mbed OS Update

ARM

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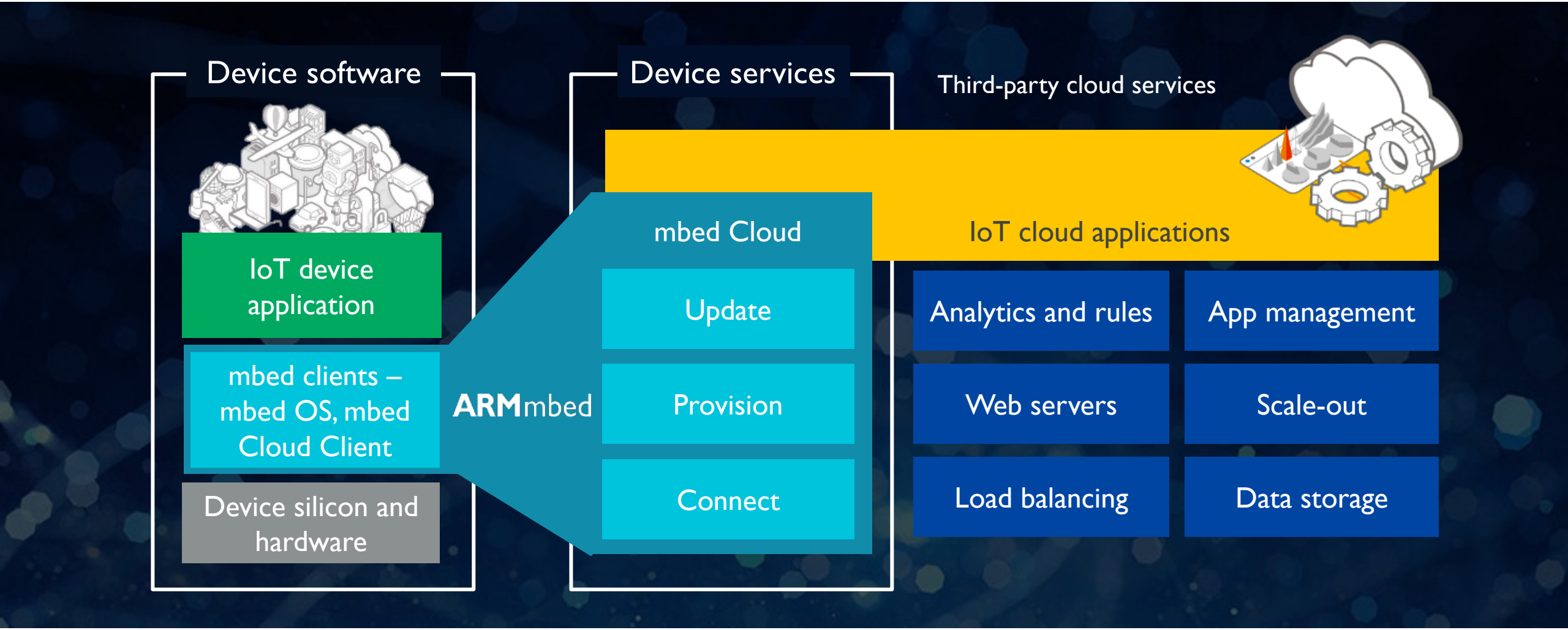
ARM mbed: Connecting chip to cloud



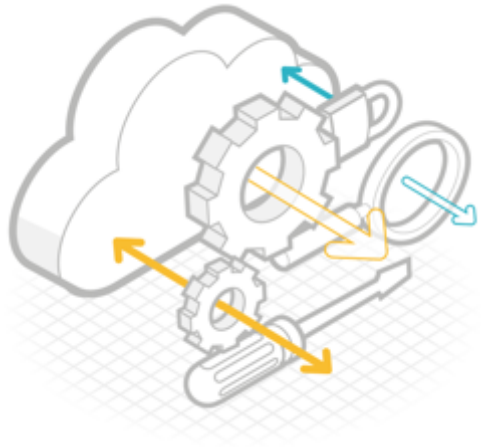
ARM

mbed OS

Platform OS requirements

- Accelerate the **development** of IoT devices
  - Integrate all the necessary software components needed for constrained IoT devices (MCUs)
  - Bring modern development methodologies and choice to MCUs to improve productivity
  - Provide OS functionality and APIs across many vendor solutions to enable choice

- Accelerating the **deployment** of IoT devices
  - Provide standardised connectivity to the cloud across different transports
  - Provide manageability from the cloud to open opportunities and reduce cost/risk



- Develop and leverage an **ecosystem**
  - Freely available and open source to remove barriers to entry and enable adoption
  - In collaboration with partners to provide maximum gearing of investment for everyone
  - The tools and web infrastructure to support an ecosystem and create network effects

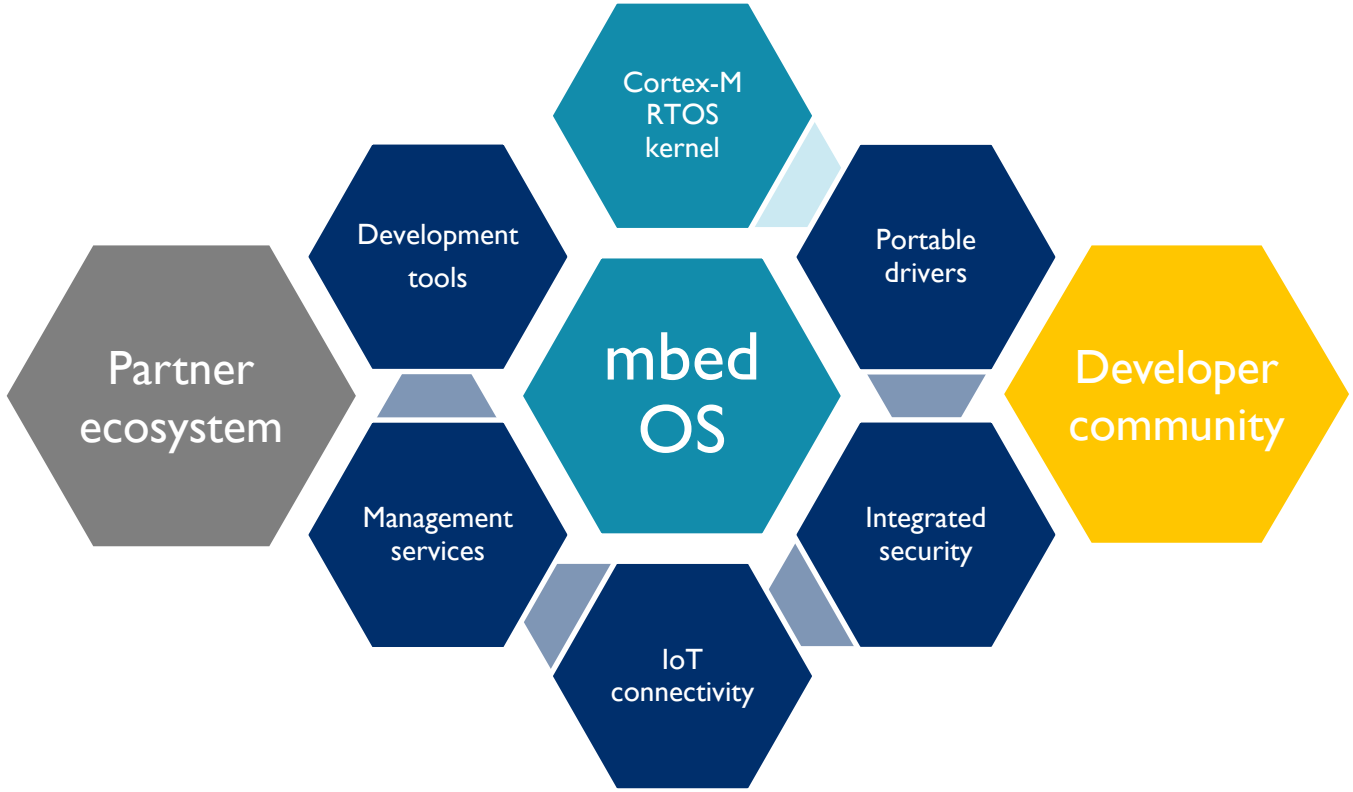
mbed OS 5

mbed OS is built to address the disruptive jump in complexity for embedded software

Addresses built-in security, multi-protocol connectivity and device updatability

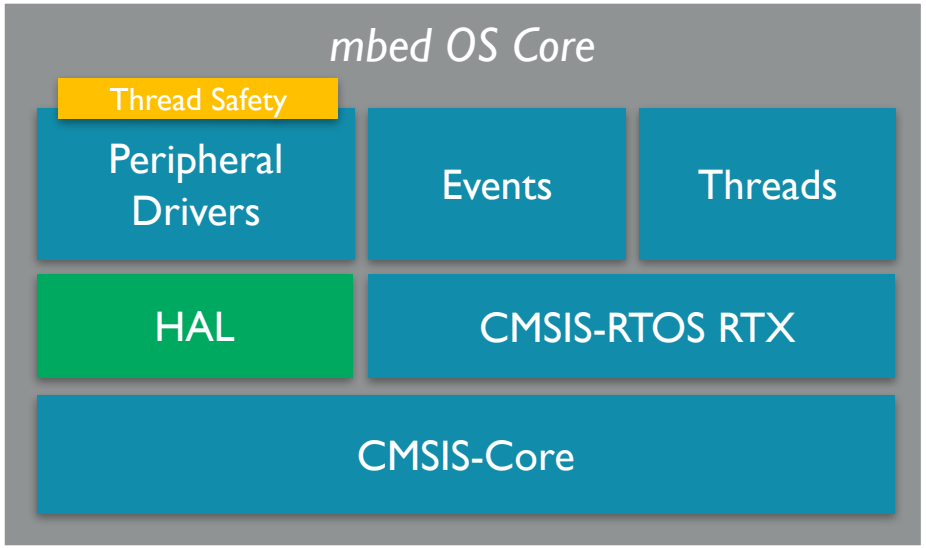
Over 85 silicon platforms supported for developers today

Open collaboration across the ecosystem accelerates IoT system development

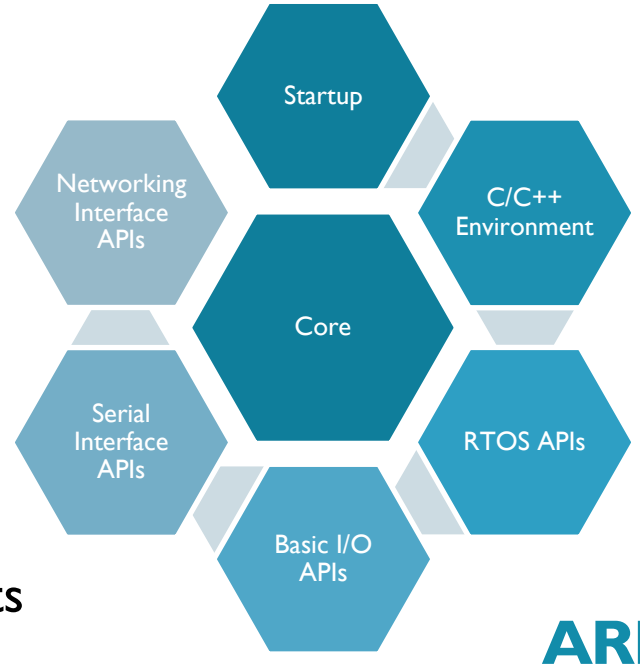


ARM

mbed OS Core



- Includes an RTOS Kernel
  - Built on the open source CMSIS-RTOS RTX
  - Established, widely used RTOS kernel
  - Very small kernel optimised for constrained memory devices
- Includes peripheral driver APIs, consistent across devices
  - Start-up and environment initialisation
  - Memory maps and cross-toolchain support and integration
  - Driver APIs for all common peripherals, supported across all MCUs
- Application and component libraries can be built unchanged
  - Provides portability for developers and helps to deliver network effects



ARM

mbed OS Connectivity

LAN

Ethernet

BLE

WiFi

Thread

WAN

Cellular

LoRaWAN

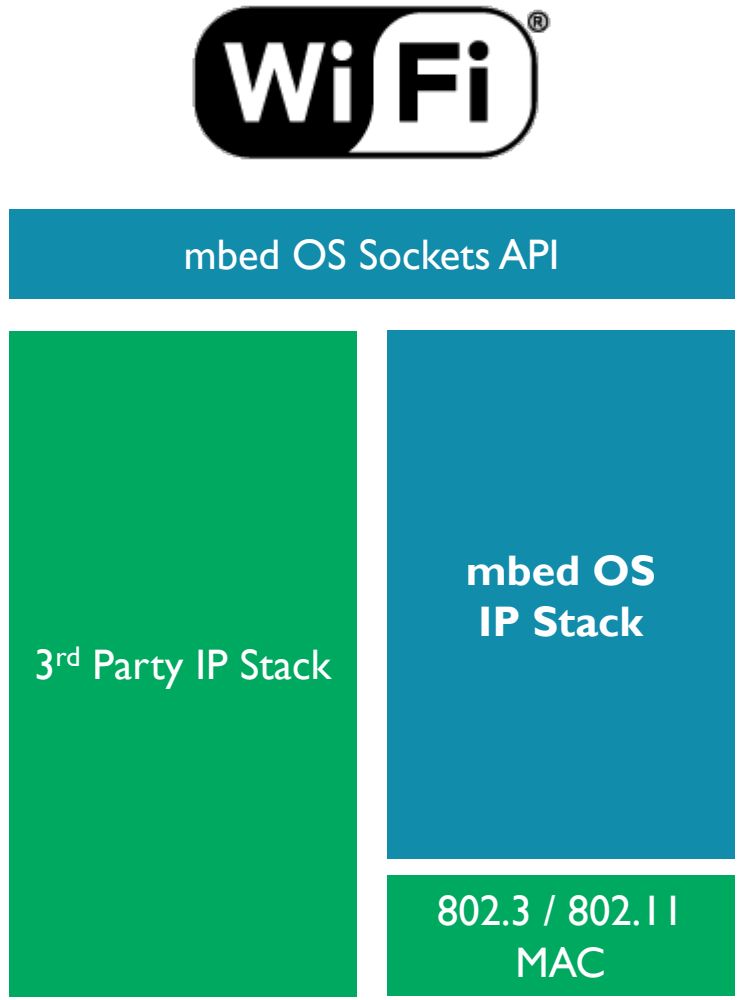
Sub-GHz 6LoWPAN

NB-IoT

Ethernet / Wi-Fi integration in mbed OS

- **Native dual mode IP stack**
  - Integrated stack with MAC porting interface
  - Qualification tested and compliant with the latest version of the Bluetooth Core Specification

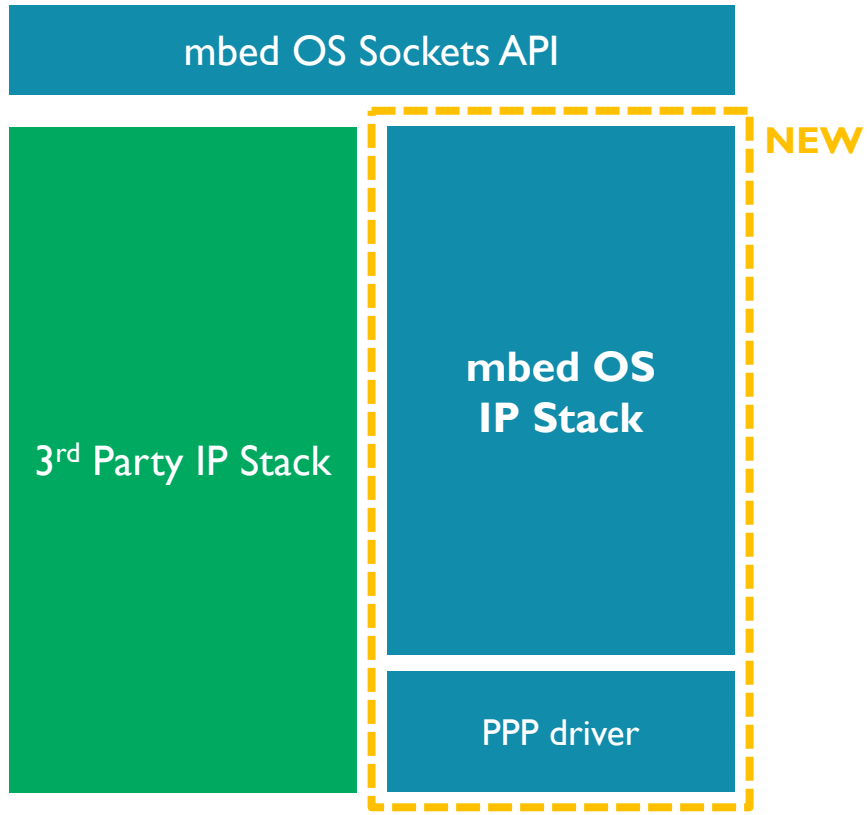
- Unified MAC integrations
  - Simplified integration for partners
  - Consistent behaviour across silicon platforms
  - Testing can focus on MAC port



Cellular integration in mbed OS

- **Native 3GPP 27.007 driver included in mbed OS 5.5**
  - Integrated with mbed OS IP stack
  - IPv4 network capability

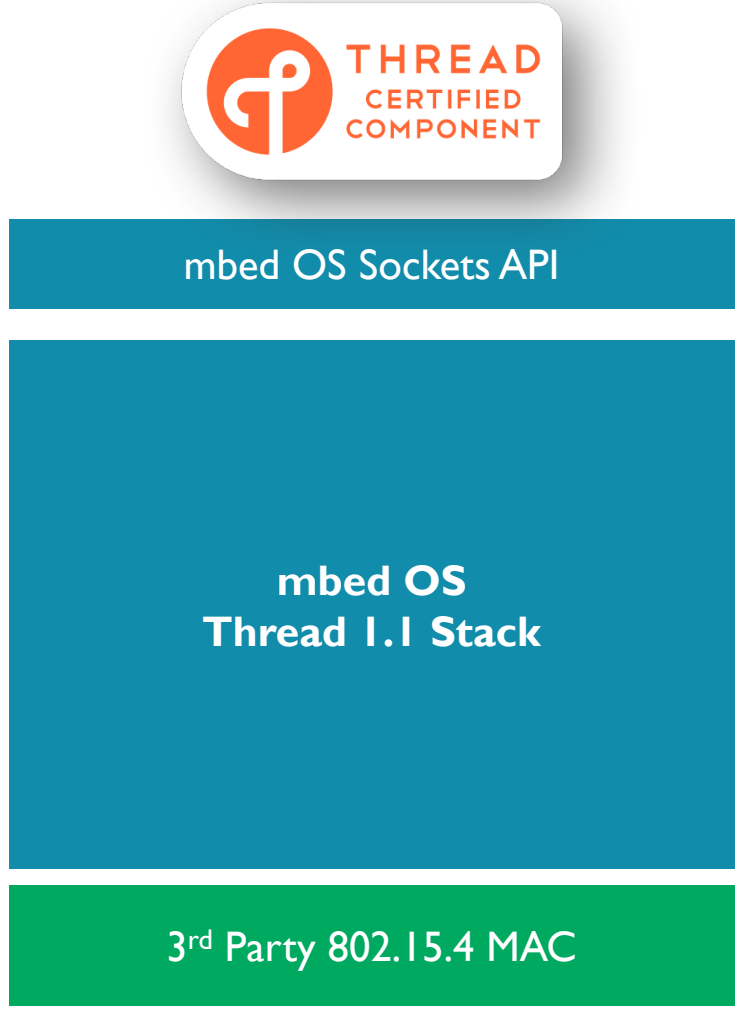
- Extendable architecture
  - UART based AT modem driver
  - Easily extensible to support other digital interfaces such as SPI, USB, etc.
  - Testing can focus on PPP driver



Thread integration in mbed OS

- **Certified Thread 1.1 stack included in mbed OS 5.4**
  - Any silicon or module partner can now enable developers with Thread 1.1 by using existing or porting a new 802.15.4 transceiver

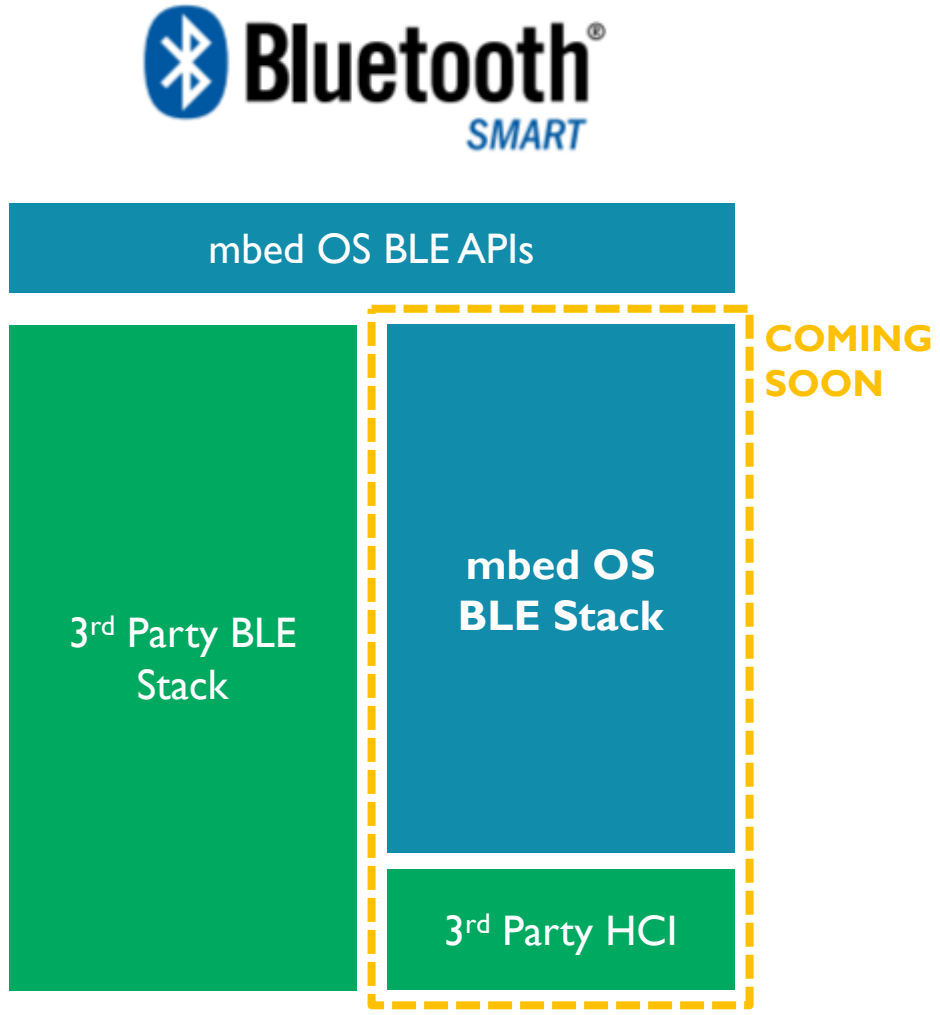
- Release includes developer access to:
  - Thread node support in mbed OS
  - Border router application
  - Linux-based access point reference design



BLE integration in mbed OS

- **Native BLE stack coming to mbed OS**
  - Integrated stack with HCI porting interface
  - Qualification tested and compliant with the latest version of the Bluetooth Core Specification

- Showing ~5x reduction in LoC for integration
  - Simplified integration for partners
  - Consistent behaviour across silicon platforms
  - Testing can focus on HCI port



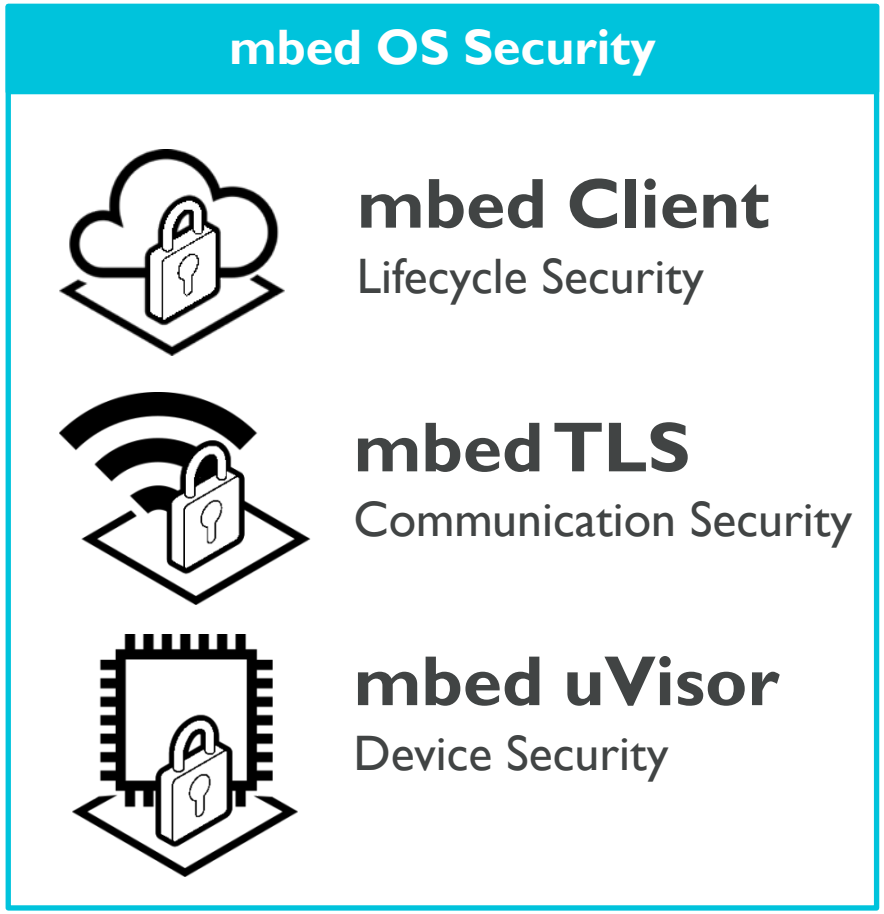
LoRa integration in mbed OS

- LoRa and LoRaWAN networks
  - Begining to be trialed world wide by operators and cities
  - Bring-your-own infrastructure
- mbed OS already supports LoRa
  - Building in native LoRaWAN support
  - First LoRaWAN APIs available for partner review in mbed OS 5.3

mbed OS Security

Covers three main types of threat

1. Security of system, including ability to provision, manage and update devices (e.g. security fix)
2. Security of communications between device and cloud services
3. Security and integrity of device itself from untrusted or malicious code



mbed OS Tools

- Free core tools provide compilation, test and collaboration workflows
- 3rd party partner industry tools support
- Active Developer Website: developer.mbed.com

mbed OS DVCS Support

git

mercurial

GitHub

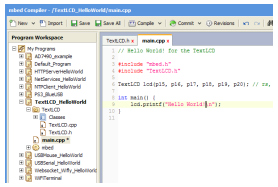
Atlassian Bitbucket

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

KEIL™ Tools by ARM
ARM Compiler 5

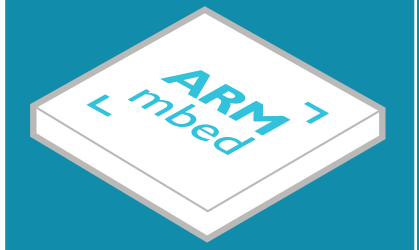
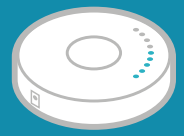
IAR SYSTEMS

GCC

ARM

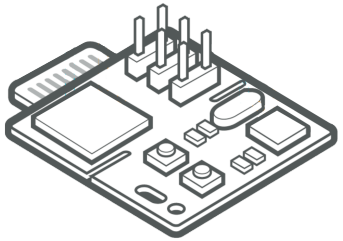
mbed OS Modularity

- mbed OS scales across a diversity of IoT device requirements

	 **BLE Beacon**	 **WiFi Appliance**	 **Thread Device**	 **Sub-Ghz Mesh**	 **LoRa Sensor**
Key mbed OS Components	RTOS, Drivers, BLE	RTOS, Drivers, TLS, Client	RTOS, Thread, TLS, Client	RTOS, 6LoWPAN Mesh, TLS, Client	RTOS, Drivers, LoRa Library
Example Hardware Components	Cortex-M0 with BLE Radio	Cortex-M3 + WiFi Network Co-processor	Cortex-M4 with 2.4GHz 802.15.4 & Crypto	Cortex-M3 + 802.15.4 Transceiver	Cortex-M0 + LoRa Transceiver

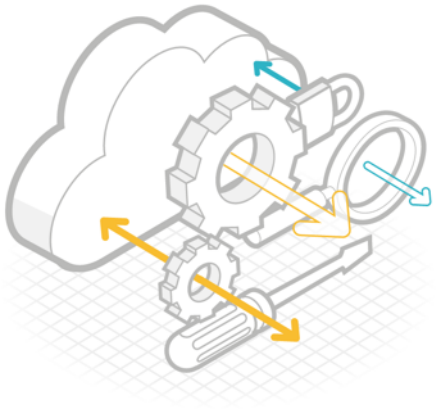
mbed OS Modules

- mbed OS targeting wireless modules
  - mbed OS runs on the module itself, and acts as the SDK
  - Will be presented to developers as first-class citizens
- Accelerate time to market for production designs
- Timescales
  - Current focus is on WiFi, Cellular and LoRa modules
  - We are identifying modules and module partners now



mbed OS 5.5 headline features

CMSIS5 and CMSIS-RTOS2



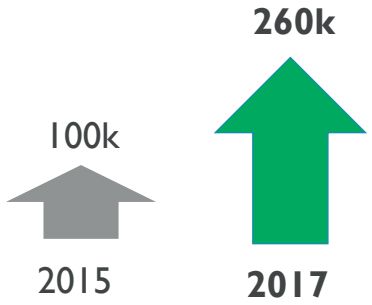
Entropy/Acceleration Partner HW support

Bootloader and firmware update framework

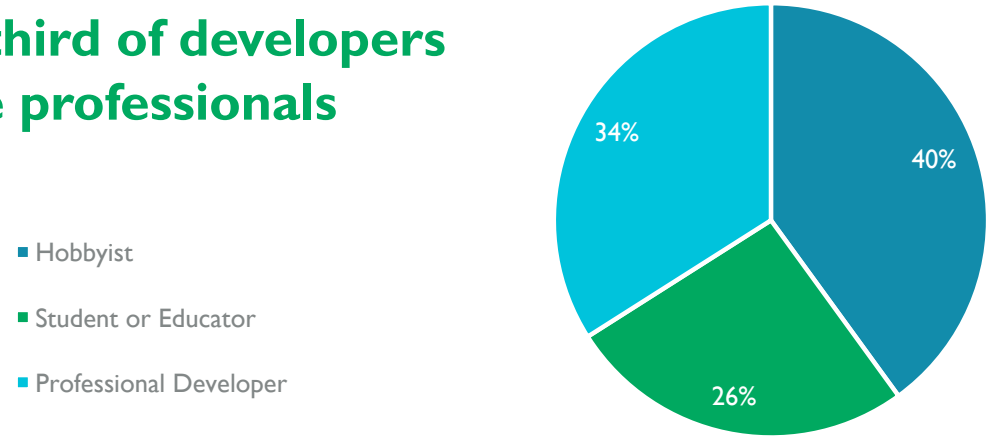
mbed OS developers

mbed Developers

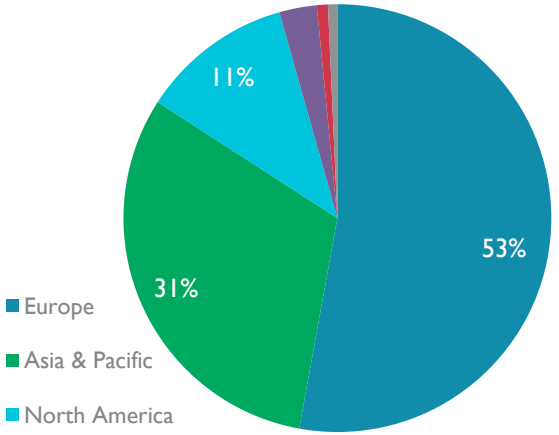
Over 250k registered developers



A third of developers are professionals



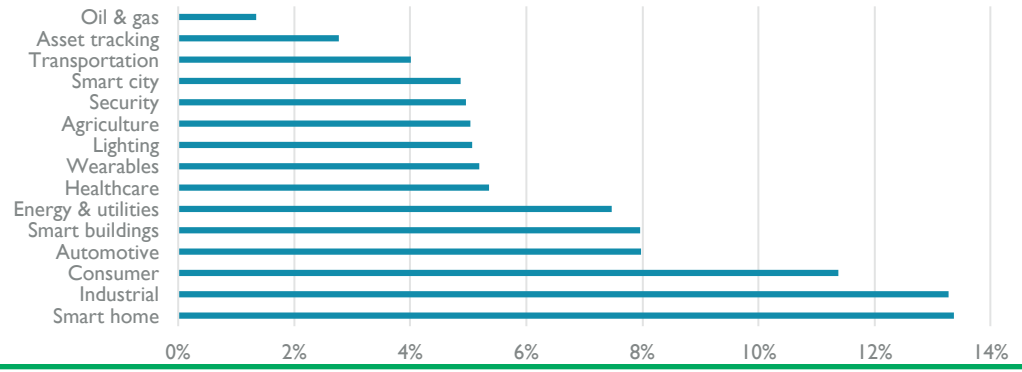
A global footprint



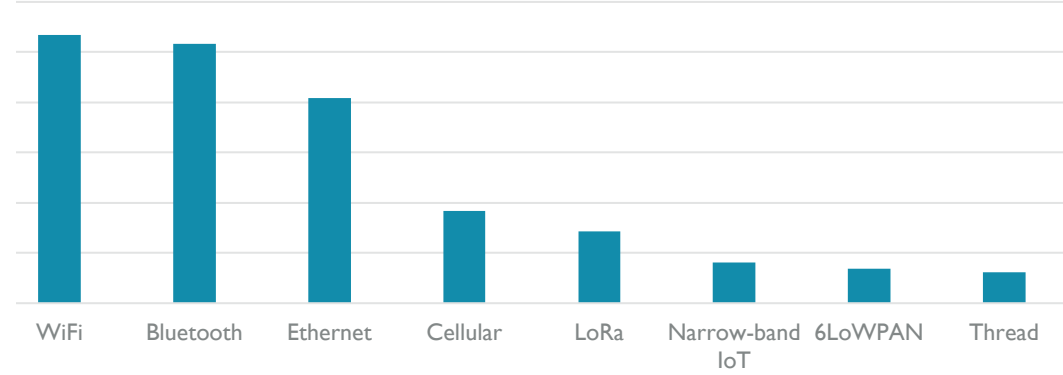
Source: mbed.com, mbed developer survey 2017

mbed Product Development

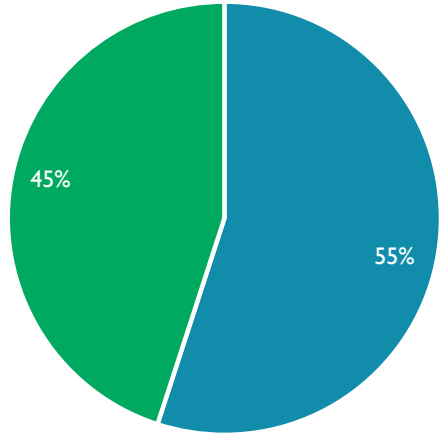
Products target a diversity of IoT markets



Products use a diversity of connectivity



45% of projects expect to achieve deployment



- Don't expect mbed project to be deployed into the market
- Do expect mbed project to be deployed into the market

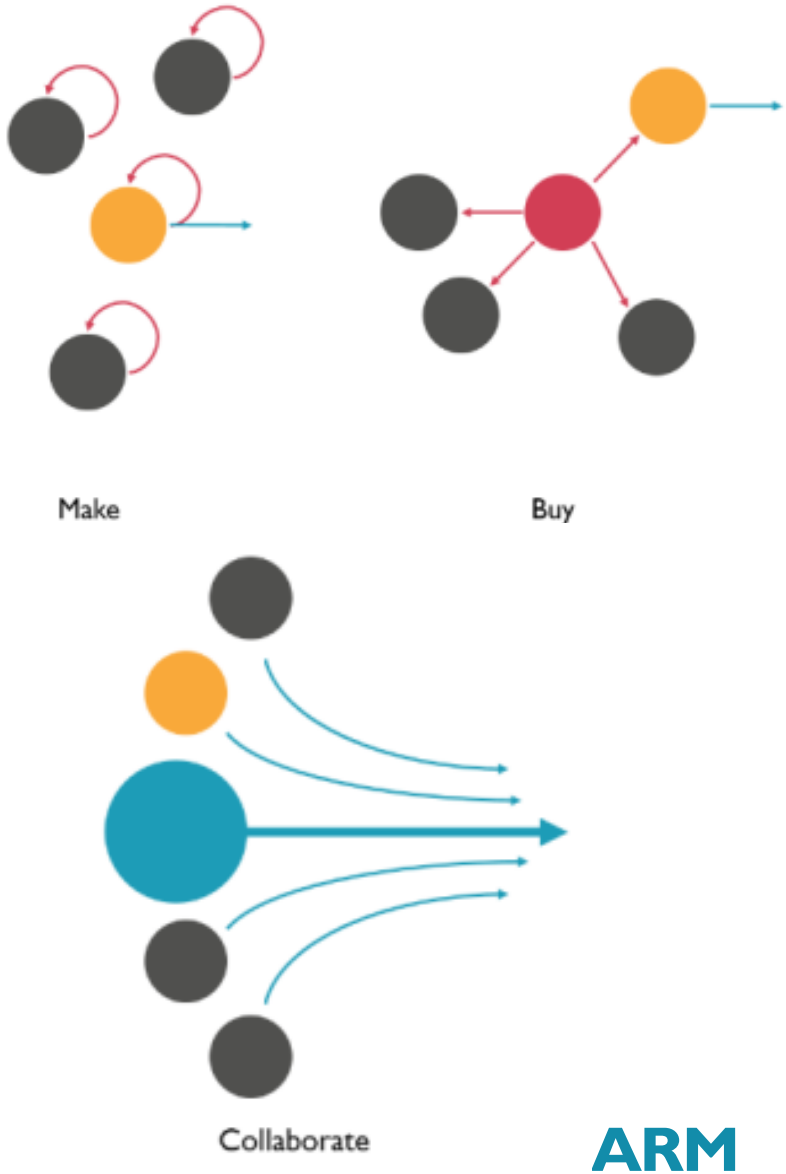
Source: mbed.com, mbed developer survey 2017

mbed OS
contribution and licensing

mbed OS Development Model

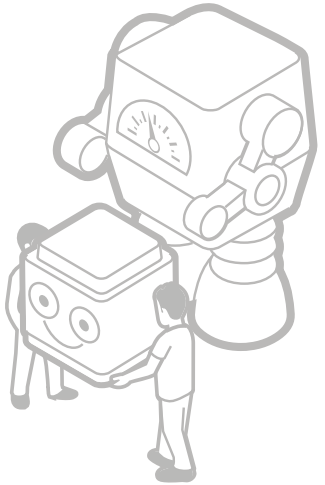
- mbed OS is an open source project developed by ARM, Partners, and a worldwide developer community

- Building mbed OS in collaboration allows:
  - Increased effect of the effort put into it
  - Increased overall developing power
  - Increased reach and network effects
  - Focus on individual core capabilities



mbed OS Licensing and Contribution

- mbed OS is primarily open source, under Apache 2.0 or compatible licenses
  - Proprietary partner components (like radio drivers) can be under free binary license
- Partners pay a membership fee to support and contribute to project
  - Our partners share a vision for the future where development and deployment of commercial Internet of Things (IoT) devices is possible at scale, and a desire to collaborate on concrete plans and projects to make that vision a reality.
- Developers can use it for free



partnership@mbed.com

Release content classification

- Features
  - New capability of software or API addition
  - Cannot be backported. Only included in a release by way of next release branch

Main Releases

- Fixes
  - Defined change in behavior – could be considered breaking from an application perspective
  - Applicable for targets and common code
  - No merge or backport restrictions (Release notes mitigate invasive change in behavior)
- Target support
  - MCU support for mbed OS and does not modify common code
  - No merge or backporting restrictions

Patch Releases

ARM

Thank you!