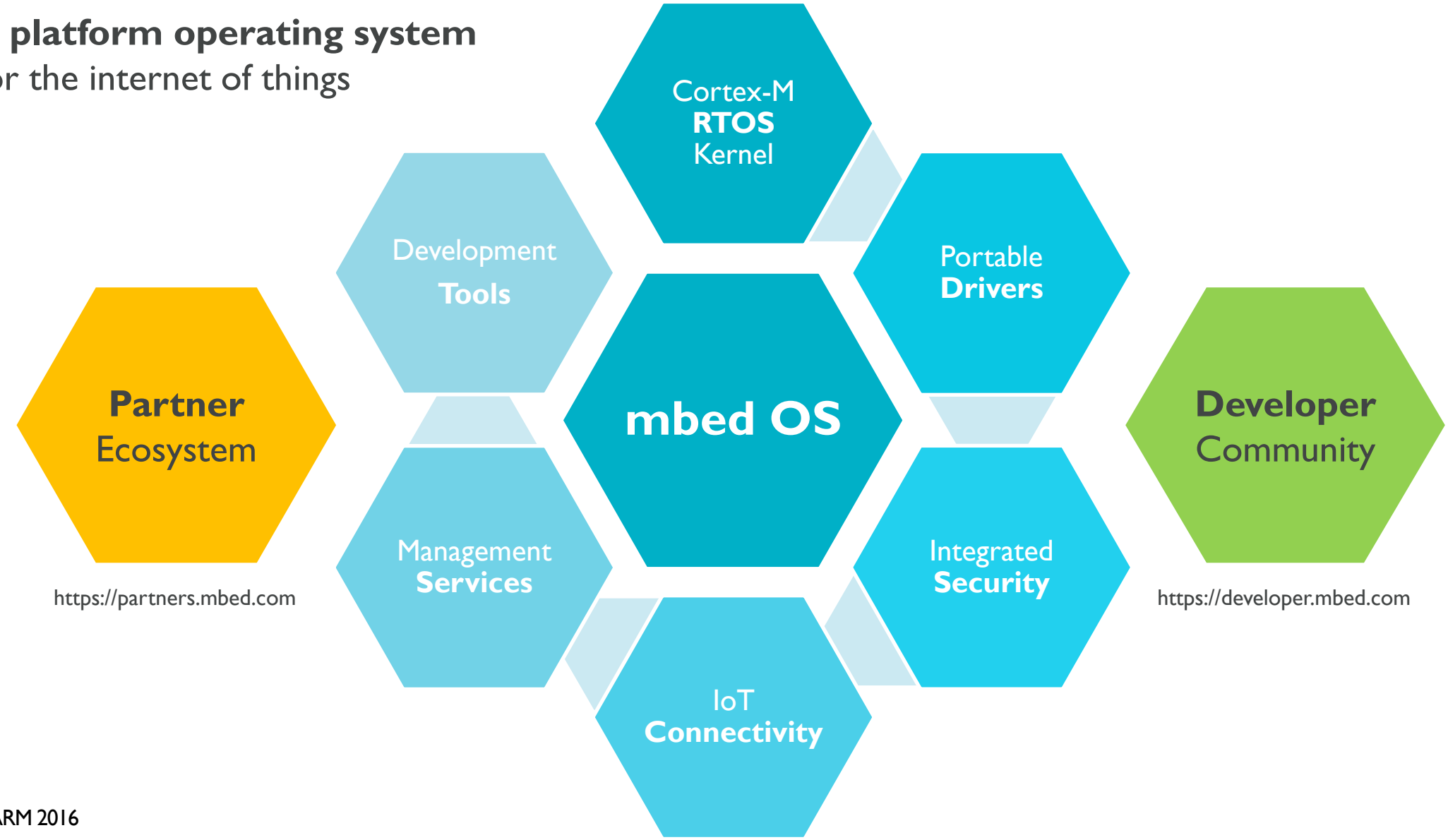
mbed OS 5

A **platform operating system**
for the internet of things



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